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Cleanup Action Plan

Voluntary Cleanup Program ID: NW2009
Cleanup Site ID: 4175
Facility/Site ID: 4765174
Former Cherry Street Cleaners
2510 E Cherry St
Seattle, WA 98122

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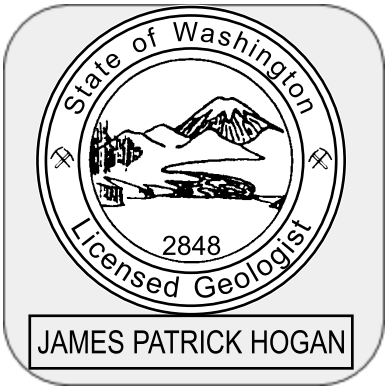

Executive Summary

On behalf of Voluntary Cleanup Program ("VCP") Customer Cherry Street Cleaners, The Environmental Liability & Asset Management Group, LLC (dba The ELAM Group) submits this *Cleanup Action Plan* ("CAP") for the Former Cherry Street Cleaners located at 2510 E Cherry St in Seattle, Washington ("Facility") to the State of Washington Department of Ecology ("Ecology") in accordance with the reporting requirements of the Voluntary Cleanup Program ("VCP"). The CAP details the cleanup standards for the Facility, the method(s) of cleanup that will be used to achieve these cleanup standards and any other requirements the cleanup must comply with to meet the requirements of the Washington Administrative Code ("WAC") Model Toxics Control Act ("MTCA") 173-340-350 through 173-340-390.

The Facility applied for the VCP after it discovered in June of 2007 during an environmental investigation that tetrachloroethene ("PCE"), a dry-cleaning solvent that the Facility used between 1968 and 2007 during its operations, was released to the environment. Since then, several investigations and interim remediation measures have been conducted, including delineation of the vertical and horizontal extent of PCE and associated daughter product impacts to soil, groundwater and soil gas/indoor air between 2007 and 2019; injection of emulsified oil substrate ("EOS") into the groundwater to remediate the source area groundwater impacts in 2011; monitoring of the EOS between 2011 and 2017; and building demolition to allow for remediation of the soils overlying the groundwater in 2013. During 2019 and 2020, a *Feasibility Study* ("FS") evaluated 11 remediation alternatives and selected Cleanup Alternative 9, *Shallow ISCO (mixing) and Deep/Saturated ISCO*.

The purpose of this CAP is to provide an explanatory document for public review that further describes how Cleanup Alternative 9 will be executed. The remedy consists of 1) a limited excavation of impacted surface soil, 2) mixing of activated persulfate reagent solution within the shallow vadose zone soil, 3) injection of Ozone into the deep vadose zone and saturated zone soil and 4) groundwater monitoring with potential for an Institutional Control and vapor mitigation measures, if needed. Implementation of the remediation for the Facility should reduce PCE mass within the Site with a goal of meeting the remediation action objectives ("RAOs").

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1 Introduction

The Environmental Liability & Asset Management Group, LLC (dba The ELAM Group) has prepared this *Cleanup Action Plan* ("CAP") for the Former Cherry Street Cleaners ("Facility") located at 2510 E Cherry St in Seattle, Washington. This CAP is being furnished to the State of Washington Department of Ecology ("Ecology") in accordance with the reporting requirements of the Voluntary Cleanup Program ("VCP"). The report details the cleanup standards for the Facility, the method(s) of cleanup that will be used to achieve these cleanup standards and any other requirements the cleanup must comply with to meet the requirements of the Washington Administrative Code ("WAC") Model Toxics Control Act ("MTCA") 173-340-350 through 173-340-390.

1.1 Purpose

The purpose of the CAP is to identify the cleanup action for the Facility and to provide an explanatory document for public review. More specifically, this CAP:

- ❏ Describes the Facility
- ❏ Summarizes current site conditions
- ❏ Summarizes the cleanup action alternatives considered in the remedy selection process
- ❏ Describes the selected cleanup action for the Facility and the rationale for selecting this alternative
- ❏ Identifies site-specific cleanup levels and points of compliance for each hazardous substance and medium of concern for the cleanup action
- ❏ Identifies applicable state and federal laws for the cleanup action
- ❏ Discusses compliance monitoring requirements
- ❏ Present a schedule for implementation of the CAP

Ecology has made a preliminary determination that a cleanup conducted in conformance with this CAP will comply with the requirements for selection of a remedy under WAC MTCA 173-340-360.

1.2 Previous Studies

Details of the prior work conducted for the Facility is publicly available through Ecology's website and web pages dedicated to Cherry Street Cleaners.[1] This CAP mainly relies on information presented in the *Remedial Investigation* (ECC 2014) *Annual Report* (ELAM 2019) and *Feasibility Study* (ELAM 2020c).

1.3 Regulatory Framework

The following regulatory agencies are involved in this matter:

1. Ecology (environmental cleanup): required oversight of VCP project in accordance with MTCA
2. Ecology (waste management): required involvement for proper waste management through a "Contained-In" Determination ("CID"); prior to commencing with waste disposal, a prior *Contained-In Determination*, dated 5/29/14, will be updated in order to:
    a. Minimize the volume of soil that is considered to be Dangerous Waste when conducting the grading and off-site disposal of surface soil
    b. Allow for the management of stored stormwater during remedy implementation, if any, as non-hazardous waste following characterization
3. Seattle Department of Construction and Inspections ("SDCI"): required involvement for a Grading Permit; documentation for the SDCI permit is publicly available through SDCI's website and web pages dedicated to the Facility[2]
4. Seattle Department of Transportation ("SDOT"): required involvement for a Street Use Permit [copies of the most recent Construction Management Plan (ELAM 2020a) and Haul Route Plan (ELAM 2020b) are included in Appendix A]

[1] Ecology, 2020, Cherry Street Cleaners , https://fortress.wa.gov/ecy/gsp/Sitepage.aspx?csid=4175 (URL last verified 6/16/20).
[2] SCDI 2020, 2510 E Cherry Street, https://cosaccela.seattle.gov/Portal/Cap/GlobalSearchResults.aspx?QueryText=2510+e+cherry+st (URL last verified 6/16/20

2 Background Information

2.1 Site History

The Facility is located at 2510 East Cherry Street, in Seattle, Washington, as shown on Figure 1. The Facility is owned by Ms. Vera Benton and consists of a 4,000 square-foot lot formerly developed with a 2,440 square-foot building, as shown on Figure 2. Electricity and telephone services were provided through overhead lines. Natural gas and water were provided through underground piping located beneath E Cherry St. Sanitary sewer was provided through underground piping located in the eastern adjoining alleyway. The building was razed, all utilities disconnected, and building foundation removed in July of 2013. A heating oil underground storage tank ("HOT") is currently located on the northern portion of the vacant lot but is drained and out of service.

2.1.1 Facility Investigation History

Several phases of investigation have been conducted to delineate the extent of chlorinated volatile organic compounds ("cVOCs")[3] in soil, groundwater and soil vapor/indoor air as summarized in the table on the next page.

[3] PCE and daughter products resulting from degradation of PCE include trichloroethene ("TCE"), cis-1,2-dichloroethene ("c-DCE") and vinyl chloride ("VC").

Year	Investigation Activity	Report Reference
2007	❑ Advanced soil boring B-1	ECC 2013
2008	❑ Advanced soil borings FB-1 through FB-10 ❑ Installed monitoring wells MW-1 through MW-10 and MW-10D	ECC 2013
2010	❑ Installed monitoring well MW-11 ❑ Installed additional SVE pilot study wells SVE-2 and VP-1 through VP-3	ECC 2013
2012	❑ Advanced soil borings SB-2 through SB-11 ❑ Installed monitoring wells MW-12 through MW-17 ❑ Conducted vapor intrusion assessments ("VIAs") at the following addresses: ❑ 2503 E. Cherry St. ❑ 2509 E. Cherry St. ❑ 2510 E. Cherry St. ❑ 2511 E. Cherry St. ❑ 2515 E. Cherry St. ❑ 2516 E. Cherry St. ❑ 2517 E. Cherry St. ❑ 2518 E. Cherry St. ❑ 720 E. 25th Ave. ❑ 711A E. 25th Ave.	ECC 2013
2013	❑ Advanced soil boring SB-21 ❑ Installed monitoring wells MW-15D, MW-17D, MW-18, MW-18D, MW-19, MW-19D, and MW-20D ❑ Conducted VIA at 720 E. 25th Ave.	ECC 2014
2014	❑ Advanced soil borings SB-12 through SB-20 and SB-22 through SB-37 ❑ Installed monitoring wells MW-21D, MW-22D, and MW-23	ECC 2014
2017	❑ Conducted VIAs at the following addresses: ❑ 720 E. 25th Ave. ❑ 2516 E. Cherry St. ❑ 2518 E. Cherry St.	ELAM 2017a ELAM 2017b
2018	❑ Conducted VIAs at the following addresses: ❑ 720 E. 25th Ave. ❑ 2516 E. Cherry St. ❑ 2518 E. Cherry St.	ELAM 2018a ELAM 2018b
2020	❑ Advanced soil borings for collection of soil to be used in a bench test of Activated Persulfate ❑ Conducted VIAs at the following addresses: ❑ 720 E. 25th Ave. ❑ 2516 E. Cherry St. ❑ 2518 E. Cherry St.	Reported herein ELAM 2020a ELAM 2020b

2.1.2 Site Remediation History

Remediation activities have included pilot testing to evaluate the efficacy of air sparge ("AS") and soil vapor extraction ("SVE") technologies, injection of emulsified oil substrate ("EOS") to augment PCE bioremediation and vacuum truck events to remove free-phase EOS that had sequestered PCE, as summarized in the table below.

Year	Remediation Activity	Report Reference
2008	❑ Completed AS/SVE pilot study testing using wells SVE-1 and MW-1D ❑ An AS/SVE system was not installed	ECC 2013
2010	❑ Completed an additional pilot study for SVE using SVE-2 and VP-1 through VP-3 ❑ Injected a total of 3,465 gallons of EOS into wells IW-1 through IW-28, MW-1, MW-2, MW-3, and MW-7 ❑ 2,310 gallons of EOS were injected into the wells within the property boundary ❑ 1,155 gallons of EOS were injected into the wells outside the property boundary	ECC 2013
2012	❑ Completed groundwater monitoring for four consecutive quarters in 2012 and 2013 as part of the EOS performance monitoring	ECC 2013
2013	❑ Demolished site building ❑ Used vacuum truck to remove 75 gallons of EOS from subsurface in 4Q	ECC 2014
2014	❑ Used vacuum truck to remove 75 gallons of EOS in 2Q and 120 gallons of EOS in 3Q	ECC 2014
2016	❑ Used vacuum truck to remove 25 gallons of EOS in 4Q ❑ 1st of four consecutive EOS performance monitoring events	ELAM 2019
2017	❑ Used vacuum truck to remove a total of 80 gallons of EOS during three events ❑ 2nd, 3rd and 4th of four consecutive EOS performance monitoring events	ELAM 2019
2018	❑ Used vacuum truck to remove 6 gallons of EOS in 1Q	ELAM 2019
2020	❑ Used vacuum truck to remove 25 gallons of EOS in 1Q	ELAM 2020e

2.2 Human Health and Environmental Concerns

As presented in the *Feasibility Study* ("FS") (ELAM 2020e), soil, groundwater and soil vapor are the affected media of concern at the Facility. Indoor air has been noted as a potential media of concern if the usages of the eastern adjoining properties change from commercial to residential.

cVOCs in soil at the Facility can migrate vertically downward until reaching groundwater, and then can migrate with the groundwater via advection and diffusion. cVOCs in soil and groundwater at the Facility can volatilize into soil gas and migrate with the soil gas via advection and diffusion. The potential for human exposure to residual cVOCs present in soil, groundwater and soil vapor at the Facility were evaluated, as summarized below:

- ❑ Soil Direct Contact - This exposure pathway is currently incomplete, but could be completed in the future during redevelopment of the Facility

- ❏ Groundwater Ingestion - This exposure pathway is currently incomplete, and anticipated to remain incomplete
- ❏ Vapor Intrusion - This exposure pathway is currently incomplete; however, continued monitoring is necessary to ensure that compliance is maintained

2.3 Cleanup Standards

2.3.1 Chemicals of Concern

As presented in the *Feasibility Study* (ELAM 2020e), the primary chemicals of concern ("COCs") for the Facility are cVOCs. More specifically, PCE, TCE, c-DCE, and/or VC are present in the soil, groundwater and/or soil gas at concentrations exceeding applicable Cleanup Levels.

2.3.2 Cleanup Levels

The Ecology Cleanup Levels and Risk Calculation ("CLARC") Unrestricted Land Use Table was utilized to determine MTCA Cleanup Levels. Contaminant concentrations detected in soil, groundwater, and soil vapor/indoor air at the Facility will be compared to MTCA Cleanup Levels, as summarized below.

Medium	MTCA Cleanup Level	PCE	TCE	c-DCE	VC
Soil	Method A / Method B	0.05 / 480 (mg/kg)	0.03 / 1.2 (mg/kg)	NA / 160 (mg/kg)	NA / 240 (mg/kg)
Groundwater	Method A / Method B	5.0 / 21 (µg/L)	5.0 / 5.4 (µg/L)	NA	0.2 / 0.029 (µg/L)
Soil Gas	Method B	160 (µg/m^3)	NA	NA	NA
Indoor Air	Method B Carcinogenic / Method C Carcinogenic	9.6 / 40 (µg/m^3)	NA	NA	NA

NA = Not Applicable, since cleanup standard is not established
mg/kg = milligram per kilogram
µg/L = micrograms per liter
µg/m^3 = micrograms per cubic meter

3 Cleanup Action Alternatives and Analysis

The FS provides an in depth analysis of 11 Cleanup Alternatives considered for this Facility. Based on the results of the evaluation, the three highest-ranking remedies for the Facility are as follows:

1. Cleanup Alternative 9 - Shallow ISCO (mixing) and Deep/Saturated ISCO
2. Cleanup Alternative 3 - Shallow ISCO (gravity), Deep/Saturated ISCO
3. Cleanup Alternative 11 - Thermal Remediation

The remainder of this report provides details for the implementation of Cleanup Alternative 9 - Shallow ISCO (mixing) and Deep/Saturated ISCO.

4 Description of Selected Remedy

4.1 Area of Remediation

Based on the available data, impacts to soil and groundwater are located throughout the entire Facility and also beyond the Facility as demonstrated by impacts to groundwater approximately 130 feet to the north, approximately 300 feet to the southeast and approximately 90 feet to the south and west. This mappable cVOC plume represents the Site and is shown on Figure 3. The remedy is designed to decrease the cVOC mass within the Site.

4.2 Description of the Cleanup Action

The ELAM Group will initiate the remedy implementation after receiving the following documentation:

- ❏ Grading Permit - Issued by SDCI
- ❏ Street Use Permit - Issued by SDOT for construction traffic and temporary closure of adjacent alleyway
- ❏ CID - Issued by Ecology for managing impacted soil
- ❏ Underground Injection Control ("UIC") registration and approval for the proposed Ozone injection points

The planned remedy, Cleanup Alternative 9 - Shallow ISCO (mixing) and Deep/Saturated ISCO, requires the following actions, in order:

1. Removal of one underground storage tank
2. Grading of a maximum of 300 cubic yards of soil from the surface of the Facility for off-site disposal (maximum depth: 2 feet below current grade)
3. Application of a chemical oxidation solution, concurrently with a soil stabilization amendment, to soil located between 2 and 10 feet below current grade via mechanical soil mixing
4. Collection of soil confirmation samples

5. Grading of a maximum of 75 cubic yards of clean backfill material to restore surface grade to original grade[4]
6. Application of hydroseeding to stabilize clean backfill material
7. Installation and operation of an Ozone-generating treatment system, which will be used to inject Ozone into the deep vadose zone soil and saturated soil for the purpose of oxidizing cVOCs and EOS
8. Collection of groundwater confirmation samples for eight consecutive quarters following completion of Ozone injection

The following subsections further describe these actions. Additionally, depending on the results obtained for the soil confirmation and/or groundwater confirmation samples, an Institutional Control may be necessary to prevent potential exposure to residual cVOC impacts as further described in Section 4.8.

4.2.1 UST Removal

The ELAM Group will provide oversight during completion of the following action items/activities by a qualified contractor:

- ❏ Procurement of a UST decommission permit through the Seattle Fire Department ("SFD")
- ❏ Removal of residual materials and rinsing of the UST using a vacuum tanker truck
- ❏ Inerting the UST with approximately 30 pounds of dry ice
- ❏ Coordination and scheduling of SFD Inspector
- ❏ Accessing the top of the UST
- ❏ Cutting an access window into the top of the UST with oversight by Marine Chemist
- ❏ Completion of final UST cleaning with vacuum tanker truck equipped with a pressure washer
- ❏ Transportation and off-site disposal of residual product and rinsate to a fully-permitted recycling/treatment facility
- ❏ Removal of UST from ground and transportation off-site to a local scrap metal recycling facility

[4] The soil mixing procedure is anticipated to lead to mounding of mixed soil, therefore the amount of backfill required to restore the site to original grade is expected to be less than the volume removed for off-site disposal

- ❏ Assistance with collection of soil samples from the base and sidewalls of the UST earthen cavity
- ❏ Procurement, transportation, placement and compaction of clean backfill

4.2.2 Soil Grading and Off-Site Disposal

The ELAM Group will provide oversight during completion of the following action items/activities by a qualified contractor:

- ❏ Procurement of an approved waste profile for soil that is considered to be Dangerous Waste
- ❏ Procurement of an approved waste profile for soil that is considered to be non-hazardous waste per the pending CID
- ❏ Installation of tree protection measures
- ❏ Grading, loading and transportation of soil Dangerous Waste to Chemical Waste Management of the Northwest located in Arlington, Oregon
- ❏ Grading, loading and transportation of soil non-hazardous waste to Waste Management's Greater Wenatchee Regional Landfill located in Wenatchee, Washington

4.2.3 Soil Mixing Remedy

Soil mixing remediation consists of mechanical mixing of soil with a chemical reagent in order to destroy and/or immobilize the COCs. The combined ISCO/ISS approach successfully decreases the mass of the COCs, enhances post-mixing characteristics of the mixed soil and minimizes leaching of the COCs from the treated area.

In order to ensure sufficient contact between the COCs in the soil and the chemical reagent, water is added to destabilize the soils. The water and mixing action creates a homogenous mixture of chemical and soil, thereby maximizing the contact between soil and chemical. The destabilized soil is then re-stabilized with an *in-situ* stabilization ("ISS") amendment, typically introduced to the soil with a second pass through the soil with the chemical mixing equipment. The ISS increases the unconfined compressive strength of the soil.

Applied to the site, the two-step approach would be difficult to implement due to property constraints, but both the ISCO and ISS can be introduced to the impacted soil in a single-pass rather than two passes. The single-pass ISCO/ISS approach uses a persulfate reagent for the ISCO. The ISCO will not activate unless alkaline conditions are present. To create the alkaline condition, Portland cement is introduced to activate the persulfate. The Portland cement also serves as the ISS. Consequently, both the persulfate and Portland cement are introduced to the impacted soil in a single pass together with water.

PeroxyChem is a chemical supplier that specializes in the single-pass remedy. They completed a bench study of various combinations of an activated persulfate reagent and Portland cement with soil and groundwater obtained from the Facility. The objectives of the bench study were as follows:

- ❏ Determination of the soil oxidant demand ("SOD")
- ❏ Determination of the base buffering capacity ("BBC") of the soil
- ❏ Determination of appropriate amounts of persulfate and Portland cement for full-scale remediation at the Facility
- ❏ Determination of post-treatment properties of treated soil
- ❏ Determination of post-treatment COC concentrations

A copy of the ISCO-ISS Bench Study report is included as Appendix B. Based on the bench test results, the report's defined *condition 3* provided satisfactory results in the most efficient manner. Extrapolating the bench test results to a full-scale ISCO/ISS remedy suggests the following amounts of reagents/amendments:

- ❏ 33,060 pounds of activated persulfate ("Klozur SP") delivered in 15 supersacks
- ❏ 1,170 pounds of sodium hydroxide ("NaOH") delivered in 2 drums
- ❏ 64 tons of Portland cement, with container specifications to be determined

The work will be conducted under the direction of The ELAM Group and a qualified subcontractor as follows:

- ❏ Receiving delivery and storage of reagents/amendments
- ❏ Preparation of the treatment solution containing the proper proportions of activated persulfate, NaOH and portland cement
- ❏ Delivery of the treatment solution and mixing with Facility soil located at a depth of 2 to 10 feet below grade (after the upper 2 feet of soil are removed as described in Section 4.2.2)

4.2.4 Interim Site Restoration

Following completion of the combined ISCO/ISS treatment, The ELAM Group will direct and undertake the following activities:

- ❏ Transportation, placement and grading of clean backfill to restore the original surface grade at the Facility
- ❏ Application of hydroseeding to stabilize clean backfill material

4.2.5 Shallow Vadose Zone Soil Confirmation Sampling

After sufficient turf growth has been established to allow for a drill rig to access the site, confirmatory soil samples will be collected from 12 locations in which previous soil sample results exceed the MTCA Cleanup Levels, as summarized in the table below.

Soil Boring Location	Depth (feet bgs)
FB-4	4
SB-19	1.7-3.1
SB-17	0.5-2.9
SB-28	1.7-3.5

Soil Boring Location	Depth (feet bgs)
VP-2	2.5
SB-15	0.5-3.1
SB-14	0.5-3.0
SB-37	1.1-2.4

Soil Boring Location	Depth (feet bgs)
VP-1	8
SB-23	1.0-3.2
SB-20	2.7
SB-38	2.5-2.9

The above-referenced soil boring locations were chosen based on the historical soil analytical data for soil samples collection from a depth of 2 to 10 feet below grade surface (“bgs”), and represent the 12 highest PCE concentrations observed within the depth horizon for the shallow vadose zone soil mixing remedy.

Each location will be continuously sampled from the surface to 10 feet bgs. The soil sample from the interval listed above and the interval exhibiting the highest total organic vapor (“TOV”) measurement will be submitted for chemical analysis. Based on this sample collection methodology, some confirmation soil borings will have one soil sample and some confirmation soil boring locations will have two soil samples. The confirmation soil samples will be submitted for chemical analysis of VOCs via US EPA Test Method 8260. The sampling procedures for soil sampling are described in the quality assurance project plan (“QAPP”) provided in Appendix C.

The combined ISCO/ISS remedy's ability to reduce the cVOCs in soil will be measured by conducting a statistical evaluation of the pre- and post-mixing soil data. Specifically, the exposure point concentration ("EPC") of the above-referenced data will be compared to an EPC of the confirmatory samples after ISCO/ISS completion. If the post-mixing EPC is lower than the MTCA Cleanup Levels, remediation of the shallow vadose zone soil will be considered complete. If not, an Institutional Control may be necessary to prevent potential exposure to residual cVOC impacts as further described in Section 4.8.

4.2.6 Ozone Injection

After the ISCO/ISS is complete, The ELAM Group will direct and undertake the following activities:

- ❏ Installation of a new power supply at the Facility to allow for the operation of the Ozone Injection Treatment System
- ❏ Installation of injection wells to allow for the injection of Ozone into the deep vadose zone soil and saturated soil
- ❏ Procurement and installation of the Ozone Injection Treatment System
- ❏ Operations and maintenance

A copy of a preliminary proposal describing the design, construction and installation of the Ozone Injection Treatment System is included in Appendix D.

4.2.7 Final Site Restoration

Following affirmation from Ecology that no further action is required, any remaining infrastructure associated with monitoring/remediation at the Facility will be removed.

4.3 Cleanup Standards and Point of Compliance

The point of compliance is described as the point where cleanup levels established in accordance with WAC 173-340-720 through 173-340-760 have been met. As defined in MTCA, point of compliance means *...the point or points where cleanup levels…shall be*

attained (Ecology 2001, Revised 2013). As presented in the FS (ELAM 2020e), the points of compliance for soil, groundwater and soil gas are summarized as follows:

- ❏ Soil: From ground surface to the top of the groundwater table at approximately 30 feet bgs
- ❏ Groundwater: The vertical point of compliance for groundwater shall extend from the upper level of the saturated zone to approximately 60 feet bgs, and the lateral points of compliance for groundwater shall extend from the Facility out to monitoring wells MW-15 and MW-15D, which are the furthest downgradient wells
- ❏ Soil Gas/Indoor Air: The point of compliance for observed impacts to soil gas/indoor air is to monitor and maintain/minimize current soil vapor conditions; in the event that the usage of the commercial properties to the east of the Facility change to residential, additional actions may be warranted

4.4 Applicable, Relevant, and Appropriate Requirements (ARARs)

The remediation for the Facility was chosen to effectively treat the COCs in the affected media and are conducive to the future land use of the Facility and surrounding area. The Applicable, Relevant and Appropriate Requirements ("ARARs") is provided in Table 1. Any cleanup action implemented at the Facility will adhere to the following WAC 173-340-360(2) minimum requirements:

- ❏ Protect human health and the environment
- ❏ Comply with cleanup standards
- ❏ Comply with applicable state and federal laws
- ❏ Provide for compliance monitoring
- ❏ Use permanent solutions to the maximum extent practicable
- ❏ Provide a reasonable restoration time frame
- ❏ Consider public concerns

Accordingly, other potentially applicable regulatory requirements for a cleanup action at this Facility include the following:

- ❏ The Federal Clean Water Act (33 USC Section 1251)
- ❏ Comprehensive Environment Response, Compensation, and Liability Act (CERCLA), 40 CFR 300
- ❏ The Resource Conservation and Recovery Act (RCRA), 40 CFR 239-282

- ❏ USDOT Hazardous Materials Regulations (HMR), 40 CFR 100 through 185
- ❏ The Toxic Substances Control Act (TSCA), 15 USC Section 2601
- ❏ The Occupational Safety and Health Act (OSHA), Part 1910 of Title 29 of the Code of Federal Regulations, 29 CFR 1910
- ❏ Washington's Dangerous Waste Regulations, Chapter 70.105 RCW; Chapter 173-303 WAC
- ❏ Washington's Solid Waste Handling Standards, Chapter 173-350 WAC
- ❏ Water Quality Standards for Groundwaters of the State of Washington, Chapter 173-200 WAC
- ❏ Federal and State Clean Air Acts, 42 USC 7401 et seq,; 40 CFR 50; RCW 70.94; WAC 173-400, 403
- ❏ The State Environmental Policy Act (SEPA), RCW 43.21C; WAC 197-11
- ❏ Washington's General Occupational Health Standards, WAC 296-62
- ❏ Washington's Safety Standards for Construction Work, WAC 296-155
- ❏ Minimum Standards for Construction and Maintenance of Wells, WAC-173-160
- ❏ *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action (Vapor Intrusion Guidance), Review Draft*, Washington State Department of Ecology, October 2009, Revised 2016, Publication Number 09-09-047
- ❏ *OSWER Technical Guide For Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, June 2015, Publication 9200.2-154
- ❏ Native American Graves Protection and Repatriation Act (NAGPRA), 43 CFR 10
- ❏ Archaeological Resources Protection Act (ARPA), 16 US Code Chapter 1B
- ❏ Regulations, codes, and permits from local cities and counties (e.g., Water Quality, Road Closure, etc.)

4.5 Restoration Time Frame

The table on the following page provides an approximate site preparation and remediation construction schedule.

Site Preparation and Remediation Construction Activity	Projected Completion Time After Receipt of Permits / Approvals (Months)
Install Perimeter Fence	Completed January 2020
Underground Storage Tank Removal	2
Cut Maximum of 300 Cubic Yards of Soil for Off-site Disposal	3
Application of Chemical Oxidation Solution and Soil Stabilization Amendment via Mechanical Soil Mixing, and Collection of Soil Confirmation Samples	3 - 5
Fill Maximum of 75 Cubic Yards of Clean Backfill Material[5]	5
Application of Hydroseeding	5
Installation and Operation of Ozone Treatment System	12 - 36
Groundwater Confirmation Sampling	36 - 48

4.6 Compliance Monitoring

4.6.1 Soil Monitoring

Soil confirmation samples will be collected from the Facility following implementation of the soil mixing remedy, as discussed in Section 4.2.5.

4.6.2 Groundwater Monitoring

Groundwater monitoring samples will be collected from the monitoring wells installed throughout the Site following implementation of the soil mixing remedy. The sampling procedures for groundwater sampling are described in the QAPP provided in Appendix C. The ELAM Group currently anticipates that groundwater monitoring will occur for a period of three years following the initiation of remediation, with sample frequency being quarterly.

[5] The soil mixing procedure is anticipated to lead to mounding of mixed soil, therefore the amount of backfill required to restore the site to original grade is expected to be less than the volume removed for off-site disposal

The ELAM Group recommends removing monitoring wells from the quarterly monitoring plan if the COCs have not exceeded the MTCA Level A Cleanup Levels for four consecutive quarters. Based on the groundwater analytical result presented in the *Annual Report* (ELAM 2019), 15 monitoring wells fit this criteria. Consequently, these 15 monitoring wells will be removed from the monitoring plan, which leaves the following 14 monitoring wells for continued monitoring (once groundwater monitoring resumes following remedy implementation), as listed below:

- ❏ MW-1
- ❏ MW-2
- ❏ MW-3
- ❏ MW-4
- ❏ MW-5
- ❏ MW-6
- ❏ MW-7
- ❏ MW-9
- ❏ MW-11
- ❏ MW-13
- ❏ MW-15
- ❏ MW-15D
- ❏ MW-23
- ❏ MW-101

After 4 consecutive quarters, and for each quarter thereafter, the data will be evaluated for monitoring well reduction per the compliance criteria of four consecutive quarters of samples not exceeding the MTCA Level A Cleanup Levels. If monitoring wells remain after 8 consecutive quarters, each well will be evaluated by calculating the EPC for the 8-quarter data set. If the EPC for each COC is lower than the respective MTCA Level A Cleanup Level, then the well will be removed from the plan.

4.6.3 Vapor Intrusion Assessment

Collection of VIA samples from the Islamic School of Seattle property located at 720 E 25th St will occur during winter “worst case” conditions for a period of four years following implementation of remediation. An annual inspection of the Twilight Exit and Tana Market properties located at 2616 and 2618 E Cherry St will be completed to verify continued commercial land use. If land use changes to residential, additional VIA may be warranted.

4.7 Schedule for Implementation

The CAP will unfold according to the following schedule:

Quarter & Year	Anticipated Activities
3Q 2020	❑ Obtain SDCI Grading Permit 6388215-GR ❑ Obtain SDOT Street Use Permit ❑ Request CID from Ecology ❑ Obtain CID from Ecology ❑ Install Project Information Sign within the Perimeter Fence ❑ Conduct EOS Gauging and Removal Event ❑ Provide Contacts on the Construction Notification List with a Remediation Construction Project Briefing (upon receipt of the required approvals/permits) ❑ Coordinate Tree Protection Requirements with Urban Forestry (at least 3 weeks prior to remediation construction activities) ❑ Verify/Update Construction Notification List and Submit to SDOT (at least 15 business days prior to remediation construction activities) ❑ Provide Contacts on the Construction Notification List with a Remediation Construction Project Memo (at least 10 business days prior to beginning of the remediation construction project) ❑ Provide Contacts on the Construction Notification List with a Remediation Construction Project Memo (monthly during the duration of the remediation construction project) ❑ Procure Temporary Sanitary Facility Service for Construction Workers
4Q 2020	❑ Grading Season Begins (April 1st) ❑ Provide Contacts on the Construction Notification List with a Remediation Construction Project Memo (monthly during the duration of the remediation construction project) ❑ Remove Underground Storage Tank ❑ Cut Maximum of 300 Cubic Yards of Soil for Off-site Disposal in Accordance with CID obtained from Ecology ❑ Procure Supplies for Soil Mixing In-situ Chemical Oxidation (“ISCO”) and In-situ Stabilization (“ISS”) Remediation ❑ Barricades for Closing Alleyway in Accordance with SDOT Street Use Permit ❑ Fresh Water Storage Tank ❑ Delivery of Water to Fill Fresh Water Storage Tank ❑ Storm Water Storage Tank (used only if needed to prevent stormwater runoff) ❑ Storage Container for Supplies ❑ Granular ISCO Treatment and ISS Reagents ❑ Pumps and Hoses for Transferring Fresh Water, and Stormwater ❑ Generator for Providing Power to Operate Pumps ❑ 4-Wheel Drive, Off-Road, Telehandler Fork Truck ❑ Personal Protective Equipment (“PPE”) ❑ Implement Soil Mixing Remediation ❑ Install Topsoil Cap and Hydroseed ❑ Install Replacement Monitoring Wells: MW-2R and MW-3R ❑ Conduct Winter Worst Case VIA for ISS, and Verify Commercial Use of Twilight Exit & Tana Market ❑ Prepare Annual Report for Submission to Ecology

1Q 2021	❑ Collect Groundwater Monitoring Samples ❑ Conduct EOS Gauging and Removal Event ❑ Apply for Permits required for Ozone Treatment System Install
2Q 2021	❑ Grading Season Ends (Oct 31st) ❑ Collect Groundwater Monitoring Samples
3Q 2021	❑ Conduct EOS Gauging and Removal Event ❑ Obtain Permits required for Ozone Treatment System Install ❑ Install New Power Supply ❑ Order Ozone Treatment System ❑ Install Ozone Injection Wells ❑ Install Ozone Treatment System ❑ Initiate Operation of Ozone Treatment System
4Q 2021	❑ Collect Groundwater Monitoring Samples ❑ Conduct Ozone Treatment System Operation and Maintenance Service and EOS Gauging ❑ Conduct Winter Worst Case VIA for ISS, and Verify Commercial Use of Twilight Exit & Tana Market ❑ Prepare Annual Report for Submission to Ecology
1Q 2022	❑ Collect Groundwater Monitoring Samples ❑ Conduct Ozone Treatment System Operation and Maintenance Service and EOS Gauging
2Q 2022	❑ Collect Groundwater Monitoring Samples ❑ Conduct Ozone Treatment System Operation and Maintenance Service and EOS Gauging
3Q 2022	❑ Collect Groundwater Monitoring Samples ❑ Conduct Ozone Treatment System Operation and Maintenance Service and EOS Gauging
4Q 2022	❑ Collect Groundwater Monitoring Samples ❑ Conduct Ozone Treatment System Operation and Maintenance Service and EOS Gauging ❑ Conduct Winter Worst Case VIA for ISS, and Verify Commercial Use of Twilight Exit & Tana Market ❑ Prepare Annual Report for Submission to Ecology
1Q 2023	❑ Collect Groundwater Monitoring Samples ❑ Conduct Ozone Treatment System Operation and Maintenance Service and EOS Gauging
2Q 2023	❑ Collect Groundwater Monitoring Samples ❑ Conduct Ozone Treatment System Operation and Maintenance Service and EOS

	Gauging
3Q 2023	❑ Collect Groundwater Monitoring Samples ❑ Conduct Ozone Treatment System Operation and Maintenance Service and EOS Gauging
4Q 2023	❑ Collect Groundwater Monitoring Samples ❑ Conduct Ozone Treatment System Operation and Maintenance Service and EOS Gauging ❑ Terminate Operation of Ozone Treatment System ❑ Conduct Winter Worst Case VIA for ISS, and Verify Commercial Use of Twilight Exit & Tana Market ❑ Prepare Annual Report for Submission to Ecology
1Q 2024	❑ Collect Groundwater Monitoring Samples
2Q 2024	❑ Collect Groundwater Monitoring Samples
3Q 2024	❑ Collect Groundwater Monitoring Samples ❑ Record Environmental Covenant, if needed
4Q 2024	❑ Prepare Annual Report for Submission to Ecology ❑ Prepare Closure Request for Submission to Ecology ❑ Receive No Further Action Status from Ecology ❑ Complete Final Site Restoration ❑ Prepare System & Well Decommissioning Report

4.8 Institutional/Engineering Controls

Institutional controls (such as land use restrictions) are legal or administrative measures or actions that would be implemented to prevent and/or minimize exposure to the impacted media either currently or potentially posing unacceptable risk to human and/or ecological receptors. Engineering controls are physical measures that are also designed to prevent or minimize exposure to the COCs remaining at a project site. The institutional control that may be implemented at the Facility described below.

4.8.1 Environmental Covenant

The planned remedial technologies will reduce the concentrations of cVOCs in the impacted media. Should the RAOs not be reached, an institutional control in the form of an Environmental Covenant ("EC") may be necessary to prevent potential exposure to residual impacts within the Facility property boundary. A draft version of the EC is provided as Appendix E.

4.8.2 Vapor Mitigation System

Although not anticipated after the planned remediation activities are complete, a vapor mitigation system ("VMS") may be necessary should land use change in the area. Should this occur, the VMS will be designed to prevent VI.

4.9 Public Participation

According to WAC MCTA 173-340-600, public participation is an integral part of Ecology's responsibility. This CAP will be submitted to Ecology and Ecology will inform the public, by notification in the Site Register, that this CAP is available for review. The public is encouraged to review and comment on this CAP.

5 References

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ECC Horizon, 2014, Remediation Investigation , VCP ID: NW2009, Cleanup Site ID: 4175, Former Cherry Custom Cleaners, PREPARED BY: ECC Horizon, 9/4/14, https://apps.ecology.wa.gov/gsp/CleanupSiteDocuments.aspx?csid=4175 (URL last verified 6/12/20).

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Tables

Table 1. Applicable, Relevant and Appropriate Requirements (ARARs)

Former Cherry Cleaners

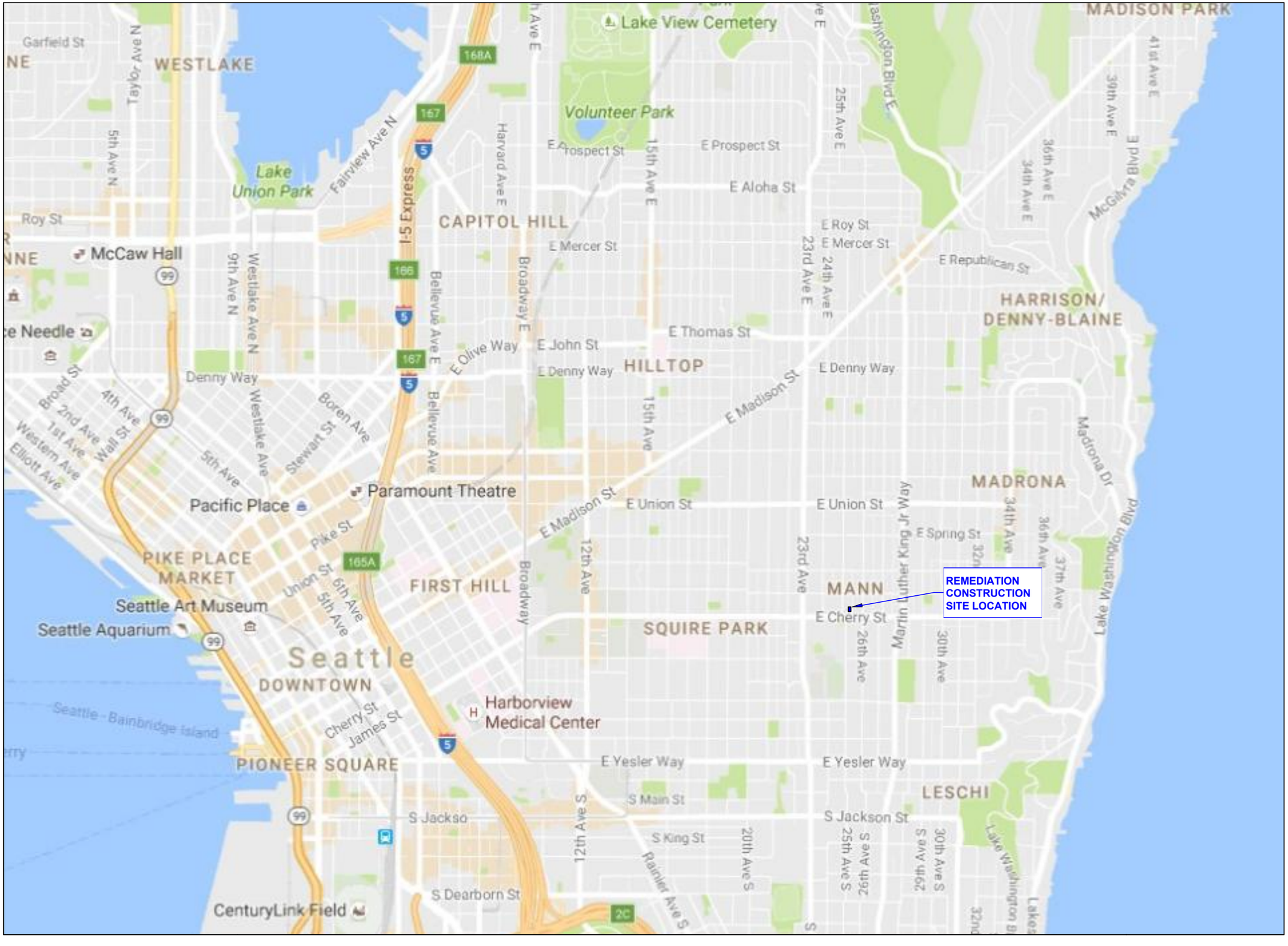
2510 E. Cherry Street, Seattle, WA 98122

VCP ID: NW2009; Cleanup Site ID: 4175

Facility/Site ID: 476174

Preliminary ARAR	Citation or Source
Model Toxics Control Cleanup Act (MTCA)	Chapter 70.105 of the Revised Code of Washington (RWC)
MTCA Cleanup Regulation	Washington Administrative Code (WAC) 173-340
Washington State Department of Ecology (Ecology) Vapor Intrusion Guidance	*Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action*, Review Draft, October 2009, Revised 2016, Publication Number 09-09-047
The State Environmental Policy Act (SEPA)	RCW 43.21C; WAC 197-11
Washington State Shoreline Management Act	RCW 90.58; WAC 173-18. 173-22 and 173-27
The Federal Clean Water Act	33 USC Section 1251
Comprehensive Environment Response, Compensation, and Liability Act (CERCLA)	40 CFR 300
The Resource Conservation and Recovery Act (RCRA)	40 CFR 239-282
USDOT Hazardous Materials Regulations (HMR)	40 CFR 100 through 185
The Toxic Substances Control Act (TSCA)	15 USC Section 2601
The Occupational Safety and Health Act (OSHA)	Part 1910 of Title 29 of the Code of Federal Regulations, 29 CFR 1910
Washington's Dangerous Waste Regulations	Chapter 70.105 RCW; Chapter 173-303 WAC
Washington's Solid Waste Handling Standards	Chapter 173-350 WAC
Water Quality Standards for Groundwaters of the State of Washington	Chaper 173-200 WAC
Federal and State Clean Air Acts	42 USC 7401 et seq,; 40 CFR 50; RCW 70.94; WAC 173-400, 403
Washington's General Occupational Health Standards	WAC 296-62
Washington's Safety Standards for Construction Work	WAC 296-155
Minimum Standards for Construction and Maintenance of Wells	WAC-173-160
U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response	*OSWER Technical Guide For Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, June 2015, Publication 9200.2-154
Native American Graves Protection and Repatriation Act (NAGPRA)	43 CFR 10
Archaeological Resources Protection Act (ARPA)	16 US Code Chapter 1B
City of Seattle regulations, codes and standards	All applicable or relavent and appropriate regulation, codes and standards
King County regulation, codes and standards	All applicable or relavent and appropriate regulation, codes and standards

Figures



TheELAMGroup

LEGEND

Remediation Construction Site

Notes:

0 750 1500 feet

Figure No: 1
Title: Site Location Map
Scale: 1" = 1,500'
Project No: WAKS2510C
Report: CAP
Drawn by: The ELAM Group
Date: 6/12/20

TheELAMGroup

LEGEND

- Monitoring Well
- Soil Boring
- Injection Well
- Soil Vapor Extraction Well
- Vapor Monitoring Point
- Underground Sanitary Sewer Line
- Underground Water Line
- Underground Natural Gas Line
- Overhead Electric Line
- Utility Pole
- Tree
- Former Building Location
- Vapor Intrusion Assessment Location

Notes:

0 30 60

Figure No: 2
Title: Site Plan
Scale: 1" = 30'
Project No: WAKS2510C
Report: CAP
Drawn by: The ELAM Group
Date: 06/11/2020

EAST COLUMBIA STREET

720 25TH AVE

727 26TH AVE

721 26TH AVE

719 26TH AVE

717 26TH AVE

711 26TH AVE

713 26TH AVE

712 26TH AVE

2621 EAST COLUMBIA ST

725 1/2 27TH AVE

721 27TH AVE

715 27TH AVE

713 27TH AVE

711 27TH AVE

705 27TH AVE

2616 E CHERRY ST

2600 E CHERRY ST

25TH AVENUE

ALLEYWAY

26TH AVENUE

27TH AVENUE

MW-4

MW-12

MW-13

MW-2

MW-3

MW-5

MW-8

MW-1

MW-7

MW-1D

MW-101

MW-9

MW-18

MW-18D

MW-19

MW-19D

FORMER OIL STORAGE

FUEL OIL FILL PORT

DRUM & TOTE STORAGE AREA

FORMER PETROLEUM FUELING AND SERVICE STATION

2516 E CHERRY ST

2518 E CHERRY ST

707 26TH AVE

2522 E CHERRY ST

MW-23

FORMER UNIQUE CLEANERS

CONCRETE SIDEWALK

MW-11

EAST CHERRY STREET

MW-6

MW-15

MW-15D

2503 E CHERRY ST

2509 E CHERRY ST

EAST CHERRY ST

2511

2515

2517

553 26TH AVE

MW-10

MW-16

MW-17

MW-17D

MW-14

652-698 25TH AVE

552 25TH AVE

545 26TH AVE

541 25TH AVE

541 26TH AVE

2605 E CHERRY ST

2615 E CHERRY ST (FORMER ON TOUCH CLEANERS)

MW-20D

551 27TH AVE

548 26TH AVE

549 27TH AVE

547 27TH AVE

544 26TH AVE

543 27TH AVE

540 26TH AVE

MW-21D

MW-22D

(SHALLOW ZONE NOT ENCOUNTERED)

TheELAMGroup

LEGEND

- Monitoring Well
- Underground Sanitary Sewer Line
- Underground Water Line
- Underground Natural Gas Line
- Overhead Electric Line
- Utility Pole
- Tree
- Former Building Location
- Vapor Intrusion Assessment Location

Notes:

A COC Concentration exceeds MTCA Method A.

N

0 30 60

Figure No: 3

Title: Groundwater COC Plume Extent

Scale: 1" = 30'

Project No: WAKS2510C

Report: CAP

Drawn by: The ELAM Group

Date: 07/09/2020

Appendix A

Project Planning Documents

Appendix A.1

Construction Management Plan

TheELAMGroup

Email: info@elamusa.com
Website: www.elamusa.com
Twitter: @elam_usa
Tel: 888-510-ELAM
Fax: 317-567-9022

Construction Management Plan (Revision 4)

Master Use Permit 3018999
Former Cherry Street Cleaners
2510 E. Cherry Street
Seattle, Washington 98122

Prepared By
Chris Sloffer, CHMM

Reviewed By
Eric Peterson
August 22, 2018

Seattle Department of Transportation
September 6, 2018

Revised By
Chris Sloffer, CHMM
January 9, 2020

Table of Contents

Figures

1. Project Overview

1.1 Project Address

Former Custom Cherry Cleaners
2510 E. Cherry Street
Seattle, Washington 98122

King County Assessor Parcel #: 6840700205

A Site Location Map is provided as Figure 1 and a Site Plan is provided as Figure 2.

1.2 Site Development

The site is currently an undeveloped parcel. In order to remediate soil impacted by historical dry cleaning activities conducted at the property, The Environmental Liability & Asset Management Group, LLC ("The ELAM Group") proposes the following site preparation and remediation construction activities:

- ❏ Installation of site perimeter fencing to prevent access to the site
- ❏ Coordinate tree protection requirements with Urban Forestry [(206) 684-5693] at least 3 weeks prior to remediation construction activities
- ❏ Removal of one underground storage tank
- ❏ Grading of a maximum of 300 cubic yards of soil from the surface of the site for transportation off-site for disposal (maximum depth: 2 feet below current grade)
- ❏ Application of a chemical oxidation solution, concurrently with a soil stabilization amendment, to soil located between 2 and 10 feet below current grade via mechanical soil mixing
- ❏ Collection of soil confirmation samples
- ❏ Grading of a maximum of 75 cubic yards of clean backfill material to restore surface grade to original grade[1]
- ❏ Application of hydroseeding to stabilize clean backfill material

[1] The soil mixing procedure is anticipated to lead to mounding of mixed soil, therefore the amount of backfill required to restore the site to original grade is expected to be less than the volume removed for off-site disposal

2. Construction Communication

2.1 Contact Person

The ELAM Group serves as an environmental consultant and the point of contact at The ELAM Group is:

Chris Sloffer
Senior Project Scientist
The ELAM Group
161 Lakeview Drive Suite B
Noblesville, IN 46060

chris.sloffer@elamusa.com
(888) 510-ELAM (3526)

2.2 Construction Notification List

Beginning on the next page is a list of the properties located within 300 feet of the remediation construction project site and businesses located within a 3 block radius of the site. The remediation construction project site and properties located within 300 feet of the site are shown on Figure 3.

Upon receipt of the required permits and approvals, the contacts on the list will be verified and updated, as necessary. The verified/updated list will be used for project notifications and submitted to the Seattle Department of Transportation (“SDOT”) for review at least 15 business days prior to beginning the proposed construction activities.

Property Address	Taxpayer	Taxpayer Address
720 25TH AVE	ISLAMIC SCHOOL OF SEATTLE	720 25TH AVE SEATTLE WA 98122
727 26TH AVE	MUHAMMAD YACIN	727 26TH AVE SEATTLE WA 98122
2525 E COLUMBIA ST	MUHAMMAD YACIN	727 26TH AVE SEATTLE WA 98122
721 B 26TH AVE	HOFFMAN LINDA	723 A 26TH AVE SEATTLE WA 98122
721 A 26TH AVE	YOSHIMURA JENNIFER+PESSOTTO	721 A 26TH AVE SEATTLE WA 98122
717 B 26TH AVE	WILSON TERRY N	717 B 26TH AVE SEATTLE WA 98122
717 A 26TH AVE	POULSEN MIKEL	717 26TH AVE #A SEATTLE WA 98122
711 B 26TH AVE	BALUYOT EMELISSA	711 B 26TH AVE SEATTLE WA 98122
711 A 26TH AVE	TALBOT SARAH+BERTELLI YANTR	711 26TH AVE #A SEATTLE WA 98122
2514 E CHERRY ST	CHERRY VALLEY	1122 E PIKE ST PMB 1130 SEATTLE WA 98122
2516 E CHERRY ST	CHERRY VALLEY	1122 E PIKE ST PMB 1130 SEATTLE WA 98122
2518 E CHERRY ST	CHERRY VALLEY	1122 E PIKE ST PMB 1130 SEATTLE WA 98122
723 B 26TH AVE	D S EDISON LLC	500 108TH AVE NE #2400 BELLEVUE WA 98004
723 A 26TH AVE	SCHWINDEN ANDREW	721 B 26TH AVE SEATTLE WA 98122
719 B 26TH AVE	PARRA SONIA	719 B 26TH AVE SEATTLE WA 98122
713 B 26TH AVE	GRODNIK ANN	713 B 26TH AVE SEATTLE WA 98122
713 A 26TH AVE	SOMERSON WENDY	713 A 26TH AVE SEATTLE WA 98122
707 26TH AVE	HO KWONG-LEUNG	707 26TH AVE SEATTLE WA 98122

Property Address	Taxpayer	Taxpayer Address
2522 E CHERRY ST	OAKES SCOTT C+MARY A	1145 17TH AVE E SEATTLE WA 98112
710 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
712 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
714 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
716 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
718 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
720 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
722 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
724 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
726 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
728 26TH AVE	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
2600 E COLUMBIA ST	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
2605 E COLUMBIA ST	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
2607 E COLUMBIA ST	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
2609 E COLUMBIA ST	LOW INCOME HOUSING INSTITUTE	2407 1ST AV #200 SEATTLE WA 98121
704 26TH AVE	BREWER SYDNE	704 26TH AVE SEATTLE WA 98122
702 26TH AVE	BURBANK BROOKE ELIZABETH+WO	702 26TH AVE SEATTLE WA 98122
700 26TH AVE	RAFTUS DEBORAH L	700 26TH AVE SEATTLE WA 98122

Property Address	Taxpayer	Taxpayer Address
2600 E CHERRY ST	SCHUESSLER KATHRYN	2600 E CHERRY STREET SEATTLE WA 98122
2602 E CHERRY ST	GOUGH JASON	2602 E CHERRY ST SEATTLE WA 98122
2604 E CHERRY ST	HINTZ BRIAN A+TERRI L	16520 SE 59TH PL BELLEVUE WA 98006
2606 E CHERRY ST	HINTZ BRIAN A+TERRI L	16520 SE 59TH PL BELLEVUE WA 98006
2608 E CHERRY ST	SUN GUOWEI+YI LIU	412 11TH AVE UNIT 203 SEATTLE WA 98122
2605 E CHERRY ST	CHERA BELAYANESH S	23607 78TH AVE W EDMONDS WA 98026
548 26TH AVE	GREEN AARON	548 26TH AVE SEATTLE WA 98122
553 26TH AVE	JORDAN GEORGE L	1125 30TH AVE SEATTLE WA 98122
555 26TH AVE	JORDAN GEORGE L	1125 30TH AVE SEATTLE WA 98122
557 26TH AVE	JORDAN GEORGE L	1125 30TH AVE SEATTLE WA 98122
2511 E CHERRY ST	JORDAN GEORGE L	1125 30TH AVE SEATTLE WA 98122
2515 E CHERRY ST	JORDAN GEORGE L	1125 30TH AVE SEATTLE WA 98122
2517 E CHERRY ST	JORDAN GEORGE L	1125 30TH AVE SEATTLE WA 98122
545 26TH AVE	WRIGHT HELEN M	545 26TH AVE SEATTLE WA 98122
541 26TH AVE	HAYES MICHAEL P+SARAH C SLA	541 26TH AVE SEATTLE WA 98122
542 25TH AVE	THOMPSON ANDREW L+BATES GLE	542 25TH AVE SEATTLE WA 98122
546 25TH AVE	JORDAN TRUST GEORGE + NETTI	1125 30TH AVE SEATTLE WA 98122
552 25TH AVE	JORDAN TRUST GEORGE + NETTI	1125 30TH AVE SEATTLE WA 98122

Property Address	Taxpayer	Taxpayer Address
2503 E CHERRY ST	JORDAN TRUST GEORGE + NETTI	1125 30TH AVE SEATTLE WA 98122
2509 E CHERRY ST	JORDAN TRUST GEORGE + NETTI	1125 30TH AVE SEATTLE WA 98122
500 23RD AVE	SEATTLE CITY OF DPR	PROPERTY MANAGEMENT 800 MAYNARD AVE S 3RD FL SEATTLE WA 98134
520 23RD AVE	SEATTLE CITY OF DPR	PROPERTY MANAGEMENT 800 MAYNARD AVE S 3RD FL SEATTLE WA 98134
530 23RD AVE	SEATTLE CITY OF DPR	PROPERTY MANAGEMENT 800 MAYNARD AVE S 3RD FL SEATTLE WA 98134
537 25TH AVE	SEATTLE CITY OF DPR	PROPERTY MANAGEMENT 800 MAYNARD AVE S 3RD FL SEATTLE WA 98134
2323 E CHERRY ST	SEATTLE CITY OF DPR	PROPERTY MANAGEMENT 800 MAYNARD AVE S 3RD FL SEATTLE WA 98134
2401 E CHERRY ST	SEATTLE CITY OF DPR	PROPERTY MANAGEMENT 800 MAYNARD AVE S 3RD FL SEATTLE WA 98134
2400 E JEFFERSON ST	SEATTLE CITY OF DPR	PROPERTY MANAGEMENT 800 MAYNARD AVE S 3RD FL SEATTLE WA 98134
700 24TH AVE	SEATTLE PUBLIC SCHOOLS	2445 3RD AVE S PO BOX 34165 SEATTLE WA 98124
714 24TH AVE	SEATTLE PUBLIC SCHOOLS	2445 3RD AVE S PO BOX 34165 SEATTLE WA 98124
2410 E CHERRY ST	SEATTLE PUBLIC SCHOOLS	2445 3RD AVE S PO BOX 34165 SEATTLE WA 98124
2412 E CHERRY ST	SEATTLE PUBLIC SCHOOLS	2445 3RD AVE S PO BOX 34165 SEATTLE WA 98124

Businesses within a 3 block radius of site	Address
DUR DUR CAFE TEA	2212 E CHERRY ST SEATTLE, WA 98122
BRAID EXPRESS	705 23RD AVE SEATTLE, WA 98122
BP / AMPM	665 23RD AVE SEATTLE, WA 98122
COYOTE CENTRAL	2300 E CHERRY ST SEATTLE, WA 98122
ALTSPACE, LLC	2318 E CHERRY ST SEATTLE, WA 98122
GARFIELD COMMUNITY CENTER	2323 E CHERRY ST SEATTLE, WA 98122
SANCTUARY CHURCH SEATTLE	2323 E CHERRY ST SEATTLE, WA 98122
TWILIGHT EXIT	2514 E CHERRY ST SEATTLE, WA 98122
TANA MARKET	2518 E CHERRY ST SEATTLE, WA 98122
CLOUD 9 HOOKAH LOUNGE	2522 E CHERRY ST SEATTLE, WA 98122
MESKEL RESTAURANT	2605 E CHERRY ST SEATTLE, WA 98122
23RD & CHERRY FELLOWSHIP HALL	2701 E CHERRY ST SEATTLE, WA 98122
CAFE SELAM	2715 E CHERRY ST SEATTLE, WA 98122
ZAGOL ETHIOPIAN RESTAURANT	2722 E CHERRY ST SEATTLE, WA 98122
FAT'S CHICKEN AND WAFFLES	2726 E CHERRY ST SEATTLE, WA 98122

2.3 Communication Methods

The contacts on the Construction Notification List will be provided with a remediation construction project briefing memo via mail upon receipt of the required permits and approvals. The remediation construction project briefing memo will provide the following information:

- ❏ Proposed Remediation Construction Activities
- ❏ SDOT Permits
- ❏ Proposed Schedule
- ❏ Construction Hours
- ❏ 24-hour Emergency Contact/Complaint Hotline

The above information will also be posted on a “Project Information” sign located at the project site.

The 24-hour Emergency Contact/Complaint Hotline [(888) 510-ELAM (3526)] will serve as the primary access point to the construction contact. Calls received during normal construction hours will be answered by a member of the staff, if possible, or be allowed to leave a voicemail message. Calls received outside normal construction hours will be allowed to leave a voicemail message. Voicemail messages will be retrieved and responded to as soon as possible, and no later than the next work day.

In addition to the initial briefing memo, monthly remediation construction project status memos will be provided during the duration of the project to the contacts on the Construction Notification List. The monthly memo will provide the current status of the remediation construction project and include announcement of anticipated impacts to sidewalk, parking, street and noise.

2.4 Notification Timing & Tracking

The contacts on the Construction Notification List will be provided with a remediation construction project briefing memo via mail upon receipt of the required permits and approvals, and at least 10 business days prior to beginning work.

It should be noted that notification of at least 10 business days is also required prior to any work outside of the Construction Hours listed in Section 3.1.

In addition to the initial briefing memo, monthly remediation construction project status update memos will be provided during the duration of the project.

The remediation construction project briefing and monthly project status update memos will be shipped via First-Class Mail with United States Postal Service (“USPS”) Tracking®.

2.5 Construction Project and Known Special Events in the Vicinity

The ELAM Group has not identified any existing construction projects or known projects and special events (parade, run, marathon, community event) that might begin or occur during the life of the remediation construction project. However, the ELAM Group will be aware of the potential of Special Events to occur proximal to the project site and coordinate right-of-way use for each event with SDOT at least 10 business days prior to the event.

3. Construction Noise and Sensitive Receivers

3.1 Construction Hours

The ELAM Group proposes conducting the remediation construction activities detailed in Section 1.2 during the following proposed work hours:

- ❏ Between 7:00 am and 6:00 pm on weekdays/non-legal holidays
- ❏ Between 9:00 am and 6:00 pm on Saturdays/legal holidays

Impact noise (auger pile drilling/shaking auger is considered impact noise) hours are as follows:

- ❏ Between 7:00 am and 5:00 pm on weekdays/non-legal holidays
- ❏ Between 9:00 am and 5:00 pm on Saturdays/legal holidays

No Sunday work unless there is an emergency, and SDCI Noise Abatement approves and issues a Temporary Noise Variance.

Working in the right-of-way outside 8am - 5pm is considered off hours work. Off hours work, which includes all holidays and weekends, must be approved at least 72 hours in advance. Contact Danny Young @ danny.young@seattle.gov or by phone @ (206) 233-3849.

3.2 High Noise-Generating Activities

Noise may be generated by construction equipment (skid steer, excavator, dump truck(s), etc.) during the proposed hours of work. Please note, auger pile drilling/shaking auger is considered impact noise.

3.3 Noise-Sensitive Receivers

No known sensitive receivers have been identified.

3.4 Construction Noise Management

The ELAM Group is responsible for the behavior of remediation construction project personnel (including subcontractor and vendor employees) and the following procedures will be implemented to reduce or prevent general noise impacts:

- ❏ Construction activities will be limited to the proposed hours of work listed in Section 3.1
- ❏ Any vehicle/equipment requiring an alarm (such as a backup warning) will be equipped with an “Ambient Sensitive Broadband Alarm”
- ❏ No queuing of remediation construction vehicles adjacent to residential uses
- ❏ Drive through staging area, if possible

In the event that the City of Seattle noise ordinance is violated, the City of Seattle will issue the violation document to The ELAM Group.

4. Construction Milestones

4.1 Schedule

The ELAM Group proposes to start the proposed site preparation and remediation construction project after receiving the following permits / approvals:

- ❏ Grading Permit - Issued by Seattle Department of Construction and Inspections ("SDCI")
- ❏ Street Use Permit - Issued by SDOT for construction traffic and temporary closure of adjacent alleyway
- ❏ Contained Out Determination - Issued by Washington State Department of Ecology for managing impacted soil

The ELAM Group proposes the following site preparation and remediation construction schedule:

Site Preparation and Remediation Construction Activity	Projected Completion Time After Receipt of Permits / Approvals (Months)
Install Perimeter Fence	Prior to Receipt of Permits / Approvals
Underground Storage Tank Removal	2
Cut Maximum of 300 Cubic Yards of Soil for Off-site Disposal	3
Application of Chemical Oxidation Solution and Soil Stabilization Amendment via Mechanical Soil Mixing, and Collection of Soil Confirmation Samples	3 - 7
Fill Maximum of 75 Cubic Yards of Clean Backfill Material[2]	7
Application of Hydroseeding	7

[2] The soil mixing procedure is anticipated to lead to mounding of mixed soil, therefore the amount of backfill required to restore the site to original grade is expected to be less than the volume removed for off-site disposal

5. Off-site Construction Worker Parking

5.1 Location

The ELAM Group anticipates a maximum of five construction workers onsite at any time during the duration of the remediation construction project. Vehicle parking will occur either onsite, at the adjacent Islamic School of Seattle property located at 720 25th Avenue, or nearby public parking on city streets.

6. Right of Way Use

6.1 SDOT Coordination

The ELAM Group understands that right of way use must be approved by the SDOT prior to beginning work, and that site and traffic control plans are not approved during the Construction Management Plan review process. The ELAM Group also understands that any Construction Management Plan requirements that affect right-of-way use must be reflected on the required plans, and pedestrian mobility must be shown on the site and traffic control plans for both working and non-working hours. The ELAM Group further understands that the SDOT requests right of way use planning happen at least 3 months prior to beginning work. The ELAM Group will allow for these timing requirements during planning for site work, and will contact SDOT Street Use at **SDOTPermits@seattle.gov** or **(206) 684-5253** for review and submittal lead times.

6.2 Material Management

The ELAM Group anticipates removing a maximum volume of 300 cubic yards of material from the Site, conducting soil mixing of a chemical oxidant treatment solution, conducting soil stabilization, and placing clean backfill over the treated/stabilized soil to bring the surface back to original grade. Truck loading and unloading will occur via use of the adjacent alleyway, which will prevent truck queuing or staging on city streets or adjacent to residential uses. Using the paved alleyway will also minimize the tracking of debris onto city streets.

6.3 Route between Site and Interstate

Tractor-trailer traffic from Interstate 5 will exit the Interstate onto James Street and travel east. James Street becomes E James Way and then becomes E Cherry Street. Prior to arriving at the site, tractor-trailer traffic will turn north on 25th Ave, then east on E Columbia St and then south into the alleyway located adjacent to the site.

Unloading/loading will occur in the alleyway adjacent to the site. Using the alleyway for unloading and loading will prevent tracking of debris onto city streets.

Once delivered materials are unloaded from (or waste materials are loaded onto) the tractor-trailer, the tractor-trailer can turn west onto E Cherry Street, which becomes E

James Way and then James Street. From James Street, the tractor-trailer traffic can enter onto Interstate 5.

The Haul Route is shown on Figures 4 & 5.

6.4 Primary Trucking Company

The primary trucking company is Wyser Construction Company, Inc. located at 19015 109th Avenue SE, Snohomish, WA 98296. The phone number for Wyser Construction Company, Inc. is (425) 742-0898. The Onsite Supervisor is to be determined.

6.5 Anticipated Tractor-Trailer Traffic

Based on the scope of work presented in Section 1.2, The ELAM Group anticipates the following tractor-trailer traffic:

- ❏ Delivery/pickup of construction equipment
- ❏ Removal of UST
- ❏ Delivery of one load of fill material for void created during UST removal
- ❏ Removal of 2 loads of dangerous waste soil for transport to Subtitle C Facility
- ❏ Removal of 14 loads of waste soil for transport to Subtitle D Facility
- ❏ Delivery/pickup of storage containers
- ❏ Delivery of chemical oxidant reagent and soil stabilization amendment
- ❏ Delivery of water for preparing chemical oxidant solutions and equipment cleaning purposes
- ❏ Delivery of 4 loads of fill material restore surface grade to original condition

Arrival of tractor-trailers at the site will be staggered, so that only one tractor-trailer is at the site at any point in time. No truck queuing or staging will be allowed at or in the vicinity of the job site. Furthermore, no compression braking (i.e. jake braking) will be tolerated and all applicable traffic laws will be adhered to as defined in Seattle Municipal Code Title 11.

6.6 Pedestrian Mobility

The ELAM Group does not anticipate any disruptions to pedestrian mobility during the implementation of the proposed remediation construction project.

Pedestrian access must be maintained per the 10-2015 Pedestrian Mobility in and Around Work Zones Director's Rule (http://www.seattle.gov/transportation/drules.htm)

6.7 Street Closures

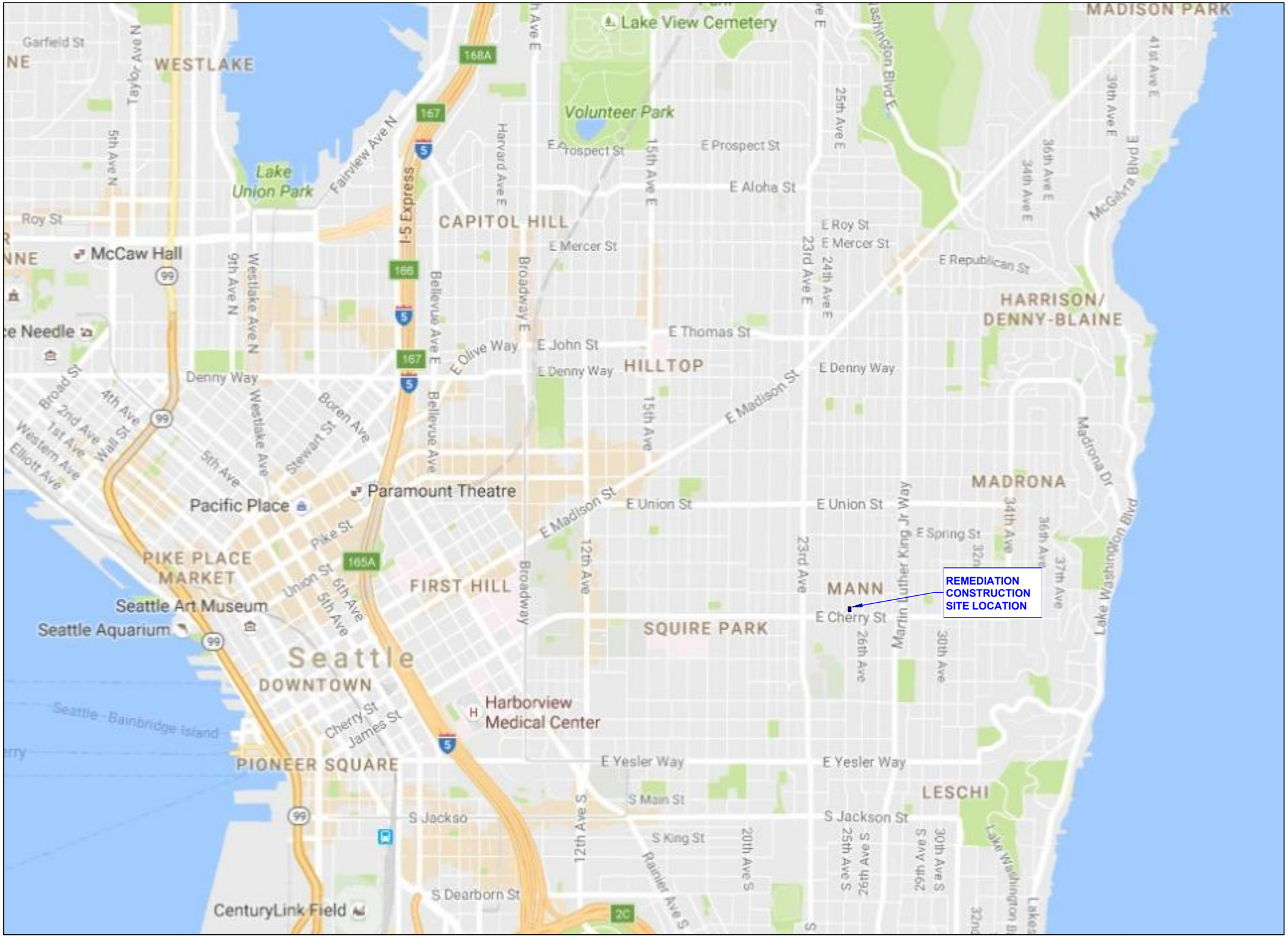
The ELAM Group does not anticipate any street closures (such as parking lane closures, bike lane closures, or travel lane closure) during the implementation of the proposed remediation construction project. However, The ELAM Group does anticipate using the adjacent alleyway for the loading and unloading of materials during the remediation construction project and the periodic closure of parking spaces proximal to the adjacent alleyway to assist with ingress/egress.

The ELAM Group will obtain the required Street Use Permit prior to scheduling work.

7. Traffic impacts and Traffic Operations Center Infrastructure

The ELAM Group does not anticipate any significant impacts to traffic infrastructure.

Figures



TheELAMGroup

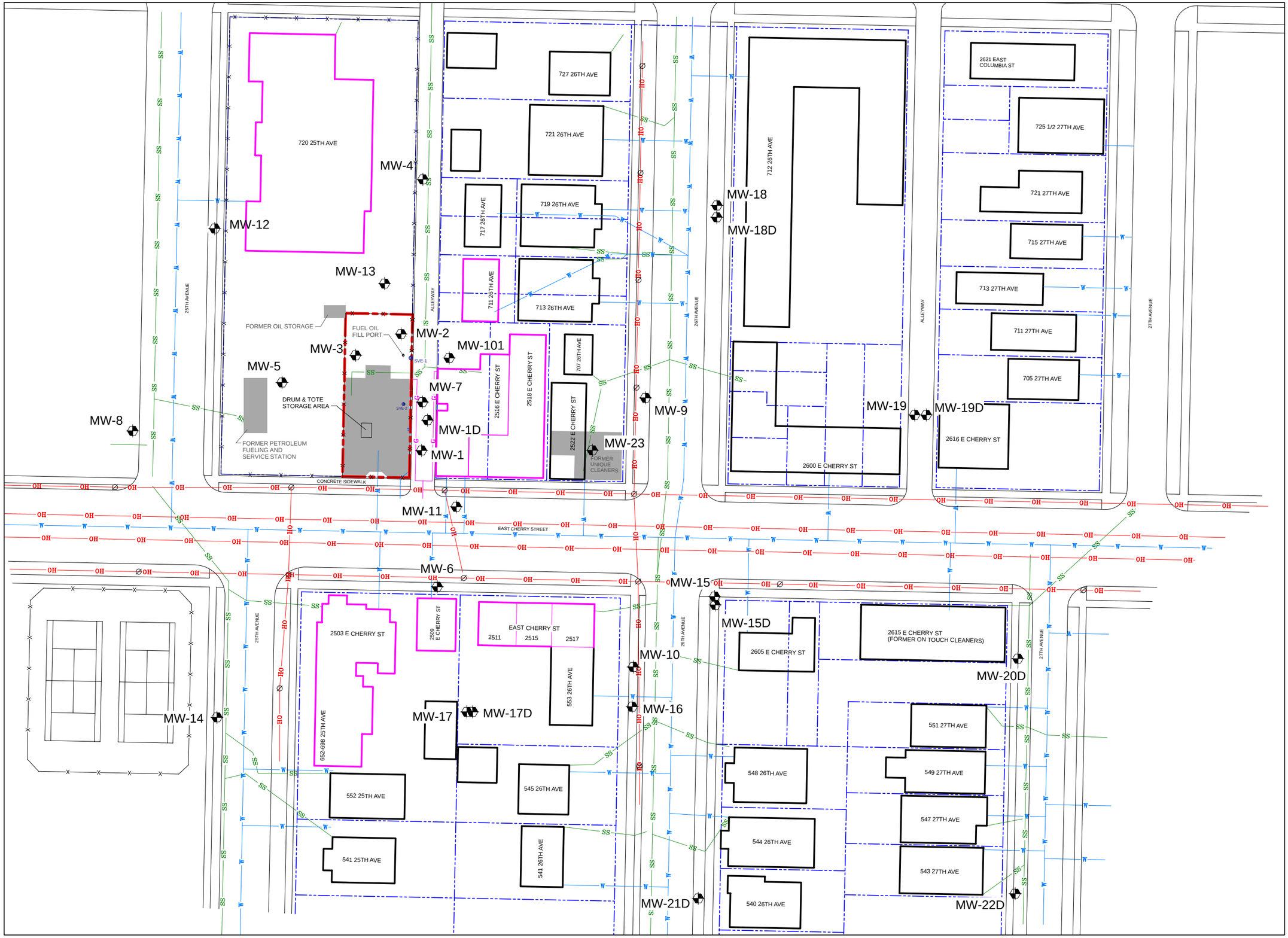
LEGEND

Remediation Construction Site

Notes:

0 750 1500 feet

Figure No: 1
Title: Site Location Map
Scale: 1" = 1,500'
Project No: WAKS2510C
Report: Construction Management Plan
Drawn by: The ELAM Group
Date: 5/31/18



TheELAMGroup

LEGEND

- Monitoring Well
- Soil Vapor Extraction Well
- SS — Underground Sanitary Sewer Line
- W — Underground Water Line
- G — Underground Natural Gas Line
- OH — Overhead Electric Line
- ∅ Utility Pole
- Former Building Location
- Vapor Intrusion Assessment Location

Notes:

N

0 30 60

Figure No:	2
Title:	Site Plan
Scale:	1" = 60'
Project No:	WAKS2510C
Report:	Construction Management Plan
Drawn by:	The ELAM Group
Date:	5/31/18

LEGEND

Approximate Site Boundary

Properties Within 300 Feet of Site

N

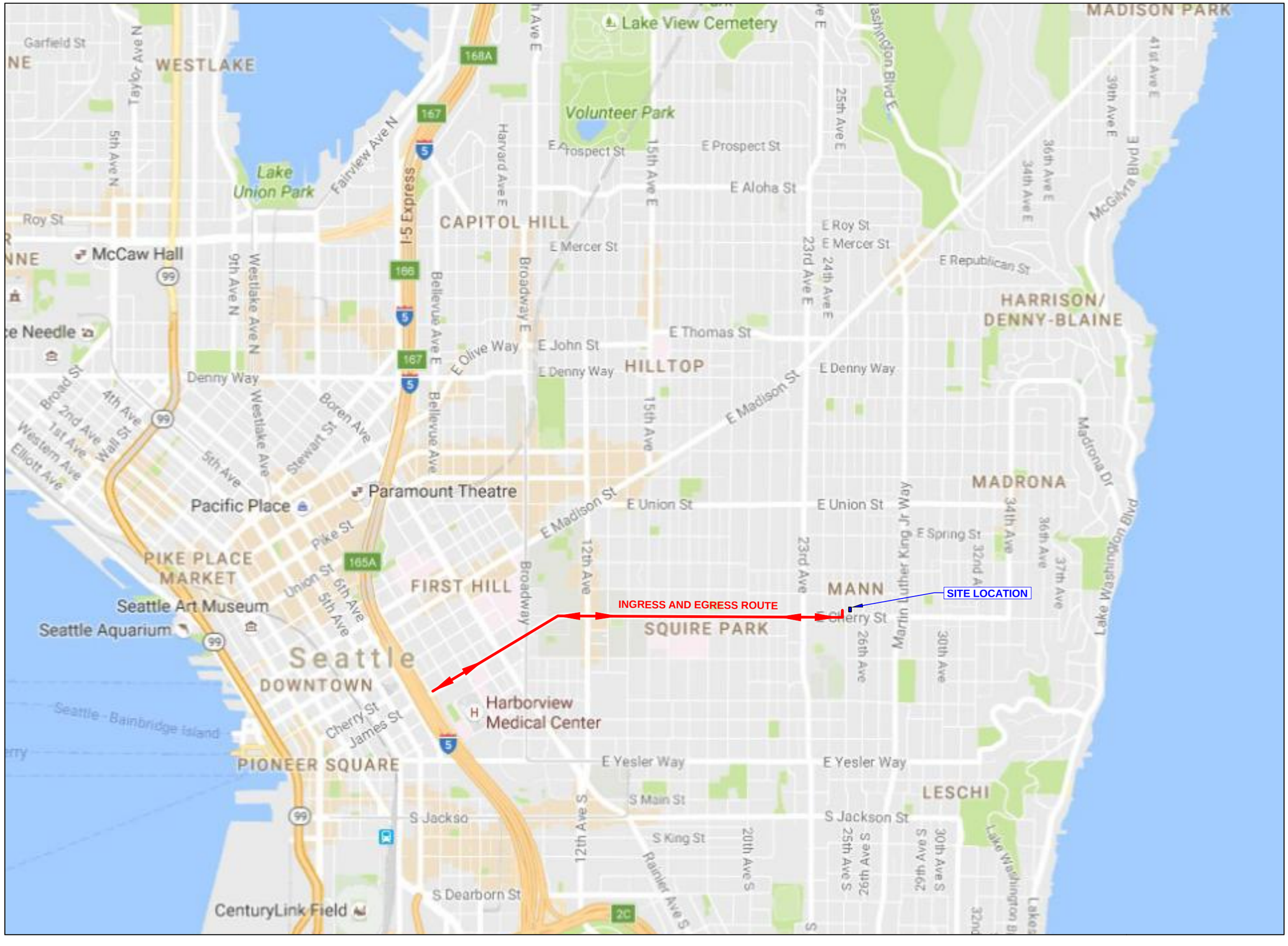
0 60 120 feet

STATE:	Washington
COUNTY:	King
PARCEL:	6840700250
TOWNSHIP LINE:	T25N
RANGE LINE:	R4E
SECTION:	33
CITY:	Seattle
ADDRESS:	2510 E Cherry Street
UTM Cooridinates:	10T 552637m E 5272993m N

Source: http://seattlecitygis.maps.arcgis.com

Figure No: 3
Title: Nearby Properties Map
Scale: 1:1,440 (1 in = 120 ft)
Project No: WAKS2510C
Report: Construction Mgmt Plan
Drawn by: The ELAM Group
Date: 8/22/18

TheELAMGroup



TheELAMGroup

LEGEND

Subject Site

Ingress/Egress Route

Notes:

N

0 750 1500 feet

Figure No:	4
Title:	Haul Route Between Interstate 5 and Site
Scale:	1" = 1,500'
Project No:	WAKS2510C
Report:	Haul Route Plan
Drawn by:	The ELAM Group
Date:	9/28/2018

TheELAMGroup

LEGEND

- Monitoring Well
- Fence
- Excavation Site Boundary
- Off-Site Property Boundary

Notes:

N

0 20 40

Figure No: 5
Title: Haul Route Near Site
Scale: 1" = 40'
Project No: WAKS2510C
Report: Haul Route Plan
Drawn by: The ELAM Group
Date: 9/28/2018

Appendix A.2

Haul Route Plan

TheELAMGroup

Email: info@elamusa.com
Website: www.elamusa.com
Twitter: @elam_usa
Tel: 888-510-ELAM
Fax: 317-567-9022

Haul Route Plan (Revision 2)

Master Use Permit 3018999
Former Cherry Street Cleaners
2510 E. Cherry Street
Seattle, Washington 98122

Prepared By
Chris Sloffer, CHMM

Reviewed By
Eric Peterson

Revised By
Chris Sloffer, CHMM

January 9, 2020

Table of Contents

Figures

1. Project Overview

1.1 Project Address

Former Custom Cherry Cleaners
2510 E. Cherry Street
Seattle, Washington 98122

King County Assessor Parcel #: 6840700205

A Site Location Map is provided as Figure 1 and a Site Plan is provided as Figure 2.

1.2 Site Development

The site is currently an undeveloped parcel. In order to remediate soil impacted by historical dry cleaning activities conducted at the property, The Environmental Liability & Asset Management Group, LLC ("The ELAM Group") proposes the following site preparation and remediation construction activities:

- ❏ Installation of site perimeter fencing to prevent access to the site
- ❏ Coordinate tree protection requirements with Urban Forestry [(206) 684-5693] at least 3 weeks prior to remediation construction activities
- ❏ Removal of one underground storage tank
- ❏ Grading of a maximum of 300 cubic yards of soil from the surface of the site for transportation off-site for disposal (maximum depth: 2 feet below current grade)
- ❏ Application of a chemical oxidation solution, concurrently with a soil stabilization amendment, to soil located between 2 and 10 feet below current grade via mechanical soil mixing
- ❏ Collection of soil confirmation samples
- ❏ Grading of a maximum of 75 cubic yards of clean backfill material to restore surface grade to original grade[1]
- ❏ Application of hydroseeding to stabilize clean backfill material

[1] The soil mixing procedure is anticipated to lead to mounding of mixed soil, therefore the amount of backfill required to restore the site to original grade is expected to be less than the volume removed for off-site disposal

1.3 Route between Site and Interstate

Tractor-trailer traffic from Interstate 5 will exit the Interstate onto James Street and travel east. James Street becomes E James Way and then becomes E Cherry Street. Prior to arriving at the site, tractor-trailer traffic will turn north on 25th Ave, then east on E Columbia St and then south into the alleyway located adjacent to the site.

Unloading/loading will occur in the alleyway adjacent to the site. Using the alleyway for unloading and loading will prevent tracking of debris onto city streets.

Once delivered materials are unloaded from (or waste materials are loaded onto) the tractor-trailer, the tractor-trailer can turn west onto E Cherry Street, which becomes E James Way and then James Street. From James Street, the tractor-trailer traffic can enter onto Interstate 5.

The Haul Route is shown on Figures 3 & 4.

1.4 Primary Trucking Company

The primary trucking company is Wyser Construction Company, Inc. located at 19015 109th Avenue SE, Snohomish, WA 98296. The phone number for Wyser Construction Company, Inc. is (425) 742-0898. The Onsite Supervisor is to be determined.

1.5 Anticipated Tractor-Trailer Traffic

Based on the scope of work presented in Section 1.2, The ELAM Group anticipates the following tractor-trailer traffic:

- ❏ Delivery/pickup of construction equipment
- ❏ Removal of UST
- ❏ Delivery of one load of fill material for void created during UST removal
- ❏ Removal of 2 loads of dangerous waste soil for transport to Subtitle C Facility
- ❏ Removal of 14 loads of waste soil for transport to Subtitle D Facility
- ❏ Delivery/pickup of storage containers
- ❏ Delivery of chemical oxidant reagent and soil stabilization amendment
- ❏ Delivery of water for preparing chemical oxidant solutions and equipment cleaning purposes

- ❏ Delivery of 4 loads of fill material restore surface grade to original condition

Arrival of tractor-trailers at the site will be staggered, so that only one tractor-trailer is at the site at any point in time. No truck queuing or staging will be allowed at or in the vicinity of the job site. Furthermore, no compression braking (i.e. jake braking) will be tolerated and all applicable traffic laws will be adhered to as defined in Seattle Municipal Code Title 11.

1.6 Construction Hours

The ELAM Group proposes conducting the remediation construction activities detailed in Section 1.2 during the following proposed work hours:

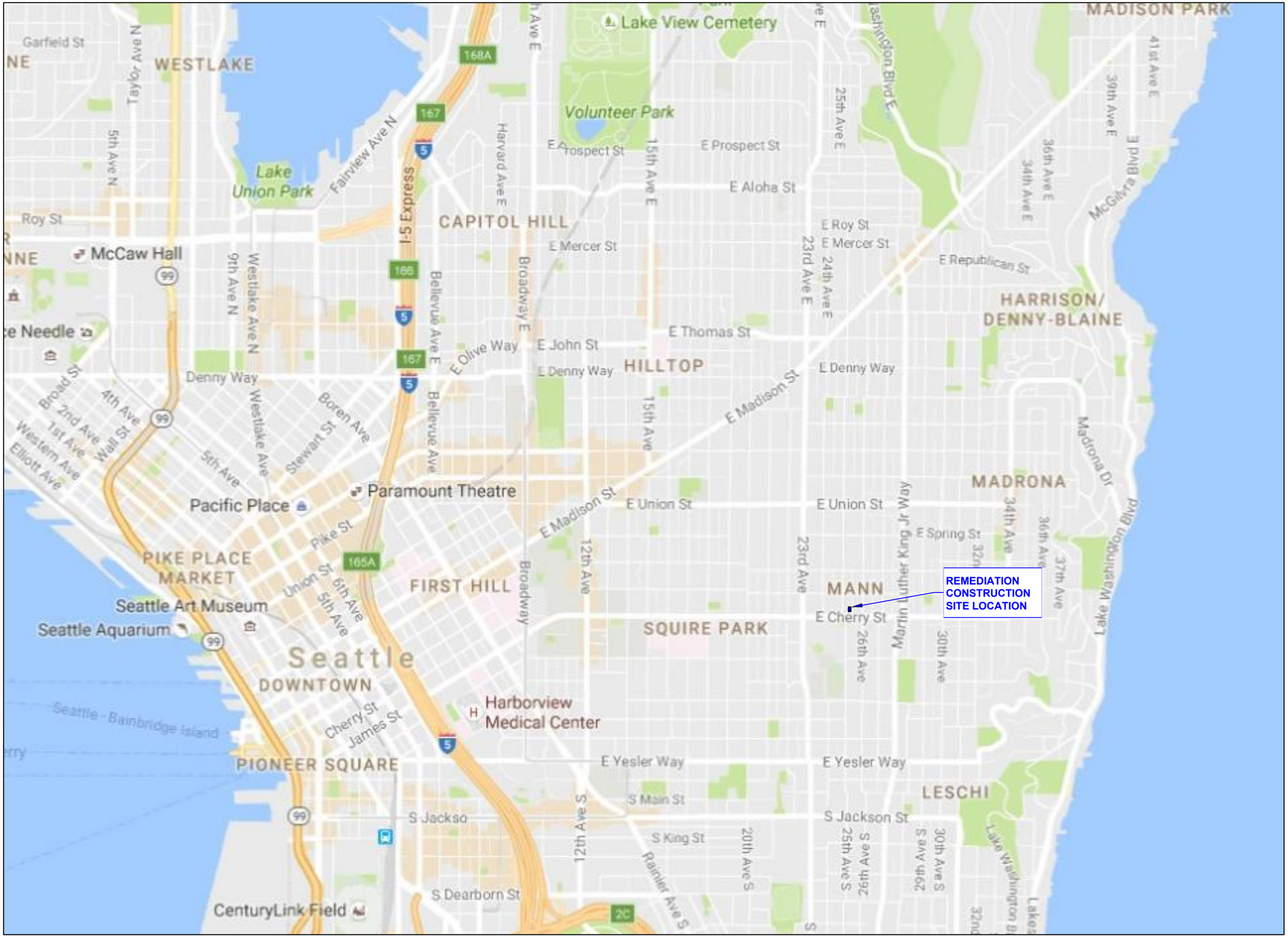
- ❏ Between 7:00 am and 6:00 pm on weekdays/non-legal holidays
- ❏ Between 9:00 am and 6:00 pm on Saturdays/legal holidays

1.7 Permits

The ELAM Group proposes to start the remediation construction project after receiving the following permits / approvals:

- ❏ Master Use Permit and Grading Permit
  - ❏ Construction Management Plan conditionally approved via email correspondence dated 9/6/18
- ❏ Contained Out Determination - for managing impacted soil
- ❏ Street Use Permit - for construction traffic and temporary closure of adjacent alleyway

Figures



TheELAMGroup

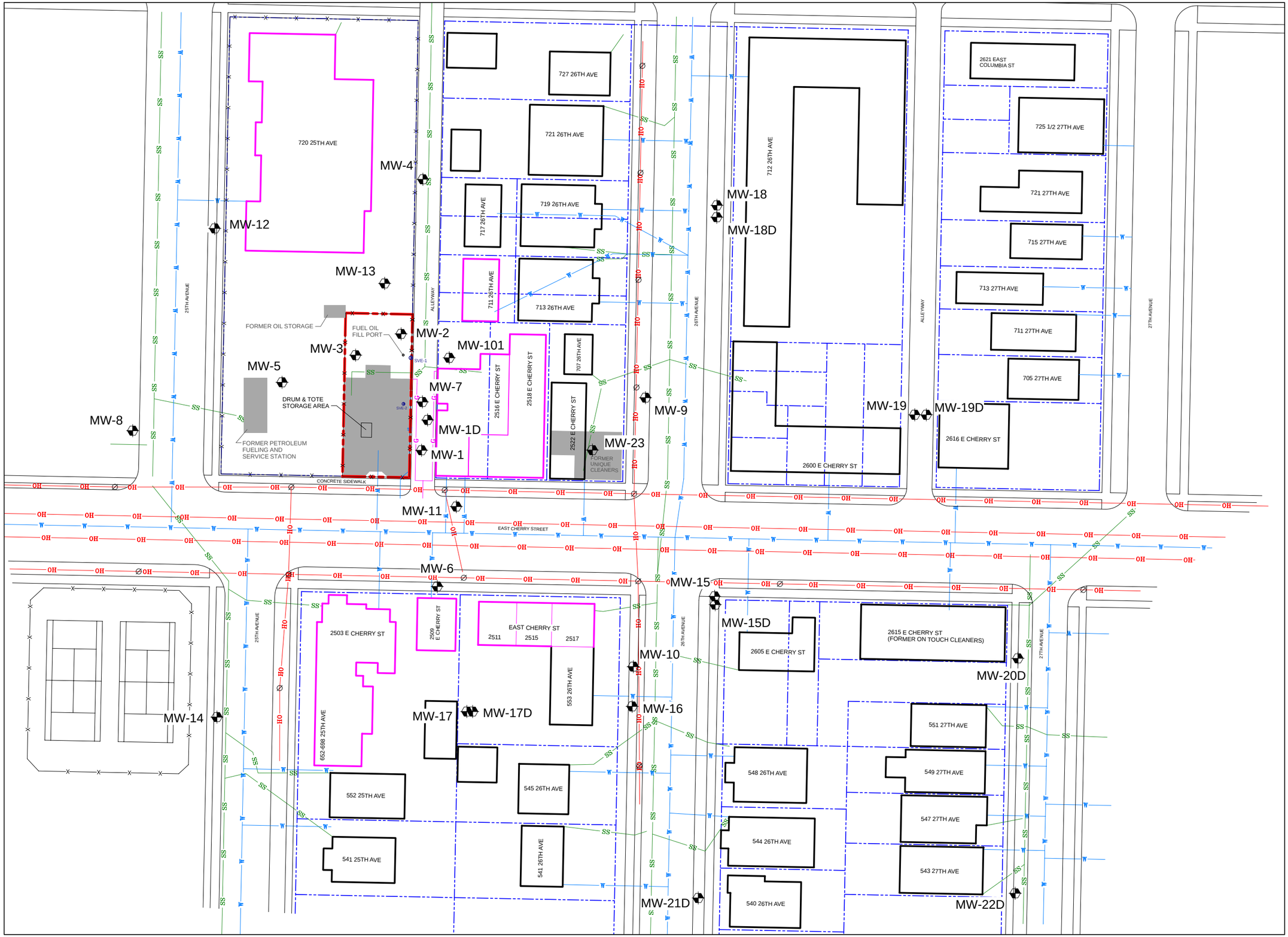
LEGEND

Remediation Construction Site

Notes:

0 750 1500 feet

Figure No: 1
Title: Site Location Map
Scale: 1" = 1,500'
Project No: WAKS2510C
Report: Haul Route Plan
Drawn by: The ELAM Group
Date: 5/31/18



TheELAMGroup

LEGEND

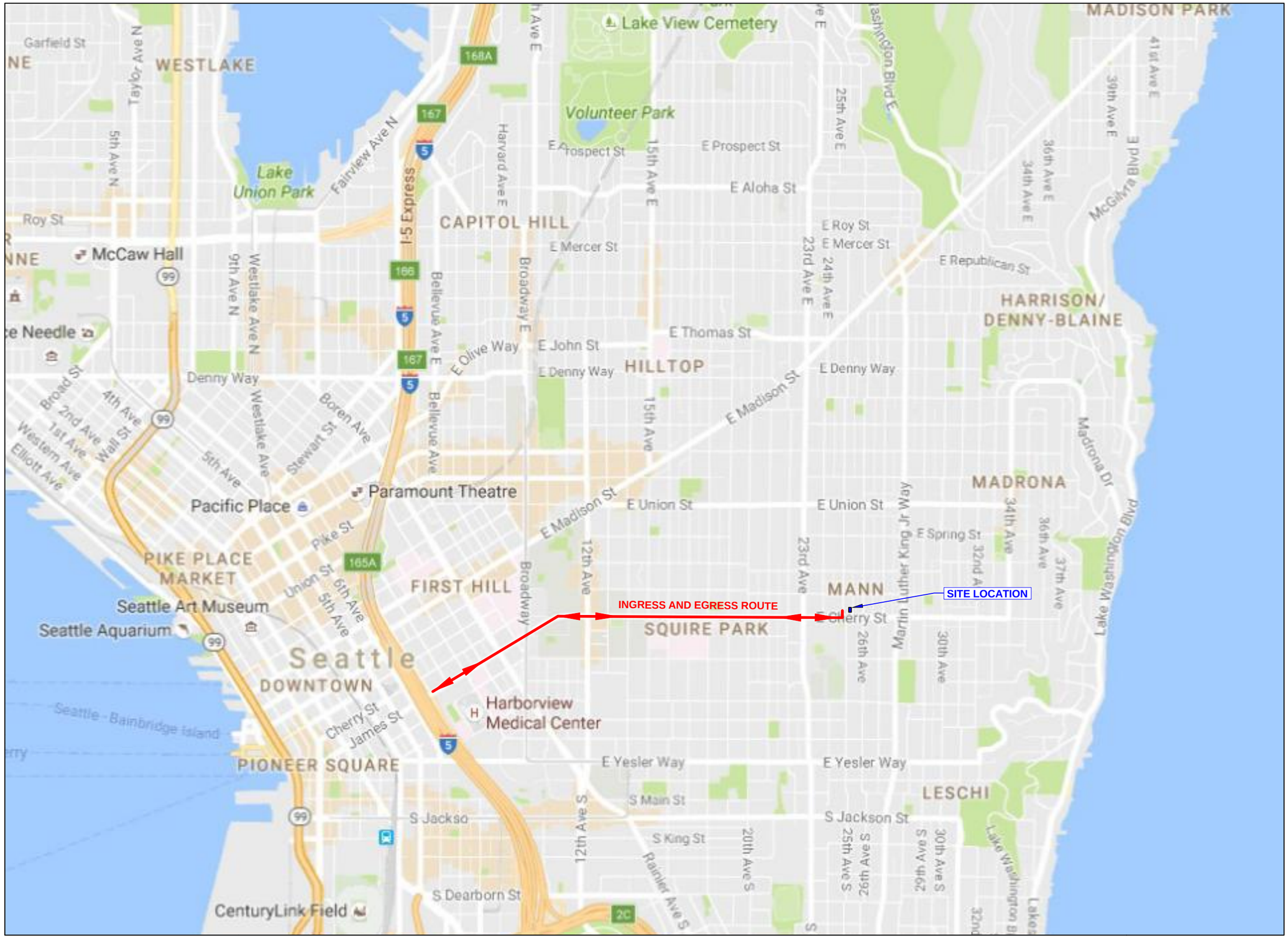
- Monitoring Well
- Soil Vapor Extraction Well
- SS — Underground Sanitary Sewer Line
- W — Underground Water Line
- G — Underground Natural Gas Line
- OH — Overhead Electric Line
- Utility Pole
- Former Building Location
- Vapor Intrusion Assessment Location

Notes:

N

0 30 60

Figure No:	2
Title:	Site Plan
Scale:	1" = 60'
Project No:	WAKS2510C
Report:	Haul Route Plan
Drawn by:	The ELAM Group
Date:	5/31/18



TheELAMGroup

LEGEND

Subject Site

Ingress/Egress Route

Notes:

N

0 750 1500 feet

Figure No:	3
Title:	Haul Route Between Interstate 5 and Site
Scale:	1" = 1,500'
Project No:	WAKS2510C
Report:	Haul Route Plan
Drawn by:	The ELAM Group
Date:	9/28/2018

TheELAMGroup

LEGEND

- Monitoring Well
- Fence
- Excavation Site Boundary
- Off-Site Property Boundary

Notes:

N

0 20 40

Figure No: 4
Title: Haul Route Near Site
Scale: 1" = 40'
Project No: WAKS2510C
Report: Haul Route Plan
Drawn by: The ELAM Group
Date: 9/28/2018

Appendix B

ISCO-ISS Bench Study Final Report

PeroxyChem

ISCO-ISS BENCH STUDY

IN SOIL FROM THE FORMER CHERRY STREET CLEANERS, SEATTLE, WA SITE

FINAL REPORT

Prepared for:

ELAM
161 Lakeview Drive, Suite B
Noblesville, IN 46060
P (888) 510-3526 x108

***Submitted by*:**
PeroxyChem
Project No.: PC 01942

April 2020

PeroxyChem

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Project Background

PeroxyChem Environmental Solutions conducted a bench-scale study to evaluate the combined remedial approach of in situ chemical oxidation (ISCO) with in situ stabilization (ISS) for the treatment of soil impacted with chlorinated volatile organic compounds (CVOCs). Impacted soil samples were collected from the site by ELAM. This report was prepared for ELAM and presents the results and data interpretation of the ISCO-ISS bench-scale study completed between January and April 2020.

1.2 Klozur® Persulfate Technology Background

Successful field applications of Klozur® Activated Persulfate have been performed globally. These applications demonstrate the ability of Klozur activated persulfate to treat diverse organic contaminants of concern including: chlorinated ethenes (TCE, PCE, DCE and vinyl chloride), chlorinated ethanes (TCA and DCA), chlorinated methanes (carbon tetrachloride and methylene chloride), BTEX, MTBE, polyaromatic hydrocarbons (PAHs), petroleum hydrocarbons (TPHs, GRO, DRO), 1,4-dioxane and pesticides.

When activated, Klozur persulfate generates a series of power radicals capable of treating most organic contaminants of concern. Depending upon the activation method, these radicals can include the sulfate radical ($SO_4^{-}\bullet$) and hydroxyl radicals ($OH\bullet$) two of the strongest oxidizing species available, superoxide radical ($O_2^{-}\bullet$), a reductant, giving Klozur® Persulfate the power to destroy the most recalcitrant of contaminants with oxidative, and reductive pathways. Selection of the correct activation method, however, depends on many factors, including: the target contaminants, lithology, hydrogeology, and other specific site conditions.

PeroxyChem always recommends activating persulfate to support effective chemical oxidation, attainment of remedial objectives and expedited site closure.

Activated Klozur persulfate can be combined with in situ stabilization (ISS) to reduce the contaminant mass, enhance the soil characteristics post soil mixing, and to minimize the contaminant mass flux from the treated area. The combination of ISCO and ISS occurs when Portland cement, bentonite, or other solidification compounds are blended in with the activated Klozur persulfate. The amount and type of solidification agent can be varied depending upon the desired soil characteristics

2. PROJECT OBJECTIVES

The aim of this bench-scale study was to assess ISCO-ISS. Specific objectives included:

- determination of:
    - soil oxidant demand/Klozur demand test (SOD/KDT);
    - base buffering capacity (BBC) of the soil;
    - loading parameters of persulfate, activator and stabilization agent;
    - the hydraulic conductivity and compressive soil strength post treatment;
    - the contaminant levels post treatment; and
- provision of a comprehensive final report.

3. BASELINE SAMPLING

3.1 Sample Receipt and Sampling

On January 23, 2020 two coolers were received. The soil samples consisted of two 4oz jars of clean soil and sixty 4oz jars of impacted site soil. The groundwater samples consisted of one liter of clean site groundwater and five 1L bottles of impacted site water. **Photo 1** below shows a few of the received soil samples.

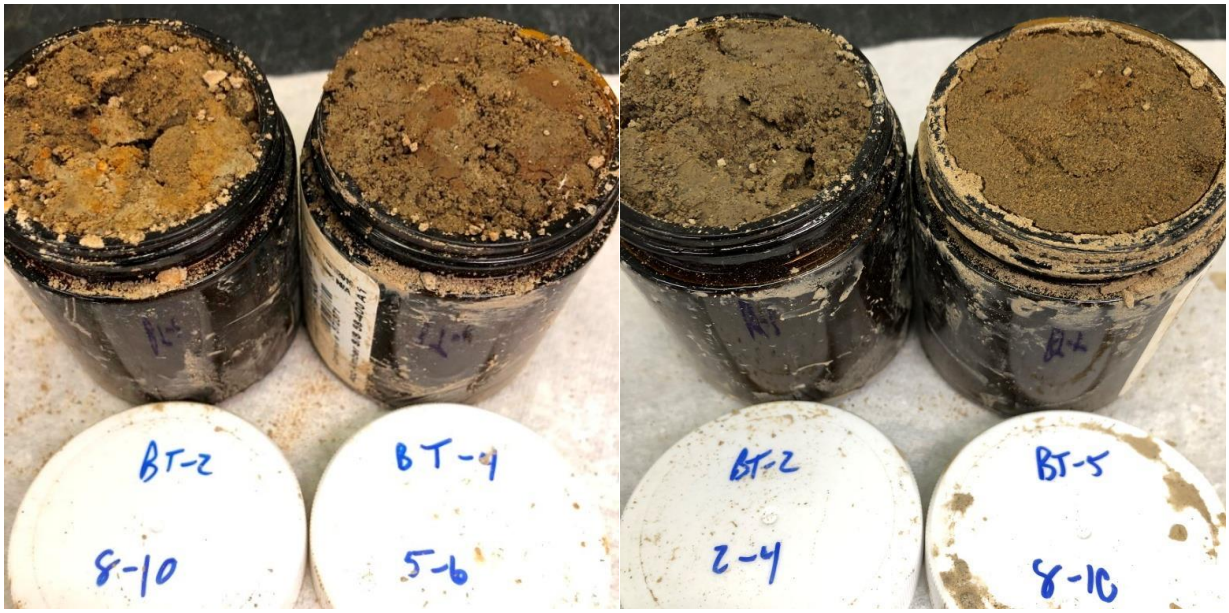


Photo 1: Contaminated soils as-received

All samples were placed into cold room storage upon receipt.

The composite groundwater was prepared by pumping the 5 x 1L bottles of MW-1 contaminated site groundwater into a Tedlar bag. The Site composite groundwater was sampled for VOCs (Method 8260), pH and oxidation reduction potential (ORP). After sampling, the composite groundwater was placed into cold room storage.

The contaminated soil was quickly transferred while removing stones to an anaerobic bag with the headspace removed and homogenized well. **Photo 2** below shows the homogenized soil.

Photo 2: Homogenized contaminated site soil

The homogenized soil was sampled in duplicate for VOCs (Method 8260) and pH. After sampling, the composite soil was placed into cold room storage. All samples were submitted to TestAmerica on ice via courier and under standard chain of custody. The pH and ORP were measured in-house using probes.

3.2 Results

The summary of results from the baseline sampling are shown below in **Tables 1 & 2**.

Table 1: Groundwater Baseline

Analysis	Parameter	Composite GW	Units
VOCs	2-Hexanone	30	µg/L
	Acetone	42 J	µg/L
	cis-1,2-Dichloroethene	3,100	µg/L
	Tetrachloroethene	330	µg/L
	trans-1,2-Dichloroethene	2.0 J	µg/L
	Trichloroethene	110	µg/L
	Total VOCs =	**3,614**	**µg/L**
Lab Parameters	pH	5.34	SI Units
	ORP	80	mV

J = Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table 2: Soil Baseline

Analysis	Parameter	Homogenized Soil	Homogenized Soil Dup	Units
VOCs	Tetrachloroethene	6.2	5.2	µg/Kg
	Total VOCs =	**6.2**	**5.2**	**µg/Kg**
	Total Average VOCs =	**5.7**		**µg/Kg**
Lab Parameters	Percent Solids	86.2	86.2	%
	pH (Slurry method)	7.36		SI Units

4 KLOZUR DEMAND TEST (KDT)

4.1 Background

Klozur® activated persulfate is a strong oxidant capable of reacting with a wide range of contaminants, including chlorinated solvents, petroleum hydrocarbons, polyaromatic hydrocarbons, gasoline additives, pesticides, and many others. Activation of the persulfate anion generates the sulfate radical, the primary species that drives the rapid destruction of the contaminants of concern. Activation can be accomplished by several methods: heat, transition metals, addition of hydrogen peroxide, or under alkaline conditions. Choice of the activation method will depend on the contaminant of concern and site characteristics.

The sulfate radical and reactive species in general can and will react with a wide assortment of compounds. As a result, activated persulfate will not only treat the contaminant of concern, but a portion of the oxidant will be used in oxidizing soil organics, reduced metals, and organic species that are not of concern. In addition, activated persulfate will undergo auto-decomposition, which will be a function of temperature, concentration and activation method. The demand upon the activated persulfate from all of these components is captured in a coarse screening test termed, “Klozur Demand Test”. It is dependent upon the site characteristics, such as the organic content of the soil, the mineral loading, and soil type and collectively must be considered for estimating the magnitude of oxidant dosing during field application.

The Klozur® Persulfate KDT test measures the loss of persulfate in the presence of soil, groundwater and activator over a period of 48 and 168 hours. The resulting KDT values can then be used as a guide to develop appropriate persulfate dosing for subsequent treatability testing and field applications. The KDT test is performed on clean soil collected from outside of the impacted area to obtain a measurement of the SOD independent of the demand from the contaminants.

4.2 Method

Client Sample Identification

Soil ID: BT-1, BT-2
GW ID: MW-8

Handling Procedures

- The soil was transferred into a stainless steel bowl and mixed well.
- The soil provided was a brown and sandy with no odor.
- On January 29, 2020, the tubes were prepared according to the PeroxyChem KDT protocol using the soil and groundwater provided.
- The experimental samples were stored at room temperature and each sample was inverted several times once per day.

4.3 Results

With alkaline activated Klozur persulfate an SOD value of 2.54 g Klozur SP/kg dry site soil was found after 48 hours. An SOD value of 4.81 g Klozur SP/kg dry site soil was found after 168 hours. Based on these results PeroxyChem recommends an SOD value of **4.8 g of Klozur / kg of dry site soil with** alkaline activated Klozur persulfate.

5. BASE BUFFERING CAPACITY

5.1 Method

On January 29, 2020, the standard base buffering capacity test was set up.

5.2 Results

The base buffering was calculated using the pH titration details and finding the amount of NaOH that would have been used to reach and maintain a pH of 10.5 for 7 days.

Calculated Site NaOH demand:

Clean soil & groundwater --> 1.47 g 25% NaOH/Kg dry soil

6. ISCO-ISS EVALUATION SET UP

6.1 Method

The ISCO-ISS Evaluation is intended to assess the treatment efficacy of a combined in situ chemical oxidation (ISCO) and in situ stabilization (ISS) treatment on the contaminants in the presence of the impacted soil provided to PeroxyChem. The test consisted of evaluating nine test conditions and two controls as outlined in **Table 3**.

Table 3: ISCO ISS Test Conditions

Condition	% by Soil Mass			Target Saturation
	Klozur SP	Portland Cement	25% NaOH	
0	0	0	0	90%
1	4	0	0.134	
2	1	2	0.034	125 - 150%
3	1	4	0.034	
4	2	4	0.067	
5	3	4	0.101	
6	1	6	0.034	
7	2	6	0.067	
8	4	6	0.134	
9	2	8	0.067	
10	4	8	0.134	

In consultation with ELAM, the decision was made to use DI water throughout the study and spike in Tetrachloroethylene (PCE) at a concentration of 120 µg/Kg soil. To this end, a 120 mg/L PCE stock solution was prepared in DI water.

Teflon bags with air removed were set up for the contaminant analysis to minimize volatilization of contaminants. Standard 2"x4" concrete molds were set up for the hydraulic conductivity and compressive soil strength tests.

For the controls, condition 0 & 1, the mass of soil was added first to the Teflon bag, then DI water followed by the PCE spike. The Klozur SP and 25% NaOH were added additionally to Condition 2 prior to PCE addition. For each condition, the blend was mixed well in the bag prior to PCE addition. The Teflon bags were then clamped shut and mixed well again. Soil moisture of 90% saturation was targeted. **Photos 3&4** show the Teflon bags after set up.

For the ISCO-ISS treatments, conditions 2-10, the soil, Klozur SP, 25% NaOH, Portland Cement and DI water were added to a stand mixer bowl and blended together using the paddle attachment. Soil moisture of 125 - 150% saturation was targeted for the mixture. The PCE spike was then added and quickly mixed well. A sub sample of the resulting mixture was quickly transferred to the Teflon bag. The bags were clamped shut with air removed. The remaining mixture was transferred to 2"x4" cylinder molds for hydraulic conductivity and compressive strength analysis.

The bags were stored at room temperature and in the dark. On day 14, the bags were sent to TestAmerica for VOC analysis. The cylinders were stored at room temperature and in the dark until they were sent for day 28 analysis to Geotesting Express for hydraulic conductivity and compressive soil strength measurements.

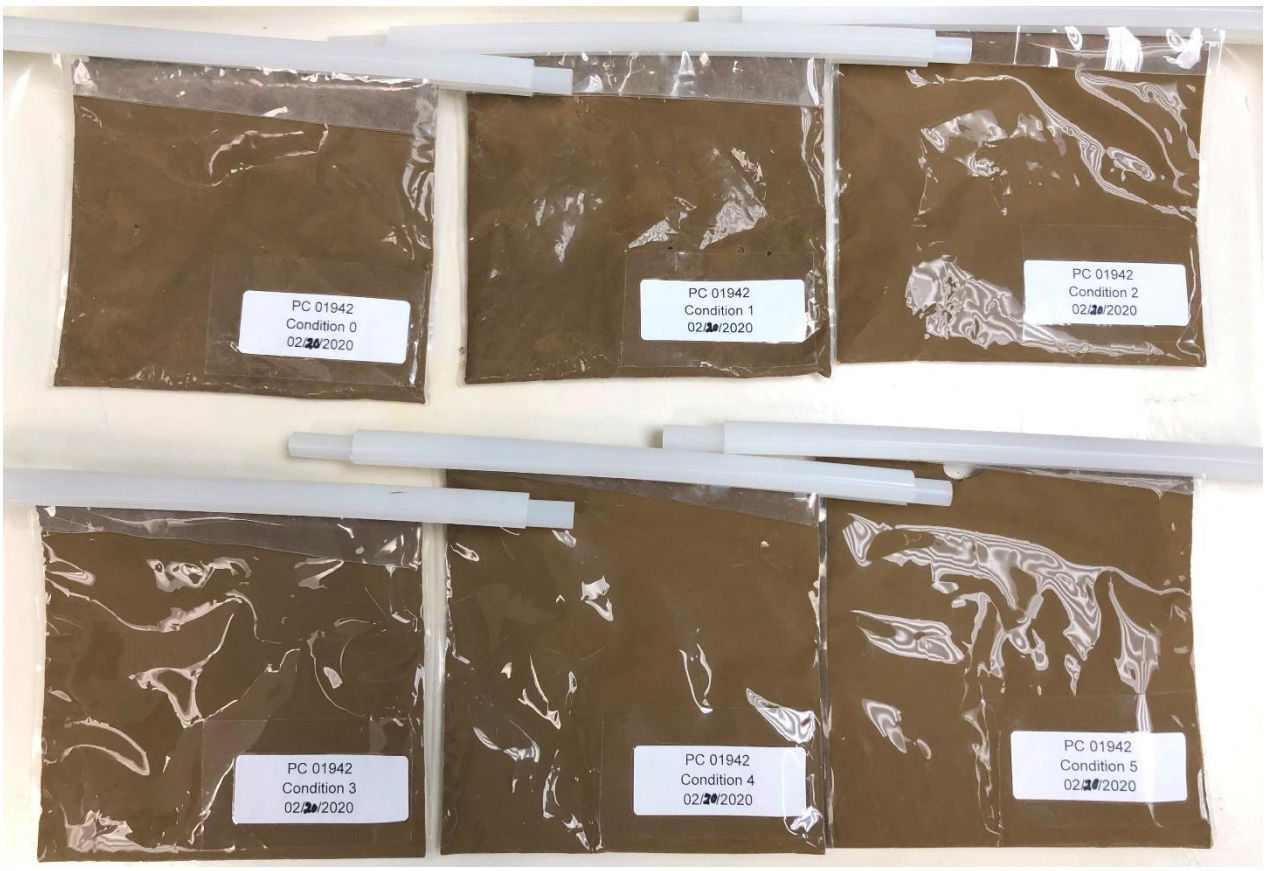


Photo 3: VOC bags after set up, conditions 0-5

Photo 4: VOC bags after set up, conditions 6-10

Full breakdown of component masses for set up are below in **Table 4.**

Table 4: Bag and Cylinder Set Up

Condition	% WHC	Mass (g)			Volume (mL)	Mass (g)	120 mg/L PCE stock solution (µL)
		Site Soil	DI H2O	Klozur SP	25% NaOH	PC	
0	90	200	15.0	0.00	0.000	0.0	200
1	90	200	15.0	8.00	0.211	0.0	200
2	137.5	1,350	267	13.50	0.361	27.0	1,350
3	137.5	1,350	294	13.50	0.361	54.0	1,350
4	137.5	1,350	294	27.00	0.712	54.0	1,350
5	137.5	1,350	294	40.50	1.074	54.0	1,350
6	137.5	1,325	301	13.25	0.355	79.5	1,325
7	137.5	1,325	301	26.50	0.699	79.5	1,325
8	137.5	1,325	287	53.00	1.398	79.5	1,325
9	137.5	1,300	301	26.00	0.686	104.0	1,300
10	137.5	1,300	301	52.00	1.372	104.0	1,300

6.2 Results

The summary of analytical data and lab parameters are below in **Table 5.** The consistently best CVOC treatment was observed in the 2 – 4% Portland Cement concentrations with 1 – 3% Klozur SP. Increased compressive soil strength was observed with increasing Portland Cement.

Table 5: Summary of Analytical Data

Condition	Day 14 Total CVOCs (µg/Kg)	Day 28 Compressive Soil Strength (psi)	Day 28 Hydraulic Conductivity @ 20°C (cm/sec)
0	13	Untestable	Untestable
1	20	Untestable	Untestable
2	3.8	5	2.5×10^{-6}
3	0.0	80	1.1×10^{-6}
4	3.5	55	7.4×10^{-7}
5	3.8	45	1.2×10^{-6}
6	3.6	120	1.7×10^{-7}
7	8.3	230	2.9×10^{-7}
8	6.2	155	2.8×10^{-7}
9	15	325	1.1×10^{-7}
10	5.4	345	3.6×10^{-6}

Table 6: Day 14, ISCO-ISS Evaluation Full VOC Contaminant Detection Results

			Condition										
		Control	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
		0% SP	4% SP	1% SP	1% SP	2% SP	3% SP	1% SP	2% SP	4% SP	2% SP	4% SP	
		0% PC	0% PC	2% PC	4% PC	4% PC	4% PC	6% PC	6% PC	6% PC	8% PC	8% PC	
Analysis	**Parameter**	0% Na(OH)	0.134% NaOH	0.034% NaOH	0.034% NaOH	0.067% NaOH	0.101% NaOH	0.034% NaOH	0.067% NaOH	0.134% NaOH	0.067% NaOH	0.134% NaOH	**Units**
VOCs	Tetrachloroethene	13	20	3.8	ND (2.8)	3.5	3.8	3.6	8.3	6.2	15	5.4	µg/Kg
	Total CVOCs =	**13**	**20**	**3.8**	**0.0**	**3.5**	**3.8**	**3.6**	**8.3**	**6.2**	**15**	**5.4**	**µg/Kg**
	% Removal of CVOCs =		**-53.8%**	**70.8%**	**100%**	**73.1%**	**70.8%**	**72.3%**	**36.2%**	**52.3%**	**-15.4%**	**58.5%**	
	2-Butanone (MEK)	ND (6.3)	21	81	120	160	160	120	98	61	ND (6.8)	22	µg/Kg
	Acetone	ND (25)	240	850	1,200	810	1,500	700	830	660	600	380	µg/Kg
	Bromomethane	ND (6.3)	4.5 J	ND (6.7)	ND (7.0)	ND (6.8)	ND (7.0)	ND (6.8)	ND (6.7)	ND (6.8)	ND (6.8)	ND (6.6)	µg/Kg
	m&p-Xylene	ND (5.0)	ND (4.9)	ND (5.4)	1.6 J	ND (5.4)	0.91 J	1.5 J	1.4 J	ND (5.5)	ND (5.4)	1.1 J	µg/Kg
	o-Xylene	ND (2.5)	ND (2.5)	ND (2.7)	1.0 J	ND (2.7)	ND (2.8)	1.1 J	0.90 J	ND (2.7)	ND (2.7)	ND (2.6)	µg/Kg
Lab Parameters	Percent Solids	79.5	80.9	74.2	71.1	74.1	71.8	73.1	75.1	73.1	73.4	75.9	%
	Initial Persulfate	NA	40.00	10.00	10.00	20.00	30.00	10.00	20.00	40.00	20.00	40.00	g/Kg
	Day 14 Residual Persulfate	NA	34.32	1.00	0.58	4.13	9.43	0.17	2.65	12.07	1.32	12.15	g/Kg
	% Persulfate Consumption =		**14.2%**	**90.0%**	**94.2%**	**79.3%**	**68.6%**	**98.3%**	**86.8%**	**69.8%**	**93.4%**	**69.6%**	
	pH (Slurry method)	7.47	3.74	10.77	11.69	11.42	11.09	11.81	11.74	12.00	11.88	11.89	SI Units

J = Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

7. OBSERVATIONS & CONCLUSIONS

In terms of % removal of CVOCs, test conditions 1 and 9 show negative percent removals. This likely arises from two factors:

- Spiking of soils. While precise aliquots of PCE stock solution are added to each treatment condition, the soil itself is not inherently homogeneous. Table 2 shows the homogenized soil duplicate results are in close agreement. This effectively rules out soil variability. In our experience, soil spiking with CVOCs is difficult to accomplish in a completely uniform manner under lab conditions.
- Insufficient base addition (condition 1). This is readily observed by the low pH in the day 14 results (Table 6).

Appendix C

Quality Assurance Project Plan

TheELAMGroup

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Quality Assurance Project Plan

Voluntary Cleanup Program ID: NW2009
Cleanup Site ID: 4175
Facility/Site ID: 4765174
Former Cherry Street Cleaners
2510 East Cherry Street
Seattle, WA 98122

Prepared By

Chris Sloffer, CHMM #12673

Reviewed By

James P. Hogan, RG #2848

June 25, 2020

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1 Introduction

The Environmental Liability & Asset Management Group, LLC (dba The ELAM Group) has prepared this *Quality Assurance Project Plan* ("QAPP") for the Former Cherry Street Cleaners ("Facility") located at 2510 E Cherry Street in Seattle, Washington. This QAPP was prepared for inclusion in the *Cleanup Action Plan* ("CAP), which is being furnished to the State of Washington Department of Ecology ("Ecology") in accordance with the reporting requirements of the Voluntary Cleanup Program ("VCP"). This QAPP is associated with the environmental investigation and remediation of the site, and details the objectives, sample design and procedures necessary to demonstrate that regulatory compliance has been achieved with regard to selected Constituents of Concern ("COCs").

The purpose of this document is as follows:

- ❏ Provide a structure to ensure data collected during site investigation activities meet project objectives and requirements
- ❏ Outline a Sampling and Analysis Plan ("SAP") that adequately characterizes potential impacts to soil, groundwater, emulsified oil substrate ("EOS"), soil gas and indoor air during remediation and closure activities

1.1 Facility Name

Former Cherry Street Cleaners
2510 East Cherry Street
Seattle, Washington 98122

1.2 Facility Location

The Facility is located at 2510 East Cherry Street in Seattle, Washington, as shown on Figures 1 and 2. Figure 1 is a topographic map and Figure 2 is a site plan depicting the site and surrounding land use.

1.3 Constituents of Concern

The following list of COCs for this site matches the historically observed COCs:

- ❏ Volatile Organic Compounds ("VOCs"), including the following:
  - ❏ Tetrachloroethene ("PCE")
  - ❏ Trichloroethene ("TCE")
  - ❏ cis-1,2-Dichloroethene ("cDCE")
  - ❏ Vinyl Chloride ("VC")

1.4 Responsible Agencies

This facility is managed through Ecology's VCP. The VCP contact for this facility is:

Mr. Christopher Maurer
Voluntary Cleanup Program ("VCP")
Washington Department of Ecology ("ECY")
P.O. Box 47600
Olympia, WA 98504-7600

christopher.maurer@ecy.wa.gov
(360) 407-7223

1.5 Project Organization

The key personnel and associated contact information are listed in Table 1-1 below.

Table 1-1. Key Personnel Contact Information and Responsibilities

Title	Name	Phone Number Email Address	Responsibilities
Ecology Site Manager	Christopher Maurer	(360) 407-7223 christopher.maurer@ecy.wa.gov	Ecology regulatory oversight
Ecology Quality Assurance Officer ("QAO")	Ecology Scientific Services	See Ecology Site Manager	Review data for quality assurance
Property Owner	Ms. Vera Benton	See PRP Designated Project Manager	PRP contact
PRP Designated Project Manager	James Hogan, RG #2848 The ELAM Group	(888) 510-3526 x102 james.hogan@elamusa.com	Oversee investigation and remediation activities
PRP QAO	James Hogan The ELAM Group	(888) 510-3526 x102 james.hogan@elamusa.com	Review data for quality assurance and quality control
PRP Field Team Leader	James Hogan The ELAM Group	(888) 510-3526 x102 james.hogan@elamusa.com	Direct field activities
Laboratory QAO	Timothy Sandager Pace Analytical Services, LLC	(612) 607-6456 timothy.sandager@pacelabs.com	Direct and report laboratory procedures and results
Laboratory QAO	Carolynne Trout Pace Analytical Services, LLC	(612) 607-6351 carolynne.trout@pacelabs.com	Direct and report laboratory procedures and results

2 Background

This section provides a brief description of the site, an operational history, a brief summary of previous inspections and investigations.

2.1 Site History

The former Cherry Street Cleaners facility is located at 2510 East Cherry Street, in Seattle, Washington, as shown on Figure 1. The former Cherry Street Cleaners business and property is owned by Ms. Vera Benton. The Facility consists of a 4,000 square-foot lot formerly developed with a 2,440 square-foot building, as shown on Figure 2. Electricity and telephone services were provided through overhead lines. Natural gas and water were provided through underground piping located beneath E Cherry St. Sanitary sewer was provided through underground piping located in the eastern adjoining alleyway. The building was razed, all utilities disconnected, and building foundation removed in July of 2013. A heating oil underground storage tank ("HOT") is currently located on the northern portion of the vacant lot.

2.2 Facility Investigation History

Several phases of investigation have been conducted to delineate the extent of chlorinated volatile organic compounds ("cVOCs")[1] in soil, groundwater and soil vapor/indoor air as summarized in the following table.

Year	Investigation Activity	Report Reference
2007	❑ Advanced soil boring B-1	ECC 2013
2008	❑ Advanced soil borings FB-1 through FB-10 ❑ Installed monitoring wells MW-1 through MW-10 and MW-10D	ECC 2013
2010	❑ Installed monitoring well MW-11 ❑ Installed additional SVE pilot study wells SVE-2 and VP-1 through VP-3	ECC 2013

[1] PCE and daughter products resulting from degradation of PCE include trichloroethene ("TCE"), cis-1,2-dichloroethene ("c-DCE") and vinyl chloride ("VC").

Year	Investigation Activity	Report Reference
2007	❑ Advanced soil boring B-1	ECC 2013
2008	❑ Advanced soil borings FB-1 through FB-10 ❑ Installed monitoring wells MW-1 through MW-10 and MW-10D	ECC 2013
2010	❑ Installed monitoring well MW-11 ❑ Installed additional SVE pilot study wells SVE-2 and VP-1 through VP-3	ECC 2013
2012	❑ Advanced soil borings SB-1 through SB-11 ❑ Installed monitoring wells MW-12 through MW-17 ❑ Conducted vapor intrusion assessments ("VIAs") at the following addresses: ❑ 2503 E. Cherry St. ❑ 2509 E. Cherry St. ❑ 2510 E. Cherry St. ❑ 2511 E. Cherry St. ❑ 2515 E. Cherry St. ❑ 2516 E. Cherry St. ❑ 2517 E. Cherry St. ❑ 2518 E. Cherry St. ❑ 720 E. 25th Ave. ❑ 711A E. 25th Ave.	ECC 2013
2013	❑ Advanced soil boring SB-21 ❑ Installed monitoring wells MW-15D, MW-17D, MW-18, MW-18D, MW-19, MW-19D, and MW-20D ❑ Conducted VIA at 720 E. 25th Ave.	ECC 2014
2014	❑ Advanced soil borings SB-12 through SB-20 and SB-22 through SB-37 ❑ Installed monitoring wells MW-21D, MW-22D, and MW-23	ECC 2014
2017	❑ Conducted VIAs at the following addresses: ❑ 720 E. 25th Ave. ❑ 2516 E. Cherry St. ❑ 2518 E. Cherry St.	ELAM 2017a ELAM 2017b
2018	❑ Conducted VIAs at the following addresses: ❑ 720 E. 25th Ave. ❑ 2516 E. Cherry St. ❑ 2518 E. Cherry St.	ELAM 2018a ELAM 2018b
2020	❑ Advance soil borings for collection of soil to be used in a bench test of Activated Persulfate ❑ Conducted VIAs at the following addresses: ❑ 720 E. 25th Ave. ❑ 2516 E. Cherry St. ❑ 2518 E. Cherry St.	Reported herein ELAM 2020a ELAM 2020b

2.3 Site Remediation History

Remediation activities have included pilot testing to evaluate the efficacy of air sparge ("AS") and soil vapor extraction ("SVE") technologies, injection of emulsified oil

substrate (“EOS”) to augment PCE bioremediation, and vacuum truck events to remove free-phase EOS that had sequestered PCE, as summarized in the table below.

Year	Remediation Activity	Report Reference
2008	❑ Completed AS/SVE pilot study testing using wells SVE-1 and MW-1D ❑ An AS/SVE system was not installed	ECC 2013
2010	❑ Completed an additional pilot study for SVE using SVE-2 and VP-1 through VP-3 ❑ Injected a total of 3,465 gallons of EOS into wells IW-1 through IW-28, MW-1, MW-2, MW-3, and MW-7 ❑ 2,310 gallons of EOS were injected into the wells within the property boundary ❑ 1,155 gallons of EOS were injected into the wells outside the property boundary	ECC 2013
2012	❑ Completed groundwater monitoring for four consecutive quarters in 2012 and 2013 as part of the EOS performance monitoring	ECC 2013
2013	❑ Demolished site building ❑ Used vacuum truck to remove 75 gallons of EOS from subsurface in 4Q	ECC 2014
2014	❑ Used vacuum truck to remove 75 gallons of EOS in 2Q and 120 gallons of EOS in 3Q	ECC 2014
2016	❑ Used vacuum truck to remove 25 gallons of EOS in 4Q ❑ 1st of four consecutive EOS performance monitoring events	ELAM 2019
2017	❑ Used vacuum truck to remove a total of 80 gallons of EOS during three events ❑ 2nd, 3rd and 4th of four consecutive EOS performance monitoring events	ELAM 2019
2018	❑ Used vacuum truck to remove 6 gallons of EOS in 1Q	ELAM 2019
2020	❑ Used vacuum truck to remove 25 gallons of EOS in 1Q	ELAM 2020e

3 Project Data Quality Objectives

3.1 Project Objectives and Problem Definition

This section discusses the Data Quality Objectives ("DQOs") for the work to be conducted at the site. The identified COCs and sampling media were developed based on past site inspections and history. Information and data obtained from the site and surrounding areas are used to quantify potential risks and develop remedial options.

3.2 Data Quality Objectives

DQOs are quantitative and qualitative criteria upon which project decisions are based. DQOs are based on USEPA guidance[2] and generally cover the following items:

- ❏ Describe the problem to be investigated
- ❏ Identify what questions the study will attempt to answer, what actions (decisions) may result, and who the primary decision maker is
- ❏ Identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement(s)
- ❏ Define study boundaries, and when and where data should be collected

The qualitative DQOs are summarized in Table 3-1 and the quantitative DQOs are summarized in Table 3-2 and Table 3-3, which are located on the following pages.

[2] USEPA, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process,* EPAQA/G-4, EPA/240/B-06/001: https://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf (URL last verified 6/25/20).

Table 3-1. Data Quality Objectives for Site Investigation

Step	Description
1 State the Problem	Contaminants of Concern ("COC") are present in soil, groundwater, EOS and soil gas at concentrations exceeding Washington Administrative Code ("WAC") Model Toxics Control Cleanup Act ("MTCA") Cleanup Levels. At the conclusion of remedial activities, confirmatory soil samples will be collected to establish the effectiveness of remediation. Groundwater samples will be collected during the performance monitoring period following remediation to establish post-remediation COCs concentration trends following source area treatment.
2 Identify the Decision	Determine if COCs are present in soil and groundwater at concentration above or below MTCA Cleanup Levels following completion of remedial activities.
3 Identify Inputs to the Decision	❑ Previous site inspection records ❑ Local hydrogeology ❑ Site and surrounding land use ❑ Visual inspections ❑ Laboratory analysis of characterization samples
4 Define the Boundaries	Geographic: The Facility is currently a 4,000 square foot vacant lot and impacts to groundwater extend approximately 130 feet to the north, approximately 300 feet to the southeast, and approximately 90 feet to the south and west.
5 Develop a Decision Rule	If levels of detected COCs exceed an applicable MTCA Cleanup Levels, an Institutional Control may be needed to prevent potential exposure to residual cVOC impacts and/or vapor mitigation measures may need to be implemented.
6 Specify Limits on Decision Errors	Limits on the decision errors are not needed because the COC concentrations for each sample will be compared to the appropriate regulatory levels.
7 Optimize the Design for Obtaining Data	Monitoring well and confirmatory soil sample locations are specified in the CAP

The Ecology Cleanup Levels and Risk Calculation ("CLARC") Unrestricted Land Use Table was utilized to determine MTCA Cleanup Levels. Contaminant concentrations detected in soil, groundwater, and soil vapor/indoor air at the Facility will be compared to MTCA Cleanup Levels, as summarized below.

Table 3-2. Chemicals of Concern, Laboratory Limits and Screening Levels

Medium	MTCA Cleanup Level	PCE	TCE	c-DCE	VC
Soil	Method A / Method B	0.05 / 480 (mg/kg)	0.03 / 1.2 (mg/kg)	NA / 160 (mg/kg)	NA / 240 (mg/kg)
Groundwater	Method A / Method B	5.0 / 21 (µg/L)	5.0 / 5.4 (µg/L)	NA	0.2 / 0.029 (µg/L)
Soil Gas	Method B	160 (µg/m^3)	NA	NA	NA
Indoor Air	Method B Carcinogenic / Method C Carcinogenic	9.6 / 40 (µg/m^3)	NA	NA	NA

NA = Not Applicable, since cleanup standard is not established
mg/kg = milligram per kilogram
µg/L = micrograms per liter
µg/m^3 = micrograms per cubic meter

3.3 Data Quality Indicators and Measurement Quality Objectives

The following definitions are used to establish Data Quality Indicators ("DQIs") for the field and laboratory analyses.

- Accuracy is the closeness of agreement between an observed value and an accepted reference value. The difference between an observed value and the reference value includes components of both systematic error (bias) and random error. Laboratories assess the overall accuracy of their instruments and analysis methods (independent of sample or matrix effects) through the measurement of "standards," which are materials of accepted reference values. Accuracy will vary from analysis to analysis because of individual sample and matrix effects. In an individual analysis, accuracy can be measured and expressed in terms of the recovery of surrogate compounds (organic analyses) or recovery of spiked

compounds (inorganic analyses). This gives an indication of expected recovery for analytes tending to behave chemically like the spiked or surrogate compounds.

- ❏ Precision is the agreement among a set of replicate measurements without consideration of the "true" or accurate value, i.e., variability between measurements of the same material for the same analyte. Precision is measured in a variety of ways, including statistically, such as calculating variance or standard deviation.
- ❏ Completeness is defined as the percentage of measurements made that are judged to be valid measurements.
- ❏ Representativeness expresses the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, process condition, or an environmental condition. Representativeness is a qualitative parameter, which is dependent upon the proper design of the sampling program and the laboratory QC protocol.
- ❏ Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This goal is achieved through using standard techniques to collect and analyze representative samples and reporting analytical results in appropriate units.

3.4 Data Review and Validation

Data review will be conducted in accordance with The ELAM Group's data management procedures.

3.5 Data Management Procedures

The following section provides The ELAM Group's data management procedures on document data management, field data management and document preparation and control. This information is provided along with details of The ELAM Group's procedures to be followed during data collection, management and presentation.

3.5.1 Data Recording

The ELAM Group has a paperless data storage policy. In this regard, The ELAM Group's official data documentation are secured electronically through an encrypted server. All field data, forms, and analytical reports will thus be provided to The ELAM Group electronically and stored on a secure data server to allow for document preparation, storage, retrieval, and control.

Each data form or document (e.g., boring logs, tables, and figures) will be checked for accuracy after completion by a licensed or certified professional. Analytical data summary tables will contain the sample name, sample location (including depth for soils), sampling date, and analytical results.

3.5.2 Data Reduction

Field data such as groundwater levels or field measured parameters and procedures, will be reduced to determine information such as water elevation, aquifer yield, or the conditions under which field data was obtained. Calculations will be reviewed for accuracy by an independent licensed or certified peer reviewer before submittal of the final report.

The analytical laboratory will perform data reduction and verification for the analysis it performs. Data reduction for field screening and aqueous parameter analysis will be performed in accordance with the analytical procedures or methodologies consistent with the equipment utilized.

3.5.3 Data Transmission

Field samples will be submitted to an accredited analytical laboratory and the result received by The ELAM Group in electronic format. The ELAM Group's data manager will review the data within 1 week of receipt and advise on any necessary actions required to rectify errors.

3.5.4 Data Analysis

Once the data are properly uploaded into The ELAM Group data management system, the data will be used to interpret site conditions. Multiple data tables may be produced for internal and / or external use for evaluating site conditions and planning for additional site activities.

3.6 Assessment Oversight

Three levels of data verification shall be employed for site work, as follows:

- ❏ Sample collection
- ❏ Data documentation and data management system entry
- ❏ Report generation processes

Data which does not meet the DQO of the project will be flagged or qualified in The ELAM Group's data management system during the data validation process.

4 Sampling and Analysis Plan

For each activity that will involve the screening or collection of samples, the following will be described:

- ❏ Sample locations
- ❏ Media to be sampled
- ❏ Analytes (COCs)
- ❏ Sampling rationale

4.1 Soil Sampling

4.1.1 Site Investigation Soil Samples

Site Investigations have been completed. Any additional site investigation soil borings may or may not be advanced into the first saturated zone, which is expected to be encountered at a depth of approximately 30 feet below grade, based on previous investigations. Each soil boring will be continuously logged and sampled in accordance with Ecology guidelines.

In an attempt to bias the soil sample data to the soil most likely to be impacted with COCs while also evaluating the exposure pathways for direct contact and groundwater ingestion, soil samples may be submitted to a laboratory for chemical analysis of VOCs using the following general criteria:

- ❏ One sample with the highest total organic vapor ("TOV") measurement within 15 feet of the surface (regardless of saturation) for comparison to soil MTCA Cleanup Levels associated with the direct contact exposure pathway
- ❏ One sample with the highest TOV measurement above first saturated zone encountered (regardless of depth) for comparison to soil MTCA Cleanup Levels associated with the migration to groundwater exposure pathway
- ❏ Any additional interval requested by the designated PM, based on field observations

One soil sample interval may satisfy both of the first two criteria listed above. However, more than one soil sample interval may be required to satisfy each of the above criteria.

Soil samples and associated quality assurance/quality control ("QA/QC") samples will be analyzed for the COCs listed in Section 1.3. QA/QC samples will include field duplicates, matrix spike ("MS") and matrix spike duplicate ("MSD") samples collected at a rate of one QA/QC sample per 20 investigative samples. Additionally, a laboratory-supplied trip blank will accompany any VOC samples from time of collection until time of laboratory analysis. The trip blank sample will only be analyzed for VOCs.

Soil samples for VOC analysis will be collected in accordance with Method 5035A. Additional details regarding field screening and soil sampling procedures are provided in Section 6.2 and 6.3, respectively.

4.1.2 Confirmatory Soil Samples

Confirmatory soil samples will be collected as specified in the CAP. Soil samples and associated quality assurance/quality control ("QA/QC") samples will be analyzed for the COCs listed in Section 1.3. QA/QC samples will include field duplicates, matrix spike ("MS") and matrix spike duplicate ("MSD") samples collected at a rate of one QA/QC sample per 20 investigative samples. Additionally, a laboratory-supplied trip blank will accompany any VOC samples from time of collection until time of laboratory analysis. The trip blank sample will only be analyzed for VOCs.

Soil samples for VOC analysis will be collected in accordance with Method 5035A. Additional details regarding field screening and soil sampling procedures are provided in Section 6.2 and 6.3, respectively.

4.2 Groundwater Sampling

4.2.1 Site Investigation - Borehole Grab Samples

In order to obtain groundwater data for screening purposes, borehole sampling will be completed in the saturated interval most likely to exhibit impacts. Additionally, groundwater elevation measurements will be collected where feasible. A laser level and

survey rod will be used to survey the top-of-casing ("TOC") elevation and ground elevation to the nearest 0.01 feet at each location.

After installation, each borehole will remain undisturbed for a minimum of one hour to allow the water level to equilibrate to atmospheric conditions. Prior to collecting a groundwater sample for laboratory analysis, each borehole will be purged with a bailer, peristaltic pump, or tubing and check valve to remove a minimum of one well volume of water.

Groundwater samples and associated QA/QC samples will be analyzed for the COCs listed in Section 1.3. QA/QC samples will include field duplicates and MS/MSD samples collected at a rate of one QA/QC sample per 20 investigative samples. Additionally, a laboratory-supplied trip blank will accompany the samples from time of collection until time of laboratory analysis. The trip blank sample will be analyzed for VOCs only.

To minimize VOC loss due to volatilization during sampling, samples for VOC analysis from boreholes will be collected with a bailer.

4.2.2 Permanent Monitoring Well Grab Samples

In order to obtain groundwater data for screening and performance monitoring purposes, permanent monitoring wells will be completed in the saturated interval most likely to exhibit impacts. Additionally, groundwater elevation measurements will be collected. A laser level and survey rod will be used to survey the top-of-casing ("TOC") elevation and ground elevation to the nearest 0.01 feet at each location.

After installation, each permanent monitoring well will be developed and then remain undisturbed for a minimum of 24 hours. Prior to collecting a groundwater sample for laboratory analysis, each permanent well will be purged with a bladder pump using low-flow methodology to determine when a representative sample should be collected.

Groundwater samples and associated QA/QC samples will be analyzed for the COCs listed in Section 1.3. QA/QC samples will include field duplicates and MS/MSD samples collected at a rate of one QA/QC sample per 20 investigative samples. Additionally, a laboratory-supplied trip blank will accompany the samples from time of collection until time of laboratory analysis. The trip blank sample will be analyzed for VOCs only.

To minimize VOC loss due to volatilization during sampling, samples for VOC analysis from permanent monitoring wells will be collected using low-flow methodology.

4.3 Soil Gas Sampling

In order to determine the risk posed by potential COC vapors in both exterior soil gas (SGe) and/or sub-slab soil gas (SGss), soil gas sampling may be conducted. Soil gas samples and associated QA/QC samples will be analyzed for VOCs by USEPA Method TO-15.

4.4 Indoor Air Sampling

In order to address potential vapor intrusion ("VI") exposure pathways resulting from the potential migration of COCs in soil gas into indoor air, indoor air sampling may be conducted in conjunction with SGe and/or SGss, where applicable. Indoor air samples and associated QA/QC samples will be analyzed for VOCs by USEPA Method TO-15.

4.5 EOS Sampling

In order to determine the risk posed by potential COC present in free-phase EOS at the site, EOS sampling may be conducted. EOS samples will be analyzed for VOCs by USEPA Method 8260, as a solid.

5 Request for Analyses

The following section presents the analytical support for the project, which includes the following:

- ❏ Requested analysis
- ❏ Constituents of concern ("COCs")
- ❏ Laboratory which will conduct the analysis
- ❏ Available resources
- ❏ Turnaround times for analytes

The analytical parameters for laboratory analysis are presented in Table 5-1 below.

Table 5-1. Requested Laboratory Analytical Parameters

Analytical Parameter	EPA Method Reference
Volatile Organic Compounds (VOCs)	USEPA Methods 8260 or TO-15

5.1 Analyses Narrative

Normal sample turnaround times are anticipated for the sample analysis. There are not specific QC requirements or modified sample preparation techniques required under this QAPP. The analysis requested will be the analytical laboratory requirements for the parameters requested. The analytical methods, containers, preservation and holding time requirements for analytes are summarized in Table 5-2, located on the following page.

Table 5-2. Analytical Method, Containers, Preservation and Holding Times Requirements for Analytes

Analytical Parameter and/or Analytical Method Number	Media	Containers (number, type, size/volume)	Preservation Requirements (chemical, temperature, light protection)	Maximum Holding Times
VOC EPA Method 8260 (collected via Method 5035)	Soil	Three 40-mL tared vial + jar for % moisture	None, 4° C/ freeze within 48 hrs	14 days
VOC EPA Method 8260	Groundwater	Three 40-mL glass vials	HCL, 4° C	14 days
VOC EPA Method TO-15	Air	1 liter or 6 liter Summa Canister	None	30 days

5.2 Analytical Laboratory

The analytical laboratory retained for analysis of chemicals in soil and groundwater is Envision Laboratories, Inc. The point of contact at the laboratory is:

Timothy Sandager
Pace Analytical Services, LLC
1700 Elm Street SE
Minneapolis, MN 55414
Phone: (612) 607-6456
Fax: (612) 607-6444
E-mail: timothy.sandager@pacelabs.com

The laboratory quality assurance plan and standard operating procedures are incorporated into this QAPP by reference, as summarized in Table 5-3 below.

Table 5-3. Location of QA and SOP Documents

QA Protocol	Appendix
Pace Analytical Services, LLC	Appendix A

6 Field Methods and Procedures

6.1 Field Equipment

Below is a list of field equipment and materials needed for sampling of soil and groundwater

6.1.1 List of Equipment Needed

Table 6-1. Field and Sampling Equipment

Description of Equipment	Dedicated (Yes/No)	See Section
Personal protective equipment (“PPE”)	no	See Health and Safety Plan
Decontamination Supplies	yes	7
Soil and Groundwater Sampling Vials/Jar	yes	5.1
Sample Log Sheets	yes	8
Sample labels/tags	yes	8
Coolers, ice packs	no	8
Sampling bowls and equipment	no	6.0
Plastic disposable trowels	yes	6.0
Self-leveling survey equipment	no	6.4
Peristaltic pump	no	6.4
Interface probe	no	6.4
Trash bags	no	8.0
Photoionization Detector (“PID”)	no	6.2, 6.3
Sampling tool (knife, corer, spatula, etc)	no	6.6
Disposable low lint wipes for cleaning tools	yes	6.6
Silicone caulk or appropriate sealant	no	6.6

6.1.2 Calibration of Field Equipment

Field equipment will be calibrated prior to use according to the manufacturer's instructions and recommendations.

6.2 Field Screening

Each soil boring will be advanced to groundwater with the assistance of Geoprobe dual-tube sampling equipment. During the advancement, soil will be retrieved continuously throughout the entire borehole depth with dedicated, disposable Geoprobe acetate liners of 4 or 5-feet in length.

The retrieved samples will be evaluated for the presence of total organic vapors ("TOVs") using a PID. The PID measurements serve as a surrogate for the presence of COCs such that the highest PID measurements are assumed to represent the highest concentration of COCs. The PID measurements will be recorded on the field form along with the rest of the soil description.

6.2.1 PID

Field soil sampling and screening procedures will involve the following:

1. Half-fill a clean, unused Ziploc baggie with soil immediately upon retrieval
2. Close the Ziploc baggie
3. Squeeze and shake the bag for at least 30 seconds to break up soils and allow for headspace development
4. If ambient temperatures are below freezing, headspace development is to be within a heated vehicle or building
5. Unzip the corner of the bag approximately one to two inches and insert the probe; record the maximum meter response; erratic responses should be discounted as a result of high organic vapor concentrations or conditions of elevated headspace moisture
6. The PID shall be operated and calibrated to yield TOVs in parts per million ("ppm"); PID instruments should be operated with a 10.2 electron-volt ("eV") lamp source

6.3 Soil

6.3.1 Surface Soil Sampling

Surface soil samples, if deemed necessary, will be collected from the upper 6 inches of soil.

Equipment:

1. Appropriate Laboratory-supplied Sample Containers
2. PID
3. Ziploc baggies
4. Hand trowel, hand auger, or split-spoon
5. Sample labels
6. Plastic (disposable) trowels

Procedure:

1. Decontaminate all re-usable equipment before advancing each soil boring
2. Setup soil logging table
3. Don an unused, clean pair of nitrile gloves prior to collecting each soil sample
4. Collect surface soil samples either with a hand trowel or hand auger
5. Place soils for laboratory analyses in laboratory approved sampling jars as per laboratory specifications; samples to be analyzed for VOCs will be collected prior to other samples, and in accordance with Method 5035A
6. Place soil for field screening into a ziploc baggie
7. Label sample jars and record time of core retrieval and time of sampling
8. Record samples on Chain-of-Custody form
9. Place samples in iced sample cooler
10. Field screen soil in ziploc baggie in accordance with the procedure defined in Section 6.2
11. Make and record lithologic description of the soils in the Field Book
12. Transport samples to the laboratory; samples collected via Method 5035A for VOC analysis must be frozen/preserved within 48 hours of collection

6.3.2 Subsurface Soil Sampling

Subsurface soil samples, either hand auger samples or samples obtained from a drilling rig via split-spoons or dedicated acetate liners, will be sampled according to the following procedures.

Subsurface samples will be collected by boring to the desired sample depth using a hand auger or drill rig. Once the desired sample depth is reached, soil samples will be collected as independent, discrete samples. Samples will be placed and sealed in a Ziploc bag and screened in accordance with Section 6.2. A lithologic description of the soil sample will be made in the Field Book. Samples to be analysed for VOCs will be collected for a secondary soil boring located within 1 foot of initial soil boring.

Procedure:

1. Decontaminate all re-usable equipment before advancing each soil boring
2. Setup soil logging table
3. Don an unused, clean pair of nitrile gloves prior to collecting each soil sample
4. Retrieve soil cores from hand auger, split-spoon sampler, or acetate liner
5. Place a portion of each sample interval into 2 sealable, unused plastic bags (1 bag for field screening in accordance with Section 6.2, and bag for potential laboratory analysis of constituents of concern other than VOCs)
6. Field screen soil in ziploc baggie in accordance with Section 6.2 procedure
7. Make and record lithologic description of the soils on a soil boring log form
8. Place soils for laboratory analyses in laboratory approved sampling jars as per laboratory specifications
9. Label sample jars and record time of sampling
10. Record samples on Chain-of-Custody form
11. Place samples in iced sample cooler
12. Evaluate field screening results and field observations to select appropriate depth intervals for laboratory analysis of VOCs
13. Advance a secondary soil boring with clean tooling within 1 foot of initial soil boring, in order to retrieve targeted depth interval(s) for VOC analysis
14. Record time that targeted soil interval retrieved from soil boring
15. Collect VOC samples in accordance with Method 5035A
16. Label sample jars and record time of sample collection
17. Record samples on Chain-of-Custody form
18. Place samples in a dedicated laboratory sample cooler equipped with ice

19. Ensure that all samples collected via Method 5035A for VOC analysis are frozen/preserved within 48 hours of collection
20. Arrange for delivery of the samples to the laboratory

6.4 Groundwater Sampling

6.4.1 Water-Level Measurements

After installation, each borehole will remain undisturbed for a minimum of one hour to allow the water level to equilibrate to atmospheric conditions. The procedure for measuring the water level in a well is as follows:

1. Remove plugs or caps from all wells to allow water level to stabilize before gauging
2. Don an unused, clean pair of nitrile gloves prior to gauging each well
3. Decontaminate water level indicator prior to gauging each well
4. Gauge the depth to water relative to the surveyed TOC in each well using a water level indicator as necessary, based on the specific work scope
5. Record all measurements to the nearest 0.01 foot in the field log or field forms

6.4.2 Grab Samples from Boreholes

1. The borehole will remain undisturbed for at least 1 hour prior to development and sample collection
2. Boreholes will be developed by purging at least 1 well volume of water with a bailer, peristaltic pump, or tubing and check valve, while visually monitoring turbidity
3. Don clean, disposable gloves while collecting samples; change gloves between sampling locations
4. Label sample jars provided by the laboratory
5. Collect water samples using either a bailer, tubing and check valve apparatus, or peristaltic pump. To minimize VOC loss due to volatilization during sampling, samples for VOC analysis will be collected first, using a bailer.
    a. Bailer
        i. Attach string to disposable bailer and slowly lower bailer into the water allowing the bailer to fill with water with minimal disturbance

ii. Bring the bailer to the surface and fill sample containers with water sample. Ensure there is no headspace in VOA containers

b. Tubing and Check Valve
   i. Connect check valve to clean, unused tubing and lower tubing and check valve into the water column to the desired sample depth
   ii. Use reciprocating motion to bring water up the tubing to the surface and fill sample containers with water
   iii. Decontaminate re-usable check valve between boreholes

c. Peristaltic Pump
   i. Insert new flexible tubing into the peristaltic pump head
   ii. Connect sample tubing to the intake side of the flexible tubing and place in the monitoring well at the desired sample depth
   iii. Connect a short piece of tubing to the effluent side of the flexible tubing
   iv. Turn on the pump and adjust the flow to a rate less than 1 L per minute
   v. Collect water into appropriate sample containers
   vi. Dispose of sample and flexible tubing after sample has been collected

6. Record well location and time of sampling in field book
7. Record samples on Chain-of-Custody form
8. Place samples in iced shipping container
9. Transport samples to the laboratory

6.4.3 Low-Flow Groundwater Sampling from Permanent Monitoring Wells

Permanent monitoring wells will be developed by purging at least 1 well volume of water with a bailer, peristaltic pump, or tubing and check valve, while visually monitoring turbidity. Once turbidity has visually decreased, a turbidity meter will be utilized to collect readings until three consecutive readings do not vary by more than 10%. Following development and prior to sample collection, a permanent monitoring well will remain undisturbed for at least 24 hours.

Peristaltic pumps may be used for collection of any groundwater samples, except those intended for VOC analysis. If a peristaltic pump is used, the peristaltic pump set-up procedures listed in 6.4.2 will be used and low-flow sampling will be completed as

described herein. Down-hole bladder pumps may be used for samples intended for VOC analysis.

Equipment:

1. Down-hole bladder pump or peristaltic pump
2. Dedicated teflon sleeve and sample tubing
3. Multiprobe aqueous chemistry meter
4. Transparent flow through cell
5. Water level indicator

Procedure:

1. Slowly lower bladder pump into well so as not to disturb and fine material which may be in the well
2. The pump intake should be placed in the approximate center of the saturated portion of the well screen, at least two feet off the bottom of the well, if possible to further minimize turbidity
3. The pump should not be raised or lowered while taking samples or purging the well
4. Water level readings should be taken during purging and sampling to insure that the drawdown in the well is less than 0.3 feet
5. Begin purging the well at the lowest flow volume settings, adjustments to higher flow volumes can be made provided total drawdown is no greater than 0.3 feet
6. Turbidity, pH, temperature, specific conductivity, oxygen-reduction potential (redox), and dissolved oxygen (DO) should be monitored during purging
7. Stability is achieved once three consecutive readings do not vary by more than the following:
    a. - turbidity +/- 10%
    b. - DO +/- 10%
    c. - conductivity & temperature +/- 3%
    d. - redox +/- 10 millivolts
    e. - pH +/- 0.1
8. The frequency of recording aqueous parameters will be dependent upon the volumetric exchange of the flow cell and associated tubing
9. If aqueous parameters do not stabilize after 5 casing volumes or 30 minutes, the project manager will be contacted

10. If a well dewaters during purging and three casing volumes are not purged, then the well will be allowed to recharge up to 80% of the static water column and dewatered once more; after water levels have recharged a second time to 80% of the static water column, groundwater samples will be collected
11. Once the aqueous parameters have stabilized, groundwater samples will be collected into the appropriate laboratory containers after disconnecting the tubing from the inlet side of the in-line flow cell
12. Label sample jars and record well location and time of sampling in field book
13. Record samples on Chain-of-custody form
14. Place samples in sample cooler
15. Dispose of all sample tubing and bladder pump sleeves
16. Decontaminate water level meter
17. Samples will be labeled, stored in iced shipping containers with COC documentation, and transported to the contract laboratory

Sample Handling and Preparation:

1. Samplers will don clean, unused disposable gloves while collecting samples; Gloves will be changed between sampling locations
2. Field activities, conditions, and sampling data (e.g., sample description) will be recorded in a field notebook. Any deviations from the sampling protocol will be noted on field records and will be brought to the attention of the project manager.
3. Collected samples will be placed in appropriate laboratory-supplied containers; samples will be labeled, stored in iced shipping containers with chain-of-custody documentation, and transported to the contract laboratory, as appropriate.

6.5 Exterior Soil Gas (SGe) Sampling

Equipment List:

1. SPX Dielectric Helium Detector MGD-2002
2. Helium Tank
3. Helium Shroud
4. Purge Pump
5. Tedlar Bags
6. Masterflex Tubing
7. Polyethylene Tubing: 0.17” ID x 0.25” OD

8. 1-Liter Summa Canisters

SGe Sampling Procedure:

1. Calculate purge volumes for each proposed SGe sample collection location and record in field notebook
2. Connect inlet of purge pump to the SGe sample location
3. Connect outlet of purge pump to tedlar bag
4. Place helium shroud over SGe sample location
5. Open valve on helium tank to flood helium shroud with helium while monitoring helium concentration within the helium shroud with helium detector
6. Adjust flow rate of helium into shroud accordingly to maintain target helium concentration of at least 50% helium
7. Purge 3 volumes of soil gas from the SGe sample location (as calculated in Step 1) into the tedlar bag with the purge pump, while maintaining the target helium concentration within the helium shroud
8. Once purging is complete, close valve on helium tank and remove helium shroud from SGe sample location
9. Once helium detector reading has returned to zero, connect helium detector to tedlar bag and record helium concentration for soil gas within tedlar bag
    a. If helium is not detected, proceed with collection of the soil gas sample for laboratory analysis
    b. If helium is detected, inspect the SGe sample port for breaches to the seal, perform corrective measures and repeat helium leak detection test
10. Expel remaining soil gas from tedlar bag
11. Sample one Summa canister at a time using the following procedure:
    a. connect 1-Liter Summa canister to SGe probe, open value all the way and record initial pressure on Summa Canister Air Sampling Form along with "Canister #", "Flow Control #", and "Sample ID"
    b. watch Summa Canister discharge and close the valve when the pressure is between -5" Hg and -3" Hg **(NOTE: do not run two canisters at once to prevent mishandling)**
    c. label canisters appropriately, double check that the valve is closed and record the final pressure on Summa Canisters Air Sampling Form
    d. plug port and bolt down flush mount cover
12. Collect field duplicate if applicable

13. Collect outdoor air sample upwind, if applicable
14. Complete Chain-Of-Custody for Summa Canister
15. Complete Summa Canister Air Sampling Form
16. Record sampling activities in the field logbook, note any deviations from planned sampling

Sample Handling and Preparation:

1. Samplers will wear clean, disposable gloves while collecting samples. Gloves will be changed between sampling locations.
2. Field activities, conditions, and sampling data (e.g., sample description) will be recorded in a field notebook. Any deviations from the sampling protocol will be noted on field records and will be brought to the attention of the project manager.

6.6 Sub-slab Soil Gas (SGss) Sampling

6.6.1 SGss Port Installation Procedure

Threaded Vapor Pin® subslab sample ports will be installed below surface grade as follows:

1. A recessed portion of the port will be constructed using a drill to partially penetrate the concrete approximately 1 inch using a 1.5-inch diameter drill bit
2. Within the recessed hole, a sample port will be constructed using a drill to fully penetrate through the concrete using a ⅝-inch diameter drill bit
3. A Vapor Pin® will be inserted through the ⅝-inch hole as follows:
    a. A clean, unused silicone sleeve will be donned to a stainless steel sample port prior to insertion
    b. The assembled sleeve and port will be driven through the concrete with Vapor Pin® tooling
    c. The sleeve and port will be visually inspected for proper sealing
    d. A cap will be affixed to the Vapor Pin barb to seal the sample port when not in use
4. The sample port will be completed with a stainless steel flushmount cover screwed onto the threaded portion of the Vapor Pin® to protect the recessed port when not in use

6.6.2 SGss Port Integrity Testing and Air Purging Procedure

Prior to sampling, the integrity of each sample port seal will be inspected with a water dam test. During the water dam test, soil gas will be purged through the tubing. The procedures for the water dam test and purging are as follows:

1. Remove the stainless steel cover
2. Pour distilled water into the recessed area of the port
3. Monitor the water level while purging one liter ("1L") of soil gas from the sample port as follows:
    a. Using a hand-operated transfer pump, disposable polyethylene ("PE") tubing will be connected between the barbed fitting of the sample port and the barbed fitting of the transfer pump intake and another piece of PE tubing will be connected between the barbed fitting of the effluent end of the transfer pump and the barbed fitting of a 1L Tedlar bag
    b. After purging 1L of soil gas into the Tedlar bag, the valve on the Tedlar bag will be sealed
    c. The air within the Tedlar bag will then be expelled outdoors, downwind of the sampling area
4. If the water level does not change, the seal is intact and sampling may proceed
5. If the water level lowers, the area around the port will be sealed with quick-drying cement and/or the port will be removed, the old silicone sleeve will be discarded and replaced with an unused silicone sleeve, the port will be re-installed per Section 3.1.1 and then re-tested until a seal is found to be intact[3]
6. After the water dam test is complete, the water will be evacuated from the recessed area

6.6.3 SGss Sample Collection Procedure

Equipment List:

1. Purge Pump
2. Tedlar Bags
3. Masterflex Tubing
4. Polyethylene Tubing: 0.17" ID x 0.25" OD

[3] If a seal cannot be established, an entirely new SGss port will be installed within 1 foot of the original location. .

5. Distilled Water
6. 6-Liter Summa Canisters

SGss Sampling Procedure:

1. Select sub-slab sample port(s) for sampling
2. Complete water dam test while purging sub-slab sample port
    a. Remove rubber cap from sample port
    b. Connect inlet of purge pump to sample port
    c. Connect outlet of purge pump to tedlar bag
    d. Fill recessed cavity of sample location with distilled water
    e. Purge 1 liter of sub-slab soil gas into tedlar bag while observing level of water in recessed cavity
        i. If water level does not change, remove water from recessed cavity and proceed with sub-slab soil gas sample collection
        ii. If water level changes, remove water from recessed cavity, assess sample port, perform corrective measures and repeat water dam test
    f. Expel remain sub-slab soil gas in tedlar bag outside
3. Setup one Summa Canister at a time as follows:
    a. unpack the flow controller and Summa Canister, ensure the valve is fully closed and remove brass cap from the canister.
    b. tighten the flow controller using the 9/16th wrench provided. ***(Note: quarter turn past finger tight is sufficient)***
    c. connect a flow controller to a 6-L Summa Canister
    d. record 'Sample ID', 'Canister #', and 'Flow Controller #' on Summa Canister Air Sampling Form
4. Turn valve counterclockwise until there is no resistance
5. Record the Initial, 1-Hour, 2-Hour vacuum readings
6. If any vacuum readings are evacuating too quickly, close valve and monitor during Hour 2 and Hour 3 (if necessary) to confirm slower evacuation rate
7. If 24 hour-TWA (or 8 hour-TWA) rate is not projected, replace Summa canister and restart
8. Record Hour 22 and Hour 23 (or Hour 6 and Hour 7) and Final vacuum readings
9. Close valve if any reading is between -5" Hg and -3" Hg or lower (Note: do not overtighten)
10. Complete Chain-Of-Custody form for 6-Liter Summa Canister

11. Complete Indoor Air Building Survey Checklist
12. Complete Summa Canister Air Sampling Form
13. Record all sampling activities in the field logbook, note any deviations from planned sampling.

Sample Handling and Preparation:

1. Samplers will wear clean, disposable gloves while collecting samples. Gloves will be changed between sampling locations.
2. Field activities, conditions, and sampling data (e.g., sample description) will be recorded in a field notebook. Any deviations from the sampling protocol will be noted on field records and will be brought to the attention of the project manager.

6.7 Indoor Air Sampling

Equipment List:

1. 6-Liter Summa Canisters

Air Sampling Procedure:

1. Select locations inside building for sampling
2. Setup one Summa Canister at a time as follows:
    a. unpack the flow controller and Summa Canister, ensure the valve is fully closed and remove brass cap from the canister.
    b. tighten the flow controller using the 9/16th wrench provided. ***(Note: quarter turn past finger tight is sufficient)***
    c. connect a flow controller to a 6-L Summa Canister
    d. record 'Sample ID', 'Canister #', and 'Flow Controller #' on Summa Canister Air Sampling Form
    e. place Summa Canister at approximately 3' to 5' height in the predetermined location
3. Turn valve counterclockwise until there is no resistance
4. Record the Initial, 1-Hour, 2-Hour vacuum readings
5. If any vacuum readings are evacuating too quickly, close valve and monitor during Hour 2 and Hour 3 (if necessary) to confirm slower evacuation rate
6. If 24 hour-TWA (or 8 hour-TWA) rate is not projected, replace Summa canister and restart

7. Record Hour 22 and Hour 23 (or Hour 6 and Hour 7) and Final vacuum readings
8. Close valve if any reading is between -5" Hg and -3" Hg or lower (Note: do not overtighten)
9. Complete Chain-Of-Custody form for 6-Liter Summa Canister
10. Complete Indoor Air Building Survey Checklist
11. Complete Summa Canister Air Sampling Form
12. Record all sampling activities in the field logbook, note any deviations from planned sampling.

Sample Handling and Preparation:

1. Samplers will wear clean, disposable gloves while collecting samples. Gloves will be changed between sampling locations.
2. Field activities, conditions, and sampling data (e.g., sample description) will be recorded in a field notebook. Any deviations from the sampling protocol will be noted on field records and will be brought to the attention of the project manager.

6.8 EOS Sampling

1. Don clean, disposable gloves while collecting samples; change gloves between sampling locations
2. Label sample jars provided by the laboratory
3. Collect an EOS sample using a bailer after attaching string to disposable bailer and slowly lowering the bailer into the EOS floating on the water table; Then bring the bailer to the surface
4. Transfer EOS sample into appropriate sample containers and ensure there is no headspace in VOA containers
5. Record well location and time of sampling in field book
6. Record samples on Chain-of-Custody form
7. Place samples in iced shipping container
8. Transport samples to the laboratory

7 Decontamination Procedures

The objective of decontamination is to reduce the likelihood of sample cross-contamination. It is anticipated that disposable equipment will be used to collect samples for most sampling purposes. However, decontamination procedures are described below in the event that non-dedicated sampling equipment is used, such as with a stainless steel trowel, hand auger, etc.

Sampling equipment and reusable materials that contact the soil and/or water will be decontaminated prior to use on site and between sampling locations. All drilling equipment will be decontaminated prior to use and between each borehole location. Decontamination will consist of the following:

1. Non Phosphate detergent wash, consisting of a dilute mixture of Liquinox and distilled water (visible soil to be removed by scrubbing)
2. Distilled water rinse

8 Disposal of Residual Materials

Investigation-derived waste ("IDW") generated during the work will be containerized in Department of Transportation ("DOT")-approved 55-gallon steel drums and staged on-site pending proper characterization and disposal.

Residual materials and/or sampling supplies will be disposed of according to state requirements. Used PPE and disposable equipment will be double bagged and placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. Any PPE and disposable equipment that is to be disposed of which can still be reused will be rendered inoperable before disposal in the refuse dumpster.

9 Sample Documentation and Shipment

9.1 Field Notes

Field notes will be recorded in the field logbooks.

9.1.1 Field Logbooks

Field logbooks will be maintained throughout the entire sampling and remedial program. General entries made in the field logbook will include the following information:

- ❏ Date
- ❏ Location of Site
- ❏ Weather Conditions (i.e., Clear, Overcast, Windy, Sunny, etc.), Wind Direction and Velocity (i.e., SE @ 10 mph) and Temperature (F°)
- ❏ Name(s) of Field Personnel and visitors (Print)
- ❏ Field Procedures and work plan references
- ❏ Field Objectives for the day
- ❏ Time Log and Description of Observed Site Conditions throughout day
- ❏ Signature

Specific entries will be made for each day of sampling and will record the following information in the field logbook:

- ❏ Team members participating in the sampling
- ❏ Time of arrival/entry on site and time of site departure
- ❏ Other personnel on site
- ❏ Summary of any meetings or discussions with tribal, contractor, or states/federal agency personnel
- ❏ Field objectives for the day
- ❏ Deviations from sampling plans, site safety plans, and SAP procedures
- ❏ Changes in personnel and responsibilities with reasons for the changes
- ❏ Levels of safety protection
- ❏ Calibration readings for equipment

9.1.2 Photographs

Photographs may be taken of the field activities, as necessary, to photodocument sampling, and other field conditions. Photographs will also be taken at the sampling locations and at other areas of interest on site. The photographs may serve to verify the information entered in the field logbook. For each photograph taken, the following information will be written in the logbook or recorded in a separate field photography log:

- ❏ Time, date, location, and weather conditions
- ❏ Description of the subject photographed
- ❏ Name of person taking the photograph

9.2 Labeling

Samples will be labeled to properly cross-reference them to a site plan followed by an abbreviation for sample media (i.e., “S” for soil, “G” for groundwater); and then either the sample depth in 10th of a foot for soil or date for groundwater and waste. Examples are provided below:

- ❏ Soil: SB10:S100106 represents a soil sample collected from SB-10 with a depth interval of 10.0’ to 10.6’
- ❏ Groundwater: MW8:G031519 represents a groundwater sample collected from MW-8 on 3/15/19
- ❏ Waste: Drum2:W040219 represents a waste sample collected from Drum 2 on 4/2/19

9.3 Sample Chain-Of-Custody Forms and Custody Seals

Each shipment of samples for laboratory analysis will be accompanied by a Chain-of-Custody. If multiple coolers are sent to the laboratory, copies of the complete Chain-of-Custody will be included within each cooler. The Chain-of-Custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, locked up, or kept in a secured

area that is restricted to authorized personnel. Until the samples are shipped, the custody of the samples will be the responsibility of The ELAM Group or the entity conducting the sampling. The sampling personnel will sign the Chain-of-Custody form in the "relinquished by" box and record date, time, and air bill number, if applicable. The sample numbers for all field samples, field QC samples, and duplicates will be documented on the form. A self-adhesive custody seal will be placed across the lid of each sample if shipped. The shipping containers in which samples are stored (usually a sturdy picnic cooler or ice chest) will be sealed with self-adhesive custody seals any time they are not in someone's possession or view before shipping.

9.4 Package and Shipment

Sample containers will be placed in a strong-outside cooler. The sample packaging procedures that will be followed for the soil samples are described below.

1. When ice is used, pack in zip-locked, double plastic bags; seal drain plug of the cooler with fiberglass tape to prevent melting ice from leaking out of the cooler
2. Line cooler bottom with bubble wrap to prevent breakage during shipment
3. Check caps for tightness and, if not full, mark the sample volume level of liquid samples on the outside of the sample bottles with indelible ink
4. Secure bottle/container tops with clear tape and custody seal all container tops
5. Affix sample labels onto the containers with clear tape
6. Wrap all glass sample containers in bubble wrap to prevent breakage
7. Seal all sample containers in heavy duty plastic zip-lock bags; write the sample numbers on the outside of the plastic bags with indelible ink
8. Place samples in a sturdy cooler(s) lined with a large plastic trash bag; enclose the appropriate chain-of-custody forms in a zip-lock plastic bag affixed to the underside of the cooler lid
9. Fill empty space in the cooler with ice bags, bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment
10. Ice used to cool samples will be double sealed in two zip lock plastic bags and placed on top and around the samples to chill them to the correct temperature
11. Each ice chest will be securely taped shut with fiberglass strapping tape, and custody seals will be affixed to the front, right and back of each cooler if shipped

10 Quality Control

10.1 Field Quality Control Samples

Field quality control samples are intended to help evaluate conditions resulting from field activities and are intended to accomplish two primary goals, assessment of field contamination and assessment of sampling variability. The former looks for substances introduced in the field due to environmental or sampling equipment and are assessed using blanks of different types. The latter includes variability due to sampling technique and instrument performance as well as variability possibly caused by the heterogeneity of the matrix being sampled and is assessed using replicate sample collection. The following subsections cover field QC.

10.1.1 Assessment of Field Contamination (Blanks)

Field contamination will be assessed through the collection of different types of blanks and include:

- ❏ Equipment Blanks
- ❏ Field Blanks
- ❏ Trip Blanks
- ❏ Temperature Blanks

10.1.1.1 Equipment Blanks

In general, equipment (rinsate) blanks verify the effectiveness of decontamination procedures for non-dedicated equipment and will be collected when reusable, non-disposable sampling equipment (e.g., trowels, hand augers, and non-dedicated groundwater sampling pumps) are being used for sample collection. Equipment blanks will be collected for soil and groundwater samples, where applicable. These blanks are submitted “blind” to the laboratory, packaged like other samples and assigned their own unique identification number. Equipment rinsate blanks will be collected by pouring distilled water over the decontaminated sampling equipment. A minimum of one equipment rinsate blank will be collected per matrix each day that sampling equipment

is decontaminated in the field. These blanks are submitted "blind" to the laboratory, packaged like other samples and assigned their own unique identification number.

10.1.1.2 Field Blanks

Field blanks will be collected if contamination from ambient conditions in the sample area are suspected. Field blank samples will be obtained by pouring distilled water into a sampling container at the sampling point. A minimum of one field blank will be prepared each day sampling occurs in the field. These blanks are submitted "blind" to the laboratory, packaged like other samples and each with its own unique identification number.

10.1.1.3 Trip Blanks

Trip blanks are only relevant to VOC sampling efforts. One trip blank will be submitted to the laboratory for analysis with each shipment of samples for VOC analysis. Trip blanks will be prepared by the laboratory to evaluate if the shipping and handling procedures are introducing contaminants into the samples.

10.1.1.4 Temperature Blanks

For each cooler that is transported to the laboratory a sample container filled with distilled water will be included. This blank will be used by the sample receiving custodian at the laboratory to check the temperature of samples upon receipt.

10.1.2 Field Duplicate or Co-located Samples

Duplicate samples are collected simultaneously with a standard sample from the same source under identical conditions but are placed into separate sample containers. Field duplicates will consist of a homogenized sample divided in two or else a co-located sample. Each duplicate portion will be assigned its own sample number so that it will be blind to the laboratory. A duplicate sample is treated independently of its counterpart to enable assessment of field sampling procedures through comparison of the results.

In accordance with the RCG, at least one field duplicate will be collected per parameter for every 20 samples. Every group of analytes for which a standard sample is analyzed will also include the analysis of one or more duplicate samples. Duplicate samples should be collected from areas of known or suspected contamination. Since the objective is to assess variability due to sampling technique and possible sample heterogeneity, source variability is a good reason to collect co-located samples, not to avoid their collection.

Duplicate samples will be preserved, packaged, and sealed in the same manner as other samples of the same matrix. A separate sample number and station number will be assigned to each duplicate, and it will be submitted blind to the laboratory.

10.2 Laboratory Quality Control Samples

Laboratory QA procedures and the use of Quality Control Samples by the laboratory is presented in Appendices A and B.

11 Field Variances

Changes in field conditions on the actual day of sampling or conditions different from that expected will be documented in the field logbook along with digital photographs, when appropriate, to document the noted field variances. If conditions render it necessary to modify the QAPP or SAP, The ELAM Group Project Manager will be notified of the proposed changes and approve such changes prior to implementation in the field.

12 Field Health and Safety Procedures

A Health and Safety Plan (“HASP”) has been prepared for the site and will be utilized while conducting the planned sampling activities.

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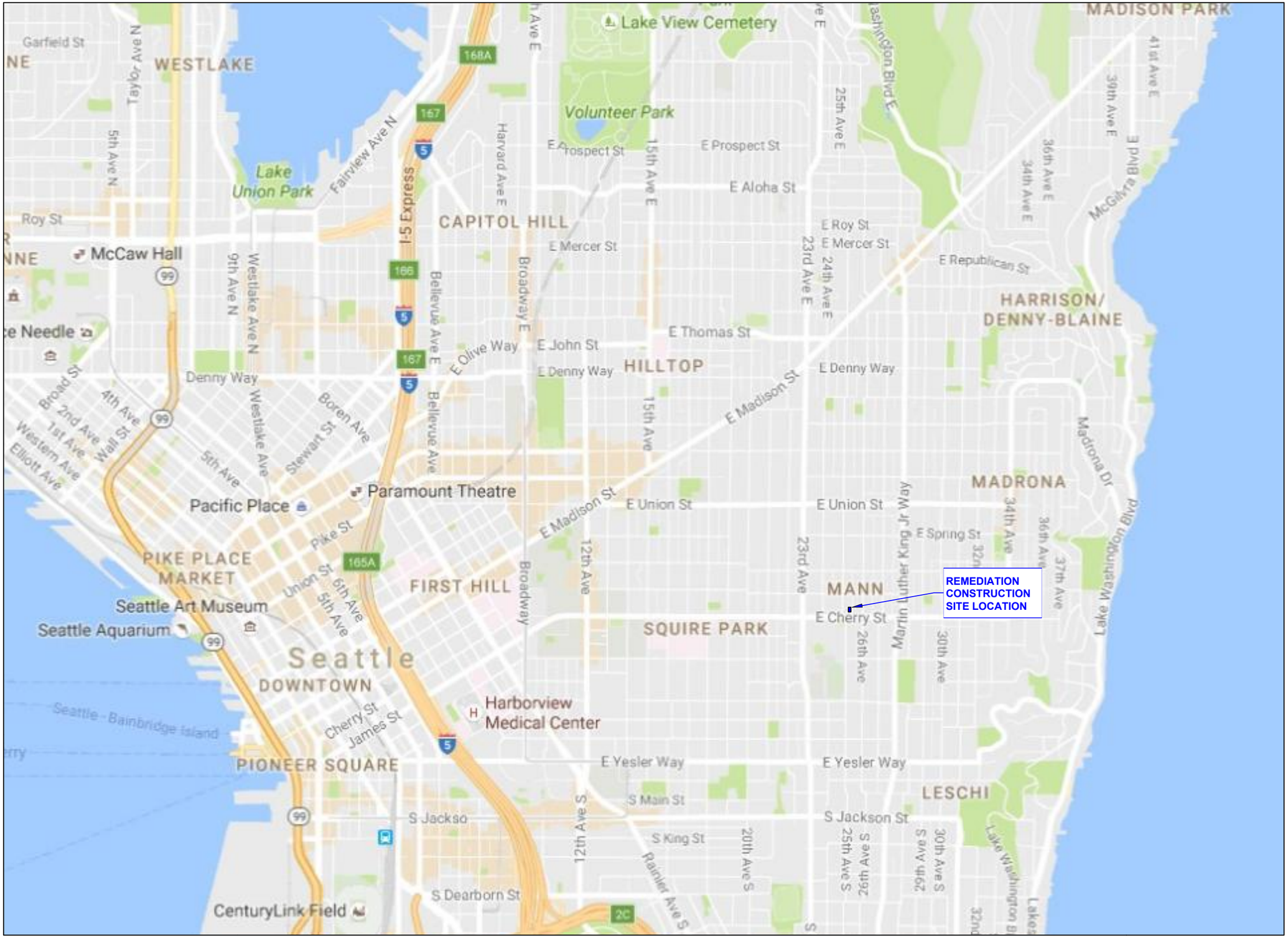
Figures



TheELAMGroup

LEGEND

Remediation Construction Site

Notes:

N

0 750 1500 feet

Figure No: 1
Title: Site Location Map
Scale: 1" = 1,500'
Project No: WAKS2510C
Report: QAPP
Drawn by: The ELAM Group
Date: 6/25/20

TheELAMGroup

LEGEND

- Monitoring Well
- Soil Boring
- Injection Well
- Soil Vapor Extraction Well
- Vapor Monitoring Point
- Underground Sanitary Sewer Line
- Underground Water Line
- Underground Natural Gas Line
- Overhead Electric Line
- Utility Pole
- Tree
- Former Building Location
- Vapor Intrusion Assessment Location

Notes:

Figure No:	2
Title:	Site Plan
Scale:	1" = 30'
Project No:	WAKS2510C
Report:	QAPP
Drawn by:	The ELAM Group
Date:	06/25/2020

Appendix A

Pace Analytical Services, LLC

Quality Manual

Pace Analytical®

ENVIRONMENTAL SCIENCES

Document Information

Document Number: ENV-MAN-NW-0001 **Revision:** 02

Document Title: Quality Manual

Department(s): Quality

Date Information

Effective Date: 07 Jan 2020

Notes

Document Notes:

All Dates and Times are listed in: Central Time Zone

Signature Manifest

Document Number: ENV-MAN-NW-0001 **Revision:** 02

Title: Quality Manual

All dates and times are in Central Time Zone.

ENV-MAN-NW-0001 - Quality Manual

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Management Approval

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Christine Kne (009327)	Lab Analyst II	06 Jan 2020, 08:13:28 AM	Approved
David Randall (008925)	Manager - Lab Services	06 Jan 2020, 09:48:37 AM	Approved
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Alexander Reynolds (004831)	Lab Analyst I	07 Jan 2020, 08:40:56 AM	Approved
Dave White (004945)	Systems Manager	07 Jan 2020, 09:55:23 AM	Approved
Keith Sturgeon (003603)	Manager - Lab Services	07 Jan 2020, 12:20:02 PM	Approved
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Daniel Toms (009312)	Laboratory Supervisor II	07 Jan 2020, 02:53:16 PM	Approved

TITLE PAGE

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Dave White	Regional Manager - Systems	1700 Elm St SE, Minneapolis, MN 55414	612-656-2269
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Alexander Reynolds	Scientist 1[3]	4730 Oneota Street, Duluth, MN 55807	218-336-2120
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Table of Contents

1.0 PURPOSE AND SCOPE

1.1 Purpose

This quality manual (manual) outlines the quality management system and management structure of the laboratories and service centers affiliated with Pace Analytical Services, LLC (PAS). A laboratory is defined by PAS as any PAS facility, however named, that provides testing, sampling, or field measurement services. When the term 'laboratory" is used in this manual, the term refers to all locations listed on the Title Page of this manual and in Section 4.1.3 unless otherwise specified.

The PAS quality management system is also referred to as the quality program throughout this document. In this context, the phrase "quality management system" and "quality program" are synonymous.

The quality management system is the collection of policies and processes established by PAS management to consistently meet customer requirements and expectations, and to achieve the goals to provide PAS customers with high quality, cost-effective, analytical measurements and services.

The quality management system is also intended to establish conformance[1] and compliance with the current versions of the following international and national quality system standards:

- ISO/IEC 17025: *General requirements for the competence of testing and calibration laboratories*
- NELAC/TNI Standard Volume 1: *Management and Technical Requirements for Laboratories Performing Environmental Analysis*

[1]The statement of conformity to these Standards pertains only to testing and sampling activities carried out by the laboratory at its physical address, in temporary or mobile facilities, in-network, or by laboratory personnel at a customer's facility.

In addition to the international and national standards, the quality management system is designed to achieve regulatory compliance with the various federal and state programs for which the laboratory provides compliance testing and/or holds certification or accreditation. When federal or state requirements do not apply to all PAS locations, the requirements for compliance are provided in addendum to this manual or in other documents that supplement the manual. Customer-specific project and program requirements are not included in the manual in order to maintain client confidentiality.

- A list of accreditation and certifications held by each laboratory associated with this manual is provided in Appendix A.
- A list of analytical testing capabilities offered by each laboratory associated with this manual is provided in Appendix B.

1.2 Scope and Application

This manual applies to each of the PAS locations listed on the Title Pages and in Section 4.1.3.

The manual was prepared from a quality manual template (template) created by PAS corporate quality personnel. The template outlines the minimum requirements PAS management considers necessary for every PAS laboratory, regardless of scope of services or number of personnel, to establish in order to maintain a quality management system that achieves the objectives of PAS's Quality Policy (See 4.2.2). In this regard, the template is the mechanism used by the corporate officers (a.k.a. 'top management') to communicate their expectations and commitment for the PAS quality program to all PAS personnel.

The laboratory also has the responsibility to comply with federal and state regulatory and program requirements for which it provides analytical services and holds certification or accreditation. When those requirements are more stringent than the template, the requirements for compliance are provided in addendum to this manual or in other documents that supplement the manual. This document structure maintains consistency in the presentation of the quality management system across the network while providing the laboratory a mechanism to describe and achieve compliance requirements on a program basis.

1.2.1 Quality Manual Template

The quality manual template is developed by the Corporate Quality Director with contribution and input from corporate quality personnel and the corporate officers. Approval of the template by the corporate officers (aka "top management") confirms their commitment to develop and maintain a quality management system appropriate for the analytical services offered by the organization and to communicate their expectations of the quality program to all personnel.

The template and instructions for use of the template are released by corporate quality personnel to quality assurance manager(s) responsible for each laboratory (Local QA). Local QA uses the template to prepare the laboratory's manual by following the instructions provided. Since the template provides the minimum requirements by which all PAS locations must abide, the laboratory may not alter the font, structure or content of the template except where specified by instruction to do so. As previously stated, program specific requirements are provided in addendum or in documents that supplement this manual.

The template is reviewed by corporate quality personnel every two years and updated if needed. More frequent review and revision may be necessary to manage change, to maintain conformance and compliance to relevant standards, or to meet customer expectations.

See standard operating procedure (SOP) ENV-SOP-CORQ-00015 *Document Management and Control* for more information.

1.2.2 Laboratory Quality Manual

The manual is approved and released to personnel under the authority of local management. The manual is reviewed annually and location specific information is updated, if needed. More frequent review and revision may be necessary when there are significant changes to the organizational structure, capabilities, and resources of the laboratory. Review and revision of the manual is overseen by local QA. If review indicates changes to the main body of the manual are necessary to maintain conformance and compliance to relevant standards, or to meet customer expectations, local QA will notify corporate quality personnel to initiate review and/or revision of the template.

See SOP ENV-SOP-CORQ-00015 *Document Management and Control* for more information.

1.2.3 References to Supporting Documents

The template and the manual includes references to other laboratory documents that support the quality management system such as policies and standard operating procedures (SOPs). These references include the document's document control number and may include the document title.

This information is subject to change. For example, an SOP may be converted to a policy or the document's title may change. For these types of administrative changes, the manual and template are updated to reflect the editorial change during the document's next scheduled review/revision cycle or the next time a new version of the document is released, whichever is sooner.

Local QA maintains a current list of controlled documents used at each PAS location to support the quality management system. This list, known as the Master List, lists each document used by document control number, title, version, effective date, and reference to any document(s) that the current version supersedes. When there is a difference between the template and/or manual and the Master List, the document information in the Master List takes precedence. The current Master List is readily available to personnel for their use and cross-reference. Parties external to the laboratory should contact the laboratory for the most current version.

2.0 REFERENCES

References used to prepare this manual include:

- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act." Federal Register, 40 CFR Part 136, most current version.
- "Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods." SW-846.
- "Methods for Chemical Analysis of Water and Wastes", EPA 600-4-79-020, 1979 Revised 1983, U.S. EPA.
- U.S. EPA Contract Laboratory Program Statement of Work for Organic Analysis, current version.
- U.S. EPA Contract Laboratory Program Statement of Work for Inorganic Analysis, current version.
- "Standard Methods for the Examination of Water and Wastewater." Current Edition APHA-AWWA-WPCF.
- "Annual Book of ASTM Standards", Section 4: Construction, Volume 04.04: Soil and Rock; Building Stones, American Society of Testing and Materials.
- "Annual Book of ASTM Standards", Section 11: Water and Environmental Technology, American Society of Testing and Materials.
- "NIOSH Manual of Analytical Methods", U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, most current version.
- "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water", U.S. EPA, Environmental Monitoring and Support Laboratory – Cincinnati (Sep 1986).
- Quality Assurance of Chemical Measurements, Taylor, John K.; Lewis Publishers, Inc. 1987.
- Methods for Non-conventional Pesticides Chemicals Analysis of Industrial and Municipal Wastewater, Test Methods, EPA-440/1-83/079C.
- Environmental Measurements Laboratory (EML) Procedures Manual, HASL-300, US DOE, February, 1992.
- Requirements for Quality Control of Analytical Data, HAZWRAP, DOE/HWP-65/R1, July, 1990.

- Quality Assurance Manual for Industrial Hygiene Chemistry, AIHA, most current version.
- National Environmental Laboratory Accreditation Conference (NELAC) Standard- most current version.
- ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories- most current version.

  The following are implemented by normative reference to ISO/IEC 17025:

  - ISO/IEC Guide 99, *International vocabulary of metrology –Basic and general concepts and associated terms*
  - ISO/IEC 17000, *Conformity assessment – Vocabulary and general principles*
- Department of Defense Quality Systems Manual (QSM), most current version.
- TNI (The NELAC Institute) Standard- most current version applicable to each lab.
- UCMR Laboratory Approval Requirements and Information Document, most current version.
- US EPA Drinking Water Manual, most current version.

3.0 TERMS AND DEFINITIONS

Refer to Appendix C for terms, acronyms, and definitions used in this manual and in other documents used by the laboratory to support the quality management system.

4.0 MANAGEMENT REQUIREMENTS

4.1 Organization

4.1.1 Legal Identity

Pace Analytical Services, LLC is authorized under the State of Minnesota to do business as a limited liability company.

4.1.1.1 Change of Ownership

If there is a change of ownership, if a location goes out of business, or if the entire organization ceases to exist, Pace Analytical Services, LLC ensures that regulatory authorities are notified of the change within the time-frame required by each state agency for which the location is certified or accredited.

Requirements for records and other business information are addressed in the ownership transfer agreement or in accordance with appropriate regulatory requirements, whichever takes precedence.

4.1.2 Compliance Responsibility

Laboratory management has the responsibility and authority to establish and implement procedures and to maintain sufficient resources necessary to assure its activities are carried out in such a way to meet the compliance requirements of the quality management system.

4.1.3 Scope of the Quality Management System

The quality management system applies to work carried out at each location covered by this manual including permanent facilities, at sites away from its permanent facilities, or in associated temporary or mobile facilities.

This permanent and mobile facilities to which this manual applies includes:

Name	Pace Analytical Services, LLC
Address:	1700 Elm Street SE
City, State, Zip	Minneapolis, MN 55414
Phone Number	612-607-1700
Service Type:	Laboratory

Name	Pace Analytical Services, LLC
Address:	150 N 9th Street
City, State, Zip	Billings, MT 59101
Phone Number	406-254-7726
Service Type:	Laboratory

Name	Pace Analytical Services, LLC
Address:	315 Chestnut Street
City, State, Zip	Virginia, MN 55792
Phone Number	218-735-6700
Service Type:	Laboratory

Name	Pace Analytical Services, LLC
Address:	4730 Oneota Street
City, State, Zip	Duluth, MN 55807
Phone Number	218-727-6380
Service Type:	Laboratory

Name	Pace Analytical Services, LLC
Address:	11001 Hampshire Ave S.
City, State, Zip	Bloomington, MN 55438
Phone Number	612-607-1700
Service Type:	Service Center

Name	Pace Analytical Services, LLC
Address:	3702 E Roeser Rd, Suite 19
City, State, Zip	Phoenix, AZ 85040
Phone Number	612-297-1376
Service Type:	Service Center

4.1.4 Organization History and Information

Founded in 1978, Pace Analytical Services, LLC (PAS) is a privately held scientific services firm operating one of the largest full service contract laboratory and service center networks

in the United States. The company's network offer inorganic, organic and radiochemistry testing capabilities; specializing in the analysis of trace level contamination in air, drinking water, groundwater, wastewater, soil, biota, and waste.

With over 90 laboratories and services centers in the contiguous US and in Puerto Rico, the network provides project support for thousands of industry, consulting, engineering and government professionals.

Pace delivers the highest standard of testing and scientific services in the market. We offer the most advanced solutions in the industry, backed by truly transparent data, a highly trained team, and the service and support that comes from four decades of experience.

4.1.4.1 Organization Structure

Each location maintains a local management structure under the oversight and guidance of corporate personnel. Local management is responsible for making day-to-day decisions regarding the operations of the facility, implementing the quality management system, upholding the requirements of the quality program, and for supervision of personnel.

Local management is provided by a General Manager (GM), Quality Manager (QM), Manager – Client Services (MNGR-CS), Information Technology (IT) Manager, Department Managers (DM) and/or Department Supervisors (DS), however named.

Some locations may also have any one of the following management positions: Regional Quality Manager, Manager - Operations (MNGR-OPS), Technical Specialist (TS), or Technical Manager (TM), however named. When the location does not have a TS or TM, technical management is provided jointly by the GM, QM, DM, and DS.

The GM, however named reports to a Regional Operations Manager (RGM), who is responsible for the management of multiple laboratories and service centers within a geographical region, and who reports directly to the Chief Operating Officer (COO). The QMs have indirect reporting relationship to the Corporate Director of Quality.

Refer to the organization charts provided in Appendix D to view the management structure, reporting relationships, and the interrelationships between positions.

4.1.5 Management Requirements

4.1.5.1 Personnel

The laboratory is staffed with administrative and technical personnel who perform and verify work under the supervision of managerial personnel.

- Technical personnel include analysts and technicians that generate or contribute to the generation of analytical data and managerial personnel that oversee day to day supervision of laboratory operations. Including the reporting of analytical data and results, monitoring QA/QC performance, and monitoring the validity of analysis to maintain data integrity and reliability.
- Administrative personnel support the day-to-day activities of the laboratory.
- IT personnel maintain the information technology systems and software used at the laboratory.

- Client services personnel include project managers and support staff that manage projects.
- Managerial personnel make day-to-day and longer term decisions regarding the operations of the facility, supervise personnel, implement the quality management system and uphold the requirements of the quality program.

All personnel regardless of responsibilities are expected to carry out their duties in accordance with the policies and processes outlined in this manual and in accordance with standard operating procedures (SOPs) and other quality system documents. The laboratory's policies and procedures are designed for impartiality and integrity. When these procedures are fully implemented, personnel remain free from undue pressure and other influences that adversely impact the quality of their work or data.

4.1.5.1.1 Key Personnel

Key personnel include the management positions that have the authority and responsibility to plan, direct, and control, activities of the division (corporate) or the laboratory.

The following tables list key personnel positions by PAS job title and the position's primary deputy:

Key Personnel: Corporate

Key Personnel	Primary Deputy
Chief Executive Officer	Chief Operating Officer
Chief Operating Officer	Chief Executive Officer
Chief Compliance Officer	Quality Director
Corporate Quality Director	Chief Compliance Officer
Health and Safety Director	Chief Compliance Officer
IT Director	LIMS Administrator, however named.

Key Personnel: Laboratory

Key Personnel	Primary Deputy
Regional Director - Operations	Chief Operating Officer or as designated.
General Manager	Regional Director - Operations
Manager - Quality	Corporate Quality Manager or as designated.
Manager – Client Services	General Manager
Local IT	Corporate IT Director or as designated.
Department Manager	General Manager
Quality Manager 2[1]	Corporate Quality Manager
Technical Specialist[1]/Manager[1] Acting Technical Manager TNI	Manager - Quality
Manager - Operations[1]	General Manager.

[1] *Position may not be staffed at each location.*

Some state certification programs require the agency to be notified when there has been a change in key personnel. Program-specific requirements and time-frames for notification by agency, are tracked and upheld by local QA, when these requirements apply.

4.1.5.2 Roles and Responsibilities

The qualifications, duties, and responsibilities for each position are detailed in job descriptions maintained by PAS's corporate Human Resource's Department (HR).

The following summaries briefly identify the responsibility of key personnel positions in relation to the quality management system.

Chief Executive Officer (CEO): The CEO has overall responsibility for performance of the organization and endorses the quality program. Working with corporate and laboratory management, the CEO provides the leadership and resources necessary for PAS locations to achieve the goals and objectives of the quality management system and quality policy statement.

Chief Operating Officer (COO): The COO oversees all aspects of operations management including, strategic planning, budget, capital expenditure, and management of senior management personnel. In this capacity, the COO provides leadership and resources necessary to help top management at each PAS location achieve the goals and objectives of the quality management system and quality policy statement.

Chief Compliance Officer (CCO): The CCO oversees the quality assurance and environmental health and safety programs (HSE) for each business unit. The CCO is responsible for planning and policy development for these groups to ensure regulatory compliance and to manage risk. The position provides leadership and guidance necessary for all PAS locations to achieve the goals and objectives of the quality and HSE programs.

The CCO also serves as the Ethics Officer (ECO). The ECO develops the Ethics and Data Integrity Policy and Training Program, and provides oversight for reporting and investigation of ethical misconduct to maintain employee confidentiality during the process. The ECO provide guidance and instruction for follow-up actions necessary to remedy the situation and deter future recurrence.

Corporate Director of Quality: The Corporate Director of Quality is responsible for developing and maintaining the PAS quality program under guidance and assistance from the CEO, COO, and CCO. This position helps develop corporate quality policy and procedure and analyzes metric data and other performance indicators to assess and communicate the effectiveness of the quality program to top management. The position provides leadership and guidance for implementation of the quality program across all PAS locations.

Corporate Director of Information Technology: The Corporate Director of IT oversees the systems and processes of information technology used to support the quality program. These systems include Laboratory Information Management Systems (LIMS); data acquisition, reduction, and reporting software; virus-protection, communication tools, and ensuring the integrity and security of electronic data.

Regional Director - Operations (RGM): The SGM has full responsibility for administrative and operations management and performance of a group of PAS laboratories and service centers. Working with the COO and local laboratory

management, the SGM provides leadership, guidance and resources, including allocation of personnel, necessary to achieve the goals of PAS quality program.

General Manager (GM): The GM is responsible for the overall performance and administrative and operations management of a PAS location and associated service center(s). This position is responsible to provide leadership and resources, including allocation and supervision of personnel, necessary for the location to implement and achieve the goals of the PAS quality program. In this capacity, the position assures laboratory personnel are trained on and understand the structure and components of the quality program defined in this manual as well as the policies and procedures in place to implement the quality management system.

The GM of NELAC/TNI Accredited laboratories are also responsible for the designation of technical personnel to serve as acting technical managers for TNI for the fields of accreditation held by the laboratory (See Section 4.1.5.2.1) and for notifying the accreditation body (AB) of any extended absence or reassignment of these designations.

Quality Manager (QM): The QM oversees and monitors implementation of the quality management system and communicates deviations to laboratory management. The QM is independent of the operation activities for which they provide oversight and has the authority to carry out the roles and responsibilities of their position without outside influence.

Additionally, in accordance with the TNI Standard, the QM:

- serves as the focal for QA/QC and oversees review of QC data for trend analysis;
- evaluates data objectively and perform assessments without outside influence;
- has document training and experience in QA/QC procedures and the laboratory's quality system;
- has a general knowledge of the analytical methods offered by the laboratory;
- coordinates and conducts internal systems and technical audits;
- notifies laboratory management of deficiencies in the quality system;
- monitors corrective actions;
- provides supports to technical personnel and may serve as the primary deputy for the acting TNI Technical Manager(s).

Manager - Client Services (MNGR-CS): The MNGR-CS oversees project management personnel. This position is responsible for training and management of client facing staff that serve as the liaison between PAS and the customer to ensure that projects are successfully managed to meet the expectations and needs of PAS customers. This position is also responsible for sharing positive and negative customer feedback with laboratory management so that this information may be used to improve the quality program.

Local IT Manager, however named: Local IT managers are responsible for maintaining the IT systems used to support the quality program. These systems include Laboratory Information Management Systems (LIMS); data acquisition, reduction, and reporting software; virus-protection, communication tools, and ensuring the integrity and security of electronic data.

Department Manager (DM): The DM is responsible for administrative and operations management and implementation of the quality management system in the work area he/she oversees. These responsibilities include but are not limited to: training and supervision of personnel, monitoring work activity to maintain compliance with this manual, SOPs, policies and other instructional documents that support the quality management system; method development, validation and the establishment and implementation of SOPs to assure regulatory compliance and suitability for intended purpose; monitoring QA/QC performance, proper handling and reporting of nonconforming work, purchasing of supplies and equipment adequate for use, maintaining instrumentation and equipment in proper working order and calibration, and general maintenance of administrative and technical processes and procedures established by the laboratory.

Quality Manager 2 (QM2): The QM2 provides support to the quality manager and assists the quality manager with implementation of the quality management system for one or more site locations.

Technical Specialist (TS): The TS provides technical oversight and guidance to laboratory personnel. Responsibilities may include but are not limited to: research and development, method development and validation, development of standard operating procedures, proposal and contract review. The TS may also be responsible for QA/QC trend analysis, technical training, and technology improvement.

Manager - Operations (MNGR-OPS): The MNGR-OPS is responsible for management of production and/or other duties assigned by the GM or SGM.

4.1.5.2.1 **Acting Technical Manager (TNI Accreditation):**

For PAS locations that are NELAC/TNI accredited:

The TNI Standard specifies requirements for the qualification and duties of technical personnel with managerial responsibility. These requirements are associated in the Standard to the designation 'technical manager(s), however named'. These responsibilities may be assigned to multiple individuals and are not associated with any specific job title.

For PAS, these TNI requirements for personnel that provide technical oversight correlate with PAS's job descriptions for Department Manager or Supervisor. However, the duties may be assigned to any PAS employee that meets the TNI specified qualifications.

Personnel assigned this designation retain their PAS assigned job title. The job title may be appended with *"acting as technical manager for*

TNI" and the technology or field of accreditation for which the employee is approved, if necessary.

When TNI Accreditation Bodies (AB) refer to these employees as 'technical manager' or 'technical director' on the official certificate or the scope of accreditation, this reference is referring to their approval to carry out duties of the 'technical manager, however named' as specified in the TNI Standard.

In accordance with the TNI Standard, the acting Technical Manager(s) for TNI are responsible for monitoring the performance of QC/QA in the work areas they oversee.

If the absence of any employee that is approved as acting technical manager for TNI exceeds 15 calendar days, the duties and responsibilities specified in the TNI Standard are reassigned to another employee that meets the qualifications for the technology or field of accreditation or they are assigned to the position's deputy, the quality manager.

4.1.5.3 Conflict of Interest

A conflict of interest is a situation where a person has competing interests. Laboratory management looks for potential conflict of interest and undue pressures that might arise in work activities and then includes countermeasures in policies and procedures to mitigate or eliminate the conflict.

See policy COR-POL-0004 *Ethics Policy* for more information.

4.1.5.4 Confidentiality

Laboratory management is committed to preserving the confidentiality of PAS customers and confidentiality of business information.

Procedures used by the laboratory to maintain confidentiality include:

- A Confidentiality Agreement which all employees are required to sign at the time of employment and abide by the conditions of throughout employment;
- Record retention and disposal procedures that assure confidentiality is maintained;
- Physical access controls and encryption of electronic data; and
- Protocol for handling Confidential Business Information (CBI).

Client information obtained or created during work activities is considered confidential and is protected from intentional release to any person or entity other than the client or the client's authorized representative information provided to PAS, except when the laboratory is required by law to release confidential information to another party, such as a regulatory agency or for litigation purposes. In which case, the laboratory will notify the client of the release of information and the information provided.

The terms of client confidentiality are included in PAS Standard Terms and Conditions (T&C). With the acceptance of PAS Terms and Conditions and/or the implicit contract for analytical services that occurs when the client sends samples to the laboratory for testing, the client authorizes PAS to release confidential information when required.

See policy COR-POL-0004 *Ethics Policy* for more information.

4.1.5.5 Communication

Communication is defined as the imparting or exchanging of news and information. Effective (good) communication occurs when the person(s) you are exchanging information with actively gets the point and understands it.

4.1.5.5.1 Workplace Communication

Good communication in the workplace is necessary to assure work is done correctly, efficiently, and in accordance with client expectations.

Instructions for how to carry out work activities are communicated to personnel via written policy, standard operating procedures, and standard work instructions.

Information about laboratory performance (positive and negative) and ideas for improvement are communicated using various communication channels such as face to face meetings, video conferencing, conference calls, email, memoranda, written reports, and posters.

4.1.5.5.2 External Communication

Communication with external parties such as customers, vendors, business partners, and regulatory agencies takes place every day.

Laboratory management ensure personnel learn to communicate in professional and respectful ways in order to build strong relationships, and learn to communicate effectively to avoid misunderstanding.

4.2 Quality Management System

4.2.1 Quality Management System Objectives

The objectives of the laboratory's quality management system are to provide clients with consistent, exemplary professional service, and objective work product that is of known and documented quality that meets their requirements for data usability and regulatory compliance.

Objective work product is analytical services, data, test results, and information that is not influenced by personal feeling or opinions. The quality of being objective is also known as 'impartiality'.

4.2.1.1 Impartiality

The laboratory achieves and maintains impartiality by implementing and adhering to the policies and processes of the quality management system, which are based on industry accepted standards and methodologies.

The laboratory's procedures for handling nonconforming work (See 4.9), corrective and preventive actions (See 4.11) and management review (See 4.15) are the primary mechanisms used to identify risk to impartiality and to prompt actions necessary to eliminate or reduce the threat when risk to impartiality is suspected or confirmed.

4.2.1.2 Risk and Opportunity Assessment

Risks are variables that make achieving the goals and objectives of the quality management system uncertain. An opportunity is something that has potential positive consequences for the laboratory.

Laboratory personnel manage risks and opportunities on a daily basis by carrying out the processes that make up the quality management system. Some of the ways in which the quality management system is designed to identify, minimize, or eliminate risk on a daily basis include but are not limited to:

- Capability and capacity reviews of each analytical service request to assure the laboratory can meet the customer's requirements;
- Maintenance of accreditation and certification for test methods in multiple states and programs to cover a broad range of jurisdiction for regulatory compliance;
- SOPs and other controlled instructional documents are provided to personnel to eliminate variability in process. These documents include actions to counter risk factors inherent in the process and are reviewed on a regular basis for on-going suitability and relevancy;
- Participation in proficiency testing programs and auditing activities to verify on-going competency and comparability in performance;
- Provision of on-the-job training and established protocol for quality control (QC) corrective action for nonconforming events;
- An established program for ethics, and data integrity;
- Tiered data review process;
- Culture of continuous improvement;
- Monitoring activities to assess daily and long term performance; and
- Annual critical review of the effectiveness the quality management system.

PAS also promotes a continuous improvement culture based on the principles of lean manufacturing. These principles include 3P (Process, Productivity, Performance) and Kaizen. 3P is a platform used by Pace to share best practices and standardization across the network to achieve operational excellence. Kaizen is a team based process used to implement tools and philosophies of lean to reduce waste and achieve flow

with the purpose of improving both external and internal customer satisfaction. PAS's lean programs and activities help to mitigate risk because they generate a collective understanding of vulnerabilities and utilize group-effort to develop and implement solutions at all levels.

Risk and opportunities may also be formally identified using specific risk and opportunity assessment methods such as SWOT Analysis (Strength, Weakness, Opportunity, Threats) and 3-Stage Impact/Probability Grids.

4.2.1.3 Communication of the Quality Management System

This manual is the primary mechanism used by laboratory management to communicate the quality management system to laboratory personnel.

To assure personnel understand and implement the quality program outlined in the manual:

- All laboratory personnel are required to sign a Read and Acknowledgement Statement to confirm the employee has: 1) been informed of the manual by laboratory management, 2) has access to the manual, 3) has read the manual 4) understands the content of the manual, and 5) agrees to abide by the requirements, policies and procedures therein.
- Personnel are informed that the manual provides the "what" of the quality management system. The "how to" implementation of the quality management system is provided in policy, SOPs, standard work instructions, and other controlled instructional documents.

4.2.2 Quality Policy Statement

The quality policy of the laboratory is to provide customers with data of known and documented quality fit for their intended purpose. The laboratory achieves this policy by implementing the quality management system defined in this manual, by following industry accepted protocol for analytical testing and quality assurance and quality control (QA/QC) activities, by conformance with published and industry accepted testing methodologies, and by compliance with international and national standards for the competency and/or accreditation of testing laboratories.

Intrinsic to this policy statement is each of the following principles:

- The laboratory will provide customers with reliable, consistent, and professional service. This is accomplished by making sure the laboratory has the resources necessary to maintain capability and capacity; that staff are trained and competent to perform the tasks they are assigned; that client-facing staff are trained and prepared to find solutions to problems and to assist customers with their needs for analytical services. Customer feedback, both positive and negative, is shared with personnel and used to identify opportunities for improvement.
- The laboratory maintains a quality program that complies with applicable, state, federal, industry standards for analytical testing and competency.

  ISO/IEC 17025 and the TNI (The NELAC Institute) Standard is used by PAS to establish the minimum requirements of the PAS quality program.

ISO/IEC 17025 is a competency standard that outlines the general requirements for the management system for calibration and testing laboratories. It is the primary quality system standard from which other quality system standards, such as the TNI Standard, are based. The TNI Standard are consensus standards that provides management and technical requirements for laboratories performing environmental analysis.

- Laboratory management provides training to personnel so that all personnel are familiar with the quality management system outlined in this manual and that they understand that implementation of the quality management system is achieved by adherence to the organization's policies and procedures.
- Laboratory management continuously evaluates and improves the effectiveness of the quality management system by responding to customer feedback, and other measures of performance, such as but not limited to: the results of internal/external audits, proficiency testing, metrics, trend reports, and annual and periodic management reviews.

4.2.2.1 Ethics Policy / Data Integrity Program

PAS has established a comprehensive ethics and data integrity program that is communicated to all PAS employees in order that they understand what is expected of them. The program is designed to promote a mindset of ethical behavior and professional conduct that is applied to all work activities.

The key elements of the PAS Ethics / Data Integrity Program include:

- Ethics Policy (COR-POL-0004);
- Ethics Compliance Officer;
- Standardized data integrity training course taken by all new employees on hire and a yearly refresher data integrity training course for all existing employees;
- Policy Acknowledgement Statements that all PAS personnel, including contract and temporary, are required to sign at the time of employment and again during annual refresher training to document the employee's commitment and obligation to abide by the company's standards for ethics, data integrity and confidentiality;
- SOPs that provide instructions for how to carry out a test method or process to assure tasks are done correctly and consistently by each employee;
- On the Job Training;
- Data integrity monitoring activities which include, but are not limited to, secondary and tertiary data review, internal technical and system audits, raw data audits, data mining scans, and proficiency testing; and
- Confidential reporting process for alleged ethics and data integrity issues.

All laboratory managers are expected to provide a work environment where personnel feel safe and can report unethical or improper behavior in complete confidence without fear of retaliation. Retaliation against any employee that reports a concern is not tolerated.

PAS has engaged Lighthouse Services, Inc. to provide personnel with an anonymous reporting process available to them 24 hours a day/7 days per week. The alert line may be used by any employee to report possible violations of the company's ethics and data integrity program. When using the reporting process, the employee does need to specify the location of concern and when reporting by email, also include the company name. Messages are collected, documented, reviewed, and will be followed up on by the Ethics Compliance Officer to resolve the matter. Investigations concerning data integrity are kept confidential.

Lighthouse Compliance Alert Lines:

English Speaking US & Canada	(844) 940-0003
Spanish Speaking North America	(800) 216-1288
Internet	www.lighthouse-services.com/pacelabs
Email	reports@lighthouse-services.com

4.2.3 Management Commitment: Quality Management System

Evidence of management's commitment for the development, maintenance, and on-going improvement of the quality management system is provided by the application of their signature of approval to this manual. Their signature confirms they understand their responsibility to implement the quality management system outlined in this manual, to communicate the quality program to personnel, and to uphold requirements of the program during work activities.

4.2.4 Management Commitment: Customer Service

Management communicates the importance of meeting customer and regulatory requirements to personnel by training personnel on the quality management system outlined in this manual, implementing the quality management system outlined in this manual, and upholding these requirements for all work activities.

4.2.5 Supporting Procedures

Documents that support this manual and quality management system are referenced throughout this manual. The structure of the document management system is outlined in SOP ENV-SOP-CORQ-0015 *Document Management and Control* and summarized in the following subsections.

4.2.5.1 Quality Management System Document Structure

Documents associated with the quality management system are classified into document types that identify the purpose of the document and establish how the document is managed and controlled.

Document types are ranked to establish which documents takes precedence when there is an actual or perceived conflict between documents and to establish the hierarchal relationships between documents. The ranking system also provides information to document writers and reviewers to assure downline documents are in agreement with documents of higher rank. Project specific documents are not ranked

because client specific requirements are not incorporated into general use documents in order to maintain client confidentiality.

PAS Quality Management System Documents: Internal

Document Type	Purpose
Quality Manual	Outlines the laboratory's quality management system and structure and how it works for a system including policy, goals, objectives and detailed explanation of the system and the requirements for implementation of system. Includes roles and responsibilities, relationships, procedures, systems and other information necessary to meet the objectives of the system described.
Policy	Provide requirements and rules for a PAS process and is used to set course of actions and to guide and influence decisions. Policy describes the "what", not the "how".
Standard Operating Procedure	Provide written and consistent set of instructions or steps for execution of a routine process, method, or set of tasks performed by PAS. Includes both fundamental and operational elements for implementation of the systems described in PAS manual(s). Assures that activities are performed properly in accordance with applicable requirements. Designed to ensure consistency, protect EHS of employees and environment, prevent failure in the process and ensure compliance with company and regulatory requirements. SOPs describes the "how" based on policy.
Standard Work Instruction	Provide step by step visual and/or written instruction to carry out a specific task to improve competency, minimize variability, reduce work injury and strain, or to boost efficiency and quality of work (performance). SWI are associated with an SOP unless the task described is unrelated to generation of or contribution to environmental data or analytical results.
Template	Pre-formatted document that serves as a starting point for a new document.
Guide	Provide assistance to carry out a task. Most often used for software applications.
Form	Used for a variety of purposes such as to provide a standardized format to record observations, to provide information to supplement an SOP.

PAS Quality Management System Documents: External

Certificate	Lists parameters, methods, and matrices for which the laboratory is certified/accredited to perform within the jurisdiction of the issuing regulatory agency or accreditation body.
Reference Document	Provide information, protocol, instructions, and/or requirements. Issued by the specifier. Examples include quality system standards such as ISO/IEC, TNI, DoD and published referenced methods such as Standard Methods, ASTM, SW846, EPA, and federal and state regulatory bodies.
Project Document	Provides requirements necessary to meet individual client expectations for intended use of data. Examples include: project quality assurance plans (QAPP), client-program technical specifications, contracts, and other agreements.

Document Hierarchy

Rank	Document
1	Reference Documents
2	Corporate Manual
3	Corporate Policy
4	Corporate SOP
5	Corporate SWI, Templates & Forms
6	Laboratory Manual
7	Laboratory SOP
8	Laboratory SWI, Templates, & Forms
NA	Project Documents[1]

4.2.6 Roles and Responsibilities

The roles and responsibilities of technical management and of the quality manager are provided in section 4.1.5.1.2.

4.2.7 Change Management

When significant changes to the quality management system are planned, these changes are managed by corporate quality personnel to assure that the integrity of the quality management system is maintained.

4.3 Document Control

4.3.1 General

The laboratory's procedures for document control are provided in SOP ENV-SOP-CORQ-0015 *Document Management and Control.*

The documents that support the quality management system include internally generated documents such as manuals, policies, standard operating procedures, standard work instructions, forms, guides, and templates and external source documents such as but not limited to, regulations, standards, reference methods, manuals, and project-specific documents.

The laboratory uses electronic document management software (eDMS) to carry out the procedures of the SOP. eDMS automates the process for unique document identification, version control, approval, access, and archival.

4.3.2 Document Approval and Issue

Documents that are part of the quality management system are reviewed by qualified personnel and approved by laboratory management prior by to release for general use.

Local QA maintains a master list of controlled documents used at the laboratory. The master list includes the document control number, document title, and current revision status and is made available to personnel for their reference.

Only the approved versions of documents are available to personnel for use. The eDMS system does not allow user access to draft versions of documents except to personnel assigned to work on the draft. eDMS also restricts access to archived documents except to authorized users, such as local QA, in order to prevent the use of obsolete documents.

See SOP ENV-SOP-CORQ-0015 *Document Management and Control* for more information.

4.3.3 Document Review and Change

Unless a more frequent review is required by regulatory, certification or accreditation program. the laboratory formally reviews documents at least every two years to ensure the document remains current, appropriate, and relevant.

Documents are also informally reviewed every time the document is used. Personnel are expected to refer to and follow instructions in controlled documents when they carry out their work activities. Consequently, any concerns or problems with the document should be caught and brought to the attention of laboratory management on an on-going basis.

Documents are revised whenever necessary to ensure the document remains usable and correct. Older document versions and documents no longer needed are made obsolete and archived for historical purposes.

The laboratory does not allow hand-edits to documents. If an interim change is needed pending re-issue of the document, the interim change is communicated to those that use the document using a formal communication channel, such as SOP Change in Progress form, email, or memorandum.

The document review, revision, and archival process is managed by local QA at the location from which the document was released using the procedures established in SOP ENV-SOP-CORQ-0015 *Document Management and Control.*

4.4 Analytical Service Request, Tender, and Contract Review

The laboratory's management and/or client service personnel perform thorough reviews of requests and contracts for analytical services to verify the laboratory has the capability, capacity, and resources necessary to successfully meet the customer's needs. These review procedures are described in laboratory SOP ENV-SOP-NW-0019 *Review of Analytical Requests.*

The procedures in this SOP(s) are established to ensure that:

- The laboratory understands the purpose of data collection in order to ensure the test methods requested are appropriate for the intended use of the data and capable of meeting the client's data quality objectives;
- The laboratory and any subcontractor has the capability, capacity, and resources to meet the project requirements and expectations within the requested time frame for delivery of work product;
- Any concerns that arise from review are discussed and resolved with the client; and
- The results of review and any correspondence with the client related to this process and/or any changes made to the contract are recorded and retained for historical purposes.

Capability review confirms that the in-network laboratories and any potential subcontractors hold required certification/accreditation for the test method, matrix, and analyte and verifies the laboratory can achieve the client's target compound list and data quality objectives (DQOs) for analytical sensitivity and reporting limits, QA/QC protocol, and hardcopy test report and electronic data deliverable (EDD) formats.

Capacity review verifies that the in-network laboratories and any potential subcontractors are able to handle the sample load and deliver work production within the delivery time-frame requested.

Resource review verifies that the laboratory and any potential subcontractors have adequate qualified personnel with the skills and competency to perform the test methods and services requested and sufficient and proper equipment and instrumentation needed to perform the services requested.

4.5 Subcontracting and In-Network Work Transfer

The terms 'subcontract' and "subcontracting" refers to work sent to a business external to PAS Analytical Services, LLC (PAS) and the term 'subcontractor' refers to these external businesses, which are also called vendors.

Work transferred within the PAS network is referred to as interregional work orders (IRWO) and network laboratories are referred to as IRWO or network laboratory.

The network of PAS laboratories offers comprehensive analytical capability and capacity to ensure PAS can meet a diverse range of client needs for any type of project. If the laboratory receives a request for analytical services and it cannot fulfill the project specifications, the laboratory's client services team will work with the client to place the work within the PAS network. When it is not possible to place the work within network, the laboratory will, with client approval, subcontract the work to a subcontractor that has the capabilities to meet the project specifications and can meet the same commitment agreed on between the laboratory and the client. Some client programs require client consent even for IRWO work transfer, and when this applies, the client services team obtains consent as required. The laboratory retains the record of client notification and their consent in the project record for historical purposes.

Whenever work is transferred to a subcontractor or an IRWO laboratory, the laboratory responsible for management of the project verifies each of these qualifications:

- The subcontractor or IRWO laboratory has the proper accreditation/certifications required for the project and these are current; and
- The use of the subcontractor or IRWO laboratory is approved by the client and/or regulatory agency, when approval is required. Record of approval is retained in the project record.

When possible, the laboratory selects subcontractors that maintain a quality management system similar to PAS and that complies with ISO/IEC 17025 and the TNI Standard(s).

PAS also evaluates and pre-qualifies subcontractors as part of company's procurement program. The complete list of approved vendors is maintained by the corporate procurement department and is made available to all PAS locations. Pre-qualification of a subcontractor does not replace the requirement for the placing laboratory to verify the capability, capacity, and resources of any selected subcontractor on a project-specific basis to confirm the subcontractor can meet the client's needs.

For both subcontracting and in-network work transfer, the project specifications are always communicated to the subcontractor or the IRWO laboratory by the project manager so that the laboratory performing the work is aware of and understands these requirements.

The procedures for subcontracting are outlined in laboratory SOPs ENV-SOP-MIN4-0010 *Subcontracting Samples* (Minneapolis, MN, Billings, MT) and ENV-SOP-VIR1-0003 *Subcontracting Samples* (Virginia, MN, Duluth, MN).

4.6 Purchasing Services and Supplies

Vendors that provide services and supplies to the laboratory are prequalified by corporate procurement personnel to verify the vendor's capability to meet the needs of PAS. These needs include but are not limited to: competitive pricing, capacity to fill purchase orders, quality of product, customer service, and business reputation and stability. The records of vendor evaluation and the list of approved vendors is maintained by the corporate procurement department.

The laboratory may purchase goods and services from any supplier on the approved vendor list.

The specifications (type, class, grade, tolerance, purity, etc.) of supplies, equipment, reagents, standard reference materials and other consumables used in the testing process are specified in SOPs. The SOP specifications are based on the governing requirements of the approved reference methods and any additional program driven regulatory specification, such as drinking water compliance. All requisitions for materials and consumables are approved by the department supervisor to confirm the purchase conforms with specified requirements. After approval the requisition is handled by the laboratory's designated purchasing agent. On receipt, the product is inspected and verified before use, when applicable.

The laboratory's procedure for the purchase of services and supplies is specified in laboratory SOP ENV-SOP-NW-0030 *Laboratory Supply Procedures.*

4.7 Customer Service

Project details and management is handled by the laboratory's customer service team. Each customer is assigned a Project Manager (PM) that is responsible for review of contract requirements and handling laboratory to customer communication about the project status.

4.7.1 Commitment to Meet Customer Expectations

The laboratory cooperates and works closely with our customers to ensure their needs are met and to establish their confidence in the laboratory's capability to meet their needs for analytical services and expectations for service.

Each customer's project is handled by a project manager (PM) that is the customer's primary point of contact. The PM gathers information from the customer to ensure the details of their request are understood. After samples are received, the PM monitors the progress of the project and alerts the customer of any delays or excursions that may adversely impact data usability. Laboratory supervisors are expected to keep the PM informed of project status and any delays or major issues, so that the PM can keep the client informed.

PAS also has a team of subject matter experts (SME) available to provide customers with advice and guidance and any other assistance needed. SME are selected by top management based on their knowledge, experience, and qualifications.

The laboratory encourages customers to visit the laboratory to learn more about the laboratory's capabilities, observe performance and to meet laboratory personnel.

PAS customers expect confidentiality. Laboratory personnel will not divulge or release information to a third party without proper authorization unless the information is required for litigation purposes. See Section 4.1.5.3 of this manual and policy COR-POL-0004 *Ethics Policy* for more information on the laboratory's policy for client confidentiality.

4.7.2 Customer Feedback

The laboratory actively seeks positive and negative feedback from customers through surveys and direct communication. Information from the client about their experience working with the laboratory and their satisfaction with work product is used to enhance processes and practices and to improve decision making. Customer feedback is communicated to laboratory management and corporate personnel in monthly reports and analyzed yearly during management review (See 4.15) to identify risk and opportunity. Corrective, preventive, or continuous improvement actions are taken based on nature of and/or feedback trends.

Also see sections 4.9, 4.10, 4.11, 4.12, 4.14, and 4.15 for more information about how customer feedback is managed by the laboratory and used to enhance the quality management system.

4.8 Complaints

Complaints provide opportunities to improve processes and build stronger working relationships with our clients.

The laboratory's complaint resolution process includes three steps. First, handle and resolve the complaint to mutual satisfaction. Second, perform corrective action to prevent recurrence (See 4.11). Third, record and track the complaint and use these records for risk and opportunity assessment and preventive action (See 4.12)

4.9 Nonconforming Work

4.9.1 Definition of Nonconforming Work

Nonconforming work is work that does not conform to customer requirements, standard specifications, laboratory policies and procedures, or that does not meet acceptance criteria.

The discovery of non-conforming work comes come from various sources which include, but are not limited to:

- results of quality control samples and instrument calibrations;
- quality checks on consumables and materials;
- general observations of laboratory personnel;
- data review;
- proficiency testing;
- internal and external audits;
- complaints and feedback;
- management review and reports; and
- regulatory and certification and accreditation actions.

The way in which the laboratory handles nonconforming work depends on the significance and impact (risk) of the issue. Some issues may simply require correction, others may require investigation, corrective action (See 4.11) and/or data recall (See 4.16). When the laboratory releases data and test results associated with nonconforming QC and acceptance criteria test results are qualified or non-conformances are noted in the final analytical report to apprise the data user of the situation. (See 5.10)

Nonconforming work also includes unauthorized departure from laboratory policies, procedures and test methods. Authorized departures are explained in the following subsections. Situations that do not conform to these conditions are considered unauthorized departure(s).

4.9.1.1 Authorized Departure from SOP

An authorized departure from a test method SOP is one that has been reviewed and approved by the Department Manager, Technical Manager, Acting Technical Manager for TNI, Quality Manager, or the General Manager. Review is conducted to confirm the departure does not conflict with regulatory compliance requirements for which the data will be used or does not adversely affect data integrity. The departure may originate from client request or may be necessary to overcome a problem.

An authorized departure from administrative or process-oriented SOP is typically necessary to correct an error in the SOP. These departure requests are reviewed and pre-approved by the local QA Manager. Documentation of SOP departures and approval decisions are retained by the laboratory as evidence that the departure was authorized. When necessary, approved departures from test method SOPs are noted in the final test report to advise the data user of any ramification to data quality.

4.9.1.2 Authorized Departure from Test Methods (Method Modifications)

When test results are associated to a published reference test method, the laboratory's test method SOP must be consistent with the test method. If the test method is mandated for use by a specific regulatory program such as drinking water or wastewater or a certification or accreditation program, such as TNI/NELAC, the SOP must also comply with or include these requirements. If the procedures in the SOP are modified from the test method, these modifications must be clearly identified in the SOP. The conditions under which the laboratory may establish an SOP that is modified from these reference documents, and what is considered a modification are specified in ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

Modifications that do not meet the requirements of this SOP (ENV-SOP-CORQ-0011) are unauthorized. Client requests to deviate from the test method are handled as client requests to depart from the test method SOP since it is the SOP that the laboratory follows when performing work.

4.9.1.3 Stop Work Authority

Stop Work Authority provides laboratory personnel with the responsibility and obligation to stop work when there is a perceived unsafe condition or behavior that may result in an unwanted event.

All laboratory and corporate personnel have the authority to stop work when needed to preserve data integrity or safety of workers.

Once a stop work order has been initiated and the reason for doing so is confirmed valid; laboratory management is responsible for immediate correction and corrective action (see section 4.10) before resumption of work.

4.10 Continuous Improvement

The laboratory's quality management system is designed to achieve continuous improvement through the implementation of the quality policy and objectives outlined in this manual. Information about the laboratory's activities and performance is gained from many sources such as customer feedback, audits, QC, trend analysis, business analytics, management reports, proficiency testing, and management systems review. This information is subsequently used during the laboratory's corrective action (see section 4.11) and preventive action (see section 4.12) processes and to establish goals and objectives during annual review of the management system (see section 4.15).

PAS also promotes a continuous improvement culture based on the principles of lean manufacturing. These principles include 3P (Process, Productivity, Performance) and Kaizen. 3P is a platform used by Pace to share best practices and standardization across the network to achieve operational excellence. Kaizen is a team based process used to implement tools and philosophies of lean to reduce waste and achieve flow with the purpose of improving both external and internal customer satisfaction.

4.11 Corrective Action

Corrective action is process used to eliminate the cause of a detected nonconformity. It is not the same as a correction. A correction is an action taken to fix an immediate problem. The goal of the corrective action process is to find the underlying cause(s) of the problem and to put in place fixes to prevent the problem from happening again. The corrective action process, referred to as CAPA by PAS, is one of the most effective tools used by the laboratory to prevent nonconforming work, identify risk and opportunity, and improve service to our customers.

The laboratory has two general processes for corrective action:

The process used for actions taken in response to day to day quality control (QC) and acceptance criteria exceptions (nonconformance) that occur during the day to day testing process are called corrections. These events do not usually include formal methods for cause analysis; instead the reason for the failure is investigated through troubleshooting or other measures. Required actions for correction of routine nonconformance is specified in laboratory SOPs. When corrective action is not taken, cannot be taken, or is not successful, test results associated with the nonconforming work are qualified in the final test report. Documentation of the nonconformance and corrective action taken is documented in the analytical record.

A formal 7 step corrective action process is used when there is a problem or departure from the quality management system, technical activities, or when the extent of a single problem has significant impact on data, regulatory compliance or customer needs. These problems are identified through various activities such as but not limited to: quality control trends, internal and external audits, management review, customer feedback, and general observation.

The laboratory's 7 Step CAPA Process includes:

1) Define the Problem
2) Define the Scope of the Problem
3) Contain the Problem
4) Root Cause Analysis
5) Plan Corrective Action
6) Implement Corrective Action
7) Follow Up / Effectiveness Check

The formal CAPA process may be initiated by any employee. Once the process is initiated it is overseen and coordinated by laboratory management. The CAPA process is documented using an electronic or paper-based system. The CAPA record includes tracking information, dates, individuals involved, those responsible for action plan implementation and follow-up, and timelines and due dates.

For more information about the laboratory's procedure for corrective action, see laboratory SOP ENV-SOP-NW-0014 *Corrective Action/Preventive Action Process*. Additional explanation about certain aspects of the laboratory's corrective action process are outlined in the next three subsections.

4.11.1 Root Cause Analysis

Root cause analysis (RCA) is the process of investigation used by the laboratory to identify the underlying cause(s) of the problem. Once causal factors are identified, ways to mitigate the causal factors are reviewed and corrective action(s) most likely to eliminate the problem are selected.

The laboratory uses different methods to conduct this analysis. The most common approach is 5-Why, but fishbone diagrams, or even brainstorming may be appropriate depending on the situation. The method used is documented in the CAPA record.

4.11.2 Effectiveness Review

Monitoring corrective actions for effectiveness is shared by laboratory supervisors and quality assurance personnel. Effectiveness means the actions taken were sustainable and appropriate. Sustainable means the change is still in place. Appropriate means the action(s) taken prevented recurrence of the problem since the time corrective action was taken.

The time-frame in which effectiveness review takes place depends on the event and is recorded in the CAPA record with any addition actions that need to be taken.

Corrective action trends are also monitored by laboratory management and used to identify opportunities for preventive action or to gain lessons learned when actions taken were not adequate to solve the problem. See Section 4.12 (Preventive Action) and 4.15 (Management Review) for more information.

4.11.3 Additional Audits

When non-conformances or other problems cast doubt on compliance with the laboratory's policies, procedures, or compliance to regulatory requirements; laboratory management schedules a special audit of the area of activity in accordance with Section 4.14.1 as soon as possible. These special audits are used to determine the scope of the problem and to provide information for the CAPA process. Additional full-scale audits are done when a serious issue or risk to the laboratory's business is identified.

4.12 Preventive Action

Preventive action is an action taken to eliminate the cause of a potential nonconformity and to achieve improvement. Preventive action is a forward thinking process designed to prevent problems opposed to reacting to them (corrective action).

Some examples of preventative action include, but are not limited to:

- Scheduled instrument maintenance (Preventative maintenance)

- Addition of Staff and Equipment
- Professional Development Activities
- Implementation of New Technology

The laboratory looks for opportunities for preventive action from a variety of sources including but not limited to: employee idea's, customer feedback, business partners input, trend analysis, business analytics, management reviews, proficiency testing results, lean management events, and risk-benefit analysis.

The process for preventive actions follows the same 7 step process for corrective action except "problem" is replaced with "opportunity", "cause analysis" is replaced with "benefit analysis", and "corrective action" is replaced with "preventive action".

Laboratory management evaluates the success of preventive actions taken in any given year during annual management review. See Section 4.15 for more information.

4.12.1 Change Management

Preventive actions may sometimes result in significant changes to processes and procedures used by the laboratory. Laboratory management evaluates the risks and benefits of change and includes in its implementation of change process, actions to minimize or eliminate any risk. The types of changes for which risk are considered and managed include: infrastructure change, change in analytical service offerings, certification or accreditation status, instrumentation, LIMS changes, and changes in key personnel.

For more information about the laboratory's procedures for preventive action see laboratory SOP ENV-SOP-NW-0014 *Corrective Action/Preventive Action Process.*

4.13 Control of Records

A record is a piece of evidence about the past, especially an account of an act or occurrence kept in writing or some other permanent form. Laboratory records document laboratory activities and provide evidence of conformity to the requirements established in the quality management system. These records may be hardcopy or electronic on any form of media.

4.13.1 General Requirements

4.13.1.1 Procedure

The laboratory's procedures for control of records is provided in laboratory SOP ENV-SOP-NW-0026 *Data and Records Archival.*

The procedures in the SOP are established to assure quality and technical records are identified, retained, indexed, and filed to allow for retrieval during the entire retention time frame. During storage, records are kept secure and protected from deterioration. At the end of the retention time, the records are disposed of properly in order to maintain client confidentiality and to protect the interests of the company.

In general, laboratory records fall into three categories: quality, technical, and administrative.

Examples of each are provided in the following table:

Record Type	Includes Records of:
Quality	Documents: Document Types listed in SOP ENV-SOP-CORQ-016 Audits: Internal and External Certificates and Scopes of Accreditation Corrective & Preventive Action Management Review Data Investigations Method Validation Instrument Verification Training Records
Technical	Raw Data Logbooks Certificates of Traceability Analytical Record Test Reports & Project Information Technical Training Records & Demonstration of Capability
Administrative	Personnel Records Finance/Business

4.13.1.2 Record Legibility and Storage

Records are designed to be legible and to clearly identify the information recorded. Manual entries are made in indelible ink; automated entries are in a typeface and of sufficient resolution to be read. The records identify laboratory personnel that performed the activity or entered the information.

Records are archived and stored in a way that they are retrieved. Access to archived records is controlled and managed.

For records stored electronically, the capability to restore or retrieve the electronic record is maintained for the entire retention period. Hardcopy record are filed and stored in a suitable environment to protect from damage, deterioration, or loss. Hardcopy records may be scanned to PDF for retention. Scanned records must be checked against the hardcopy to verify the scan is complete and legible.

Records are kept for a minimum of 10 years unless otherwise specified by the client or regulatory program.

The date from which retention time is calculated depends on the record. In general, the retention time of technical records of original observation and measurement is calculated from the date the record is created. If the technical record is kept in a chronological logbook, the date of retention may be calculated from the date the logbook is archived. The retention time of test reports and project records, which are considered technical records, is calculated from the date the test report was issued. The retention time of quality records is usually calculated from the date the record is archived.

Refer to the laboratory's record management SOP for more information.

4.13.1.3 Security

The laboratory is a secure facility and access to records is restricted to laboratory personnel.

4.13.1.4 Electronic Records

The data systems used to store electronic records is backed up in accordance with laboratory SOP ENV-SOP-NW-0026 *Data and Records Archival.* Access to archived records stored electronically is maintained by personnel responsible for management of the electronic system.

4.13.2 Technical Records

In addition to the requirements identified in subsections 4.13.1.1 through 4.13.1.4, the requirements in the following subsections also apply to technical records.

4.13.2.1 Description

Technical records are the accumulation of data and information generated from the analytical process. These records may include forms, worksheets, workbooks, checklists, notes, raw data, calibration records, final test reports, and project record. The accumulated record essentially need to provide sufficient detail to historically reconstruct the process and identify the personnel that performed the tasks associated with a test result.

4.13.2.2 Real Time Recordkeeping

Personnel are instructed and expected to always record observations, data, and calculations at the time they are made. Laboratory managers are responsible to assure that data entries, whether made electronically or on hardcopy, are identifiable to the task.

4.13.2.3 Error Correction

Errors in records must never erased, deleted or made illegible. Use of correction fluid, such as white-out is prohibited. In hardcopy records, the error is corrected by a single-strike through the original entry and the new entry recorded alongside or footnoted to allow for readability. Corrections are initialed and dated by the person making the correction. If the correction is not self-explanatory, a reason for the correction is recorded.

For electronic records, equivalent measures of error correction or traceability of changes made is kept. For example, audit trails provide records of change.

Maintenance of proper practices for error correction is monitored through the tiered data review process described in Section 5.9.3. Laboratory records are reviewed throughout the data review process. Individuals performing these reviews flag errors that are not properly corrected and bring these to the attention of the department manager or supervisor of the work area in which the record was generated so that the problem may be addressed and corrected with the individual(s) that did not make the correction properly.

4.14 Audits

The laboratory performs internal systems and technical audits to assess compliance to this manual and to other laboratory procedures, such as policy, SOP and SWI. Since the processed in this manual are based on the relevant quality system standards and regulatory and accreditation/certification

program requirements the laboratory provides services for, the internal audits also assess on-going compliance to these programs.

The laboratory is also audited by external parties such as regulatory agencies, customers, consultants and non-government assessment bodies (NGAB).

Information from internal and external audits is used by laboratory management to address compliance concerns and opportunities where improvement will increase the reliability of data.

Deficiencies, observations and recommendations from audits are managed by local QA using the laboratory's formal CAPA process. See Section 4.11 for more information.

4.14.1 Internal Audit

The laboratory's internal audit program is managed by local QA in accordance with a pre-determined audit schedule established at the beginning of each calendar year. The schedule is prepared to assure that all areas of the laboratory are reviewed over the course of the year. Conformance to the schedule is reported to both laboratory management and corporate quality personnel in a monthly QA report prepared by the quality manager.

Although the QA Manager creates the audit schedule, it is the shared responsibility of local QA and laboratory managers to assure the schedule is maintained. aboratory supervisors cooperate with QA to provide the auditors with complete access to the work area, personnel, and records needed.

Internal audits are performed by personnel approved by the quality manager. In general, personnel may not audit their own activities unless it can be demonstrated that an effective and objective audit will be carried out. The auditor must be trained, qualified, and familiar enough with the objectives, principles, and procedures of laboratory operations to be able to perform a thorough and effective evaluation.

The laboratory's internal audit program includes:

- System Audits & Method Audits: The purpose of these audits is to determine if daily practice is consistent with laboratory's SOPs and if SOPs are compliant with adjunct policy and procedures. Auditing techniques includes analyst interviews and observation and records review. These audits are performed per the pre-determined schedule.

- Raw Data / Final Test Report Audits: The purpose of these audits is to review raw data and/or a final test reports to verify the final product is consistent with customer/project requirements and supported as compliant to SOPs, reference methods, with test results that are properly qualified when necessary, accurate, and of known and documented quality. The reviews should also identify opportunities for improvement and best practices.

- Special Audits: Special audits are those performed ad hoc to follow up on specific a specific issue such as a client complaint, negative feedback, concerns of data integrity or ethics, or a problem identified through other audits. Special audits may be scheduled or unscheduled. Unscheduled internal audits are conducted whenever doubts are cast on the laboratory's compliance with regulatory requirements or its own policies and procedures. These unscheduled internal audits may be conducted at any time and may be performed without an announcement to laboratory personnel.

When observations and findings from any audit (internal or external) cast doubt on the validity of the laboratory's testing results, the laboratory takes immediate action to initiate investigate the problem and take corrective action. (Also see 4.11 and 4.16)

The laboratory's internal audit program and auditing procedures are further described in laboratory SOP ENV-SOP-NW-0020 *Internal and External Audits.*

4.14.1.1 Corporate Compliance Audit

The laboratory may also be audited by corporate quality personnel to assess the laboratory's compliance to the company's quality management program and to evaluate the effectiveness of implementation of the policies and procedures that make up the quality management system. The purpose of the compliance audit is to identify risks and opportunities and to assist laboratory management achieve the goals and objectives of the company's quality program.

4.15 Management Review

The laboratory's management team formally reviews the management system on an annual basis to assess for on-going suitability and effectiveness and to establish goals, objectives, and action plans for the upcoming year.

At a minimum, following topics are reviewed and discussed:

- The on-going suitability of policies and procedures including HSE (Health, Safety and Environment) and waste management;
- Reports from managerial and supervisory personnel including topics discussed at regular management meetings held throughout the year;
- The outcome of recent internal audits;
- Corrective and preventive actions;
- Assessments by external bodies;
- The results of interlaboratory comparisons or proficiency tests;
- Changes in the volume and type of the work;
- Customer and personnel feedback, including complaints;
- Effectiveness of improvements / preventive actions made since last review;
- Internal and external issues of relevance and risk identification;
- A review of the status of actions from prior management reviews; and
- Other relevant factors, such as quality control activities, resources, and staff training.

The discussion and results of this review are documented in a formal report prepared by laboratory management. This report includes a determination of the effectiveness of the management system and its processes; goals and objectives for improvements in the coming year with timelines and responsibilities, any other need for change. See laboratory SOP ENV-SOP-CORQ-0005 *Review of Laboratory Management System* for more information.

Goals and action items from annual management systems review are shared with employees to highlight focus areas for improvement in addition to areas in which the laboratory has excelled.

4.16 Data Integrity

The laboratory's procedures for data integrity reviews are described in SOP ENV-SOP-CORQ-0010 *Data Recall.*

Customers whose data are affected by these events are notified in a timely manner, usually within 30 days of discovery. Some accreditation programs also require notification to the accreditation body (AB) within a certain time-frame from date of discovery when the underlying cause of the issue impacts accreditation. The laboratory follows any program or project specific client notification requirements for notification, when applicable.

5.0 TECHNICAL REQUIREMENTS

5.1 General

Many factors contribute to the correctness and reliability of the technical work performed by the laboratory. These factors are fall under these general categories:

- Human Performance
- Facility and Environmental Conditions
- Test Method Performance and Validation
- Measurement Traceability
- Handling of Samples

The impact of each of these factors varies based on the type of work performed. To minimize negative effects from each these factors, the laboratory takes into account the contribution from each of these categories when developing test method and process (administrative) SOPs, evaluating personnel qualifications and competence, and in the selection of equipment and supplies used.

5.2 Personnel

5.2.1 Personnel Qualifications

The laboratory's program for personnel management is structured to ensure personnel are selected, qualified, and competent to perform the roles and responsibilities of their position based on education, experience, and training.

Qualifications, duties, responsibilities, and authorities of each position are specified in job descriptions maintained by corporate HR (See Section 5.2.4). These job descriptions provide the general basis for the selection of personnel for hire and are used by the laboratory to communicate to personnel the duties, responsibilities, and authorities of their position.

The term "personnel" refers to individuals employed by the laboratory directly as full-time, part-time, or temporary, and individuals employed by the laboratory by contract, such as through an employment agency. The term "personnel" is used interchangeably with the term "employee" throughout this manual. For purposes of this manual, these terms are equivalent.

The personnel management program is structured to establish and maintain records for each of the following:

- Selection of personnel;
- Training of personnel;
- Supervision of personnel;
- Authorization of personnel; and
- Monitoring Competence of personnel.

5.2.1.1 Competence

Competence is the ability to apply a skill or series of skills to complete a task or series of tasks correctly within defined expectations.

Competence for technical personnel authorized by PAS to provide opinion and interpretation of data to customers also includes the demonstrated ability to:

- Apply knowledge, experience, and skills needed to safely and properly use equipment, instrumentation, and materials required to carry out testing and other work activities in accordance with manufacturer specifications and laboratory SOPs;
- Understand and apply knowledge of general regulatory requirements necessary to achieve regulatory compliance in work product; and
- Understand the significance of departures and deviations from procedure that may occur during the analytical testing process and the capability and initiative to troubleshoot and correct the problem, document the situation and decision making process, and to properly qualify the data and analytical results.

The laboratory's requirements for the competence of personnel (education, qualification, work experience, technical skills, and responsibilities) are specified in job descriptions created by management and kept by human resources (HR). The job description provides the basis for the selection of personnel for each position.

An employee is considered competent when he/she has completed required training.

The policies and standard operating procedures (SOPs) for the following topics are established by management as minimum required training for all personnel:

- Ethics and Data Integrity
- Quality Manual
- Safety Manual
- Quality Management System
- Technical Process and Procedure relevant to their job tasks
- Successful Demonstration of Capability (DOC) – Analytical Personnel Only

Personnel are initially authorized competent to independently carry out their assigned duties when required training is complete and documented.

Records of training and qualification provide the record of competence for the individual. Qualification records may include but are not limited to diploma, transcripts, and curriculum vitae (CV).

The on-going competence of each employee is monitored by laboratory management through on-the-job performance. Analytical employees are also required to successfully complete another demonstration capability for each test method performed on an annual basis.

5.2.2 Training

Training requirements are outlined in policies COR-POL-0023 *Mandatory Training Policy.* COR-POL-0004 *Ethics Policy*, and laboratory SOP ENV-SOP-NW-0025 *Employee Orientation and Training.* Additional training requirements may also be specified in other documents, such as manuals

5.2.2.1 Training Program and Goals

The laboratory's training program includes 4 elements:

- Identification of Training Needs
- Training Plan Development and Execution
- Documentation and Tracking
- Evaluation of Training Effectiveness

Laboratory management establishes goals and training needs for individual employees based on their role, education, experience, and on-the-job performance.

Training needs for all employees are based on business performance measures that include but are not limited to:

- Quality Control Trends
- Process Error / Rework Trends
- Proficiency Testing Results
- Internal & External Audit Performance
- Management Review Goals

Training is delivered using various methods that incorporate techniques that appeal to the main learning styles: visual, aural, linguistic, and kinesthetic. Techniques include, on-the-job, instructor-led, self-study, eLearning, and blended.

The employee's direct supervisor is responsible for oversight of the employee's training plan and for providing adequate time to the employee to complete training assignments. Both the supervisor and employee are responsible to make sure the employee's training status and training records are current and complete.

The laboratory's QA department monitors the training status of personnel and provides the status to the General Manager (GM) at least monthly or more frequently, if necessary. The status report is used by laboratory management to identify overdue training assignments, the reasons for the gaps, and to make arrangements for completion.

The following subsections highlight specific training requirements:

5.2.2.1.1 New Hire Training

New hire training requirements apply to new personnel and to existing employee's starting in a new position or different work area.

Required new hire training includes each of the following:

- Ethics and Data Integrity (See 5.2.2.1.3)
- Quality Manual / Quality Management System (See 5.2.2.1.4)
- Safety Manual and any training requirements specified in the manual.
- Policies & SOPs relevant to their job tasks
- Technical personnel that test samples must also successfully complete an initial demonstration of capability (IDOC) for the test methods performed before independently testing customer samples. (See 5.2.2.1.5). Independent testing means handling of client samples without direct supervision of the work activity by the supervisor or a qualified trainer.

All required training must be current and complete before the employee is authorized to work independently. Until then, the employee's direct supervisor is responsible for review and acceptance of the employee's work product.

5.2.2.1.2 On-Going Training

Personnel receive on-going training in each of the following topics:

- Ethics and Data Integrity (See 5.2.2.1.3)
- Quality Manual / Quality Management System (See 5.2.2.1.4)
- Safety Training
- Changes to Policies & SOPs
- Specialized Training
- Technical employees that carry of testing must also successfully complete on-going demonstration of capability (ODOC) for all test methods performed on an annual basis. (See 5.2.2.1.5)

Personnel are expected to maintain their training status and records of training current and complete and to complete training assignments in a timely manner.

5.2.2.1.3 Ethics and Data Integrity Training

Data integrity training is provided to all new personnel and refresher data integrity training is provided to all employees on an annual basis. Personnel are required to acknowledge they understand that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment, or civil/criminal prosecution.

The initial data integrity training and the annual refresher training is documented with a signature attendance sheet or other form of documentation to provide evidence that the employee has participated in training on this topic and understand their obligations related to data integrity.

The following topics and activities are covered:

- Policy for honesty and full disclosure in all analytical reporting;
- Prohibited Practices;
- How and when to report data integrity issues;
- Record keeping. The training emphasizes the importance of proper written documentation on the part of the analyst with respect to those cases where analytical data may be useful, but are in one sense or another partially nonconforming;
- Training Program, including discussion regarding all data integrity procedures;
- Data integrity training documentation;
- In-depth procedures for data monitoring; and
- Specific examples of breaches of ethical behavior such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards.

All PAS personnel, including contract and temporary, are required to sign an "Attestation of Ethics and Confidentiality" at the time of employment and during annual refresher training. This document clearly identifies inappropriate and questionable behavior. Violations of this document result in serious consequences, including prosecution and termination, if necessary.

Also see SOP-ENV-COR-POL-0004 *Ethics Policy* for more information.

5.2.2.1.4 Management System Documents Training

PAS Manuals, policies, and SOPs are the primary documents used by regulatory bodies and PAS customers to verify the laboratory's capability, competency. and compliance with their requirements and expectations.

In addition to on-the-job training, employees must have a signed Read and Acknowledgement Statement on record for the laboratory quality manual, and the policies and SOPs relating to his/her job responsibilities. This statement when signed by the employee electronically or by wet signature, confirms that the employee has received, read, and understands the content of the document, that the employee agrees to follow the document when carrying out their work tasks; and the employee understands that unauthorized change to procedures in an SOP is not allowed except in accordance with the SOP departure policy (See 4.9.9.1) and SOP ENV-CORQ-0016 *Standard Operating Procedures and Standard Work Instructions* for more information.

5.2.2.1.5 Demonstration of Capability (DOC)

Technical employees must also complete an initial demonstration of capability (IDOC) prior to independent work on client samples analyzed by the test methods they perform. After successful IDOC, the employee must demonstrate continued proficiency (CDOC) for the test method on an annual basis. If more than a year has passed since the employee last performed the method; then capability must be re-established with an IDOC.

Demonstration of capability (IDOC and DOC) is based on the employee's capability to achieve acceptable precision and accuracy for each analyte reported by the laboratory for the test method using the laboratory's test method SOP.

Records of IDOC and ODOC are kept in the employee's training file.

For more information, see laboratory SOP ENV-SOP-NW-0025 *Orientation and Training Procedures.*

5.2.2.2 Effectiveness of Training

The results of the performance measures used to identify training needs are the same measures used by the laboratory to measure effectiveness of the training program. Improvement in key performance measures suggest the training program is successful. (See 5.2.2.1)

Effectiveness of individual employee training is measured by their demonstrated ability to comprehend the training material and apply knowledge and skills gained to their job task. Measurements include but are not limited to:

- Testing of the employee's knowledge of the quality management system, policies, and technical and administrative procedures through various mechanisms, such as quizzes, observation, and interviews.
- Demonstrated ability to convey information correctly and factually in written and verbal communication to internal and external parties.
- Demonstrated ability to carry out tasks in accordance with SOPs and other work instructions.
- Demonstrated ability to make sound decisions based on guidance and information available.
- Demonstrated initiative to seek help or guidance when the employee is unsure of how to proceed.

5.2.3 Personnel Supervision

Every employee is assigned a direct supervisor, however named, who is responsible for their supervision. Supervision is the set of activities carried out by the supervisor to oversee the progress and productivity of the employees that report to them.

General supervisory responsibilities may include but are not limited to:

- Hiring Employees
- Training Employees
- Performance Management
- Development, oversight, and execution of personnel training plans
- Monitoring personnel work product to assure the work is carried out in accordance with this quality manual, policies, SOPs, and other documents that support the quality management system.

5.2.4 Job Descriptions

Job Descriptions that define the required education, qualifications, experience, skills, roles and responsibilities, and reporting relationships for each PAS position are established by top management and kept by corporate HR. PAS laboratories use these job descriptions as the source of positions and job titles for the laboratory. The job descriptions apply to employees who are directly employed by PAS, part-time, temporary, technical and administrative and by those that are under contract with PAS through other means.

The job descriptions include the education, expertise, and experience required for the position and the responsibilities and duties, including any supervisory or managerial duties assigned to the position.

5.2.5 Authorization of Technical Personnel

Laboratory management authorizes technical personnel to perform the technical aspects of their position after it has been verified that the employee meets the qualifications for the position, has successfully completed required training, and the employee has demonstrated capability. After initial authorization, technical personnel are expected to maintain a current and complete training record, demonstrate on-going capability at least annually for each test

method performed, and produce reliable results through accurate analysis of certified reference materials, proficiency testing samples, and/or routine quality control samples in order to remain authorized to continue to perform their duties.

Records to support authorization including, education, experience, training, and other evaluations are kept by the laboratory.

5.3 Accommodations and Facilities

5.3.1 Facilities

The laboratory is designed to support the correct performance of procedures and to not adversely affect measurement integrity or safety. Access to the laboratory is controlled by various measures, such as card access, locked doors, main entry. Visitors to the laboratory are required to sign-in and to be escorted by laboratory personnel during their visit. A visitor is any person that is not an employee of the laboratory.

5.3.2 Environmental Conditions

The laboratory is equipped with energy sources, lighting, heating, and ventilation necessary to facilitate proper performance of calibrations and tests. The laboratory ensures that housekeeping, electromagnetic interference, humidity, line voltage, temperature, sound and vibration levels are appropriately controlled to ensure the integrity of specific measurement results and to prevent adverse effects on accuracy or increases in the uncertainty of each measurement.

Environmental conditions are monitored, controlled, and recorded as required by the relevant specifications, methods, and procedures. Laboratory operations are stopped if it is discovered that the laboratory's environmental conditions jeopardize the analytical results.

5.3.3 Separation of Incompatible Activities

The layout and infrastructure of each work area including air handling systems, power supplies, and gas supplies of each laboratory work area is specifically designed for the type of analytical activity performed. Effective separation between incompatible work activities is maintained. For example, sample storage, preparation, and chemical handling for volatile organic analysis (VOA) is kept separate from semi-volatile organic (SVOA).

The laboratory separates samples known or suspected to contain high concentration of analytes from other samples to avoid the possibility for cross-contamination. If contamination is found, the source of contamination is investigated and resolved in accordance with laboratory SOPs.

5.3.4 Laboratory Security

Security is maintained by controlled access to the building and by surveillance of work areas by authorized personnel. Access is controlled to each area depending on the required personnel, the sensitivity of the operations performed, and possible safety concerns. The main entrance is kept unlocked during normal business hours for visitors, and is continuously monitored by laboratory staff. All visitors must sign a visitor's log, and a staff member must accompany them during the duration of their stay.

5.3.5 Good Housekeeping

The laboratory ensures good housekeeping practices in work areas to maintain a standard of cleanliness necessary for analytical integrity and personnel health and safety. Minimally, these measure include regular cleaning of the work area. Where necessary, areas are periodically monitored to detect and resolve specific contamination and/or possible safety issues.

5.4 Test Methods

5.4.1 General Requirements

The laboratory uses test methods and procedures that are appropriate for the scope of analytical services the laboratory offers.

Instructions on the use and operation of equipment and sample handling, preparation, and analysis of samples are provided in SOPs. The instructions in SOPs may be supplemented with other documents including but not limited to, standard work instructions (SWI), manuals, guides, project documents and reference documents.

These documents are managed using the procedures described in SOP ENV-SOP-CORQ-0015 *Document Management and Control* and SOP ENV-SOP-CORQ-0016 *Standard Operating Procedures and Standard Work Instructions.*

Deviations to test method and SOPs are allowed under certain circumstances. See sections 4.9.1.1 and 4.9.1.2 for more information.

5.4.2 Method Selection

The test methods and protocols used by the laboratory are selected to meet the needs of the customer, are appropriate for the item tested and intended use of the data, and to conform with regulatory requirements when regulatory requirements apply.

In general, the test methods offered are industry accepted methods published by international, regional, or national standards. The laboratory bases its procedure on the latest approved edition of a method unless it is not appropriate or possible to do so or unless regulatory requirements specify otherwise.

The laboratory confirms that it can perform the test method and achieve desired outcome before analyzing samples (see section 5.4.5). If there is a change in the published analytical method, then the confirmation is repeated.

When a customer does not specify the test method(s) to be used, the laboratory may suggest test methods that are appropriate for the intended use of the data and the type of samples to be tested. The laboratory will also inform customers when test methods requested are considered inappropriate for their purpose and/or out of date. This discourse takes place during review of analytical service requests (See Section 4.4).

5.4.3 Laboratory Developed Methods

A laboratory developed method is a method developed from scratch (no published source method), a procedure that modifies the chemistry from the source method, or a procedure that exceeds the scope and application of the source method.

Laboratory developed methods must be validated prior to use (see section 5.4.5) and the procedure documented in a test method SOP.

The requirements for non-standard methods (Section 5.4.4) also apply to laboratory developed methods.

5.4.4 Non-standard Methods

A non-standard method is a method that is not published or approved for use by conventional industry standards for the intended purpose of the data. Non-standard methods must be validated prior to use (see section 5.4.5) and the procedure developed and documented in a test method SOP.

At a minimum, the following information must be included in the procedure:

- Title / Identification of Method;
- Scope and Application;
- Description of the type of item to be analyzed;
- Parameters or quantities and ranges to be determined;
- Apparatus and equipment, including technical performance requirements;
- Reference standards and reference materials required;
- Environmental conditions required and any stabilization period needed
- Description of the procedure, including:
    - Affixing identification marks, handling, transporting, storing and preparing of items;
    - Checks to be made before the work is started;
    - Verifying equipment function and, where required, calibrating and/or adjusting the equipment before each use;
    - Method of recording the observations and results;
    - Any safety measures to be observed;
    - Criteria and/or requirements for approval/rejection;
    - Data to be recorded and method of analysis and presentation; and
    - Uncertainty or procedure for estimating uncertainty.

Use of a non-standard method for testing must be agreed upon with the customer. The agreement, which is retained by the laboratory in the project record, must include the specifications of the client's requirements, the purpose of testing, and their authorization for use of the non-standard method.

5.4.5 Method Validation

5.4.5.1 Validation Description

Validation is the process of conformation and the provision of objective evidence that the stated requirements for a specific method/procedure are fulfilled.

The laboratory's requirements and procedures for method validation are outlined in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

5.4.5.2 Validation Summary

All test methods offered by the laboratory are validated before use to confirm the procedure works and the data and results achieved meet the goals for the method. The extent of validation performed is based on technology and other factors as defined in the validation SOP (ENV-SOP-CORQ-0011).

Results of validation are retained are kept in accordance with the laboratory's SOP ENV-SOP-NW-0026 *Data and Records Archival* for retention of technical records.

The need to repeat validation is assessed by laboratory management when there are changes to the test method.

5.4.5.3 Validation of Customer Need

Laboratory management reviews the results of test method validation, which include accuracy, precision, sensitivity, selectivity, linearity, repeatability, reproducibility, robustness, and cross-sensitivity, against general customer needs to ensure the laboratory's procedure for the test method will meet those needs.

The review procedure is detailed in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

The following subsections highlight some of these concepts:

5.4.5.3.1 Accuracy

Accuracy is the degree to which the result of a measurement, calculation, or specification conforms to the correct value or a standard. When the result recovers within a range from the known value (control limit); the result generated using the laboratory's test method SOP is considered accurate.

5.4.5.3.2 Precision

Precision refers to the closeness of two or more measurements to each other. It is generally measured by calculating the relative percent difference (RPD) or relative standard deviation (RSD) from results of separate analysis of the same sample. Precision provides information about repeatability, reproducibility, and robustness of the laboratory's procedure.

5.4.5.3.3 Limits of Detection (LOD) (Chemistry)

The LOD is the minimum result which can be reliably discriminated from a blank with a predetermined confidence level. The LOD establishes the limit of method sensitivity and is also known as the detection limit (DL) or the method detection limit (MDL).

Values below the LOD cannot be reliably measured and are not reported by the laboratory unless otherwise specified by regulatory program or test method.

The LOD is established during method validation and after major changes to the analytical system or procedure that affect sensitivity are made.

The laboratory's procedure for LOD determination is detailed in laboratory SOP ENV-SOP-NW-0018 *Determination of LOD and LOQ*. The SOP complies with 40 CFR 136 Appendix B or the current industry approved and accepted guidance for this process.

5.4.5.3.4 Limits of Quantitation (LOQ) and Reporting Limit (RL)

The LOQ is the minimum level, concentration, or quantity of a target analyte that can be reported with a specified degree of confidence. The LOQ is established at the same time as the LOD. The laboratory's procedure for determination and verification of the LOQ is detailed in laboratory SOP ENV-SOP-NW-0018 *Determination of LOD and LOQ*.

The LLOQ is the value of the lowest calibration standard. The LOQ establishes the lower limit of quantitation.

The LOQ and LLOQ represent quantitative sensitivity of the test method.

- The LOQ must always be equal to or greater than the LLOQ and the LLOQ must always be greater than the LOD.
- Any reported value (detect or non-detect) less than the LLOQ is a qualitative value.

The RL is the value to which the presence of a target analyte is reported as detected or not-detected. The RL is project-defined based on project data quality objectives (DQO). In the absence of project specific requirements, the RL is usually set to the LOQ or the LLOQ. Depending on the relationship of the RL to the LLOQ or LOQ, both the RL value may be or quantitative.

For more information, refer to laboratory SOP ENV-SOP-NW-0018 *Determination of LOD and LOQ*.

5.4.5.3.5 Linearity

Linearity is a mathematical concept applied to calibration models that employ multiple points to establish a calibration range used for quantitative analysis. Linearity is measured differently based on the calibration model. In general, if linearity is demonstrated than the slope of the response of standards are sufficiently close to one another. The accuracy of the linear regression and non-linear curves is verified by checking percent error or relative standard error (RSE), which is the process of refitting calibration data back to the model to determine if the results are accurate. For linear curves that use

average calibration or response factor, error is measured by relative standard difference (RSD).

Linearity also establishes the range of quantitation for the test method used which directly impacts the sensitivity of the test method and uncertainty in measurement results. As previously noted, the LLOQ establishes the lower limit of quantitation. Similarly, the upper range of linearity establishes the upper limit of quantitation. In general, results outside of this range are considered qualitative values. However, some inorganic methods allow for extension of the linear range above the upper limit of quantitation when accuracy at this value is verified.

Linearity can also be used to establish repeatability, reproducibility, and robustness of the laboratory's test method. When linearity is demonstrated using a specific calibration model during method validation, then use of this same calibration model to achieve linearity on a day to day basis confirms the laboratory's method is repeatable, reproducible, and robust.

5.4.5.3.6 Demonstration of Capability (DOC)

The DOC performed during method validation confirms that the test method acceptable precision and accuracy. The procedure used for DOC for method validation is the same as described in section 5.2.2.1.5 for demonstration of analyst capability.

5.4.6 Measurement Uncertainty

The laboratory provides an estimate of uncertainty in testing measurements when required or on client request. In general, the uncertainty of the test method is reflected in the control limits used to evaluate QC performance. (See 5.9.1.1.10). ISO/IEC supports this concept with language that reads when a well-recognized test method specifies limits to the values of the major source of uncertainty of measurement and specifies the form of presentation of calculated results, the laboratory has satisfied the requirements on analytical uncertainty by following the test method and reporting instructions.

When measurement uncertainty cannot be satisfied through control limits, the laboratory will provide a reasonable estimation of uncertainty. A reasonable estimation is based on knowledge of method performance and previous experience. When estimating the analytical uncertainty, all uncertainty components which are of importance in the given situation are taken into account.

5.4.7 Control of Data

The laboratory has policies and processes in place to assure that reported data is free from calculation and transcription errors, that quality control is reviewed and evaluated before data is reported, and to address manual calculation and integration.

5.4.7.1 Calculations, Data Transfer, Reduction and Review

Whenever possible, calculations, transfer of data, and data reduction are performed using validated software programs. (See 5.4.7.2)

If manual calculations are necessary, the results of these calculations are verified during the data review process outlined in section 5.9.3.

5.4.7.1.1 Manual Integration

The laboratory's policy and procedures for manual integration are provided in SOP ENV-SOP-CORQ-0006 *Manual Integration.*

This SOP includes the conditions under which manual integration is allowed and the requirements for documentation.

Required documentation of manual integration includes:

- complete audit trail to permit reconstruction of before and after results;
- identification of the analyst that performed the integration and the reason the integration was performed; and
- the individual(s) that reviewed the integration and verified the integration was done and documented in compliance with the SOP.

5.4.7.2 Use of Computers and Automated Acquisition

Whenever possible the laboratory uses software and automation for the acquisition, processing, recording, reporting, storage, and/or retrieval of data.

Software applications developed by PAS are validated by corporate IT for adequacy before release for general use. Commercial off the shelf software is considered sufficiently validated when the laboratory follows the manufacturer or vendor's manual for set-up and use. Records of validation are kept by the corporate information technology (IT) group or by the local laboratory, whichever group performed the validation.

The laboratory's process for the protection of data stored in electronic systems include:

- Individual user names and passwords for Laboratory Information Management Systems (LIMS) and auxiliary systems used to store or process data.
- Employee Training in Computer Security Awareness
- Validation of spreadsheets used for calculations to verify formulas and logic yield correct results and protection of these cells to prevent unauthorized change.
- Operating system and file access safeguards
- Protection from Computer Viruses
- Regular system backup; and testing of retrieved data

The laboratory's process for software development and testing process includes:

- Verification the software application works as expected and is adequate for use and fulfills compliance requirements, such as the need to record date/time of data generation.
- Change control to assure requests for changes are reviewed and approved by management before the change is made.
- Communication channels to assure all staff are aware of changes made.
- Version Control and maintenance of historical records.

These procedures are detailed in Corporate policies COR-POL-0010 *IT Policy* and COR-POL-0012 *Pace User Virus Protection Policy* and laboratory SOP ENV-SOP-MIN4-0036 *Avalon Software Development.*

5.5 Equipment

5.5.1 Availability of Equipment

The laboratory is furnished with all equipment and instrumentation necessary to correctly perform the tests offered in compliance with the specifications of the test method and to achieve the accuracy and sensitivity required.

5.5.2 Calibration

Equipment and instrumentation is checked prior to use to verify it performs within tolerance for its intended application.

Laboratory management is made aware of the status of equipment and instrumentation and any needs for either on a daily basis. This information is obtained during laboratory walkthroughs (LDM) that are conducted as part of the laboratory's lean program.

5.5.2.1 Support Equipment

The laboratory confirms support equipment is in proper working order and meets the specifications for general laboratory use prior to placement in service and with intermediate checks thereafter. Equipment that does not meet specifications is removed from service until repaired or replaced. Records of repair and maintenance activities are maintained.

Procedures used to carry out and record these checks are outlined laboratory SOP ENV-SOP-NW-0016 *Support Equipment.*

5.5.2.2 Analytical Instruments

Analytical instruments are checked prior to placement in service in accordance with SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.* After the initial service date, the calibration of instruments and verification calibration is performed in accordance with local test method SOPs.

The calibration procedures in the test method SOPs comply with the requirements for acceptable calibration practices outlined in corporate document ENV-SOT-CORQ-0026 *Acceptable Calibration Practices*, the reference methods, and any applicable regulatory or program requirements.

5.5.3 Equipment Use and Operation

Equipment is operated and maintained by laboratory personnel that are trained on the test method SOP. Up-to-date instructions and procedures for the use and maintenance of analytical equipment are included in SOPs and/or supplemental documents such as standard work instructions (SWI) or instrument manuals which are made readily accessible in the work area to all laboratory personnel.

5.5.4 Equipment Identification

The laboratory uniquely identifies equipment by serial number or any other unique ID system, when practical. The identifier is included in the equipment list maintained by QA.

5.5.5 Equipment Lists and Records

5.5.5.1 Equipment List

The laboratory maintains a master list of equipment that includes information about the equipment including a description, manufacturer, serial number, date placed in service, condition when received, identity, and the current location in the laboratory. The date of purchase is tracked by the procurement record. The equipment list(s) for each location covered by this manual is provided in Appendix F.

5.5.5.2 Equipment Records

In addition to the equipment list, the laboratory maintains records of equipment that include:

- Verification that equipment conforms with specifications.
- Calibration records including dates, results, acceptance criteria, and next calibration dates.
- Maintenance plan and records
- Records of damage, malfunction, or repair

The laboratory follows an equipment maintenance program designed to optimize performance and to prevent instrument failure which is described in laboratory SOPs ENV-SOP-MIN4-0091 *Preventative, Routine, and Non-Routine Maintenance* (Minneapolis, MN, Billings, MT) and ENV-SOP-VIR1-0005 *Preventative, Routine, and Non-Routine Maintenance* (Virginia, MN, Duluth, MN) or individual test method SOPs.

The maintenance program includes routine maintenance activities which are performed as recommended by the manufacturer at the frequency recommended and non-routine maintenance, which is performed to resolve a specific problem such as degradation of peak resolution, shift in calibration relationship, loss of sensitivity, or repeat failure of instrument performance checks and quality control samples.

Maintenance is performed by laboratory personnel or by outside service providers.

All maintenance activities performed by laboratory personnel are recorded by the individual(s) that performed the activity at the time the maintenance was performed in an instrument maintenance log.

The maintenance record minimally includes the date of maintenance, the initials of the person(s) performing maintenance, a description of the activity performed, why (when the maintenance is non-routine), and the return to analytical control. When maintenance is performed by an external vendor, the laboratory staples the service record into hardcopy maintenance logs or scans the record easy retrieval. The laboratory provides unrestricted access to instrument maintenance logs in order to promotes good instrument maintenance and recordkeeping practices.

If an instrument must be moved, the laboratory will use safe practices for handling and transport to minimize damage and contamination.

5.5.6 Out of Service Protocol

Equipment that has been subjected to overloading, mishandling, gives suspect results, has been shown to be defective, or is performing outside of specified limits is taken out of service and either removed from the work area or labeled to prevent accidental use until it has been repaired and verified to perform correctly.

When analytical equipment is taken out of service, the laboratory examines the potential effect it may have had on previous analytical results to identify any non-conforming work. (See section 4.9).

5.5.7 Calibration Status

The laboratory labels support equipment to indicate calibration status, whenever practicable or otherwise maintains the calibration status in a visible location in the work area. These procedures are described in laboratory SOP ENV-SOP-NW-0016 *Support Equipment.*

The calibration status of analytical instruments is documented in the analytical record. Analysts verify on-going acceptability of calibration status prior to use and with instrument performance check standards. These procedures are described in test method SOPs.

5.5.8 Returned Equipment Checks

When equipment or instrument is sent out of the laboratory for service, the laboratory ensures that the function and calibration status of the equipment is checked and shown to be satisfactory before the equipment is returned to service. These procedures are outlined in SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

5.5.9 Intermediate Equipment Checks

The laboratory performs intermediate checks on equipment to verify the on-going calibration status. For example, most test method require some form of continuing calibration verification check and these procedures are included in the test method SOP. Periodic checks of support equipment are also performed; see appendix E for more information.

5.5.10 Safeguarding Equipment Integrity

The laboratory safeguards equipment integrity using a variety of mechanisms that include but are not limited to:

- Adherence to manufacture's specification for instrument use so that settings do not exceed manufacturer's recommendation or stress the performance of the equipment.
- Established maintenance programs.

- Transparent maintenance records and unrestricted access to maintenance logs.
- Validation and approval of software before use.
- Audits to confirm instrument settings are consistent with SOPs.
- On-the-job training for safe and proper use of laboratory equipment.

5.6 Measurement Traceability

5.6.1 General

Measurement traceability refers to a property of a measurement result whereby the result can be related to a reference through an unbroken chain of calibration, each contributing to the measurement uncertainty. Traceability requires an established calibration hierarchy of equipment (instruments) used during testing including equipment used for subsidiary measurements. The laboratory assures this equipment is calibrated prior to being put into service and that the reference standard and materials used for calibration are traceable to the international standard of units (SI) or national measurement standard.

When strict traceability to SI units cannot be made, the laboratory establishes traceability with the use of reference standards and equipment obtained from competent supplier that provide calibration certificates and/or certificates of analysis (COA).

5.6.2 Equipment Correction Factors

When correction factors are used to adjust results the laboratory will assure that results in computer software are also updated. For example, if the direct instrument or reading output must be corrected based on preparation factor or concentration factors, laboratory management will assure the corrected result is also updated in the software, whenever possible.

5.6.3 Specific Requirements

5.6.3.1 Requirements for Calibration Laboratories

The laboratory does not offer calibration services to customers.

5.6.3.2 Requirements for Testing Laboratories

The laboratory has procedures in place to verify equipment is calibrated prior to being put into service. (See 5.5.2) and ensures the reference standard and materials used for calibration are traceable to the international standard of units (SI) or national measurement standard. When strict traceability to SI units cannot be made, the laboratory establishes traceability with the use of reference standards and equipment obtained from competent suppliers that provide calibration certificates and/or certificates of analysis (COA).

5.6.4 Reference Standards and Reference Materials

5.6.4.1 Reference Standards

The laboratory uses reference standards of measurement to verify adequacy of working weights and thermometers. The working weight is the weight(s) used for daily balance calibration checks and the working thermometers are used for temperature measurements on a daily basis.

Intermediate checks of the working reference measurement standards are performed to verify adequacy between calibration from an external calibration laboratory. The measurements from working weights and thermometers are compared to measurement taken by the reference standard which is traceable to SI or a national standard. The reference weights and thermometers are used solely for verification purposes unless the laboratory can prove that daily use does not adversely affect performance of the reference standard.

The laboratory performs intermediate checks of the working weights at least annually.

Working thermometers (glass and digital) are checked against the reference thermometer prior to placement in service to establish a correction factor and then rechecked annually (glass) or quarterly (digital) thereafter.

The calibration of liquid in glass reference thermometers is verified every 5 years and the calibration of digital reference thermometers is verified annually by an ISO/IEC 17025 accredited calibration laboratory or service provider that provides traceability to a national standard.

The calibration of the reference weight(s) is verified every 5 years by an ISO/IEC 17025 accredited calibration laboratory.

If criteria for the intermediate checks or recertification is not acceptable, the impact on previously reported results is evaluated using the process for evaluation of nonconforming work (See 4.9)

See laboratory SOP ENV-SOP-NW-0016 *Support Equipment* for more information about this process.

5.6.4.2 Reference Materials

The laboratory purchases chemical reference materials used (also known as stock standards) from vendors that are accredited to ISO 17034 or Guide 34. Purchased reference materials must be received with a Certificate of Analysis (COA) where available. If a reference material cannot be purchased with a COA, it must be verified by analysis and comparison to a certified reference material and/or there must be a demonstration of capability for characterization. COA are reviewed for adequacy and retained by the laboratory for future reference.

The laboratory procedure for traceability and use of these materials is provided in laboratory SOP ENV-SOP-NW-0030 *Laboratory Supply Procedures.*

This SOP includes each of the following requirements:

- Procedures for documentation of receipt and tracking. The record of entry includes name of the material, the lot number, receipt date, and expiration date.
- Storage conditions and requirements. Reference materials must be stored separately from samples, extracts, and digestates.
- Requirements to assure that preparations of intermediate or working solutions are recorded and assigned a unique identification number for tracking. Records of preparation include the lot number of the stock standard(s) used, the type and

lot number of the solvent, the formulation, date, expiration date, and the preparer's initials. The lot number of the working standards is recorded in the analytical record to provide traceability to the standard preparation record. The preparation record provides traceability to the COA, which is traceable to SI or the national measurement standard.

- A requirement that the expiration dates of prepared standards may not exceed the expiration date of the parent standard. Standards, reference materials, and reagents are not used after their expiration dates unless their reliability is thoroughly documented and verified by the laboratory. If a standard exceeds its expiration date and is not re-certified, the laboratory removes the standard and/or clearly designates it as acceptable for qualitative/troubleshooting purposes only. All prepared standards, reference materials, and reagents are verified to meet the requirements of the test method through routine analyses of quality control samples.
- The second source materials used for verification of instrument calibration are obtained from a different manufacturer or different lot from the same manufacturer.
- Procedures to check reference materials for degradation and replacement of material if degradation or evaporation is suspected.
- Procedures for labeling. At a minimum the container must identify the material, the ID of the material and the expiration date. Original containers should also be labeled with date opened.

5.6.4.3 Intermediate Checks

Checks to confirm the calibration status of standards and materials are described in laboratory SOPs. These checks, include use of second source standards and reference materials reserved only for the purpose of calibration checks.

5.6.4.4 Transport and Storage

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials. Standards and reference materials are stored separately from samples, extracts, and digestates. All standards are stored according to the manufacturer's recommended conditions. Temperatures colder than the manufacturer's recommendation are acceptable if it does not compromise the integrity of the material (e.g. remains in liquid state and does not freeze solid). In the event a standard is made from more than a single source with different storage conditions, the standard will be stored according to the conditions specified in the analytical method.

See the applicable analytical SOPs for specific reference material storage and transport protocols.

5.7 Sampling

Sampling refers to the field collection of samples and to subsamples taken by the laboratory for analysis from the field collected sample.

Subsampling procedures are included in SOP ENV-SOP-NW-0005 *Sample Homogenization and Sub-Sampling* to assure the aliquot used for testing is representative of the field collected sample.

The requirements in the following subsections apply when field sampling is performed by the laboratory.

5.7.1 Sampling Plans and SOPs

When the laboratory performs field collection of samples, sampling is carried out in accordance with a written sample plan prepared by the customer or by the laboratory and by relevant sampling SOPs. These documents are made readily accessible at the sampling location. Sampling plans and SOPs are, whenever reasonable, based on appropriate governing methods and addresses the factors to be controlled to ensure the validity of the analytical results.

5.7.2 Customer Requested Deviations

When the customer requires deviations, additions, or exclusions from the documented laboratory sampling plan and/or procedure, the laboratory records the client's change request in detail with the sampling record, communicates the change to sampling personnel, and includes this information in the final test report.

5.7.3 Recordkeeping

The laboratory assures the sampling record includes the sampling procedure used, any deviations from the procedure, the date and time of sampling, the identification of the sampler, environmental conditions (if relevant), and the sampling location.

5.8 Sample Management & Handling

5.8.1 Procedures

The laboratory's procedures for sample management and handling are outlined in laboratory SOPs ENV-SOP-MIN4-0008 *Sample Management* (Minneapolis, MN, Bloomington, MN, Phoenix, AZ, Billings, MT), ENV-SOP-DUL1-0001 *Sample Management* (Duluth, MN), ENV-SOP-VIR1-0001 *Sample Management* (Virginia, MN), ENV-SOP-MIN4-0009 *Bottle Preparation* (Minneapolis, MN, Bloomington, MN, Phoenix, AZ, Billings, MT), ENV-SOP-VIR1-0002 *Bottle Preparation* (Virginia, MN), ENV-SOP-DUL1-0002 *Bottle Preparation* (Duluth, MN), ENV-SOP-MIN4-0010 *Subcontracting Samples* (Minneapolis, MN, Billings, MT), and ENV-SOP-VIR1-0003 *Subcontracting Samples* (Virginia, MN, Duluth, MN).

The procedures in these SOPs are established to maintain the safe handling and integrity of samples from transport, storage, to disposal and during all processing steps in-between; to maintain client confidentiality, and to protect the interests of PAS and its customers.

5.8.1.1 Chain of Custody

All samples received by the laboratory must be accompanied with a Chain of Custody (COC) record. The COC provides information about the samples collected and

submitted for testing and documents the possession of samples from time of collection to receipt by the laboratory.

The COC record must minimally include the following information:

- Client name, address, phone number
- Project Reference
- Client Sample Identification (Client ID)
- Date, Time, and Location of Sampling
- Samplers Name or Initials
- Matrix
- Type of container, and total number collected each sample
- Preservatives
- Analyses Requested
- Mode of collection
- Any special instructions
- The date and time and signature of each sample transfer from time of collection to receipt in the laboratory. When the COC is transported inside the cooler, independent couriers do not sign the COC. Shipping manifests and/or air bills are the records of possession during transport.

A complete and legible COC is required. If the laboratory observes that the COC is incomplete or illegible, the client is contacted for resolution. The COC must be filled out in indelible ink. Personnel correct errors by drawing a single line through the initial entry so the entry is not obscured, entering the correct information, and initialing, and dating the change.

5.8.1.2 Legal Chain of Custody

Legal chain of custody is a chain of custody protocol used for evidentiary or legal purposes. The protocol is followed by the laboratory when requested by customer or where mandated by a regulatory program.

Legal chain of custody (COC) protocol establishes an intact, continuous record of the physical possession*, storage, and disposal of "samples" which includes, sample aliquots, and sample extracts/digestates/distillates.

Legal COC records account for all time periods associated with the samples, and identifies all individuals who physically handled individual samples. Legal COC begins at the point established by legal authority, which is usually at the time the sample containers are provided by the laboratory for sample collect or when sample collection begins.

*A sample is in someone's custody if:

- It is in one's physical possession;

- It is in one's view after being in one's physical possession;
- It has been in one's physical possession and then locked or sealed so that no one can tamper with it; and/or
- It is kept in a secure area, restricted to authorized personnel only.

Refer to laboratory SOPs ENV-SOP-MIN4-0008 *Sample Management* (Minneapolis, MN, Bloomington, MN, Phoenix, AZ, Billings, MT), ENV-SOP-DUL1-0001 *Sample Management* (Duluth, MN), ENV-SOP-VIR1-0001 *Sample Management* (Virginia, MN) for more information.

5.8.2 Unique Identification

Each sample is assigned a unique identification number by the laboratory (Lab ID) after the sample has been checked and accepted by the laboratory in accordance with the laboratory's sample acceptance policy (See 5.8.3). the Lab ID is affixed to the sample container using a durable label.

The unique identification of samples also applies to subsamples, and prepared samples, such as extracts, digestates, etc.

The lab ID is linked to the field ID (client ID) in the laboratory's record. Both IDs are linked to the testing activities performed on the sample and the documentation records of the test.

Also see 5.8.4.

5.8.3 Sample Receipt Checks and Sample Acceptance Policy

The laboratory checks the condition and integrity of samples on receipt and compares the labels on the sample containers to the COC record. Any problem or discrepancy is recorded. If the problem impacts the suitability of the sample for analysis or if the documentation is incomplete, the client is notified for resolution. Decisions and instructions from the client are maintained in the project record.

5.8.3.1 Sample Receipt Checks

The following checks are performed:

- Verification that the COC is complete and legible.
- Verification that each sample's container label includes the client sample ID, the date and time of collection and the preservative in indelible ink.
- The container type and preservative is appropriate for each test requested.
- Adequate volume is received for each test requested.
- Visual inspection for damage or evidence of tampering.
- Visual inspection for presence of headspace in VOA vials. (VOA = volatile organic analysis).
- Thermal Preservation: For chemical testing methods for which thermal preservation is required, temperature on receipt is acceptable if the measurement is above freezing but <6°C. For samples that are hand-delivered to the laboratory

immediately after sample collection, there must be evidence that the chilling process has begun, such as arrival on ice. The requirements for thermal preservation vary based on the scope of testing performed. For example, for microbiology, temperature on receipt is acceptable if the measurement is <10°C. Refer to the laboratory's SOP for sample receipt for more information.

- Chemical Preservation
- Holding Time: Sample receiving personnel are trained to recognize tests with tests where the holding time is 48 hours or less and to expedite the log-in of these samples. Except for tests with immediate holding times (15 minutes from time of collection or less), when samples are received out of hold, the laboratory will notify the client and request instruction. If the decision is made to proceed with analysis, the final test report will include notation of this instruction.

5.8.3.2 Sample Acceptance Policy

The laboratory maintains a sample acceptance policy in accordance with regulatory guidelines to clearly establish the circumstances in which sample receipt is accepted or rejected. When receipt does not meet acceptance criteria for any one of these conditions, the laboratory must document the noncompliance, contact the customer, and either reject the samples or fully document any decisions to proceed with testing. In accordance with regulatory specifications, test results associated with receipt conditions that do not meet criteria are qualified in the final test report.

All samples received must meet each of the following:

- Be listed on a complete and legible COC.
- Be received in properly labeled sample containers.
- Be received in appropriate containers that identify preservative.
- The COC must include the date and time of collection for each sample.
- The COC must include the test requested for each sample.
- Be in appropriate sample containers with clear documentation of the preservatives used.
- Be received within holding time. Any samples received beyond the holding time will not be processed without prior customer approval.
- Have sufficient sample volume to proceed with the analytical testing. If insufficient sample volume is received, analysis will not proceed without customer approval.
- Be received within appropriate temperature ranges (not frozen but ≤6°C) unless program requirements or customer contractual obligations mandate otherwise. The cooler temperature is recorded directly on the COC. Samples that are delivered to the laboratory immediately after collection are considered acceptable if there is evidence that the chilling process has been started. For example, by the arrival of the samples on ice. If samples arrive that are not compliant with these

temperature requirements, the customer will be notified. The analysis will NOT proceed unless otherwise directed by the customer. If less than 72 hours remain in the hold time for the analysis, the analysis may be started while the customer is contacted to avoid missing the hold time. Data associated with any deviations from the above sample acceptance policy requirements will be appropriately qualified.

5.8.4 Sample Control and Tracking

The samples are controlled and tracked using the Laboratory Information Management System (LIMS). The LIMS stores information about the samples and project. The process of entering information into the LIMS is called login and these procedures are described in laboratory SOPs ENV-SOP-MIN4-0008 *Sample Management* (Minneapolis, MN, Bloomington, MN, Phoenix, AZ, Billings, MT), ENV-SOP-DUL1-0001 *Sample Management* (Duluth, MN), and ENV-SOP-VIR1-0001 *Sample Management* (Virginia, MN). After log-in, a label is generated and affixed to each sample container. Information on this label, such as the lab ID, links the sample container to the information in LIMS.

At a minimum, the following information is entered during log-in:

- Client Name and Contact Information;
- The laboratory ID linked to the client ID;
- Date and time of sample collection;
- Date and time of sample receipt;
- Matrix;
- Tests Requested.

5.8.5 Sample Storage, Handling, and Disposal

The laboratory procedures for sample storage, handling and disposal are detailed in laboratory SOPs ENV-SOP-MIN4-0008 *Sample Management* (Minneapolis, MN, Bloomington, MN, Phoenix, AZ, Billings, MT), ENV-SOP-DUL1-0001 *Sample Management* (Duluth, MN), ENV-SOP-VIR1-0001 *Sample Management* (Virginia, MN), ENV-SOP-MIN4-0009 *Bottle Preparation* (Minneapolis, MN, Bloomington, MN, Phoenix, AZ, Billings, MT), ENV-SOP-VIR1-0002 *Bottle Preparation* (Virginia, MN), ENV-SOP-DUL1-0002 *Bottle Preparation* (Duluth, MN), ENV-SOP-MIN4-0010 *Subcontracting Samples* (Minneapolis, MN, Billings, MT), ENV-SOP-VIR1-0003 *Subcontracting Samples* (Virginia, MN, Duluth, MN), ENV-SOP-MIN4-0098 *Waste Handling and Management* (Minneapolis, MN), ENV-SOP-BILL-0024 *Waste Handling and Management* (Billings, MT), ENV-SOP-DUL1-0004, *Waste Handling and Management* (Duluth, MN), and ENV-SOP-VIR1-0007 *Waste Handling and Management* (Virginia, MN).

5.8.5.1 Sample Storage

The samples are stored according to method and regulatory requirements as per test method SOPs. Samples are stored away from all standards, reagents, or other potential sources of contamination and stored in a manner that prevents cross contamination. Volatile samples are stored separately from other samples. All sample fractions, extracts, leachates, and other sample preparation products are stored in the same manner as actual samples or as specified by the analytical method.

Refrigerated storage areas are maintained at ≤6°C (but not frozen) and freezer storage areas are maintained at <-10°C (unless otherwise required per method or program). The temperature of each storage area is checked and documented at least once for each day of use. If the temperature falls outside the acceptable limits, then corrective actions are taken and appropriately documented.

The laboratory is operated under controlled access protocols to ensure sample and data integrity. Visitors must register at the front desk and be properly escorted at all times. Samples are taken to the appropriate storage location immediately after sample receipt and login procedures are completed. All sample storage areas have limited access. Samples are removed from storage areas by designated personnel and returned to the storage areas as soon as possible after the required sample quantity has been taken.

5.8.5.2 Sample Retention and Disposal

The procedures used by the laboratory for sample retention and disposal are detailed in laboratory SOPs ENV-SOP-MIN4-0008 *Sample Management* (Minneapolis, MN, Bloomington, MN, Phoenix, AZ, Billings, MT), ENV-SOP-DUL1-0001 *Sample Management* (Duluth, MN), ENV-SOP-VIR1-0001 *Sample Management* (Virginia, MN), ENV-SOP-MIN4-0098 *Waste Handling and Management* (Minneapolis, MN), ENV-SOP-BILL-0024 *Waste Handling and Management* (Billings, MT), ENV-SOP-DUL1-0004, *Waste Handling and Management* (Duluth, MN), and ENV-SOP-VIR1-0007 *Waste Handling and Management* (Virginia, MN).

In general, unused sample volume and prepared samples such as extracts, digestates, distillates and leachates (samples) are retained by the laboratory for the period of time necessary to protect the interests of the laboratory and the customer.

Samples may be stored at ambient temperature when all analyses are complete, the hold time is expired, the report has been delivered, and/or when allowed by the customer or program. Samples requiring storage beyond the minimum sample retention time due to special requests or contractual obligations may be stored at ambient temperature unless the laboratory has sufficient capacity and their presence does not compromise the integrity of other samples.

After this period expires, non-hazardous samples are properly disposed of as non-hazardous waste. The preferred method for disposition of hazardous samples is to return the excess sample to the customer.

5.9 Assuring the Quality of Test Results

5.9.1 Quality Control (QC) Procedures

The laboratory monitors the validity and reliability of test results using quality control (QC) samples that are prepared and analyzed concurrently with field samples in the same manner as field samples. QC results are always associated to and reported with the field samples they were prepared and analyzed with from the same preparation or analytical batch. See the glossary for definition of preparation and analytical batch.

The results of QC performed during the testing process are used by the laboratory to assure the results of analysis are consistent, comparable, accurate, and/or precise within a specified

limit. When the results are not within acceptance criteria or expectations for method performance, correction and corrective action(s) are taken. These actions may include retesting or reporting of data with qualification to alert the end user of the situation.

Other QC measures performed include the use of certified reference materials (see 5.6.2), participation in interlaboratory proficiency testing (see 5.9.1.1), verification that formulae used for reduction of data and calculation of results is accurate (see 5.9.3), on-going monitoring of environmental conditions that could impact test results (see 5.3.2), and evaluation and verification of method selectivity and sensitivity (see 5.4.5).

QC results are also used by the laboratory to monitor performance statistical trends over time and to establish acceptance criteria when no method or regulatory criteria exist. (see 5.9.1.4).

5.9.1.1 Essential QC

Although the general principles of QC for the testing process apply to all testing, the QC protocol used for each test depends on the type of test performed.

QC protocol used by the laboratory to monitor the validity of the test are specified in test method SOPs. The SOP includes QC type, frequency, acceptance criteria, corrective actions, and procedures for reporting of nonconforming work.

These requirements in the SOP conform to the reference method and any applicable regulations or certification and accreditation program requirement for which results of the test are used. When a project requires more stringent QC protocol than specified in the SOP, project specification is followed. When the project requires less stringent QC protocol, the project specification may be followed as an authorized departure from the SOP when the project specifications meet the requirements in the mandated method and any regulatory compliance requirements for which the data will be used.

The following are examples of essential QC for Chemistry:

5.9.1.1.1 Second Source Standard (ICV/QCS)

The second source standard is a standard obtained from a different vendor than the vendor of the standards used for calibration. It is a positive control used to verify the accuracy of a new calibration relative to the purity of the standards used for calibration. This check is referred to in test method and quality system standards as the initial calibration verification (ICV) or quality control sample (QCS). The second source standard is analyzed immediately after the calibration and before analysis of any samples. When the ICV is not within acceptance criteria, a problem with the purity or preparation of the standards may be indicated.

5.9.1.1.2 Continuing Calibration Verification (CCV)

CCV is to determine if the analytical response has significantly changed since initial calibration. If the response of the CCV is within criteria, the calibration is considered valid. If not, there is a problem that requires further investigation. Actions taken are technology and method specific.

5.9.1.1.3 Method Blank (MB) / Other Blanks

A method blank is a negative control used to assess for contamination during the prep/analysis process. The MB consists of a clean matrix, similar to the associated samples that is known to be free of analytes of interest. The MB is processed with and carried through all preparation and analytical steps as the associated samples.

In general, contamination is suspected when the target analyte is detected in the MB above the reporting limit. Some programs may require evaluation of the MB to ½ the reporting limit or the detection limit. When contamination is evident, the source is investigated and corrections are taken to reduce or eliminate it. Analytical results associated with MB that does not meet criteria are qualified in the final test report.

Other types of blanks that serve as negative controls in the process may include:

- Trip Blanks (VOA)
- Storage Blanks
- Equipment Blanks
- Field Blanks
- Calibration Blanks
- Cleanup Blanks
- Instrument Blanks

5.9.1.1.4 Laboratory Control Sample (LCS)

The LCS is positive control used to measure the accuracy of process in a blank matrix. The LCS is spiked by the laboratory with a known amount of analyte. The spike is a standard solution that is pre-made or prepared from a certified reference standard. The LCS is processed with and carried through all preparation and analytical steps as the associated samples.

When the percent recovery (%R) of the LCS is within the established control limit, sufficient accuracy has been achieved. If not, the source of the problem is investigated and corrected and the procedure may be repeated. Analytical results associated with LCS that does not meet criteria are qualified in the final test report.

5.9.1.1.5 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

Matrix spikes measures the effect the sample matrix has on precision and accuracy of the determinative test method. The MS and MSD are replicates of a client sample that is spiked with known amount of target analyte.

Due to the heterogeneity of matrices even of the same general matrix type, matrix spike results mostly provide information on the effect

of the matrix to the client whose sample was used and on samples of the same matrix from the same sampling site. Therefore, MS should be client-specific when the impact of matrix on accuracy and precision is a project data quality objective. When there is not a client-specified MS for any sample in the batch, the laboratory randomly selects a sample from the batch; the sample selected at random is called a "batch" matrix spike.

The MS/MSD results for percent recovery and relative percent difference are checked against control limits. Because the performance of matrix spikes is matrix-dependent, the result of the matrix spike is not used to determine the acceptability of the test.

5.9.1.1.6 Sample Duplicate (SD)

A sample duplicate is a second replicate of sample that is prepared and analyzed in the laboratory along another replicate. The SD is used to measure precision.

The relative percent difference between replicates are evaluated against the method or laboratory derived criteria for relative percent difference (RPD), when this criterion is applicable. If RPD is not met, associated test results are reported with qualification.

5.9.1.1.7 Surrogates

Surrogates are compounds that mimic the chemistry of target analytes but are not expected to occur naturally in real world samples. Surrogates are added to each sample and matrix QC samples (MS, MSD, SD) at known concentration to measure the impact of the matrix on the accuracy of method performance. Surrogates are also added to the positive and negative control samples (MB, LCS) to evaluate performance in a clean matrix, and included in the calibration standards and calibration check standards.

The percent recovery of surrogates is evaluated against method-specified limits or statistically derived in-house limits. Project-specific limits and/or program-specific limits are used when required. Results with surrogate recovery out of limits in samples are reported with qualification. Samples with surrogate failures can also be re-extracted and/or re-analyzed to confirm that the out-of-control value was caused by the matrix of the sample and not by some other systematic error.

5.9.1.1.8 Internal Standards

Internal Standards are compounds not expected to occur naturally in field samples. They are added to every standard and sample at a known concentration prior to analysis for the purpose of adjusting the response factor used in quantifying target analytes. The laboratory follows specific guidelines for the treatment of internal

standard recoveries and further information can be found in the applicable laboratory SOP.

5.9.1.1.9 QC Acceptance Criteria and Control Limits

The QC acceptance criteria are specified in test method SOPs. The criteria in the SOP are based on the requirements in the published test method or regulatory program. When there are no established acceptance criteria, the laboratory develops acceptance criteria in accordance with recognized industry standards.

Some methods and programs require the laboratory to develop and use control limits for LCS, MS/MSD and surrogate evaluation. In laboratory developed limits are referred to as "i house" control limits. In-house control limits represent ± 3 Standard Deviations (99% confidence level) from the average recovery of at least 20 data points generated using the same preparation and analytical procedure in a similar matrix.

See laboratory SOP ENV-SOP-NW-0006 *Control Chart Generation and Trend Analysis* for more information.

5.9.1.2 Proficiency Testing (PT)

The laboratory participates in interlaboratory proficiency testing (PT) studies to measure performance of the test method and to identify or solve analytical problems. PT samples measure laboratory performance through the analysis of unknown samples provided by an external source.

The PT samples are obtained from accredited proficiency testing providers (PTP) and handled as field samples which means they are included in the laboratory's normal analytical processes and do not receive extraordinary attention due to their nature.

The laboratory does not share PT samples with other laboratories, does not communicate with other laboratories regarding current PT sample results during the duration of the study, and does not attempt to obtain the assigned value of any PT sample from the PT provider.

The laboratory initiates an investigation and corrective action plan whenever PT results are deemed unacceptable by the PT provider.

The frequency of PT participation is based on the certification and accreditation requirements held by the laboratory.

5.9.2 QC Corrective Action

When the results of QC are not within acceptance criteria or expectations for method performance, correction and corrective action(s) are taken per the specifications in the test method SOP. These actions may include retesting or reporting of data with qualification to alert the end user of the situation.

5.9.3 Data Review

The laboratory uses a tiered system for data review. The tiered process provides sequential checks to verify data transfer is complete; manual calculations, if performed, are correct, manual integrations are appropriate and documented, calibration and QC requirements are met, appropriate corrective action was taken when required, test results are properly qualified, process and test method SOPs were followed, project specific requirements were met, when applicable, and the test report is complete.

The sequential process includes three tiers referred to as primary review, secondary review, and administrative/completeness review.

Detailed procedures for the data review process are described in laboratory SOPs ENV-SOP-MIN4-0092 *Data Review Process* (Minneapolis, MN, Billings, MT) and ENV-SOP-VIR1-0006 *Data Review Process* (Virginia, MN, Duluth, MN). The general expectations for the tiered review process are described in the following sections:

5.9.3.1 Primary Review

Primary review is performed by the individual that performed the task. All laboratory personnel are responsible for review of their work product to assure it is complete, accurate, documented, and consistent with policy and SOPs.

Checks performed during primary review include but are not limited to:

- Verification that data transfer and acquisition is complete
- Manual calculations, if performed, are documented and accurate
- Manual integrations, if performed, are documented and comply with SOP ENV-SOP-CORQ-006 *Manual Integration*
- Calibration and QC criteria were met, and/or proper correction and corrective actions were taken, and data and test results associated with QC and criteria exceptions are properly qualified
- Work is consistent with SOPs and any other relevant instructional document such as SWI, program requirements, or project QAPP

5.9.3.2 Secondary Review

Secondary review is performed by qualified peer or supervisor. Secondary review is essentially a repeat of the checks performed during primary review by another person. In addition to the checks of primary review, secondary review includes chromatography review to check the accuracy of quantitative analyte identification.

5.9.3.3 Completeness Review

Completeness review is an administrative review performed prior to release of the test report to the customer. Completeness review verifies that the final test report is complete and meets project specification. This review also assures that information necessary for the client's interpretation of results are explained in the case narrative or footnoted in the test report.

5.9.3.4 Data Audits

In addition to the 3 tier data review process, test reports may be audited by local QA to verify compliance with SOPs and to check for data integrity, technical accuracy, and regulatory compliance. These audits are not usually done prior to issuance of the test report to the customer. The reports chosen for the data audits are selected at random.

If any problems with the data or test results are found during the data audit, the impact of the nonconforming work is evaluated using the process described in Section 4.9.

Also see Section 4.14 for internal audits.

5.10 Reporting

5.10.1 General Requirements

The laboratory reports results of testing in a way that assures the results are clear, and unambiguous. All data and results are reviewed prior to reporting to assure the results reported are accurate and complete.

Test results are summarized in test reports that include all information necessary for the customer's interpretation of the test results. Additional information necessary to clarify the data or disclose nonconformance, exceptions, or deviations that occurred during the analytical process are also reported to the customer in the test report.

The specifications for test reports and electronic data deliverables (EDD) are established between the laboratory and the customer at the time the request for analytical services is initiated. The report specifications include the test report format, protocol for the reporting limit (RL), conventions for the reporting of results less than the limit of quantitation (LOQ), and specification for the use of project or program specific data qualifiers. Information about review of analytical service requests is provided in Section 4.4.

5.10.2 Test Reports: Required Items

Test Reports are prepared by the laboratory at the end of the testing process. The format of the report depends on the level of reporting requested by the customer. The laboratory offers a variety of standardized test report formats and can also can provide custom test report formats, when necessary.

The level of detail required in the test report depends on the customer's needs for data verification, validation, and usability assessments that occur after the laboratory releases the test report to the customer. The test report formats offered by the laboratory provide gradient levels of detail to meet the unique needs of each customer. The laboratory project manager helps the customer select the test report format that best meets their needs. When a specific report format or protocol is required for a regulatory or program compliance, the laboratory project manager must ensure the test report selected meets those requirements.

Every test report issued by the laboratory includes each of the following items:

a) Title

b) Name and phone number of a point of contact from the laboratory issuing the report.

c) Name and address of the laboratory where testing was performed. When testing is done at multiple locations within network (IRWO), the report must clearly identify which

network laboratory performed each test and must include the physical address of each laboratory.

d) Unique identification of the test report and an identifier on each page of the report to link each page to the test report and clear identification of the end of the report.

e) The name and address of the customer

f) Identification of test methods used

g) Cross reference between client sample identification number (Sample ID) and the laboratory's identification number for the sample (Lab ID) to provide unambiguous identification of samples.

h) The date of receipt of samples, condition of samples on receipt, and identification of any instance where receipt of the samples did not meet sample acceptance criteria.

i) Date and times of sample collection, receipt, preparation, and analysis.

j) Test results and units of measurement, and qualification of results associated with QC criteria exceptions, and identification of reported results outside of the calibration range.

k) Name, title, signature of the person(s) authorizing release of the test report and date of release.

l) A statement that the results in the test report relate only to the items tested.

m) Statement that the test report may not be reproduced except in full without written approval from the laboratory.

5.10.3 Test Reports: Supplemental Items

5.10.3.1 Supplemental Requirements

The following items are included in the test report when required or relevant:

a) Explanation of departure from test method SOPs including, what the departure was and why it was necessary.

b) Statistical methods used. (Required for Whole Effluent Toxicity)

c) For solid samples, specification that results are reported on a dry weight or wet weight basis.

d) Signed Affidavit, when required by client or regulatory agency.

e) A statement of compliance / non-compliance with requirements or specifications (client, program, or standard) that includes identification of test results that did not meet acceptance criteria.

f) When requested by the client, statement of estimated measurement uncertainty. In general, for environmental testing, estimated uncertainty of measurement is extrapolated from LCS control limits. Control limits incorporate the expected variation of the data derived from the laboratory's procedure. When the control limits are specified by the test method or regulatory program, the control limits represent the expected variation of the test method and/or matrices for which the test method was designed.

g) Opinions and Interpretations.

h) If a claim of accreditation/certification is included in the test report, identification of any test methods or analytes for which accreditation/certification is not held by the laboratory if the accrediting body offers accreditation/certification for the test method/analyte. The fields of accreditation/certification vary between agencies and it cannot be presumed that because accreditation/certification is not held that it is offered or required.

i) Certification Information, including certificate number and issuing body.

5.10.3.2 Test Reports: Sampling Information

The following items are included in the test report when samples are collected by the laboratory or when this information is necessary for the interpretation of test results:

a) Date of Sampling.

b) Unambiguous identification of material samples.

c) Location of sampling including and diagrams, sketches, or photographs.

d) Reference to the sampling plan and procedures used.

e) Details of environmental conditions at time of sample that may impact test results.

f) Any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned.

5.10.4 Calibration Certificates

The laboratory does not perform calibration activities for its customers and calibration certificates are not offered or issued.

5.10.5 Opinions and Interpretations

The laboratory provides objective data and information to its customers of sufficient detail for their interpretation and decision making. Objective data and information is based solely on fact and does not attempt to explain the meaning (interpret) or offer a view or judgement (opinion). Sometimes the customer may request the laboratory provide opinion or interpretation to assist them with their decisions about the data.

When opinions and interpretations are included in the test report, the laboratory will document the basis upon which the opinions and interpretations have been made and clearly identify this content as opinion or interpretation in the test report.

Examples of opinion and interpretation include but are not limited to:

- The laboratory's viewpoint on how a nonconformance impacts the quality of the data or usability of results.
- The laboratory's judgment of fulfillment of contractual requirements.
- Recommendations for how the customer should use the test results and information.
- Suggestions or guidance to the customer for improvement.

When opinions or interpretations are verbally discussed with the customer, the content of these conversations is summarized by the laboratory and kept in the project record.

5.10.6 Subcontractor Reports

When analytical work has been subcontracted to an organization external to PAS, the test report from the subcontractor is included in its entirety as an amendment to the final test report.

Note: Test results for analytical work performed within the PAS network may be are merged into a single test report. The test report issued clearly identifies the location and address of each network location that performed testing and which tests they performed. (See 5.10.2)

5.10.7 Electronic Transmission of Results

When test results and/or reports are submitted to the customer through electronic transmission, follow the procedures established in this manual for confidentiality and protection of data.

5.10.8 Format of Test Reports

The test formats offered by the laboratory are designed to accommodate each type of analytical test method carried out by the laboratory and to minimize the possibility of misunderstanding or misuse of analytical results. The format of electronic data deliverables (EDD) follow the specifications for the EDD.

5.10.9 Amendments to Test Reports

Test reports that are revised or amended by the laboratory after date of release of the final test report to the customer are issued as a new test report that is clearly identified as an amendment or revision and that includes a reference to the originally issued final test report.

The customer is the organization doing business with PAS external to PAS.

Changes made to test results and data before the final test report is issued to the customer are not amendments or revisions, these are corrections to errors found during the laboratory's data verification and review process,

The laboratory's procedure for report amendments and revision are outlined in laboratory SOP ENV-SOP-NW-0028 *Final Report and Deliverable Contents.*

6.0 REVISION HISTORY

This Version:

Section	Description of Change
All	This version is a complete rewrite of the document this version supersedes.
7.3	Added in % Recovery, RSD, RSE definitions, %R abbreviation for Accuracy.

This document supersedes the following documents:

Document Number	Title	Version
ENV-MAN-NW-0001	Quality Manual	01

7.0 APPENDICES

7.1 Appendix A: Certification / Accreditation Listing

The certifications / accreditation lists provided in this manual represent those that were held by the named location on the effective date of this manual. This information is subject to change without notice and must not be considered valid proof of certification or accreditation status. Current certificates are maintained by Local QA and a copy of the certificate is posted to PAS's eDMS Portal for access by all PAS employees. External parties should contact the laboratory for the most current information.

7.1.1 PAS-Minneapolis

Authority	Certificate Number	Authority	Certificate Number
A2LA	2926.01	Louisiana Dept. of Environmental Quality	03086
Alabama Dept. of Environmental Management	40770	Louisiana Dept. of Health (DW)	LA006
Alaska Dept. of Environmental Conservation (DW)	MN00064	Maine Dept. of Health and Human Services	2019018
Alaska Dept. of Environmental Conservation (Contaminated Sites)	17-009	Maryland Dept. of the Environment	322
Arizona Dept. of Health Services	AZ0014	Massachusetts Dept. of Environmental Protection	M-MN064
Arkansas Dept. of Health (DW)	MN00064	Massachusetts Dept. of Environmental Protection (Drinking Water Program)	via "Minnesota ELAP via Dept. of Health"
Arkansas Dept. of Environmental Quality (WW)	19-039-0	Michigan Dept. of Environmental Quality	9909
California ELAP via State Water Resources Control Board	2929	Minnesota Dept. of Agriculture	via "Minnesota ELAP via Dept. of Health"
CNMI Saipan Bureau of Environmental and Coastal Quality	MP0003	Minnesota Dept. of Commerce (Petrofund)	1240
Colorado Dept. of Public Health and Environment	MN00064	Minnesota ELAP via Dept. of Health	1791786
Connecticut Dept. of Public Health	PH-0256	Mississippi Dept. of Health	MN00064
EPA Region 8+Wyoming	via "Minnesota ELAP via Dept. of Health"	Missouri Dept. of Natural Resources	10100
Florida Dept. of Health	E87605-43-07/01/2019	Montana Dept. of Public Health and Human Services	CERT0092
Georgia Dept. of Natural Resources	959	Nebraska Dept. of Health and Human Services	NE-OS-18-06
Guam Environmental Protection Agency	20-001R	Nevada Dept. of Conservation and Natural Resources	MN000642020-7
Hawaii Dept. of Health	MN00064	New Hampshire ELAP via Dept. of Environmental Services	208119-D

Authority	Certificate Number	Authority	Certificate Number
Idaho Dept. of Health & Welfare (Inorganics)	MN00064	New Jersey Dept. of Environmental Protection	NLC 190003
Idaho Dept. of Health & Welfare (Organics)	MN00064	New York Dept. of Health	11647
Illinois ELAP via Illinois Environmental Protection Agency	004575	North Carolina Dept. of Environmental Quality	530
Indiana Dept. of Health	C-MN-01	North Carolina Dept. of Health and Human Services (DW)	27700
Iowa Dept. of Natural Resources	368	North Dakota Dept. of Health	R-036
Kansas Dept. of Health and Environment	E-10167	Ohio Environmental Protection Agency	41244
Kentucky Dept. for Environmental Protection (DW)	KY90062	Ohio Environmental Protection Agency (VAP)	CL101
Kentucky Dept. for Environmental Protection (WW)	KY90062	Oklahoma Dept. of Environmental Quality	2019-041
Oregon ELAP via Health Authority (Primary)	MN300001-012	Vermont Dept. of Health	VT-027053137
Oregon ELAP via Health Authority (Secondary)	MN200001-012	Virginia Dept. of General Services	10304
Pennsylvania Dept. of Environmental Protection	017	Washington Dept. of Ecology	C486-19c
Puerto Rico Dept. of Health	MN00064	West Virginia Dept. of Environmental Protection	382
South Carolina Dept. of Health and Environmental Control	74003001	West Virginia Dept. of Health & Human Resources	9952 C
Tennessee Dept. of Environment and Conservation	TN02818	Wisconsin Dept. of Natural Resources	999407970
Texas Commission on Environmental Quality	T104704192-19-14	Wyoming Underground Storage Tank via A2LA	2926.1
Utah Dept. of Health	MN000642019-10		

7.1.2 PAS-Billings

Authority	Certificate Number	Authority	Certificate Number
A2LA	3590.01	Nevada-Dept. of Conservation & Natural Resources-Division of Environmental Protection	MT000122018-1
Idaho-Dept. of Health & Welfare	MT00012	North Dakota-Dept. of Health	R-209
Minnesota-Dept. of Health	030-999-442	Washington-Dept. of Ecology	C933
Montana-Dept. of Health & Human Services	CERT0040	Wyoming (UST)	3590.01 (via A2LA)

7.1.3 PAS-Virginia

Authority	Certificate Number	Authority	Certificate Number
Alaska – Contaminated Sites Department of Environmental Conservation	17-007	North Dakota State Department of Health	R-203
Minnesota Department of Agriculture	Via Minnesota Department of Health	Washington Department of Ecology	C1007
Minnesota Department of Health	1733318	Wisconsin Department of Natural Resources	998027470
Montana Department of Public Health and Human Services	CERT0103		

7.1.4 PAS-Duluth

Authority	Certificate Number	Authority	Certificate Number
Minnesota Department of Health	1640609	North Dakota Department of Health	R-105
Minnesota Department of Agriculture	N/A	Wisconsin Department of Agriculture	480341
Montana Department of Health and Human Services	CERT0102	Wisconsin Department of Natural Resources	999446800
Nevada Department of Conservation and Natural Resources	MN000372020-1		

7.2 Appendix B: Capability Listing

The capabilities listed in this Appendix were held by the location referenced on the effective date of this manual. This information is subject to change without notice. External parties should contact the laboratory for the most current information.

Table Legend:

- DW = Drinking Water
- NPW = Non-Potable Water
- SCM = Solid and Chemical Materials
- Waste = Non-Aqueous Phase Liquid (NAPL), Oil
- Tissue = Biota and Tissue

7.2.1 PAS-Minneapolis

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
1,2-Dibromo-3-chloropropane	EPA 8011			X					
1,2-Dibromomethane	EPA 8011			X					
Alaska Diesel Range Organics	AK102 DRO			X	X				
Alaska Diesel Range Organics	AK102 DRO-SV			X					
Alaska Gasoline Range Organics	AK101 GRO-MS			X	X				
Alaska Residual Range Organics	AK103 RRO				X				
Alkalinity	SM 2320 B-1997		X	X					
Alkalinity	SM 2320 B-2011		X	X					
Amenable Cyanide	SM 4500-CN^- G-1999			X					
Amenable Cyanide	SM 4500-CN^- G-2011		X	X					
Ammonia	EPA 350.1			X					
Apparent Specific Gravity	ASTM D5057-2010			X	X				
Arizona Diesel Range Organics	8015AZ DRO			X	X				

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
Arizona Gasoline Range Organics	8015AZ GRO			X	X				
Benzene	EPA 325B	X							
California Waste Extraction	22 CCR Chapter 11, Article 5, Appendix II			X	X				
Chemical Oxygen Demand	EPA 410.4			X					
Chemical Oxygen Demand	SM 5220 D-1997			X					
Chemical Oxygen Demand	SM 5220 D-2011			X					
Chloride	SM 4500-Cl^- E-1997		X	X					
Chloride	SM 4500-Cl^- E-2011		X	X					
Conductivity	EPA 120.1			X					
Conductivity	SM 2510 B-1997		X	X					
Conductivity	SM 2510 B-2011		X	X					
Continuous Liquid-Liquid Extraction	EPA 3520C			X					
Demand (BOD, cBOD)	HACH 10360			X					
Demand (BOD, cBOD)	HACH 10360 Rev 1.2 (2011)			X					
Diesel Range Organics	EPA 8015B			X	X				
Diesel Range Organics	EPA 8015C			X	X				
Diesel Range Organics	EPA 8015D			X	X				
Diesel Range Organics	NwTPH-Dx			X	X				
Diesel Range Organics	WI(95) DRO)			X	X				

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
Dioxins and Furans	EPA 1613B			X	X		X	X	
Dioxins and Furans	EPA 8280B			X	X				
Dioxins and Furans	EPA 8290			X	X		X	X	
Dioxins and Furans	EPA 8290A			X	X		X	X	
Dioxins and Furans	EPA Method 23	X							
Dioxins and Furans	EPA TO-9A	X							
Dioxins and Furans (2,3,7,8-TCDD)	EPA 1613B		X						
Dissolved Oxygen	HACH 10360			X					
Dissolved Oxygen	HACH 10360 Rev 1.2 (2011)			X					
Escherichia coli	SM 9223 B (Colilert® Quanti-Tray®)-1997			X					
Escherichia coli	SM 9223 B (Colilert®)-1997		X						
Escherichia coli	SM 9223 B-2004			X					
Fecal Coliforms	SM 9222 D (m-FC)-1997			X					
Fecal Coliforms	SM 9222 D (m-FC)-2006			X					
Ferrous Iron	SM 3500-Fe B-1997			X					
Ferrous Iron	SM 3500-Fe B-2011			X					
Fixed Gases	EPA RSK-175 (GC/FID)			X					
Fluoride	SM 4500-F^- C-1997		X	X					
Fluoride	SM 4500-F^- C-2011		X	X					

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
Gasoline Range Organics	EPA 8015B			X	X				
Gasoline Range Organics	EPA 8015C			X	X				
Gasoline Range Organics	NwTPH-Gx			X	X				
Gasoline Range Organics	WI (95) GRO			X	X				
Heterotrophic Plate Count	SM 9215 B (R2A)-94		X						
Hexavalent Chromium	SM 3500-Cr B-1997			X					
Hexavalent Chromium	SM 3500-Cr B-2011			X					
ICP Metals	EPA 200.7			X					
ICP Metals	EPA 6010B			X	X				
ICP Metals	EPA 6010C			X	X				
ICP Metals	EPA 6010D (Rev 2014)			X	X				
ICP Metals Extraction (Water)	EPA 3010A			X					
ICP/ICPMS Metals Extraction (Soil/Waste)	EPA 3050A				X	X			
ICPMS Metals	EPA 200.8		X	X					
ICPMS Metals	EPA 6020			X	X				
ICPMS Metals	EPA 6020A			X	X				
ICPMS Metals	EPA 6020B (Rev 2014)			X	X				
ICPMS Metals Extraction (Water)	EPA 3020A			X					
Inorganic Anions	EPA 300.0		X	X					

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
Inorganic Anions	EPA 9056A			X					
Lead in Ambient Air	Method IO-3.1	X							
Lead in Ambient Air	Method IO-3.4	X							
Mercury	EPA 245.1		X	X					
Mercury	EPA 6020			X	X				
Mercury	EPA 6020A			X	X				
Mercury	EPA 6020B (Rev 2014)			X	X				
Mercury	EPA 7470A			X					
Mercury	EPA 7471A				X				
Mercury	EPA 7471B				X				
Microwave Extraction	EPA 3546				X				
Moisture (Dry Weight)	ASTM D2974-07				X				
Nitrate	EPA 353.2		X	X					
Nitrate, Nitrite, Nitrate+Nitrite	SM 4500 $NO3^-$ H 1997			X					
Nitrate, Nitrite, Nitrate+Nitrite	SM 4500-$NO3^-$ H-2011			X					
Nitrate+Nitrite	EPA 353.2			X					
Nitrite	EPA 353.2		X	X					
Nitrite	SM 4500-$NO2^-$ B-1993		X	X					
Nitrite	SM 4500-$NO2^-$ B-2011			X					

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
Oil & Grease	EPA 1664A (HEM)			X					
Oil & Grease	EPA 1664B			X					
Oil & Grease	EPA 9071B				X				
Orthophosphosphate	SM 4500-P G-1999			X					
Orthophosphosphate	SM 4500-P G-2011			X					
Paint Filter Liquids Test	EPA 9095B			X					
PCB Congeners	EPA 1668A			X	X	X	X		
PCB Congeners	EPA 1668C			X	X	X	X		
Per- and polyfluoroalkyl substances (PFAS)	EPA 537		X						
Per- and polyfluoroalkyl substances (PFAS)	EPA 537-Modified			X	X				
Per- and polyfluoroalkyl substances (PFAS)	Isotope Dilution per DoD QSM v5.1			X	X				
Per- and polyfluoroalkyl substances (PFAS)	MPCA Guidance PFCs		X	X	X				
Pesticides	EPA 8081A			X	X				
Pesticides	EPA 8081B			X	X				
Petroleum Volatile Organic Compounds	EPA 8021B			X	X				
Petroleum Volatile Organic Compounds	WI(95) GRO			X	X				
pH	EPA 9045D			X					
pH	SM 4500-H+ B-1996		X	X					
pH	SM 4500-H+ B-2011		X	X					

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
Phenols	EPA 420.4			X					
PM-10	EPA Quality Assurance Handbook, Volume II, Part II								Filter
Polybrominated Diphenyl Ethers	EPA 1614						X		
Polychlorinated Biphenyls	EPA 8082			X	X	X		X	
Polychlorinated Biphenyls	EPA 8082A (Rev 2007)			X	X	X		X	
Purge and Trap Extraction	EPA 5035				X				
Purge and Trap Extraction	EPA 5035A				X				
Purge and Trap Extraction	EPA 5035B				X				
Purge and Trap Extraction	EPA 5035C				X				
Reformed Gases	ASTM D1946-90 (Rev 2006)	X							
Sample Appearance	SM 2110-2005		X	X					
Semi-Volatile Organic Compounds	EPA 625			X					
Semi-Volatile Organic Compounds	EPA 625.1			X					
Semi-Volatile Organic Compounds	EPA 8270C			X	X				
Semi-Volatile Organic Compounds	EPA 8270C SIM			X	X				
Semi-Volatile Organic Compounds	EPA 8270D (Rev 2014)			X	X				
Semi-Volatile Organic Compounds	EPA 8270D (Rev 2014) SIM			X	X				
Semi-Volatile Organic Compounds	EPA 8270E			X	X				
Semi-Volatile Organic Compounds	EPA 8270E			X	X				

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
Separatory Funnel Liquid-Liquid Extraction	EPA 3510C			X					
Sodium Absorption Ratio by Calculation	USDA Handbook No. 60			X					
SPLP Leachate	EPA 1312			X	X				
Sulfate	ASTM D516-1990		X	X					
Sulfate	ASTM D516-2002			X					
Sulfate	ASTM D516-2007			X					
Sulfate	ASTM D516-2011		X	X					
TCLP Leachate	EPA 1311			X	X				
Total Coliforms	SM 9222 B (M-Endo)-1997			X					
Total Coliforms	SM 9222 B-2006			X					
Total Coliforms	SM 9223 B (Colilert®)-1997		X						
Total Cyanide	SM 4500-CN^- E-1997		X	X					
Total Cyanide	SM 4500-CN^- E-2011		X	X					
Total Dissolved Solids	SM 2540 C-1997		X	X					
Total Dissolved Solids	SM 2540 C-2011			X					
Total Hardness as CaCO3	SM 2340 B-1997			X					
Total Hardness as CaCO3	SM 2340 B-2011			X					
Total Petroleum Hydrocarbon	EPA 1664A (SGT-HEM)			X					
Total Petroleum Hydrocarbon	EPA 1664B (SGT-HEM)			X					

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
Total Petroleum Hydrogen	EPA 9071B				X				
Total Phosphorus	SM 4500-P F-1999			X					
Total Phosphorus	SM 4500-P F-2011			X					
Total Residual Chlorine	SM 4500-Cl G-1993		X	X					
Total Residual Chlorine	SM 4500-Cl G-2011		X	X					
Total Settleable Solids	SM 2540 F-1997			X					
Total Settleable Solids	SM 2540 F-2011			X					
Total Solids	SM 2540 B-1997			X					
Total Solids	SM 2540 B-2011			X					
Total Suspended Particulates (TSP)	EPA Quality Assurance Handbook, Volume II, Part II								Filter
Total Suspended Solids	SM 2540 D-1997			X					
Total Suspended Solids	SM 2540 D-2011			X					
Total Volatile Solids	EPA 160.4			X					
Turbidity	EPA 180.1, Rev 2-1993		X	X					
Ultrasonic Extraction	EPA 3550C				X				
Ultrasonic Extraction	EPA 3550C Modified				X				
Volatile Organic Compounds	EPA 3C	X							
Volatile Organic Compounds	EPA 524.2		X						
Volatile Organic Compounds	EPA 624			X					

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Other
Volatile Organic Compounds	EPA 624.1			X					
Volatile Organic Compounds	EPA 8260B			X	X				
Volatile Organic Compounds	EPA 8260B SIM			X	X				
Volatile Organic Compounds	EPA TO-14A	X							
Volatile Organic Compounds	EPA TO-15	X							
Volatile Organic Compounds	EPA TO-15 SIM	X							
Volatile Organic Compounds	EPA TO-15 SIM Scan	X							
Volatile Organic Compounds	EPA TO-17	X							
Volatile Organic Compounds	EPA TO-3	X							
Waste Dilution	EPA 3580A					X		X	

7.2.2 PAS-Billings

Parameter	Method	Matrices					
		Air	DW	NPW	SCM	Waste	Tissue
Acidity	SM 2310B			X			
Ammonia	EPA 350.1 (MOD)			X			
Anions by IC	EPA 300.0		X	X	X		
Anions by IC	EPA 9056A			X	X		
ASA10-3.3 Specific Conductance	ASA 10-3.3				X		
Available Ammonium	EPA 350.1				X		
Available Nitrate	ASA 33-3.2 / EPA 353.2				X		
Base Saturation Analysis	EPA 6010B				X		
Carbonates as CaCO3	USDA 23				X		
Cation Exchange Capacity	EPA 6010B				X		
Chlorophyll	SM 10200H			X			
Coarse Soil Prep	ASTM D421				X		
Dry Weight	ASTM D2974				X		
GCS THC-Diesel	EPA 8015B			X	X		
GCS THC-Diesel	EPA 8015C			X	X		
GCS THC-Diesel Silica Gel	EPA 8015 Modified w/ SG			X	X		
GCV TPH GAS	EPA 8015B			X	X		
GCV TPH GAS	EPA 8015C			X	X		
Grain Size	ASTM D422				X		
Grain Size by Hydrometer	ASTM D422				X		
Leachate Preparation	1311, 1312				X		
MADEP EPH MA	MADEP EPH			X	X		
MADEP VPH MA	MADEP VPH			X	X		
MSV TCLP	EPA 8260B			X	X		
MSV TCLP	EPA 8260D			X	X		
MSV UST	EPA 8260B			X	X		
MSV UST	EPA 8260D			X	X		
Multi-Incremental Sampling	IRTC 6.2.2				X		
Nitrate + Nitrite (Preserved)	EPA 353.2		X	X			
Nitrite (Unpreserved)	SM 4500-NO2 B		X	X			
Organic Matter	ASA 29-3.5.2				X		
Percent Sand, Silt, Clay (PSA)	ASA 15-5 mod				X		
Percent Saturation	USDA 27a				X		
pH	ASA 10-3.2				X		
pH	EPA 9045D				X		

Parameter	Method	Matrices					
		Air	DW	NPW	SCM	Waste	Tissue
pH	USDA 21A				X		
pH, Electrometric	SM 4500-H+B		X	X			
Phosphate, Ortho	SM 4500-P E		X	X			
Phosphorus, Available	ASA 24-5.4 / SM4500				X		
Phosphorus, Dissolved	SM 4500-P E			X			
Phosphorus, Total	SM 4500-P E			X			
Resitivity, Calculation	D1125-14			X	X		
Salinity, Calculation	Calculated			X	X		
SAR	EPA 6010B / ASA 10.3.2.1				X		
Sieve Procedure					X		
Sobek, Calculation	Modified Sobek 3.2				X		
Sobek Extractable Sulfur	Modified Sobek 3.2				X		
Sobek Neutralization Potential	Modified Sobek 3.2				X		
Sobek SMP Buffer pH	Modified Sobek 3.2				X		
Soil Moisture Content	USDA 26				X		
Specific Conductance	SM 2510B		X	X			
Sulfide as H2S, Calculation	SM 4500-S H			X			
Sulfide Water	SM 4500-S2-D			X			
Total Diss Solids LL	SM 2540C		X	X			
Total Dissolved Solids	SM 2540C		X	X			
Total Inorganic Nitrogen, Calculation	NO2+NO3+NH3 Calculated			X			
Total Kjeldahl Nitrogen (TKN)	EPA 351.2			X			
Total Nitrogen, Calculation	40CFR PART 432.2			X			
Total Organic Nitrogen, Calculation	TKN-NH3 Calculation			X			
Total Persulfate N2	SM 4500-N C			X			
Total Settleable Solids	SM 2540F		X	X			
Total Solids	SM 2540B		X	X			
Total Sulfur	LECO				X		
Total Suspended Solids	SM 2540D		X	X			
Turbidity	SM 2130B		X	X			
VPH Confirmation	EPA 8260B			X	X		
VPH Confirmation	EPA 8260D			X	X		

7.2.3 PAS-Virginia

Parameter	Method	Matrices		
		DW	NPW	SCM
Total Volatile Solids	EPA 160.4		X	X
Turbidity	EPA 180.1	X	X	
Anions	EPA 300.0	X	X	
Anions	EPA 9056A			X
Ammonia	EPA 350.1		X	X
Total Kjeldahl Nitrogen	EPA 351.2		X	X
Nitrate+Nitrite	EPA 353.2	X	X	
Total Phosphorus	EPA 365.1		X	X
Orthophosphate	EPA 365.3		X	
Acidity	SM 2310 B		X	
Alkalinity	SM 2320 B	X	X	
Conductivity	SM 2510 B	X	X	
Salinity	SM 2520 B		X	
Amines	ASTM D2327		X	
Dry Weight	ASTM D2974			X
Total Solids	SM 2540 B		X	X
Total Dissolved Solids	SM 2540 C		X	
Total Suspended Solids	SM 2540 D		X	
Total Suspended Solids	USGS I-3765		X	
Residual Chlorine	SM 4500 Cl-G	X	X	
Chloride	SM 4500 Cl-E		X	
pH	SM 4500 H+B	X	X	
pH	EPA 9045 D			X
Sulfide	SM 4500 S-2 F		X	
BOD/CBOD	SM 5210 B		X	
COD	SM 5220 D		X	
TOC/DOC	SM 5310C		X	
TOC/DOC	EPA 9060 A		X	
TOC, 2 rep and 4 rep	EPA 9060 A			X
ICP Metals	EPA 200.7	X	X	
ICP Metals	SW846 6010C		X	X

Parameter	Method	Matrices		
		DW	NPW	SCM
ICPMS Metals	EPA 200.8	X	X	
ICPMS Metals	SW846 6020A		X	X
Mercury	EPA 245.1	X	X	
Mercury	EPA 7470 A		X	
Mercury	EPA 7471 A,B			X
Hexavalent Chromium	SM 3500 Cr-B		X	
Paint Filter	EPA 9095 B			x
Closed Cup Flash Point	EPA 1010 A		X	
T Coli, MF	SM 9222B		X	
Fecal Coliform	SM 9222D		X	
Total, E coli	SM 9223 B QT	X	X	
Total, E coli (Colilert)	SM 9223 B P/A	X		
Total, E coli (Colilert-18)	SM 9223 B P/A	X		
Total, E coli (Colisure)	SM 9223 B P/A	X		
Heterotropic Plate Count	SimPlate	X		
Chlorophyll-a	SM 10200 H		X	

7.2.4 PAS-Duluth

Parameter	Method	Matrices					
		Air	DW	NPW	SCM	Waste	Tissue
Oxidation-Reduction Potential (ORP)	ASTM 1498 2014			X			
Percent Moisture	ASTM D2974 2013				X		
Humidity Cell Testing	ASTM D5744 2018				X		
Escherichia coli (E. coli)	Colilert-18		X				
Total Coliforms	Colilert-18		X				
Fecal Coliforms	Colilert-18 Quanti-Tray			X			
Escherichia coli (E. coli)	Colilert-18 Quanti-Tray		X	X			
Total Coliforms	Colilert-18 Quanti-Tray		X				
Escherichia coli (E. coli)	ColiSure		X				
Total Coliforms	ColiSure		X				
IC25 (ON) Growth Fathead Minnow Chronic	EPA 1000			X			
NOEC (ON) Growth Fathead Minnow Chronic	EPA 1000			X			
NOEC (ON) Survival Fathead Minnow Chronic	EPA 1000			X			
IC25 Reproduction Ceriodaphnia dubia Chronic	EPA 1002			X			
NOEC Reproduction Ceriodaphnia dubia Chronic	EPA 1002			X			
NOEC Survival Ceriodaphnia dubia Chronic	EPA 1002			X			
Conductivity	EPA 120.1 1982			X			
Mass Transfer Rates of Constituents in Materials	EPA 1315 2017				X		
Total Volatile Solids (TVS)	EPA 160.4 1971			X			
Methyl Mercury	EPA 1630 1998			X	X		X
Low Level Mercury	EPA 1631 2002			X	X		
Hexane Extractable Materials (HEM, Oil and Grease)	EPA 1664A 1999			X			
Silica-Gel Treated Hexane Extractable Material (SGT-HEM)	EPA 1664A 1999			X			

Parameter	Method	Matrices					
		Air	DW	NPW	SCM	Waste	Tissue
Turbidity	EPA 180.1 1993		X	X			
LC50 Survival Fathead Minnow Acute	EPA 2000			X			
LC50 Survival Ceriodaphnia dubia Acute	EPA 2002			X			
LC50 Survival Daphnia magna Acute	EPA 2021			X			
Ammonia	EPA 350.1 1993			X	X		
Total Kjeldahl Nitrogen (TKN)	EPA 351.2 1993			X	X		
Organic Nitrogen	EPA 351.2 Minus EPA 350.1			X			
Nitrate (NO3)	EPA 353.2 1993		X	X	X		
Nitrite (NO2)	EPA 353.2 1993		X	X			
Nitrate-Nitrite (NO3+NO2)	EPA 353.2 1993			X	X		
Total Phosphorus	EPA 365.1 1993			X	X		
Orthophosphate	EPA 365.3 1993			X			
Total Phosphorus	EPA 365.3 1993			X			
Total Phenolics	EPA 420.1 1978			X			
Biochemical Oxygen Demand (BOD)	Hach 10360 2011			X			
Carbonaceous Biochemical Oxygen Demand (CBOD)	Hach 10360 2011			X			
Dissolved Oxygen	Hach 10360 2011			X			
Heteretrophic Plate Count	SimPlate		X				
Chlorophyll-A	SM 10200 H 2011			X			
Chlorophyll-A (Non-Pheophytin Corrected)	SM 10200 H 2011			X			
Pheophytin	SM 10200 H 2011			X			
Color	SM 2120 B 2011			X			
Alkalinity	SM 2320 B 2011		X	X			
Conductivity	SM 2510 B 2011		X	X			
Total Dissolved Solids (TDS)	SM 2540 C 2011		X	X			

Parameter	Method	Matrices					
		Air	DW	NPW	SCM	Waste	Tissue
Chromium VI (Hexavalent Chromium)	SM 3500 Cr B 2011			X			
Total Residual Chlorine	SM 4500 Cl E 2011			X			
Chloride	SM 4500 Cl- E 2011			X			
Total Residual Chlorine	SM 4500 Cl G 2011		X	X			
Cyanide	SM 4500 CN- E 2011		X	X			
Amenable Cyanide	SM 4500 CN- G 2011			X			
pH	SM 4500 H+ B 2011			X			
Dissolved Oxygen	SM 4500 O C 2011			X			
Sulfide	SM 4500 S2- D 2011			X			
Chemical Oxygen Demand	SM 5220 D 2011			X			
Surfactants MBAS	SM 5540 C 2011			X			
Heterotrophic Plate Count	SM 9215 E 2004		X				
Escherichia coli (E. coli)	SM 9223B 2004		X				
Total Coliforms	SM 9223B 2004		X				
Total Hardness	USGS I-1338-85			X			
Total Suspended Solids (TSS)	USGS I-3765-85			X			
Activated Sludge, Respiration Inhibition Test	OECD 209 1984				X	X	
Algae Toxicity, Growth Inhibition Test	OECD 201 2011				X	X	

7.3 Appendix C: Glossary

This glossary provides common terms and definitions used in the laboratory. **It is not intended to be a complete list of all terms and definitions used.** The definitions have been compiled mostly from the TNI Standard and DoD QSM. Although this information has been reproduced with care, errors cannot be entirely excluded. Definitions for the same term also vary between sources. When the meaning of a term used in a laboratory document is different from this glossary or when the glossary does not include the term, the term and definition is included or defined in context in the laboratory document.

Term	Definition
3P Program	PAS-The continuous improvement program used by PAS that focuses on Process, Productivity, and Performance.
Acceptance Criteria	TNI- Specified limits placed on characteristics of an item, process, or service defined in requirement documents.
Accreditation	TNI- The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. DoD- Refers to accreditation in accordance with the DoD ELAP.
Accreditation Body (AB)	TNI- The organization having responsibility and accountability for environmental laboratory accreditation and which grants accreditation under this program. DoD- Entities recognized in accordance with the DoD-ELAP that are required to operate in accordance with ISO/IEC 17011, *Conformity assessment: General requirements for accreditation bodies accrediting conformity assessment bodies.* The AB must be a signatory, in good standing, to the International Laboratory Accreditation Cooperation (ILAC) mutual recognition arrangement (MRA) that verifies, by evaluation and peer assessment, that its signatory members are in full compliance with ISO/IEC 17011 and that its accredited laboratories comply with ISO/IEC 17025.
Accuracy (%R)	TNI- The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.
Activity, Absolute	TNI- Rate of nuclear decay occurring in a body of material, equal to the number of nuclear disintegrations per unit time. NOTE: Activity (absolute) may be expressed in becquerels (Bq), curies (Ci), or disintegrations per minute (dpm), and multiples or submultiples of these units.
Activity, Areic	TNI- Quotient of the activity of a body of material and its associated area.
Activity, Massic	TNI- Quotient of the activity of a body of material and its mass; also called specific activity.
Activity, Volumic	TNI- Quotient of the activity of a body of material and its volume; also called activity concentration. NOTE: In this module [TNI Volume 1, Module 6], unless otherwise stated, references to activity shall include absolute activity, areic activity, massic activity, and volumic activity.
Activity Reference Date	TNI- The date (and time, as appropriate to the half-life of the radionuclide) to which a reported activity result is calculated. NOTE: The sample collection date is most frequently used as the Activity Reference Date for environmental measurements, but different programs may specify other points in time for correction of results for decay and ingrowth.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
American Society for Testing and Materials (ASTM)	An international standards organization that develops and publishes voluntary consensus standards for a wide range of materials, products, systems and services.
Analysis	DoD- A combination of sample preparation and instrument determination.
Analysis Code (Acode)	All the set parameters of a test, such as Analytes, Method, Detection Limits and Price.
Analysis Sequence	A compilation of all samples, standards and quality control samples run during a specific amount of time on a particular instrument in the order they are analyzed.
Analyst	TNI- The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analyte	TNI- A substance, organism, physical parameter, property, or chemical constituent(s) for which an environmental sample is being analyzed. DoD- The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family and are analyzed together.
Analytical Method	DoD- A formal process that identifies and quantifies the chemical components of interest (target analytes) in a sample.
Analytical Uncertainty	TNI- A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
Annual (or Annually)	Defined by PAS as every 12 months ± 30 days.
Assessment	TNI - The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its system to defined criteria (to the standards and requirements of laboratory accreditation). DoD- An all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection, or surveillance conducted on-site.
Atomic Absorption Spectrometer	Instrument used to measure concentration in metals samples.
Atomization	A process in which a sample is converted to free atoms.
Audit	TNI- A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.
Batch	TNI- Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same quality systems matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours or the time-frame specified by the regulatory program. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed 20 samples.
Batch, Radiation Measurements (RMB)	TNI- An RMB is composed of 1 to 20 environmental samples that are counted directly without preliminary physical or chemical processing that affects the outcome of the test (e.g., non-destructive gamma spectrometry, alpha/beta counting of air filters, or swipes on gas proportional detectors). The samples in an RMB share similar physical and chemical parameter, and analytical configurations (e.g., analytes, geometry, calibration, and background corrections). The maximum time between the start of processing of the first and last in an RMB is 14 calendar days.
Bias	TNI- The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).
Blank	TNI and DoD- A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results (See Method Blank). DoD- Blank samples are negative control samples, which typically include field blank samples (e.g., trip blank, equipment (rinsate) blank, and temperature blank) and laboratory blank samples (e.g., method blank, reagent blank, instrument blank, calibration blank, and storage blank).
Blind Sample	A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.
BNA (Base Neutral Acid compounds)	A list of semi-volatile compounds typically analyzed by mass spectrometry methods. Named for the way they can be extracted out of environmental samples in an acidic, basic or neutral environment.
BOD (Biochemical Oxygen Demand)	Chemical procedure for determining how fast biological organisms use up oxygen in a body of water.

Calibration	TNI- A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. 1) In calibration of support equipment, the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI); 2) In calibration according to test methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.
Calibration Curve	TNI- The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.
Calibration Method	A defined technical procedure for performing a calibration.
Calibration Range	DoD- The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.
Calibration Standard	TNI- A substance or reference material used for calibration.
Certified Reference Material (CRM)	TNI- Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute.
Chain of Custody	An unbroken trail of accountability that verifies the physical security of samples, data, and records.
Chain of Custody Form (COC)	TNI- Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and type of containers; the mode of collection, the collector, time of collection; preservation; and requested analyses.
Chemical Oxygen Demand (COD)	A test commonly used to indirectly measure the amount of organic compounds in water.
Client (referred to by ISO as Customer)	Any individual or organization for whom items or services are furnished or work performed in response to defined requirements and expectations.
Code of Federal Regulations (CFR)	A codification of the general and permanent rules published in the Federal Register by agencies of the federal government.
Comparability	An assessment of the confidence with which one data set can be compared to another. Comparable data are produced through the use of standardized procedures and techniques.
Completeness	The percent of valid data obtained from a measurement system compared to the amount of valid data expected under normal conditions. The equation for completeness is: % Completeness = (Valid Data Points/Expected Data Points)*100
Confirmation	TNI- Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second-column confirmation; alternate wavelength; derivatization; mass spectral interpretation; alternative detectors; or additional cleanup procedures. DoD- Includes verification of the identity and quantity of the analyte being measured by another means (e.g., by another determinative method, technology, or column). Additional cleanup procedures alone are not considered confirmation techniques.
Conformance	An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.
Congener	A member of a class of related chemical compounds (e.g., PCBs, PCDDs).
Consensus Standard	DoD- A standard established by a group representing a cross-section of a particular industry or trade, or a part thereof.
Continuing Calibration Blank (CCB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method.
Continuing Calibration Check Compounds (CCC)	Compounds listed in mass spectrometry methods that are used to evaluate an instrument calibration from the standpoint of the integrity of the system. High variability would suggest leaks or active sites on the instrument column.
Continuing Calibration Verification	DoD- The verification of the initial calibration. Required prior to sample analysis and at periodic intervals. Continuing calibration verification applies to both external and internal standard calibration techniques, as well as to linear and non-linear calibration models.
Continuing Calibration Verification (CCV) Standard	Also referred to as a Calibration Verification Standard (CVS) in some methods, it is a standard used to verify the initial calibration of compounds in an analytical method. CCVs are analyzed at a frequency determined by the analytical method.

Continuous Emission Monitor (CEM)	A flue gas analyzer designed for fixed use in checking for environmental pollutants.
Continuous Improvement Plan (CIP)	The delineation of tasks for a given laboratory department or committee to achieve the goals of that department.
Contract Laboratory Program (CLP)	A national network of EPA personnel, commercial labs, and support contractors whose fundamental mission is to provide data of known and documented quality.
Contract Required Detection Limit (CRDL)	Detection limit that is required for EPA Contract Laboratory Program (CLP) contracts.
Contract Required Quantitation Limit (CRQL)	Quantitation limit (reporting limit) that is required for EPA Contract Laboratory Program (CLP) contracts.
Control Chart	A graphic representation of a series of test results, together with limits within which results are expected when the system is in a state of statistical control (see definition for Control Limit)
Control Limit	A range within which specified measurement results must fall to verify that the analytical system is in control. Control limit exceedances may require corrective action or require investigation and flagging of non-conforming data.
Correction	DoD- Action taken to eliminate a detected non-conformity.
Corrective Action	DoD- The action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence. A root cause analysis may not be necessary in all cases.
Corrective and Preventative Action (CAPA)	The primary management tools for bringing improvements to the quality system, to the management of the quality system's collective processes, and to the products or services delivered which are an output of established systems and processes.
Critical Value	TNI- Value to which a measurement result is compared to make a detection decision (also known as critical level or decision level). NOTE: The Critical Value is designed to give a specified low probability α of false detection in an analyte-free sample, which implies that a result that exceeds the Critical Value, gives high confidence $(1-\alpha)$ that the radionuclide is actually present in the material analyzed. For radiometric methods, α is often set at 0.05.
Customer	DoD- Any individual or organization for which products or services are furnished or work performed in response to defined requirements and expectations.
Data Integrity	TNI- The condition that exists when data are sound, correct, and complete, and accurately reflect activities and requirements.
Data Quality Objective (DQO)	Systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use or end user.
Data Reduction	TNI- The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more usable form.
Definitive Data	DoD- Analytical data of known quantity and quality. The levels of data quality on precision and bias meet the requirements for the decision to be made. Data that is suitable for final decision-making.
Demonstration of Capability (DOC)	TNI- A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. DoD- A procedure to establish the ability of the analyst to generate analytical results by a specific method that meet measurement quality objectives (e.g., for precision and bias).
Department of Defense (DoD)	An executive branch department of the federal government of the United States charged with coordinating and supervising all agencies and functions of the government concerned directly with national security.
Detection Limit (DL)	DoD- The smallest analyte concentration that can be demonstrated to be different than zero or a blank concentration with 99% confidence. At the DL, the false positive rate (Type 1 error) is 1%. A DL may be used as the lowest concentration for reliably reporting a detection of a specific analyte in a specific matrix with a specific method with 99% confidence.
Detection Limit (DL) for Safe Drinking Water Act (SDWA) Compliance	TNI- Laboratories that analyze drinking-water samples for SDWA compliance monitoring must use methods that provide sufficient detection capability to meet the detection limit requirements established in 40 CFR 141. The SDWA DL for radioactivity is defined in 40 CFR Part 141.25.c as the radionuclide concentration, which can be counted with a precision of plus or minus 100% at the 95% confidence level (1.96σ where σ is the standard deviation of the net counting rate of the sample).
Deuterated Monitoring Compounds (DMCs)	DoD- SIM specific surrogates as specified for GC/MS SIM analysis.
Diesel Range Organics (DRO)	A range of compounds that denote all the characteristic compounds that make up diesel fuel (range can be state or program specific).

Digestion	DoD- A process in which a sample is treated (usually in conjunction with heat and acid) to convert the target analytes in the sample to a more easily measured form.
Document Control	The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.
Documents	DoD- Written components of the laboratory management system (e.g., policies, procedures, and instructions).
Dry Weight	The weight after drying in an oven at a specified temperature.
Duplicate (also known as Replicate or Laboratory Duplicate)	The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results of duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.
Electron Capture Detector (ECD)	Device used in GC methods to detect compounds that absorb electrons (e.g., PCB compounds).
Electronic Data Deliverable (EDD)	A summary of environmental data (usually in spreadsheet form) which clients request for ease of data review and comparison to historical results.
Eluent	A solvent used to carry the components of a mixture through a stationary phase.
Elute	To extract, specifically, to remove (absorbed material) from an absorbent by means of a solvent.
Elution	A process in which solutes are washed through a stationary phase by movement of a mobile phase.
Environmental Data	DoD- Any measurements or information that describe environmental processes, locations, or conditions; ecological or health effects and consequences; or the performance of environmental technology.
Environmental Monitoring	The process of measuring or collecting environmental data.
Environmental Protection Agency (EPA)	An agency of the federal government of the United States which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.
Environmental Sample	A representative sample of any material (aqueous, non-aqueous, or multimedia) collected from any source for which determination of composition or contamination is requested or required. Environmental samples can generally be classified as follows: • Non Potable Water (Includes surface water, ground water, effluents, water treatment chemicals, and TCLP leachates or other extracts) • Drinking Water - Delivered (treated or untreated) water designated as potable water • Water/Wastewater - Raw source waters for public drinking water supplies, ground waters, municipal influents/effluents, and industrial influents/effluents • Sludge - Municipal sludges and industrial sludges. • Soil - Predominately inorganic matter ranging in classification from sands to clays. • Waste - Aqueous and non-aqueous liquid wastes, chemical solids, and industrial liquid and solid wastes
Equipment Blank	A sample of analyte-free media used to rinse common sampling equipment to check effectiveness of decontamination procedures.
Extracted Internal Standard Analyte	Isotopically labeled analogs of analytes of interest added to all standards, blanks and samples analyzed. Added to samples and batch QC samples prior to the first step of sample extraction and to standards and instrument blanks prior to analysis. Used for isotope dilution methods.
Facility	A distinct location within the company that has unique certifications, personnel and waste disposal identifications.
False Negative	DoD- A result that fails to identify (detect) an analyte or reporting an analyte to be present at or below a level of interest when the analyte is actually above the level of interest.
False Positive	DoD- A result that erroneously identifies (detects) an analyte or reporting an analyte to be present above a level of interest when the analyte is actually present at or below the level of interest.
Field Blank	A blank sample prepared in the field by filling a clean container with reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken.
Field Measurement	Determination of physical, biological, or radiological properties, or chemical constituents that are measured on-site, close in time and sPAS to the matrices being sampled/measured, following accepted test methods. This testing is performed in the field outside of a fixed-laboratory or outside of an enclosed structure that meets the requirements of a mobile laboratory.
Field of Accreditation	TNI- Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Field of Proficiency Testing (FoPT)	TNI- Matrix, technology/method, analyte combinations for which the composition, spike concentration ranges and acceptance criteria have been established by the PTPEC.
Finding	TNI- An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement. DoD- An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive, negative, or neutral and is normally accompanied by specific examples of the observed condition. The finding must be linked to a specific requirement (e.g., this standard, ISO requirements, analytical methods, contract specifications, or laboratory management systems requirements).
Flame Atomic Absorption Spectrometer (FAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the fact that ground state metals absorb light at different wavelengths. Metals in a solution are converted to the atomic state by use of a flame.
Flame Ionization Detector (FID)	A type of gas detector used in GC analysis where samples are passed through a flame which ionizes the sample so that various ions can be measured.
Gas Chromatography (GC)	Instrumentation which utilizes a mobile carrier gas to deliver an environmental sample across a stationary phase with the intent to separate compounds out and measure their retention times.
Gas Chromatograph/ Mass Spectrometry (GC/MS)	In conjunction with a GC, this instrumentation utilizes a mass spectrometer which measures fragments of compounds and determines their identity by their fragmentation patterns (mass spectra).
Gasoline Range Organics (GRO)	A range of compounds that denote all the characteristic compounds that make up gasoline (range can be state or program specific).
Graphite Furnace Atomic Absorption Spectrometry (GFAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the absorption of light at different wavelengths that are characteristic of different analytes.
High Pressure Liquid Chromatography (HPLC)	Instrumentation used to separate, identify and quantitate compounds based on retention times which are dependent on interactions between a mobile phase and a stationary phase.
Holding Time	TNI- The maximum time that can elapse between two specified activities. 40 CFR Part 136- The maximum time that samples may be held prior to preparation and/or analysis as defined by the method and still be considered valid or not compromised. For sample prep purposes, hold times are calculated using the time of the start of the preparation procedure. DoD- The maximum time that may elapse from the time of sampling to the time of preparation or analysis, or from preparation to analysis, as appropriate.
Homogeneity	The degree to which a property or substance is uniformly distributed throughout a sample.
Homologue	One in a series of organic compounds in which each successive member has one more chemical group in its molecule than the next preceding member. For instance, methanol, ethanol, propanol, butanol, etc., form a homologous series.
Improper Actions	DoD- Intentional or unintentional deviations from contract specified or method specified analytical practices that have not been authorized by the customer (e.g., DoD or DOE).
Incremental Sampling Method (ISM)	Soil preparation for large volume (1 kg or greater) samples.
In-Depth Data Monitoring	TNI- When used in the context of data integrity activities, a review and evaluation of documentation related to all aspects of the data generation process that includes items such as preparation, equipment, software, calculations, and quality controls. Such monitoring shall determine if the laboratory uses appropriate data handling, data use and data reduction activities to support the laboratory's data integrity policies and procedures.
Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)	Analytical technique used for the detection of trace metals which uses plasma to produce excited atoms that emit radiation of characteristic wavelengths.
Inductively Coupled Plasma- Mass Spectrometry (ICP/MS)	An ICP that is used in conjunction with a mass spectrometer so that the instrument is not only capable of detecting trace amounts of metals and non-metals but is also capable of monitoring isotopic speciation for the ions of choice.
Infrared Spectrometer (IR)	An instrument that uses infrared light to identify compounds of interest.

Initial Calibration (ICAL)	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response relationship of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method.
Initial Calibration Blank (ICB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method. This blank is specifically run in conjunction with the Initial Calibration Verification (ICV) where applicable.
Initial Calibration Verification (ICV)	DoD- Verifies the initial calibration with a standard obtained or prepared from a source independent of the source of the initial calibration standards to avoid potential bias of the initial calibration.
Injection Internal Standard Analyte	Isotopically labeled analogs of analytes of interest (or similar in physiochemical properties to the target analytes but with a distinct response) to be quantitated. Added to all blanks, standards, samples and batch QC after extraction and prior to analysis.
Instrument Blank	A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination.
Instrument Detection Limits (IDLs)	Limits determined by analyzing a series of reagent blank analyses to obtain a calculated concentration. IDLs are determined by calculating the average of the standard deviations of three runs on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day.
Interference, spectral	Occurs when particulate matter from the atomization scatters incident radiation from the source or when the absorption or emission from an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible.
Interference, chemical	Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte.
Internal Standard	TNI and DoD- A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.
International Organization for Standardization (ISO)	An international standard-setting body composed of representatives from various national standards organizations.
Intermediate Standard Solution	Reference solutions prepared by dilution of the stock solutions with an appropriate solvent.
International System of Units (SI)	The coherent system of units adopted and recommended by the General Conference on Weights and Measures.
Ion Chromatography (IC)	Instrumentation or process that allows the separation of ions and molecules based on the charge properties of the molecules.
Isomer	One of two or more compounds, radicals, or ions that contain the same number of atoms of the same element but differ in structural arrangement and properties. For example, hexane (C6H14) could be n-hexane, 2-methylpentane, 3-methylpentane, 2,3-dimethylbutane, 2,2-dimethylbutane.
Laboratory	A body that calibrates and/or tests.
Laboratory Control Sample (LCS)	TNI- (also known as laboratory fortified blank (LFB), spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to evaluate the performance of all or a portion of the measurement system.
Laboratory Duplicate	Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.
Laboratory Information Management System (LIMS)	DoD- The entirety of an electronic data system (including hardware and software) that collects, analyzes, stores, and archives electronic records and documents.
Learning Management System (LMS)	A web-based database used by the laboratories to track and document training activities. The system is administered by the corporate training department and each laboratory's learn centers are maintained by a local administrator.
Legal Chain-of-Custody Protocols	TNI- Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain-of-Custody (COC) Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Limit(s) of Detection (LOD)	TNI- The minimum result, which can be reliably discriminated from a blank with predetermined confidence level. DoD- The smallest concentration of a substance that must be present in a sample in order to be detected at the DL with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. A LOD may be used as the lowest concentration for reliably reporting a non-detect of a specific analyte in a specific matrix with a specific method at 99% confidence.
Limit(s) of Quantitation (LOQ)	TNI- The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. DoD- The smallest concentration that produces a quantitative result with known and recorded precision and bias. For DoD/DOE projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard and within the calibration range.
Linear Dynamic Range	DoD- Concentration range where the instrument provides a linear response.
Liquid chromatography/ tandem mass spectrometry (LC/MS/MS)	Instrumentation that combines the physical separation techniques of liquid chromatography with the mass analysis capabilities of mass spectrometry.
Lot	TNI- A definite amount of material produced during a single manufacturing cycle, and intended to have uniform character and quality.
Management	Those individuals directly responsible and accountable for planning, implementing, and assessing work.
Management System	System to establish policy and objectives and to achieve those objectives.
Manager (however named)	The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual.
Matrix	TNI- The substrate of a test sample.
Matrix Duplicate	TNI- A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.
Matrix Spike (MS) (spiked sample or fortified sample)	TNI- A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
Matrix Spike Duplicate (MSD) (spiked sample or fortified sample duplicate)	TNI- A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.
Measurement Performance Criteria (MPC)	DoD- Criteria that may be general (such as completion of all tests) or specific (such as QC method acceptance limits) that are used by a project to judge whether a laboratory can perform a specified activity to the defined criteria.
Measurement Quality Objective (MQO)	TNI- The analytical data requirements of the data quality objectives are project- or program-specific and can be quantitative or qualitative. MQOs are measurement performance criteria or objectives of the analytical process. Examples of quantitative MQOs include statements of required analyte detectability and the uncertainty of the analytical protocol at a specified radionuclide activity, such as the action level. Examples of qualitative MQOs include statements of the required specificity of the analytical protocol, e.g., the ability to analyze for the radionuclide of interest given the presence of interferences.
Measurement System	TNI- A method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s). DoD- A test method, as implemented at a particular laboratory, and which includes the equipment used to perform the sample preparation and test and the operator(s).
Measurement Uncertainty	DoD- An estimate of the error in a measurement often stated as a range of values that contain the true value within a certain confidence level. The uncertainty generally includes many components which may be evaluated from experimental standard deviations based on repeated observations or by standard deviations evaluated from assumed probability distributions based on experience or other information. For DoD/DOE, a laboratory's Analytical Uncertainty (such as use of LCS control limits) can be reported as the minimum uncertainty.
Method	TNI- A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.
Method Blank	TNI- A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit (MDL)	TNI- One way to establish a Detection Limit; defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
Method of Standard Additions	A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration.
Minimum Detectable Activity (MDA)	TNI- Estimate of the smallest true activity that ensures a specified high confidence, $1 - \beta$, of detection above the Critical Value, and a low probability β of false negatives below the Critical Value. For radiometric methods, β is often set at 0.05. NOTE 1: The MDS is a measure of the detection capability of a measurement process and as such, it is an a priori concept. It may be used in the selection of methods to meet specified MQOs. Laboratories may also calculate a "sample specific" MDA, which indicates how well the measurement process is performing under varying real-world measurement conditions, when sample-specific characteristics (e.g., interferences) may affect the detection capability. However, the MDA must never be used instead of the Critical Value as a detection threshold. NOTE 2: For the purpose of this Standard, the terms MDA and minimum detectable concentration (MDC) are equivalent.
MintMiner	Program used by PAS to review large amounts of chromatographic data to monitor for errors or data integrity issues.
Mobile Laboratory	TNI- A portable enclosed structure with necessary and appropriate accommodation and environmental conditions for a laboratory, within which testing is performed by analysts. Examples include but are not limited to trailers, vans, and skid-mounted structures configured to house testing equipment and personnel.
National Environmental Laboratory Accreditation Conference (NELAC)	See definition of The NELAC Institute (TNI).
National Institute of Occupational Safety and Health (NIOSH)	National institute charged with the provision of training, consultation and information in the area of occupational safety and health.
National Institute of Standards and Technology (NIST)	TNI- A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States national metrology institute (or NMI).
National Pollutant Discharge Elimination System (NPDES)	A permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.
Negative Control	Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.
Nitrogen Phosphorus Detector (NPD)	A detector used in GC analyses that utilizes thermal energy to ionize an analyte. With this detector, nitrogen and phosphorus can be selectively detected with a higher sensitivity than carbon.
Nonconformance	An indication or judgment that a product or service has not met the requirement of the relevant specifications, contract, or regulation; also the state of failing to meet the requirements.
Not Detected (ND)	The result reported for a compound when the detected amount of that compound is less than the method reporting limit.
Operator Aid	DoD- A technical posting (such as poster, operating manual, or notepad) that assists workers in performing routine tasks. All operator aids must be controlled documents (i.e., a part of the laboratory management system).
Percent Recovery (%)	A measure of precision defined as the difference between the spiked concentration and the sample concentration divided by the true value. For LCS and Surrogate calculations the sample concentration is zero.
Performance Based Measurement System (PBMS)	An analytical system wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner.
Physical Parameter	TNI- A measurement of a physical characteristic or property of a sample as distinguished from the concentrations of chemical and biological components.
Photo-ionization Detector (PID)	An ion detector which uses high-energy photons, typically in the ultraviolet range, to break molecules into positively charged ions.
Polychlorinated Biphenyls (PCB)	A class of organic compounds that were used as coolants and insulating fluids for transformers and capacitors. The production of these compounds was banned in the 1970's due to their high toxicity.

Positive Control	Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.
Post-Digestion Spike	A sample prepared for metals analyses that has analytes spike added to determine if matrix effects may be a factor in the results.
Power of Hydrogen (pH)	The measure of acidity or alkalinity of a solution.
Practical Quantitation Limit (PQL)	Another term for a method reporting limit. The lowest reportable concentration of a compound based on parameters set up in an analytical method and the laboratory's ability to reproduce those conditions.
Precision	TNI- The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.
Preservation	TNI and DoD Any conditions under which a sample must be kept in order to maintain chemical, physical, and/or biological integrity prior to analysis.
Primary Accreditation Body (Primary AB)	TNI- The accreditation body responsible for assessing a laboratory's total quality system, on-site assessment, and PT performance tracking for fields of accreditation.
Procedure	TNI- A specified way to carry out an activity or process. Procedures can be documented or not.
Proficiency Testing (PT)	TNI- A means to evaluate a laboratory's performance under controlled conditions relative to a given set of criteria, through analysis of unknown samples provided by an external source.
Proficiency Testing Program (PT Program)	TNI- The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories.
Proficiency Testing Provider (PT Provider)	TNI- A person or organization accredited by a TNI-approved Proficiency Testing Provider Accreditor to operate a TNI-compliant PT Program.
Proficiency Testing Provider Accreditor (PTPA)	TNI- An organization that is approved by TNI to accredit and monitor the performance of proficiency testing providers.
Proficiency Testing Reporting Limit (PTRL)	TNI- A statistically derived value that represents the lowest acceptable concentration for an analyte in a PT sample, if the analyte is spiked into the PT sample. The PTRLs are specified in the TNI FoPT tables.
Proficiency Testing Sample (PT)	TNI- A sample, the composition of which is unknown to the laboratory, and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria.
Proficiency Testing (PT) Study	TNI- a) Scheduled PT Study: A single complete sequence of circulation and scoring of PT samples to all participants in a PT program. The study must have the same pre-defined opening and closing dates for all participants; b) Supplemental PT Study: A PT sample that may be from a lot previously released by a PT Provider that meets the requirements for supplemental PT samples given in Volume 3 of this Standard [TNI] but that does not have a pre-determined opening date and closing date.
Proficiency Testing Study Closing Date	TNI- a) Scheduled PT Study: The calendar date by which all participating laboratories must submit analytical results for a PT sample to a PT Provider; b) Supplemental PT Study: The calendar date a laboratory submits the results for a PT sample to the PT Provider.
Proficiency Testing Study Opening Date	TNI- a) Scheduled PT Study: The calendar date that a PT sample is first made available to all participants of the study by a PT Provider; b) Supplemental PT Study: The calendar date the PT Provider ships the sample to a laboratory.
Protocol	TNI A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed.
Qualitative Analysis	DoD- Analysis designed to identify the components of a substance or mixture.
Quality Assurance (QA)	TNI- An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.
Quality Assurance Manual (QAM)	A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality Assurance Project Plan (QAPP)	A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.
Quality Control (QC)	TNI- The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.

Quality Control Sample (QCS)	TNI- A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control.
Quality Manual	TNI- A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality System	TNI and DoD- A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control activities.
Quality System Matrix	TNI and DoD- These matrix definitions shall be used for purposes of batch and quality control requirements and may be different from a field of accreditation matrix: • **Air and Emissions**: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device • **Aqueous**: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts. • **Biological Tissue**: Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples shall be grouped according to origin. • **Chemical Waste**: A product or by-product of an industrial process that results in a matrix not previously defined. • **Drinking Water**: Any aqueous sample that has been designated a potable or potentially potable water source. • **Non-aqueous liquid**: Any organic liquid with <15% settleable solids • **Saline/Estuarine**: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake. • **Solids**: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.
Quantitation Range	DoD- The range of values (concentrations) in a calibration curve between the LOQ and the highest successively analyzed initial calibration standard used to relate instrument response to analyte concentration. The quantitation range (adjusted for initial sample volume/weight, concentration/dilution and final volume) lies within the calibration range.
Quantitative Analysis	DoD- Analysis designed to determine the amounts or proportions of the components of a substance.
Random Error	The EPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test due to random error. As the number of compounds measured increases in a given sample, the probability for statistical error also increases.
Raw Data	TNI- The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records.
Reagent Blank (method reagent blank)	A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.
Reagent Grade	Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.
Records	DoD- The output of implementing and following management system documents (e.g., test data in electronic or hand-written forms, files, and logbooks).
Reference Material	TNI- Material or substance one or more of whose property values are sufficiently homogenized and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Reference Method	TNI- A published method issued by an organization generally recognized as competent to do so. (When the ISO language refers to a "standard method", that term is equivalent to "reference method"). When a laboratory is required to analyze by a specified method due to a regulatory requirement, the analyte/method combination is recognized as a reference method. If there is no regulatory requirement for the analyte/method combination, the analyte/method combination is recognized as a reference method if it can be analyzed by another reference method of the same matrix and technology.
Reference Standard	TNI- Standard used for the calibration of working measurement standards in a given organization or at a given location.
Relative Percent Difference (RPD)	A measure of precision defined as the difference between two measurements divided by the average concentration of the two measurements.
Relative Standard Deviation (RSD)	A measure of precision defined by dividing the standard deviation of a series of values by the average of those values.
Relative Standard Error (RSE)	A measurement to determine if the standard error (SE) is large relative to the results.
Reporting Limit (RL)	The level at which method, permit, regulatory and customer-specific objectives are met. The reporting limit may never be lower than the Limit of Detection (i.e., statistically determined MDL). Reporting limits are corrected for sample amounts, including the dry weight of solids, unless otherwise specified. There must be a sufficient buffer between the Reporting Limit and the MDL. DoD- A customer-specified lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.
Reporting Limit Verification Standard (RLVS)	A standard analyzed at the reporting limit for an analysis to verify the laboratory's ability to report to that level.
Representativeness	A quality element related to the ability to collect a sample reflecting the characteristics of the part of the environment to be assessed. Sample representativeness is dependent on the sampling techniques specified in the project work plan.
Requirement	Denotes a mandatory specification; often designated by the term "shall".
Retention Time	The time between sample injection and the appearance of a solute peak at the detector.
Revocation	TNI- The total or partial withdrawal of a laboratory's accreditation by an accreditation body.
Sample	Portion of material collected for analysis, identified by a single, unique alphanumeric code. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis.
Sample Condition Upon Receipt Form (SCURF)	Form used by sample receiving personnel to document the condition of sample containers upon receipt to the laboratory (used in conjunction with a COC).
Sample Delivery Group (SDG)	A unit within a single project that is used to identify a group of samples for delivery. An SDG is a group of 20 or fewer field samples within a project, received over a period of up to 14 calendar days. Data from all samples in an SDG are reported concurrently.
Sample Receipt Form (SRF)	Letter sent to the client upon login to show the tests requested and pricing.
Sample Tracking	Procedures employed to record the possession of the samples from the time of sampling until analysis, reporting and archiving. These procedures include the use of a chain-of-custody form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.
Sampling	TNI- Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.
Selected Ion Monitoring (SIM)	A mode of analysis in mass spectrometry where the detector is set to scan over a very small mass range, typically one mass unit. The narrower the range, the more sensitive the detector. DoD- Using GC/MS, characteristic ions specific to target compounds are detected and used to quantify in applications where the normal full scan mass spectrometry results in excessive noise.
Selectivity	TNI- The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.
Sensitivity	TNI- The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.
Serial Dilution	The stepwise dilution of a substance in a solution.
Shall	Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification as long as the requirement is fulfilled.

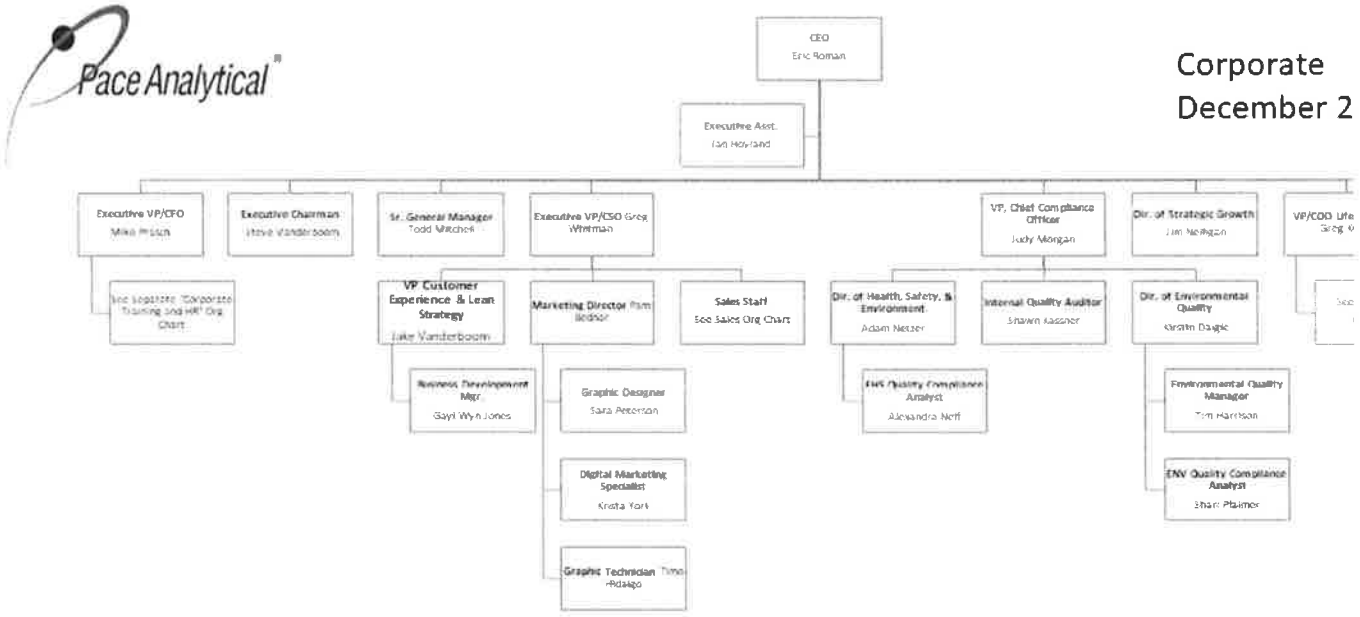
Should	Denotes a guideline or recommendation whenever noncompliance with the specification is permissible.
Signal-to-Noise Ratio (S/N)	DoD- A measure of signal strength relative to background noise. The average strength of the noise of most measurements is constant and independent of the magnitude of the signal. Thus, as the quantity being measured (producing the signal) decreases in magnitude, S/N decreases and the effect of the noise on the relative error of a measurement increases.
Source Water	TNI- When sampled for drinking water compliance, untreated water from streams, rivers, lakes, or underground aquifers, which is used to supply private and public drinking water supplies.
Spike	A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.
Standard (Document)	TNI- The document describing the elements of a laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.
Standard (Chemical)	Standard samples are comprised of a known amount of standard reference material in the matrix undergoing analysis. A standard reference material is a certified reference material produced by US NIST and characterized for absolute content, independent of analytical test method.
Standard Blank (or Reagent Blank)	A calibration standard consisting of the same solvent/reagent matrix used to prepare the calibration standards without the analytes. It is used to construct the calibration curve by establishing instrument background.
Standard Method	A test method issued by an organization generally recognized as competent to do so.
Standard Operating Procedure (SOP)	TNI- A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks.
Standard Reference Material (SRM)	A certified reference material produced by the US NIST or other equivalent organization and characterized for absolute content, independent of analytical method.
Statement of Qualifications (SOQ)	A document that lists information about a company, typically the qualifications of that company to compete on a bid for services.
Stock Standard	A concentrated reference solution containing one or more analytes prepared in the laboratory using an assayed reference compound or purchased from a reputable commercial source.
Storage Blank	DoD- A sample of analyte-free media prepared by the laboratory and retained in the sample storage area of the laboratory. A storage blank is used to record contamination attributable to sample storage at the laboratory.
Supervisor	The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses.
Surrogate	DoD- A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.
Suspension	TNI- The temporary removal of a laboratory's accreditation for a defined period of time, which shall not exceed 6 months or the period of accreditation, whichever is longer, in order to allow the laboratory time to correct deficiencies or area of non-conformance with the Standard.
Systems Audit	An on-site inspection or assessment of a laboratory's quality system.
Target Analytes	DoD- Analytes or chemicals of primary concern identified by the customer on a project-specific basis.
Technical Director	Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory.
Technology	TNI- A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.
Test	A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate.
Test Method	DoD- A definitive procedure that determines one or more characteristics of a given substance or product.
Test Methods for Evaluating Solid Waste, Physical/ Chemical (SW-846)	EPA Waste's official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with RCRA regulations.

Test Source	TNI- A radioactive source that is tested, such as a sample, calibration standard, or performance check source. A Test Source may also be free of radioactivity, such as a Test Source counted to determine the subtraction background, or a short-term background check.
The NELAC Institute (TNI)	A non-profit organization whose mission is to foster the generation of environmental data of known and documented quality through an open, inclusive, and transparent process that is responsive to the needs of the community. Previously known as NELAC (National Environmental Laboratory Accreditation Conference).
Total Petroleum Hydrocarbons (TPH)	A term used to denote a large family of several hundred chemical compounds that originate from crude oil. Compounds may include gasoline components, jet fuel, volatile organics, etc.
Toxicity Characteristic Leaching Procedure (TCLP)	A solid sample extraction method for chemical analysis employed as an analytical method to simulate leaching of compounds through a landfill.
Traceability	TNI- The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical conditions or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.
Training Document	A training resource that provides detailed instructions to execute a specific method or job function.
Trip Blank	This blank sample is used to detect sample contamination from the container and preservative during transport and storage of the sample. A cleaned sample container is filled with laboratory reagent water and the blank is stored, shipped, and analyzed with its associated samples.
Tuning	A check and/or adjustment of instrument performance for mass spectrometry as required by the method.
Ultraviolet Spectrophotometer (UV)	Instrument routinely used in quantitative determination of solutions of transition metal ions and highly conjugated organic compounds.
Uncertainty, Counting	TNI- The component of Measurement Uncertainty attributable to the random nature of radioactive decay and radiation counting (often estimated as the square root of observed counts (MARLAP). Older references sometimes refer to this parameter as Error, Counting Error or Count Error (c.f., Total Uncertainty).
Uncertainty, Expanded	TNI- The product of the Standard Uncertainty and a coverage factor, k, which is chosen to produce an interval about the result that has a high probability of containing the value of the measurand (c.f., Standard Uncertainty). NOTE: Radiochemical results are generally reported in association with the Total Uncertainty. Either if these estimates of uncertainty can be reported as the Standard Uncertainty (one-sigma) or as an Expanded Uncertainty (k-sigma, where $k > 1$).
Uncertainty, Measurement	TNI- Parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand.
Uncertainty, Standard	TNI- An estimate of the Measurement Uncertainty expressed as a standard deviation (c.f., Expanded Uncertainty).
Uncertainty, Total	TNI An estimate of the Measurement Uncertainty that accounts for contributions from all significant sources of uncertainty associated with the analytical preparation and measurement of a sample. Such estimates are also commonly referred to as Combined Standard Uncertainty or Total Propagated Uncertainty, and in some older references as the Total Propagated Error, among other similar items (c.f., Counting Uncertainty).
Unethical actions	DoD- Deliberate falsification of analytical or quality control results where failed method or contractual requirements are made to appear acceptable.
United States Department of Agriculture (USDA)	A department of the federal government that provides leadership on food, agriculture, natural resources, rural development, nutrition and related issues based on public policy, the best available science, and effective management.
United States Geological Survey (USGS)	Program of the federal government that develops new methods and tools to supply timely, relevant, and useful information about the Earth and its processes.
Unregulated Contaminant Monitoring Rule (UCMR)	EPA program to monitor unregulated contaminants in drinking water.
Validation	DoD- The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

Verification	TNI- Confirmation by examination and objective evidence that specified requirements have been met. In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.
Voluntary Action Program (VAP)	A program of the Ohio EPA that gives individuals a way to investigate possible environmental contamination, clean it up if necessary and receive a promise from the State of Ohio that no more cleanup is needed.
Whole Effluent Toxicity (WET)	The aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater (effluent).

7.4 Appendix D: Organization Chart(s)

7.4.1 PAS-Corporate



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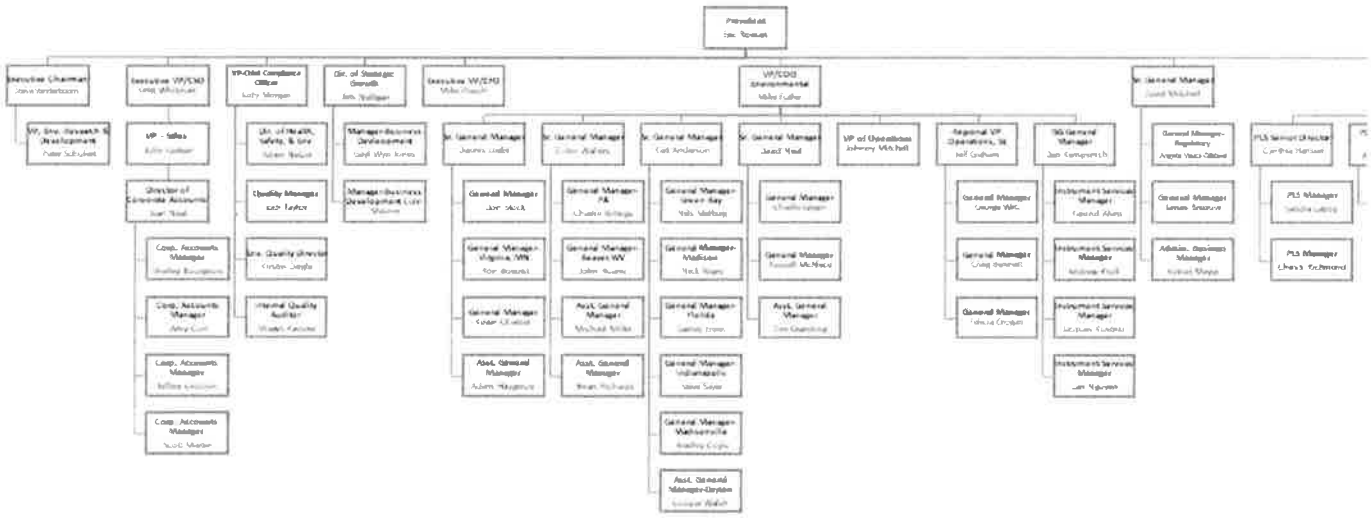

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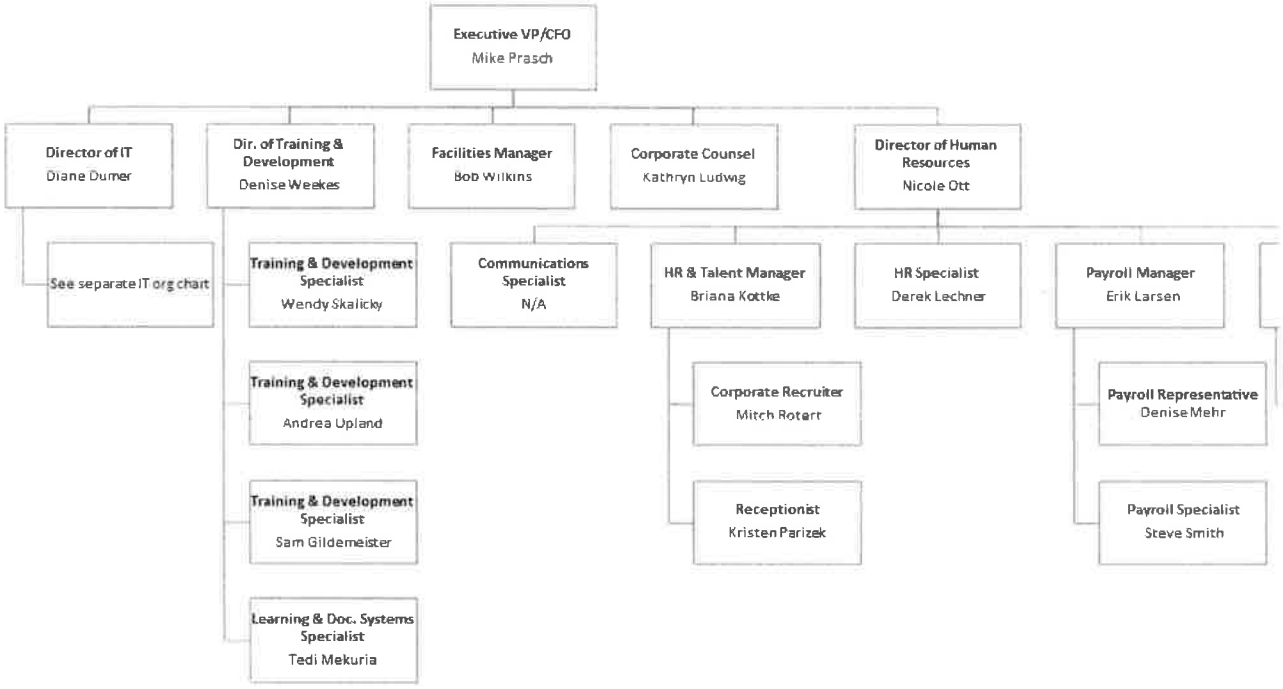

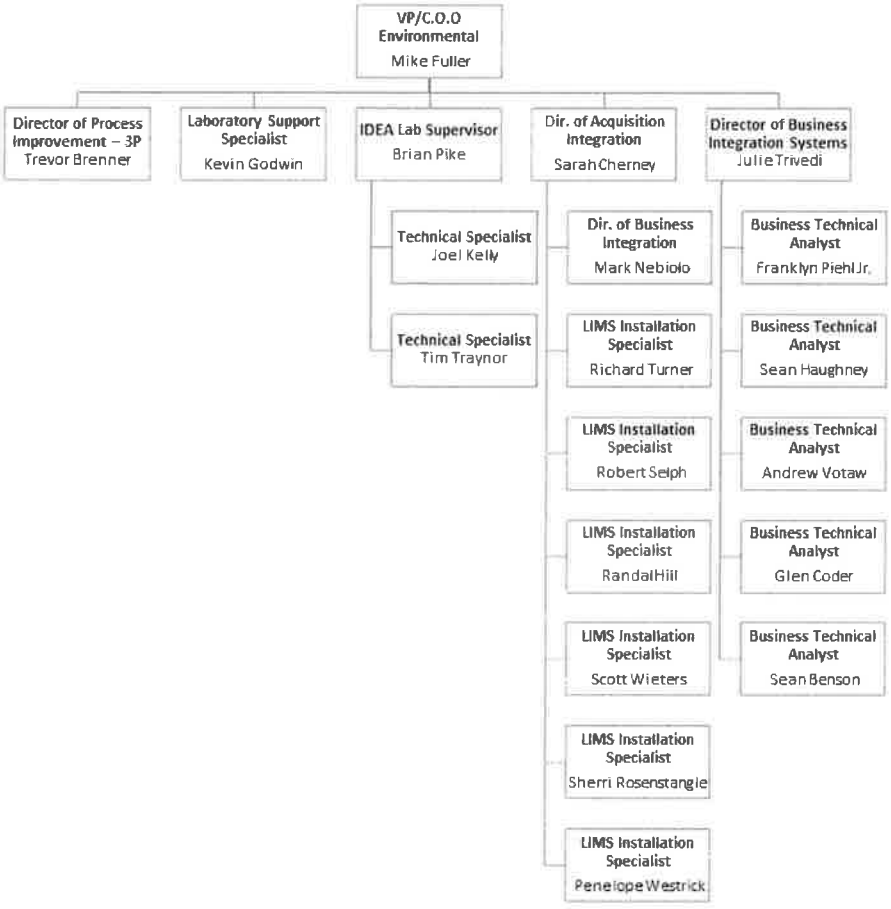

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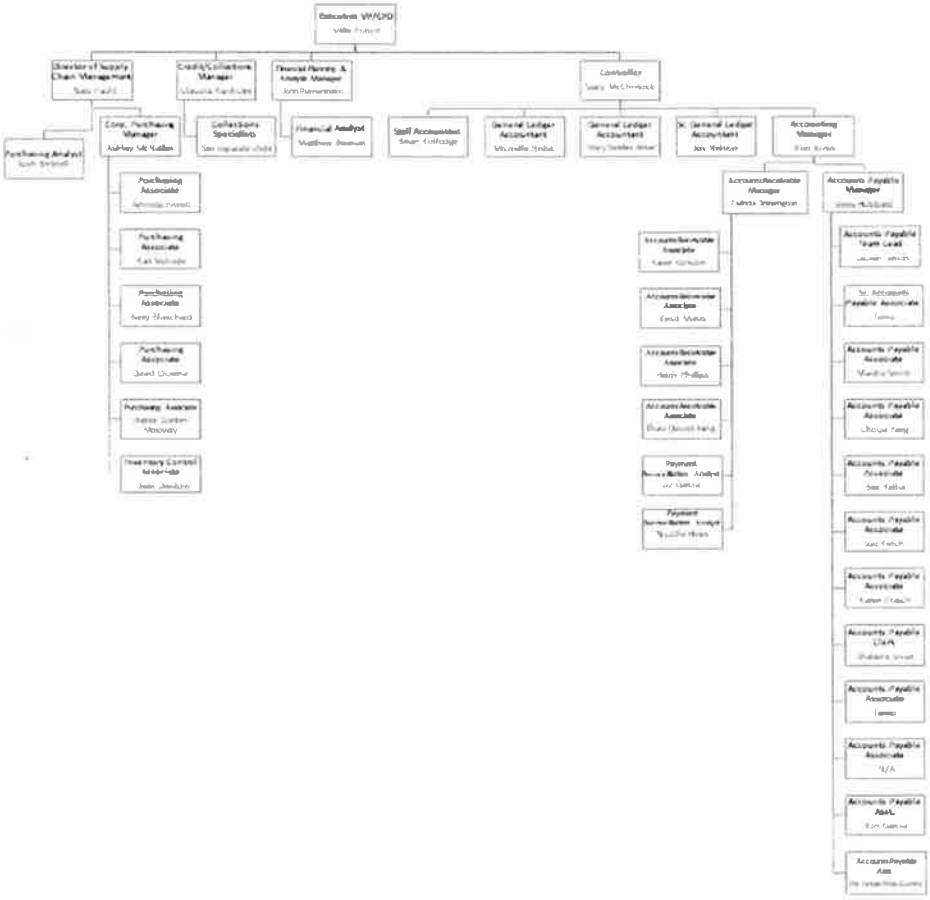

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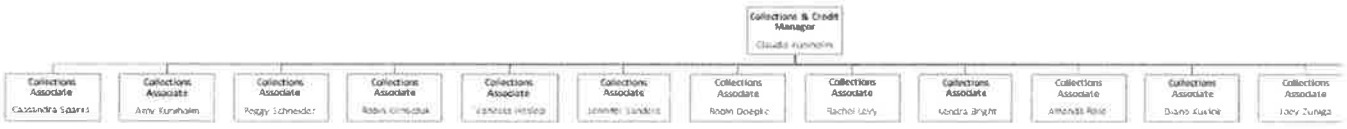
December 2019



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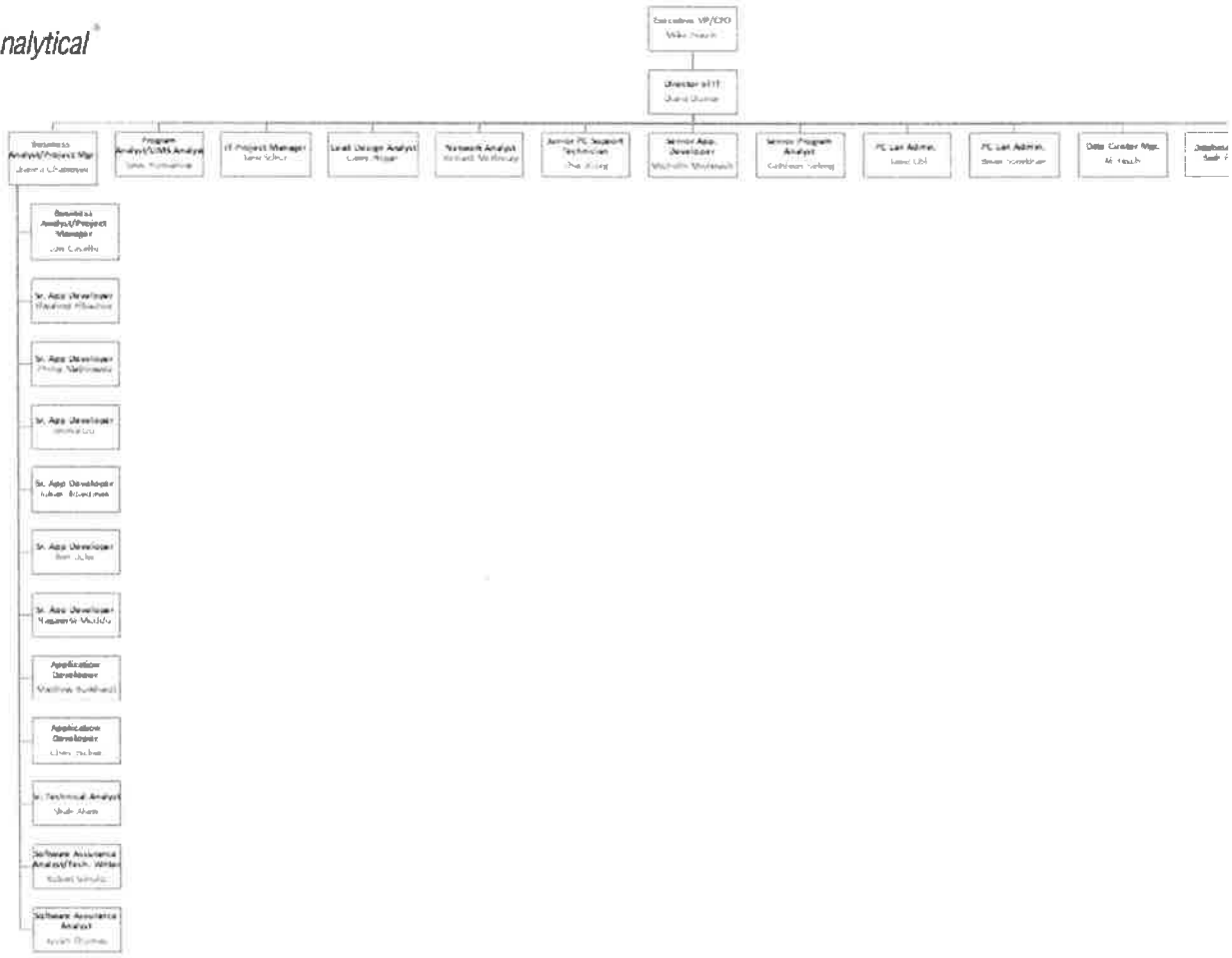
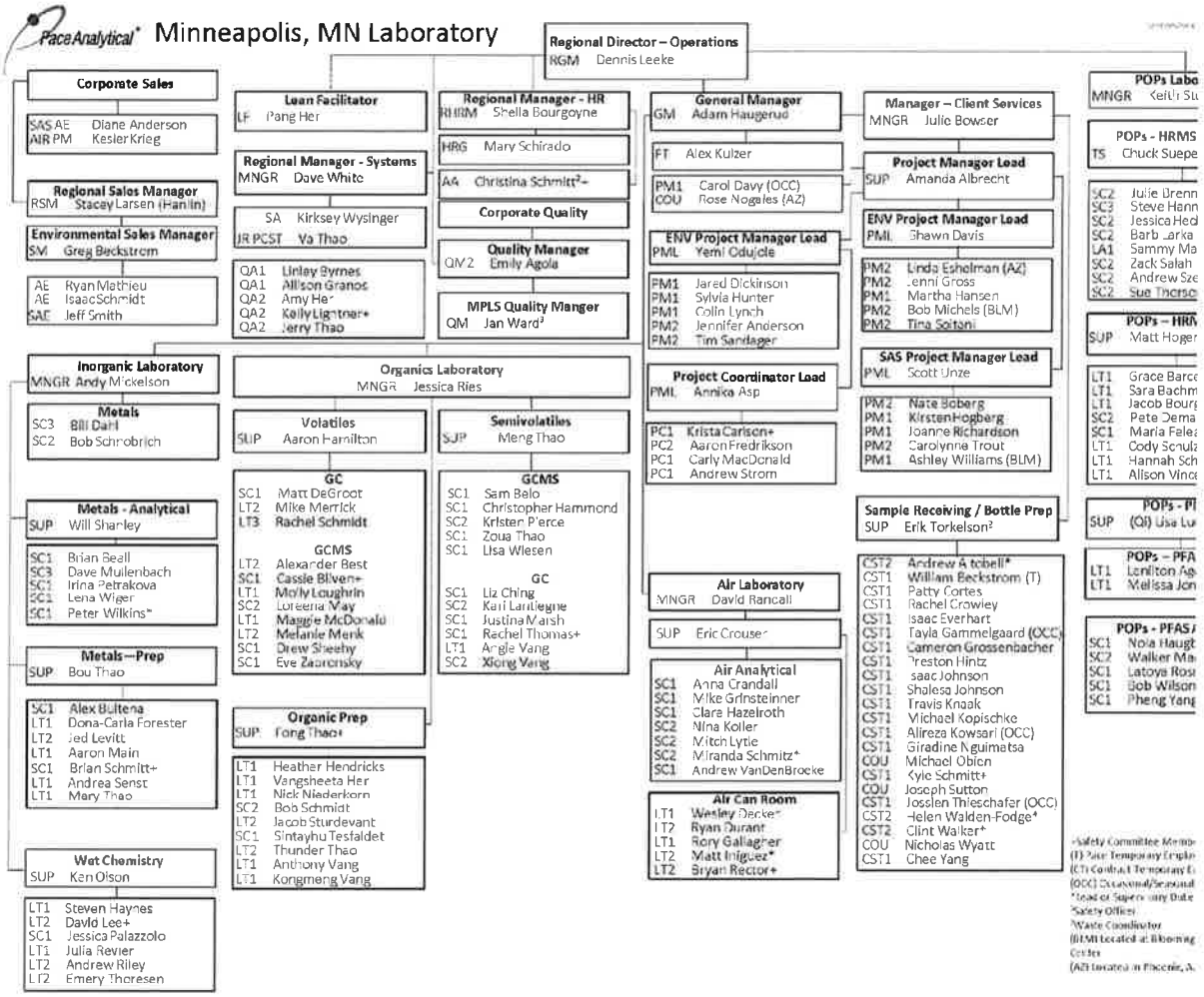
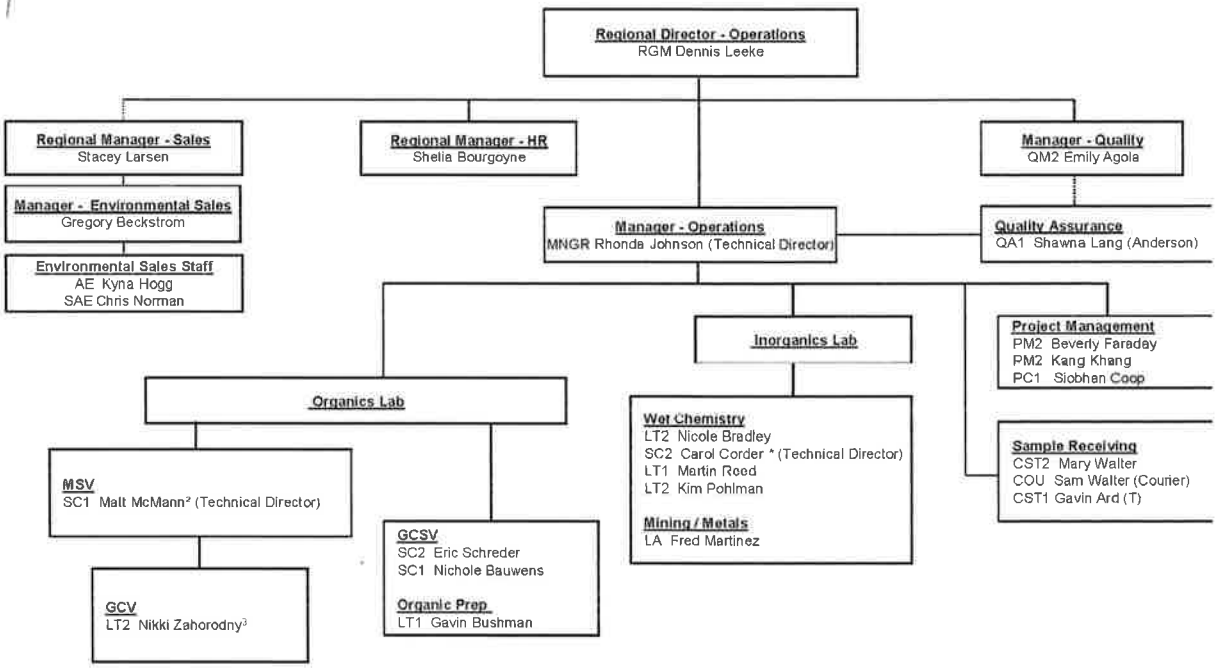


7.4.2 PAS-Minneapolis, Bloomington, and Phoenix



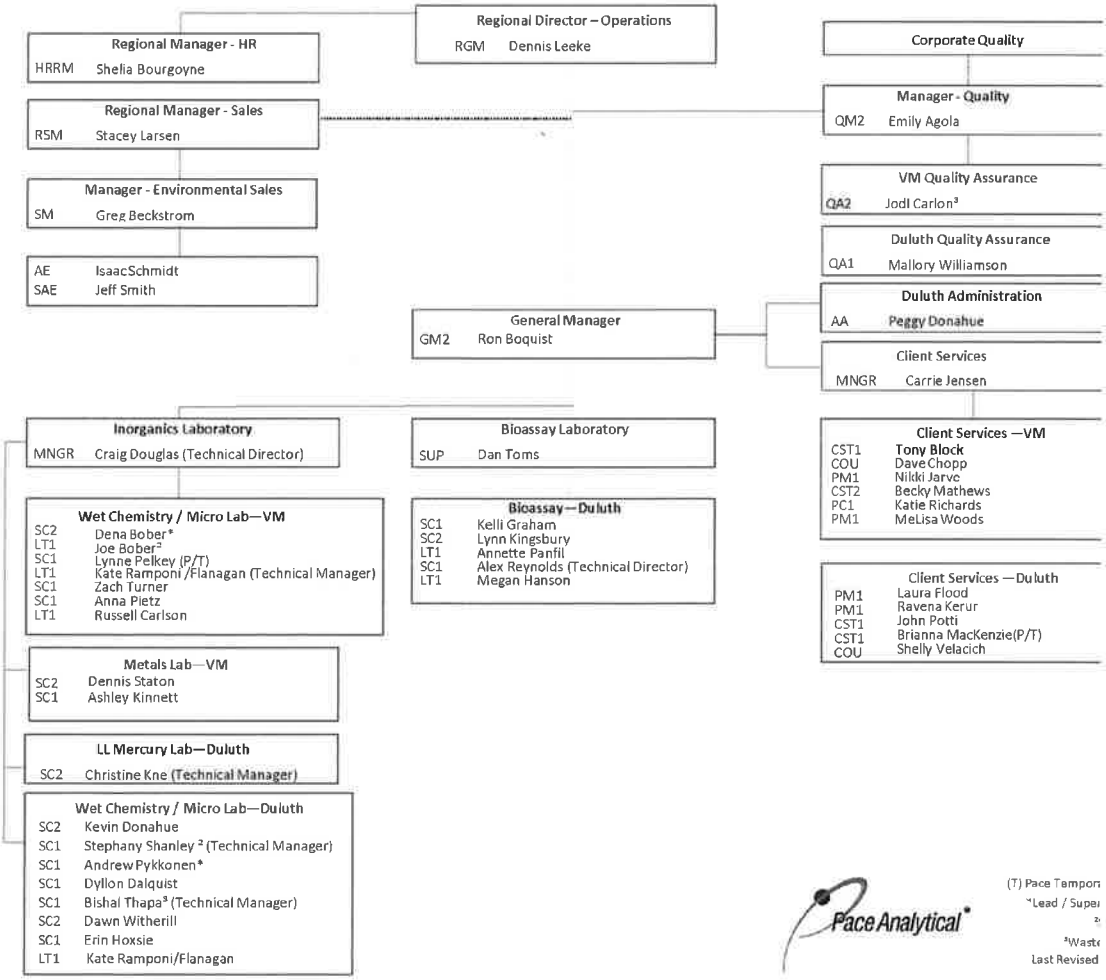
7.4.3 PAS-Billings



Dennis Leeke, Regional Director - Operations
Rhonda Johnson, Manager - Operations
Last Revised: January, 2020
*Lead / Supervisory Duties
² Safety Officer
³ Waste Coordinator
(T) Temporary Employee
(CT) Contract Temporary Employee
(OCC) Occasional Employment

7.4.4 PAS-Duluth and Virginia

Northern MN Laboratories (VIR1/DUL1)



7.5 Appendix E: Equipment Listing

The equipment listed represents equipment were held by each location on the effective date of this manual. This information is subject to change without notice. External parties should contact the location for the most current information.

7.5.1 PAS-Minneapolis, Bloomington, and Phoenix

Equipment List: PAS-Minneapolis, Bloomington, and Phoenix

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
GC	Agilent Technologies	6890N	CN10429060	2005	Unknown	Air	10AIR0	To Be Determined (TBD)
MS	Agilent Technologies	5973 Network	US43146819	2005	Unknown	Air	10AIR0	TBD
PreConcentrator	Entech Instruments, Inc.	7100A	1299	2007	Unknown	Air	10AIR0	TBD
Canister Autosampler	Entech Instruments, Inc.	7016 CA	1283	1985	Unknown	Air	10AIR0	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1587	2004	Unknown	Air	10AIR0	TBD
GC	HP	5890	2813A20766	2004	Unknown	Air	10AIR5	TBD
GC	Agilent Technologies	6890N	CN10429056	2004	Unknown	Air	10AIR7	TBD
MS	Agilent Technologies	5973 Network	US43146821	2009	Unknown	Air	10AIR7	TBD
PreConcentrator	Entech Instruments, Inc.	7100A	1611	2008	Unknown	Air	10AIR7	TBD
Canister Autosampler	Entech Instruments, Inc.	7016 CA	1239	2009	Unknown	Air	10AIR7	TBD
Canister Autosampler	Entech Instruments, Inc.	7016 CA-2	115	2009	Unknown	Air	10AIR7	TBD
GC	ALS Ready	6890A	US00034289	2013	Unknown	Air	10AIRA	TBD
Concentrator	Entech Instruments, Inc.	7032 AQ-L	1164	2013	Unknown	Air	10AIRA	TBD
MS	Agilent Technologies	5973 inert	US44621387	2010	Unknown	Air	10AIRB	TBD
GC	Agilent Technologies	6890	CN10517058	2010	Unknown	Air	10AIRB	TBD
PreConcentrator	Entech Instruments, Inc.	7200	1300	2010	Unknown	Air	10AIRB	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1488	2010	Unknown	Air	10AIRB	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1487	2010	Unknown	Air	10AIRB	TBD
GC	Agilent Technologies	7890A	CN10742037	2010	Unknown	Air	10AIRD	TBD
MS	Agilent Technologies	5975C	US73317788	2010	Unknown	Air	10AIRD	TBD
PreConcentrator	Entech Instruments, Inc.	7200	1278	2003	Unknown	Air	10AIRD	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1497	2003	Unknown	Air	10AIRD	TBD
Canister Autosampler	Entech Instruments, Inc.	7016 CA	1284	2009	Unknown	Air	10AIRD	TBD
MS	Agilent Technologies	5975C	US10407503	2009	Unknown	Air	10AIRE	TBD
GC	Agilent Technologies	7890A	CN10241030	2000	Unknown	Air	10AIRE	TBD
Thermal Desorber	Perkin Elmer	Turbomatrix 650	TD650L1009271	2000	Unknown	Air	10AIRE	TBD
Can Cleaning Rack	Pace	N/A	N/A	2010	Unknown	Air	Rack 1	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Can Cleaning Rack	Pace	N/A	N/A	2010	Unknown	Air	Rack 2	TBD
Can Cleaning Rack	Pace	N/A	N/A	Unknown	Unknown	Air	Rack 3	TBD
Refrigerator/Freezer	Keystone	KSTRC312AW	DK25BZ	Unknown	Unknown	Air	A4	TBD
Oven	Despatch	LDB Series	149432	Unknown	Unknown	Air	10AIR10	TBD
Tube Conditioner/ Dry Purger	Perkin Elmer	Turbomatrix TC220	820R4051501	Unknown	Unknown	Air	10AIR24	TBD
GC	Agilent Technologies	6890A	US00040933	Unknown	Unknown	Air	10AIRG	TBD
MSD	Agilent Technologies	5973	US10360131	Unknown	Unknown	Air	10AIRG	TBD
Thermal Desorber	Perkin Elmer	Turbomatrix 650	TD650L1210081	Unknown	Unknown	Air	10AIRG	TBD
GC	Agilent Technologies	7890A	CN10803059	2015	Used	Air	10AIRH	TBD
MS	Agilent Technologies	5975C	US80848612	Unknown	New	Air	10AIRH	TBD
Preconcentrator	Entech Instruments, Inc.	7200	1450	Unknown	New	Air	10AIRH	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1586	Unknown	New	Air	10AIRH	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1579	Unknown	New	Air	10AIRH	TBD
GC	Agilent	6890N	CN10514046	Unknown	New	Air	10AIRI	TBD
MS	Agilent	5973	US44621373	2018	New	Air	10AIRI	TBD
Preconcentrator	Entech Instruments, Inc.	7200	1623	2018	New	Air	10AIRI	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1660	2018	New	Air	10AIRI	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1661	2018	New	Air	10AIRI	TBD
Refrigerator	Beverage Air	KR48-1AS	5227060	7/1/2014	Unknown	Bloomington	Q325	TBD
GCMS	Waters/Micromass	Autospec	CN10705008	2018	New	HRMS	10MSHR14	TBD
Autosampler	Waters/Micromass	Autospec	CN21920651	2018	New	HRMS	10MSHR14	TBD
GCMS	Waters/Micromass	Autospec	M590	2018	New	HRMS	10MSHR14	TBD
Freezer	Kenmore	564.285027	80200474	Unknown	Unknown	HRMS	H2	TBD
Freezer	Dynasty	E-400-C	1206544	Unknown	Unknown	HRMS	H1	TBD
GCMS	Agilent	6890N	US10544001	2006	Unknown	HRMS	10MSHR09	TBD
GCMS	Waters/Micromass	Autospec Premier	P669	2006	Unknown	HRMS	10MSHR09	TBD
GCMS	Agilent	6890A	US00033386	2000	Unknown	HRMS	10MSHR06	TBD
GCMS	Waters/Micromass	Autospec Ultima	M496	2000	Unknown	HRMS	10MSHR06	TBD
GCMS	Waters/Micromass	Autospec Premier	P808	2015	New	HRMS	10MSHR12	TBD
Autosampler - Y	Waters/Micromass	Autospec P808	280399	Unknown	New	HRMS	10MSHR12	TBD
GCMS	Agilent	Autospec Premier	CN10471195	2015	New	HRMS	10MSHR12	TBD
GCMS	Agilent	Autospec Premier	CN11301038	2015	New	HRMS	10MSHR12	TBD
GCMS	Agilent	6890A	US00036565	2000	Unknown	HRMS	10MSHR05	TBD
GCMS	Waters/ Micromass	Autospec Ultima	M488	2000	Unknown	HRMS	10MSHR05	TBD
Autosampler F	Waters/ Micromass	Autospec	280398	Unknown	Unknown	HRMS	10MSHR05	TBD
LC-MS/MS	Sciex	4000	V23210806	2017	New	HRMS	10LCMS01	TBD
Autosampler	Agilent	1100	DE83103146	2018	New	HRMS	10LCMS01	TBD
LC-MS/MS	Sciex	4000	V1390304	2017	New	HRMS	10LCMS02	TBD
Autosampler	Agilent	1290	DE91604387	2018	New	HRMS	10LCMS02	TBD
Degassing Unit	SHIMADZU	DGU-20A5R	L20705569194 IX	2019	New	HRMS	10LCMS03	TBD
Liquid Chromatograph	SHIMADZU	Nexera X2 LC-30AD	L20555653493 US G	2019	New	HRMS	10LCMS03	TBD
Liquid Chromatograph	SHIMADZU	Nexera X2 LC-30AD	L20555653492 US G	2019	New	HRMS	10LCMS03	TBD
Autosampler	SHIMADZU	Nexera X2 SIL-30AC	L20565650974	2019	New	HRMS	10LCMS03	TBD
Reservoir Tray	SHIMADZU	Reservoir tray (Cat. No. 2258-45041-91)	L20305567270 SL	2019	New	HRMS	10LCMS03	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Liquid Chromatograph	SHIMADZU	LC-20AB	L20125650517 US D	2019	New	HRMS	10LCMS03	TBD
Communications Bus Module	SHIMADZU	CBM-20A	L20235657676 US E	2019	New	HRMS	10LCMS03	TBD
Column Oven	SHIMADZU	Nexera X2 CTO-30A	L20575550727 US	2019	New	HRMS	10LCMS03	TBD
LCMS	SCIEX	QTRAP 5500	EG250621812	2019	New	HRMS	10LCMS03	TBD
Degassing Unit	SHIMADZU	DGU-20A5R	L20705569193 IX	2019	New	HRMS	10LCMS04	TBD
Liquid Chromatograph	SHIMADZU	Nexera X2 LC-30AD	L20555653490 US G	2019	New	HRMS	10LCMS04	TBD
Autosampler	SHIMADZU	Nexera X2 SIL-30AC	L20565650975 US F	2019	New	HRMS	10LCMS04	TBD
Reservoir Tray	SHIMADZU	Reservoir tray (Cat. No. 2258-45041-91)	L20305567264 SL	2019	New	HRMS	10LCMS04	TBD
Liquid Chromatograph	SHIMADZU	LC-20AB	L20125650516 US C	2019	New	HRMS	10LCMS04	TBD
Communications Bus Module	SHIMADZU	CBM-20A	L20235657718 US F	2019	New	HRMS	10LCMS04	TBD
Column Oven	SHIMADZU	Nexera X2 CTO-30A	L20575550728 US	2019	New	HRMS	10LCMS04	TBD
LCMS	SCIEX	QTRAP 5500	EG250611812	2019	New	HRMS	10LCMS04	TBD
Liquid Chromatograph	SHIMADZU	Nexera X2 LC-30AD	L20555653491 US G	2019	New	HRMS	10LCMS04	TBD
Vortex	Fisher Scientific	cat #02215375	111220005	Unknown	Unknown	Dioxin Prep	10HR21	TBD
Freezer	Kenmore Elite	Freezer chest	W834049450	Unknown	Unknown	Dioxin Prep	DP2	TBD
Micro 100 Turbidimeter	Scientific Inc.	Micro 100 Turbidimeter	201309191	2005	Unknown	Dioxin Prep	10HR14	TBD
Microwave extraction	CEM	MarsXpress	M09903	2013	Unknown	Dioxin Prep	10HR13	TBD
Accelerated Solvent Extractor	ACE	200	1020363	Unknown	Unknown	Dioxin Prep	10HR12	TBD
N-EVAP	Organomation	8125	57966	2012	Unknown	Dioxin Prep	DW1	TBD
N-EVAP	Organomation	8125	57529	2012	Unknown	Dioxin Prep	DW2	TBD
N-EVAP	Organomation	8125	57964	2012	Unknown	Dioxin Prep	N-EVAP 4	TBD
N-EVAP	Organomation	8125	57410	2012	Unknown	Dioxin Prep	N-EVAP 5	TBD
N-EVAP	Organomation	8125	57527	2012	Unknown	Dioxin Prep	N-EVAP 6	TBD
N EVAP	Organomation	112	57528	Unknown	Unknown	Dioxin Prep	N-EVAP 7	TBD
Hypersep Vaccuum Manifold	Thermo Scientific	60104233	1632	2017	Unknown	Dioxin Prep	10HR17	TBD
Hypersep Vaccuum Manifold	Thermo Scientific	60104233	1552	2017	Unknown	Dioxin Prep	10HR16	TBD
Hypersep Vaccuum Manifold	Thermo Scientific	60104233	1713-1	2017	Unknown	Dioxin Prep	10HR15	TBD
Centrifuge	IEC - International Equipment Company	HNS II	235525200	2018	New	Dioxin Prep	10HR18	TBD
Ultrasonic Bath	Branson	3510	AAH067 (no serial number present)	2018	New	Dioxin Prep	10HR19	TBD
Orbital Shaker	VWR	DS500	416G	2018	New	Dioxin Prep	10HR20	TBD
Oven	Lindberg Blue	GO1340A-1	O06M-568117-RM	2012	Unknown	Dioxin Prep	DP4	TBD
Oven	Thermo	F6018 (Med Level)	15031960120316	Unknown	Unknown	Dioxin Prep	DP5	TBD
Oven	Thermo	F6018 (Low Level)	15032170120319	Unknown	Unknown	Dioxin Prep	DP6	TBD
Oven	Carbolite	LHT/120	21-400729	Unknown	Unknown	Dioxin Prep	DP7	TBD
freezer	SPT	UF-214W	AS0115A228W20498	2017	New	Dioxin Prep	DP6	TBD
Kiln	SKUTT Automatic Kiln	GM-1414	000489	Unknown	Unknown	Dioxin Prep	10HR22	TBD
Vortex	Fisher Scientific	cat #02215375	111220001	Unknown	Unknown	Dioxin Prep	10HR23	TBD
Centrifuge	IEC - International Equipment Company	CL Centrifuge	428-15985	Unknown	Unknown	Dioxin Prep	10HR24	TBD
Chiller	ThermoFisher Scientific	Thermoflex2500	0127680201150721	Unknown	Unknown	Dioxin Prep	10HR25	TBD

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Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Chiller	ThermoFisher Scientific	Thermoflex2500	0145040401120413	Unknown	Unknown	Dioxin Prep	10HR26	TBD
Chiller	ThermoFisher Scientific	Thermoflex2500	0145032201120413	Unknown	Unknown	Dioxin Prep	10HR27	TBD
Vortex	Fisher Brand	G-560	2-131226	Unknown	Unknown	Dioxin Prep	10HR28	TBD
Hypersep Vacuum Manifold	Thermo Scientific	60104233	1713-2	Unknown	Unknown	Dioxin Prep	10HR29	TBD
Capping Station	CEM	574100	XC2871	Unknown	Unknown	Dioxin Prep	10HR30	TBD
IL SPE Station	CPI International	N/A	N/A	Unknown	Unknown	Dioxin Prep	19562	TBD
Ultrasonic Bath	Branson	8510E-MT	EPA120597932F	Unknown	Unknown	Dioxin Prep	10HR31	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11819758	Unknown	Unknown	Dioxin Prep	10HR32	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11819751	Unknown	Unknown	Dioxin Prep	10HR33	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11334540	Unknown	Unknown	Dioxin Prep	10HR34	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11309113	Unknown	Unknown	Dioxin Prep	10HR35	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11706611	Unknown	Unknown	Dioxin Prep	10HR36	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11336607	Unknown	Unknown	Dioxin Prep	10HR37	TBD
Temperature Regulators	Thermolyne	CN45515	455000964338	Unknown	Unknown	Dioxin Prep	10HR38	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11327046	Unknown	Unknown	Dioxin Prep	10HR39	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11705717	Unknown	Unknown	Dioxin Prep	10HR40	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11309114	Unknown	Unknown	Dioxin Prep	10HR41	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11705712	Unknown	Unknown	Dioxin Prep	10HR42	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11331266	Unknown	Unknown	Dioxin Prep	10HR43	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11705714	Unknown	Unknown	Dioxin Prep	10HR44	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11312697	Unknown	Unknown	Dioxin Prep	10HR45	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11327705	Unknown	Unknown	Dioxin Prep	10HR46	TBD
PowrTrol Temperature Regulators	Glas-Col	104A PL120	11312700	Unknown	Unknown	Dioxin Prep	10HR47	TBD
Chiller	ThermoFisher Scientific	ThermoFlex900	0110204001120820	Unknown	Unknown	Dioxin Prep	10HR48	TBD
Refrigerator	Homelabs	HME030210N	HME030210N-2163	Unknown	Unknown	Dioxin Prep	10HR49	TBD
Refrigerator	Homelabs	HME030210N	HME030210N-865	Unknown	Unknown	Dioxin Prep	10HR50	TBD
Low speed Centrifuge	Premiere	XC-2450	C&AU070144	Unknown	Unknown	Dioxin Prep	10HR51	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
SPE manifold	Thermo Scientific	60104233	1848	2019	New	Dioxin Prep	10HR52	TBD
SPE manifold	Thermo Scientific	60104233	1833	2019	New	Dioxin Prep	10HR53	TBD
Ultrasonic bath	Fisher Scientific	FS30H	RTB011069292A	2019	Used	Dioxin Prep	10HR54	TBD
NEVAP	Organomation	112	8213	2019	Used	Dioxin Prep	NEVAP 8	TBD
Hypersep Vacuum Manifold	Thermo Scientific	60104233	1848-1	2019	New	Dioxin Prep	10HR55	TBD
Kiln	SKUTT Automatic Kiln	GM-1414	19G23-584	2019	New	Dioxin Prep	10HR56	TBD
SPE manifold	Thermo Scientific	60104233	1909	2019	New	Dioxin Prep	10HR57	TBD
SPE manifold	Thermo Scientific	60104233	1909	2019	New	Dioxin Prep	10HR58	TBD
Centrifuge	Damon/IEC Division	HN-SII	235511220	2019	New	Dioxin Prep	10HR59	TBD
Orbital Shaker	Lab-Line Instruments, Inc	3520	0185 0416	2019	New	Dioxin Prep	10HR60	TBD
ICPMS	Thermo Scientific	Xseries 2	SN-01298-C	2008	Unknown	Metals	10ICM3	TBD
ICPMS - autosampler	Teledyne Cetac	ASX560	071778A560	Unknown	Unknown	Metals	10ICM3	TBD
ICPMS - chiller	Thermo	NESLAB Thermoflex2500	110140001120717	Unknown	Unknown	Metals	10ICM3	TBD
ICPMS - pump	SOGEVAC pump	SV40BIFC960365V2 016	31001424325	Unknown	Unknown	Metals	10ICM3	TBD
ICPMS	Agilent 7700	G3281A	5P13142395	6/1/2013	Unknown	Metals	10ICM8	TBD
ICPMS - autosampler	Teledyne Cetac	ASX520	US011191A520	Unknown	Unknown	Metals	10ICM8	TBD
ICPMS - chiller	Agilent	G3292-80000	2U1551028	Unknown	Unknown	Metals	10ICM8	TBD
ICPMS - pump	Edwards	G31989	129449393	Unknown	Unknown	Metals	10ICM8	TBD
ICPMS	Agilent 7700	G3281A	JP12412084	Unknown	Unknown	Metals	10ICM9	TBD
ICPMS - autosampler	Teledyne Cetac	ASX520	US0312120AS520	Unknown	Unknown	Metals	10ICM9	TBD
ICPMS - chiller	Agilent	6160T21QR301	3U1621341	Unknown	Unknown	Metals	10ICM9	TBD
ICPMS - pump	Edwards	16436540	169436540	Unknown	Unknown	Metals	10ICM9	TBD
ICPMS	Agilent ICPM	7800	JP16120262	7/1/2005	New	Metals	10ICMB	TBD
ICP	Agilent Technologies	700 Series-ICP-OES	MY14160002	Unknown	New	Metals	10ICP4	TBD
ICP - autosampler	Teledyne Cetac	ASX520	12140A520	Unknown	New	Metals	10ICP4	TBD
ICP - chiller	Agilent	G8481-80003	1B13C1081	Unknown	New	Metals	10ICP4	TBD
ICP	Agilent Technologies	5100 -ICP-OES	MY15180003	2015	New	Metals	10ICP5	TBD
ICP - autosampler	Agilent	SPS4	AU15140009	Unknown	New	Metals	10ICP5	TBD
ICP - chiller	Agilent	G8481-80003	1A1550426	Unknown	New	Metals	10ICP5	TBD
Mercury Analyzer	Cetac	M7600	06201Q76	2012	Unknown	Metals	10HG4	TBD
Mercury Autosampler	Cetac	AX-520	061289A520	2010	Unknown	Metals	10HG4	TBD
Mercury Analyzer	Cetac	M7600	US15254007	2012	New	Metals	10HG08	TBD
Mercury Autosampler	Cetac	ASX-520	0315134A520	2010	New	Metals	10HG08	TBD
Mercury Analyzer	Teledyne Leeman Labs	M-7600	US18309003	2019	New	Metals	10HG09	TBD
Mercury Autosampler	Teledyne Cetac Technologies	ASX-560	0219146A560	2019	New	Metals	10HG09	TBD
Hot Block	Environmental Express	SC154	6266CECW2910	2006	Unknown	Metals	10MET02	TBD
Hot Block	Environmental Express	N/A	6083CECW2815	2006	Unknown	Metals	10MET04	TBD
Hot Block	Environmental Express	N/A	8031CECW3358	2012	Unknown	Metals	10MET08	TBD
Hot Block	Environmental Express	N/A	8031CECW3346	2012	Unknown	Metals	10MET10	TBD
Hot Block	Environmental Express	SC154	5388CEC2469	2013	Unknown	Metals	10MET22	TBD
Hot Block	Environmental Express	SC154	8708CECW3720	2013	Unknown	Metals	10MET23	TBD
Hot Block	Environmental Express	SC154	8793CECW3764	Unknown	Unknown	Metals	10MET26	TBD
Hot Block	Environmental Express	N/A	8031CECW3342	2012	Unknown	Metals	10MET09	TBD
Hot Plate	Cole Parmer	N/A	N/A	Unknown	Unknown	Metals	10MP02	TBD

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Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Hot Plate	Cole Parmer	N/A	N/A	Unknown	Unknown	Metals	10MP03	TBD
TCLP agitator/tumbler	Analytical Testing Corp	DC-20	0685RKME0010	6/19/2008	Unknown	Metals	10MET34	TBD
Hot Plate/hot block	Thermolyne	HP47135	1073970926967	1/1/2015	Unknown	Metals	10MET35	TBD
pH meter	Scientific Instruments	IQ180GLP	10240	1/1/2015	Unknown	Metals	10MP05	TBD
pH meter	Orion Research	Expandable Ion Analyzer EA 940	1343	Unknown	Unknown	Metals	10MP06	TBD
Tumbler	Analytical Testing Corp	42R5BFC1-E3	0685SAMH002	4/1/2015	Unknown	Metals	10MET36	TBD
Tumbler	Analytical Testing Corp	42R5BFC1-E3	0685SGMP0002	Unknown	Unknown	Metals	10MET38	TBD
Fridge	Danby Designer	DBC120BLS	4316063619504	2016	New	Metals	MP1	TBD
Tumbler	Analytical Testing Corp	42R5BFC1-E3	0685SGMQ0006	Unknown	Unknown	Metals	10MET39	TBD
pH meter	Oakton	pH700	2404439	Unknown	Unknown	Metals	10MP07	TBD
Temperature probe	Oakton	35613-13 (Lot code: 298)	93X052911	Unknown	Unknown	Metals	10MP07	TBD
Oven/Desiccator	Fisher Isotemp	725F	903N0075	Unknown	Unknown	Metals	10MET40	TBD
Oven - moved 07.07.15	Fisher Scientific	Isotemp Oven	510N0239	2005	Unknown	Metals	10WET20	TBD
Oven	Fisher Scientific	851F	1589080190130	Unknown	Unknown	Metals	10WET49	TBD
Stir plate	Fisher Scientific	S88857200	C272000401175991	Unknown	Unknown	Metals	10MET44	TBD
Oven/Desiccator	Fisher Isotemp	725F	903N0078	Unknown	Unknown	Metals	10MET41	TBD
Centrifuge	ThermoScientfic	Legend XT	42243876	2018	New	Metals	10MET45	TBD
Turbidity Meter	HACH	TU5200	1808718	2018	Used	Metals	10WT46 (10MET46)	TBD
Oven	Quincy Labs	10GC	G1-015608	2019	New	Metals	10MET47	TBD
ICPMS	Agilent 7900 ICP-MS	G8403A	SG19304531	2019	New	Metals	10ICMC	TBD
ICPMS - chiller	Agilent	G3292-80200	1908-01399	2019	New	Metals	10ICMC	TBD
ICPMS - pump	Agilent	9599225M013	1f19325139	2019	New	Metals	10ICMC	TBD
ICPMS - autosampler	Agilent	G8410A	AU19156705	2019	New	Metals	10ICMC	TBD
UltraSonicator	Branson	8510	RPC10096911F	2010	Unknown	O-Prep	10OP17	TBD
Sonicator	Misonix	XL 2020	G3914	2007	Unknown	O-Prep	10OP01	TBD
Sonicator	Misonix	XL 2015	G4180	2007	Unknown	O-Prep	10OP02	TBD
Sonicator	Misonix	Sonicator 3000	R1638	2007	Unknown	O-Prep	10OP04	TBD
N-EVAP	Organomation	112	8169	Unknown	Unknown	O-Prep	10OP10	TBD
N-EVAP	Organomation	112	7537	Unknown	Unknown	O-Prep	10OP11	TBD
Refrigerator	Traulsen	G20010	T34931C10	Unknown	Unknown	O-Prep	OP1	TBD
Centrifuge	IEC	Centra GP8	31210390	Unknown	Unknown	O-Prep	10OP13	TBD
Centrifuge	Damon/IEC Division	N/A	9304	Unknown	Unknown	O-Prep	10OP14	TBD
Centrifuge	International Clinical Centrifuge	CL28899M	28899M	Unknown	Unknown	O-Prep	10OP15	TBD
Muffle Furnace	Lindberg/Blue M	BF51828C-1	505296	Unknown	Unknown	O-Prep	10OP16	TBD
N-EVAP	Organomation	112	4185	2014	Unknown	O-Prep	10OP18	TBD
Buchi Concentrator-vacuum controller	Buchi Labortenchik Ag	V-855	10000162387	2014	Unknown	O-Prep	10OP21	TBD
Buchi Concentrator-vacuum pump	Buchi Labortenchik Ag	V-700	1000166230	2014	Unknown	O-Prep	10OP21	TBD
Buchi Concentrator-Recirculating Chiller	Buchi Labortenchik Ag	F-108	1019513	2014	Unknown	O-Prep	10OP21	TBD
Buchi Concentrator System	Buchi Labortenchik Ag	Q101	1000167481	2014	Unknown	O-Prep	10OP21	TBD
Microwave extraction	CEM	MarsXpress 230/60	MD3483	7/1/2014	Unknown	O-Prep	10OP19	TBD
Sonicator	Bransonic	B8200R-3	Not readable	Unknown	Unknown	O-Prep	10OP23	TBD
Sonicator	Heat Systems	XL2020	G1879	Unknown	Unknown	O-Prep	10OP22	TBD
Buchi Concentrator-vacuum controller	Buchi Labortenchik Ag	V-855	1000171188	2014	Unknown	O-Prep	10OP24	TBD
Buchi Concentrator-vacuum pump	Buchi Labortenchik Ag	V-700	1000176128	2014	Unknown	O-Prep	10OP24	TBD

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Buchi Concentrator-Recirculating Chiller	Buchi Labortenchik Ag	F-108	1000174259	2014	Unknown	O-Prep	10OP24	TBD
Buchi Concentrator System	Buchi Labortenchik Ag	Q101	1000176659	2014	Unknown	O-Prep	10OP24	TBD
Buchi Concentrator-vacuum controller	Buchi Labortenchik Ag	V-855	1000174543	2014	Unknown	O-Prep	10OP25	TBD
Buchi Concentrator-vacuum pump	Buchi Labortenchik Ag	V-700	1000176882	2014	Unknown	O-Prep	10OP25	TBD
Buchi Concentrator-Recirculating Chiller	Buchi Labortenchik Ag	F 108	1000172490	2014	Unknown	O Prep	10OP25	TBD
Buchi Concentrator System	Buchi Labortenchik Ag	Q101	1000176601	2014	Unknown	O-Prep	10OP25	TBD
Buchi Concentrator-vacuum controller	Buchi Labortenchik Ag	V-855	1000171253	2014	Unknown	O-Prep	10OP26	TBD
Buchi Concentrator-vacuum pump	Buchi Labortenchik Ag	V-700	1000174270	2014	Unknown	O-Prep	10OP26	TBD
Buchi Concentrator-Recirculating Chiller	Buchi Labortenchik Ag	F-108	1000174257	2014	Unknown	O-Prep	10OP26	TBD
Buchi Concentrator System	Buchi Labortenchik Ag	Q101	1000176658	2014	Unknown	O-Prep	10OP26	TBD
Refrigerator/freezer	Whirlpool	WH43S1E	T127161605028	Unknown	New	O-Prep	OP4	TBD
Refrigerator	Crown-Tonka Walk-Ins	Walk-in	63278-01	Unknown	Unknown	SR	C10	TBD
Refrigerator	Crown	Walk-in	N/A	Unknown	Unknown	SR	C1	TBD
Freezer	Frigidaire	FFU21F5HWK	WB12555570	Unknown	Unknown	SR	C3	TBD
Refrigerator	Beverage Air	KR48-1AS	KR48-1AS 9029136	9/1/2011	Unknown	SR	C17	TBD
Refrigerator	U.S. Cooler	Walk-in/FCL3476GL1	30692	6/1/2013	Unknown	SR	C18	TBD
Refrigerator	Carroll Coolers LLC	Walk-in	34365	9/24/2013	Unknown	SR	C16	TBD
Refrigerator	TRUE	GDM-47-HC-LD	9199842	2011	Unknown	SR	C22	TBD
Freezer	ATOSA	MBF8003	MBF8003079160617 00C40007	Unknown	Unknown	SR	C23	TBD
Freezer	Kenmore	22042410	WB65148072	2018	New	SR	C21	TBD
Refrigerator	Volition	R49-S	R49S-18010046	12/28/2019	New	SR	C24	TBD
Freezer	ATOSA	MBF8003	MBF8003AUS10031 7041900C40004	2018	New	SR	C25	TBD
Freezer	Artic Air	AF49EZ	H8148251	2018	New	SR	C26	TBD
Freezer	Whirlpool	Freezer chest	EWR223703	2018	New	SR	DP5	TBD
Refrigerator	Premium	PRF90DX	M8828208666000016 7	Unknown	Unknown	SR	C27	TBD
GC System	Agilent	7890A	CN10021030	2010	New	SVOA	10MSSA	TBD
Autosampler Tower	Agilent/HP	7693 Series	CN95203168	2010	New	SVOA	10MSSA	TBD
Autosampler Tray	Agilent/HP	7693 Series	CN10020004	2010	New	SVOA	10MSSA	TBD
MS Detector	Agilent/HP	5975C	US10030005	2010	New	SVOA	10MSSA	TBD
AutoSampler Tower	Agilent	7863B	CN75045773	2010	New	SVOA	10MSSB	TBD
GC/Oven	Agilent	7890	CN10842006	2010	New	SVOA	10MSSB	TBD
MS Detector	Agilent	5975C	US73317796	2010	New	SVOA	10MSSB	TBD
AutoSampler Tray	Agilent	7683	CN54237163	2010	New	SVOA	10MSSB	TBD
GC	Agilent	6890N	CN10550045	2011	Used	SVOA	10MSSD	TBD
MS	Agilent	5975	US53931370	2011	Used	SVOA	10MSSD	TBD
Autosampler	Agilent	G2614 A	CN54337193	2011	Used	SVOA	10MSSD	TBD
Tower 7683B	Agilent	62915A	CN52425737	2011	Used	SVOA	10MSSD	TBD
GC	Agilent	6890N	US10245155	2001	Unknown	SVOA	10MSS6	TBD
Autosampler Tower	Agilent/HP	7683	US82901662	2001	Unknown	SVOA	10MSS6	TBD
MS	Agilent/HP	5973N	US21854348	2001	Unknown	SVOA	10MSS6	TBD
Autosampler Tray	Agilent/HP	7683	US81100461	2001	Unknown	SVOA	10MSS6	TBD
GC	Agilent	6890N	CN10319023	2006	Unknown	SVOA	10MSS7	TBD
Tower 7683	Agilent	62613A	CN24728345	2006	Unknown	SVOA	10MSS7	TBD
Turret 7683	Hewlet Packard	62614A	US90403281	2006	Unknown	SVOA	10MSS7	TBD
Mass Spec 5973	Agilent	62579A	US21864477	2006	Unknown	SVOA	10MSS7	TBD
AutoSampler Tower	Agilent/HP	7683	US10417469	2008	Unknown	SVOA	10MSS8	TBD
GC/Oven	Agilent	6890 N	US10123035	2008	Unknown	SVOA	10MSS8	TBD

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MS Detector	Agilent	5973 N	US10440794	2008	Unknown	SVOA	10MSS8	TBD
AutoSampler Tray	Agilent/HP	7683	CN53536362	2008	Unknown	SVOA	10MSS8	TBD
GC/Oven	Agilent	6890 A	US00033558	1999	Unknown	SVOA	10MSS9	TBD
AutoSampler Tower	Agilent	18593B	3545A44770	1999	Unknown	SVOA	10MSS9	TBD
MS Detector	Agilent	5973 N	US90440006	1999	Unknown	SVOA	10MSS9	TBD
AutoSampler Tray	Agilent	18596C	US11207088	1999	Unknown	SVOA	10MSS9	TBD
AutoSampler Tray	Agilent	18596M	3643A43317	7/1/2014	Used	SVOA	10MSSE	TBD
Injector Tower	Agilent	G1513A	US10512270	7/1/2014	Used	SVOA	10MSSE	TBD
GC/Oven	Agilent	G1530A	US00006288	7/1/2014	Used	SVOA	10MSSE	TBD
MS Detector	Agilent	G1098A	US63810194	7/1/2014	Used	SVOA	10MSSE	TBD
Autosampler Tray	Agilent	7683B Series	CN91252935	7/1/2014	Used	SVOA	10MSSF	TBD
Injector Tower	Agilent	7683	CN54128250	7/1/2014	Used	SVOA	10MSSF	TBD
MS Detector	Agilent	5975C	US91732455	7/1/2014	Used	SVOA	10MSSF	TBD
GC	Agilent	7890A	CN10920003	7/1/2014	Used	SVOA	10MSSF	TBD
GC	Agilent	G1530A	US00025032	7/1/2014	Used	SVOA	10MSSG	TBD
MS	Agilent	G1098A	US82311330	7/1/2014	Used	SVOA	10MSSG	TBD
Autosampler Tray	HP	G2614A	US90403281	7/1/2014	Used	SVOA	10MSSG	TBD
Injector Tower	HP	G2613A	US95310976	7/1/2014	Used	SVOA	10MSSG	TBD
MS	HP	5977B	US1703R003	2000	Unknown	SVOA	10MSSH	TBD
GC	HP	7890B	CN17013216	2000	Unknown	SVOA	10MSSH	TBD
Autosampler Tray	Agilent/HP	7693	CN16480039	2000	Unknown	SVOA	10MSSH	TBD
Injector Tower	Agilent/HP	G4513A	CN95203168	2000	Unknown	SVOA	10MSSH	TBD
GC	Agilent	6890N	CN10549055	2011	Unknown	SVOA	10GCSA	TBD
Autosampler Tray	Agilent	G2614A	CN54237066	2011	Unknown	SVOA	10GCSA	TBD
Tower	Agilent	G2613A	CN54929639	Unknown	Unknown	SVOA	10GCSA	TBD
ECD 1	Agilent	G2397A	U8977	Unknown	Unknown	SVOA	10GCSA	TBD
ECD 2	Agilent	G2397A	U8978	Unknown	Unknown	SVOA	10GCSA	TBD
GC	Agilent	7890A	CN11201069	2011	Unknown	SVOA	10GCSB	TBD
Autosampler Tray	Agilent	64514A	CN11130097	2011	Unknown	SVOA	10GCSB	TBD
Tower	Agilent	64513A	CN91200383	2011	Unknown	SVOA	10GCSB	TBD
ECD 1	Agilent	G2397A	U19081	Unknown	Unknown	SVOA	10GCSB	TBD
ECD 2	Agilent	G2397A	U19082	Unknown	Unknown	SVOA	10GCSB	TBD
GC Oven	HP	5890	2750A16953	1990	Unknown	SVOA	10GCS4	TBD
AutoSampler /Tower	HP	7673A	2704A09552	1990	Unknown	SVOA	10GCS4	TBD
AutoSampler Tray	HP	7673A	2718A06429	1990	Unknown	SVOA	10GCS4	TBD
GC	Agilent	6890 N	US10126008	2004	Unknown	SVOA	10GCS7	TBD
AutoSampler Tray	Agilent/HP	G2614A	US13612659	2004	Unknown	SVOA	10GCS7	TBD
Tower	Agilent/HP	G2613A	US93809196	2004	Unknown	SVOA	10GCS7	TBD
ECD 1	Agilent	G2397A	U10055	Unknown	Unknown	SVOA	10GCS7	TBD
ECD 2	Agilent	G2397A	U2932	Unknown	Unknown	SVOA	10GCS7	TBD
GC	Agilent	7890A	CN10915106	2009	Unknown	SVOA	10GCS9	TBD
Tower	Agilent	64513A	CN10020012	2009	Unknown	SVOA	10GCS9	TBD
Autosampler Tray	Agilent	64514A	CN91100084	2009	Unknown	SVOA	10GCS9	TBD
GC	Agilent	7890B	CN18203068	2018	Unknown	SVOA	10GSLF	TBD
Autosampler	Agilent	G4514A	CN18140044	2018	Unknown	SVOA	10GSLF	TBD
AutoInjector - Front	Agilent	G4513A	CN18160191	2018	Unknown	SVOA	10GSLF	TBD
GC	Agilent	7890B	CN18203068	2018	Unknown	SVOA	10GSLR	TBD
Autosampler	Agilent	G4514A	CN18140044	2018	Unknown	SVOA	10GSLR	TBD
AutoInjector - Rear	Agilent	G4513A	CN18160194	2018	Unknown	SVOA	10GCSR	TBD
Freezer	Frigidaire	FFTR1814LW7	BA14703423	3/16/2012	Unknown	SVOA	SV3	TBD
Refrigerator	Frigidaire	FFTR1814LW7	BA14703423	3/16/2012	Unknown	SVOA	SV3	TBD
Freezer	Haier	HUM013EA	BB01H1E0100BHD 7S0358	Unknown	Unknown	SVOA	SV4	TBD
GC	Agilent	7890A	CN10848062	7/1/2014	Unknown	SVOA	10GCSFF	TBD
Autoinjector - Front	Agilent	G2913	CN44659505	7/1/2014	Unknown	SVOA	10GCSFF	TBD
Autosampler	Agilent	G2614A	CN00654640	7/1/2014	Unknown	SVOA	10GCSFF	TBD
GC	Agilent	7890A	CN10848062	7/1/2014	Unknown	SVOA	10GSFR	TBD
Autoinjector-Back	Agilent	G2913A	CN91756454	7/1/2014	Unknown	SVOA	10GSFR	TBD
Autosampler	Agilent	G2614A	CN00654640	7/1/2014	Unknown	SVOA	10GSFR	TBD
GC	Agilent	6890A	US00035764	Unknown	Unknown	SVOA	10GCSG	TBD
Autosampler Tray	Agilent	G2614A	CN43530410	Unknown	Unknown	SVOA	10GCSG	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Tower	Agilent	G2613A	US11818906	Unknown	Unknown	SVOA	10GCSG	TBD
ECD 1	Agilent	G2397A	U26804	Unknown	Unknown	SVOA	10GCSG	TBD
ECD 2	Agilent	G2397A	U26805	Unknown	Unknown	SVOA	10GCSG	TBD
Agilent	Agilent	6890A	US10238103	Unknown	Unknown	SVOA	10GCSH	TBD
GC	Agilent	7890A	CN11141025	6/1/2017	Used	SVOA	10GCSI	TBD
Autosampler Tray	Agilent	G2614A	CN84951713	6/1/2017	Used	SVOA	10GCSI	TBD
Tower	Agilent	G2613A	CN85154856	6/1/2017	Used	SVOA	10GCSI	TBD
ECD 1	Agilent	G2397A	U128247	6/1/2017	Used	SVOA	10GCSI	TBD
ECD 2	Agilent	G2397A	U30564	6/1/2017	Used	SVOA	10GCSI	TBD
GC	Agilent	7890A	CN10906059	6/1/2017	Used	SVOA	10GCSJ	TBD
Autosampler	Agilent	G2614A	CN85252214	6/1/2017	Used	SVOA	10GCSJ	TBD
Tower	Agilent	G2313A	CN85154864	6/1/2017	Used	SVOA	10GCSJ	TBD
ECD 1	Agilent	G2397A	U27008	6/1/2017	Used	SVOA	10GCSJ	TBD
ECD 2	Agilent	G2397A	U30558	6/1/2017	Used	SVOA	10GCSJ	TBD
GC	Agilent	7890A	CN10906049	6/1/2017	Used	SVOA	10GCSK	TBD
Autosampler Tray	Agilent	G4514A	CN11080020	6/1/2017	Used	SVOA	10GCSK	TBD
Tower	Agilent	G4513A	CN16480250	6/1/2017	Used	SVOA	10GCSK	TBD
ECD 1	Agilent	G2397A	U27007	6/1/2017	Used	SVOA	10GCSK	TBD
ECD 2	Agilent	G2397A	U16942	6/1/2017	Used	SVOA	10GCSK	TBD
AutoSampler	Environmental Sample Tech, Inc.	N/A	13719	1999	Unknown	VOA	10MSV1	TBD
Concentrator	Tekmar	3000	93081004	1999	Unknown	VOA	10MSV1	TBD
GC	HP	6890	US00005556	1999	Unknown	VOA	10MSV1	TBD
MS	HP	5973	US63810130	1999	Unknown	VOA	10MSV1	TBD
AutoSampler	EST Analytical	Centurion	cents211121510	2000	Unknown	VOA	10MSV5	TBD
Concentrator	Encon Evolution	N/A	EV331120210	2000	Unknown	VOA	10MSV5	TBD
GC	HP	6890	DE00020316	2000	Unknown	VOA	10MSV5	TBD
MS	HP MS	5973	US81221500	2000	Unknown	VOA	10MSV5	TBD
Concentrator	Tekmar	3000	173001	2006	Unknown	VOA	10MSV6	TBD
AutoSampler	Varian Archon	N/A	13352	2006	Unknown	VOA	10MSV6/10 MSV9	TBD
GC	Agilent	6890A	US00036184	2006	Unknown	VOA	10MSV6/10 MSV9	TBD
MS	Agilent	5973	US01140180	2006	Unknown	VOA	10MSV6/10 MSV9	TBD
AutoSampler	Environmental Sample Tech, Inc.	N/A	cents207121110	2008	Unknown	VOA	10MSV7	TBD
GC	Agilent Technologies	6850	CN107520005	2008	Unknown	VOA	10MSV7	TBD
Concentrator	Tekmar	3000	(94251012) US02060004	2008	Unknown	VOA	10MSV7	TBD
MS	Agilent Technologies	5975C	US74818132	2008	Unknown	VOA	10MSV7	TBD
GC	5975C	5975C	(CN10742012) US73337433	2011	Unknown	VOA	10MSV8	TBD
AutoSampler	EST Analytical	Centurion	cents205112310	2011	Unknown	VOA	10MSV8	TBD
Concentrator	Encon Evolution	N/A	EV333120210	2011	Unknown	VOA	10MSV8	TBD
MS	Agilent	5975C	US73337433	2011	Unknown	VOA	10MSV8	TBD
Concentrator	Tekmar	14-3100-OEL	1064004	2012	Unknown	VOA	10MSV9	TBD
GC	Agilent	6890	US10215113	2013	Unknown	VOA	10MSVA	TBD
MS	Agilent	5973	US10442746	2013	Unknown	VOA	10MSVA	TBD
autosampler/concentrator	Tekmar	Atomx 15-0000-100	US11203002	2013	Unknown	VOA	10MSVA	TBD
GC	HP	6890	US40620426	Unknown	Unknown	VOA	10MSVE	TBD
Concentrator	Teledyne Tekmar	14-9800-100	CN10427049	Unknown	Unknown	VOA	10MSVE	TBD
AutoSampler	Teledyne Tekmar	15-0500-000	US12058001	Unknown	Unknown	VOA	10MSVE	TBD
MS	HP	5973	US40620426	Unknown	Unknown	VOA	10MSVE	TBD
GC	Agilent	7890B	CN16433144	2017	New	VOA	10MSVF	TBD
AutoSampler	EST Analytical	Centurion	CENTS205112310	2000	New	VOA	10MSVF	TBD
Concentrator	EST Analytical	Encon Evolution	EV332120210	2000	New	VOA	10MSVF	TBD
MS	Agilent	5977B	US1701R009	2017	New	VOA	10MSVF	TBD
GC	Agilent	7890B	CN18043128	2018	New	VOA	10MSVG	TBD

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Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
MS	Agilent	5977B	US1816R028	2018	New	VOA	10MSVG	TBD
Auto-sampler	EST	CenturionW	CENTW646061218	2018	New	VOA	10MSVG	TBD
Concentrator	EST	Encon EV	EV974061218	2018	New	VOA	10MSVG	TBD
AutoSampler	EST Analytical	Centurion	cent132042304	1990	Unknown	VOA	10GCV3	TBD
Concentrator	Tekmar Dohrmann	3000	94189002	1990	Unknown	VOA	10GCV3	TBD
GC	HP	5890 Series II	3133A37290	1990	Unknown	VOA	10GCV3	TBD
AutoSampler	Environmental Sample Tech, Inc.	N/A	13713	1990	Unknown	VOA	10GCV5	TBD
Concentrator	Tekmar	3100	99343009	1990	Unknown	VOA	10GCV5	TBD
GC	HP	G1530A	US00020223	2012	Unknown	VOA	10GCV5	TBD
AutoSampler	EST Analytical	Archon 8100	13719	2012	Unknown	VOA	10GCV6	TBD
Concentrator	Tekmar	14-3100-EOL	US020600004	2012	Unknown	VOA	10GCV6	TBD
GC	Agilent/HP	HP 6890	US00042909	6/1/2013	Unknown	VOA	10GCV6	TBD
AutoSampler	EST Analytical	Centurion	CENT244112907	7/1/2014	Unknown	VOA	10GCV9	TBD
Concentrator	EST Analytical	Encon	580013108P	7/1/2014	Unknown	VOA	10GCV9	TBD
GC	Agilent Technologies	7890A	CN12071022	Unknown	Unknown	VOA	10GCV9	TBD
GC	Agilent Technologies	G1530A	US00002531	2005	Used	VOA	10AIR9--renamed to 10GCVA	TBD
Headspace Sampler	Agilent Technologies	G1888	IT00507022	2005	Used	VOA	10AIR9--renamed to 10GCVA	TBD
Oven	Thermo Scientific	N/A	6520-6528	Unknown	Unknown	VOA	10VOA03	TBD
Refrigerator	Crown	Walk-in	N/A	Unknown	Unknown	VOA	C2	TBD
Refrigerator	Beverage Air	KR74-1AS	6331221	Unknown	Unknown	VOA	C7	TBD
Sonicator	Fisher Scientific	FS220	RWA040963796A	Unknown	Unknown	VOA	10VOA04	TBD
Freezer	Frigidaire	LFFH21F7HWG	WB94954367	2013	Unknown	VOA	V5	TBD
Refrigerator	Norlake Scientific	NSLF482WAW/1	96020404	Unknown	Unknown	VOA	V6	TBD
Oven	Lindberg/Blue M	MO1450PSA-1	U19R-507936-UR	Unknown	Unknown	VOA	10WT56	TBD
Refrigerator/Freezer	Frigidaire	FRT8G7HW0	BA72845548	Unknown	Unknown	VOA	V8	TBD
Refrigerator	Amana	ABB2221WEB1	K13809596	7/1/2014	Used	VOA	V7	TBD
Incubator	Fisher Scientific	Isotemp Incubator	115770704-57744	2006	Unknown	Wet Chem	10WET16	TBD
Incubator	Fisher Scientific	307	30100031/WB24501232	1996	Unknown	Wet Chem	10WET22	TBD
Incubator	Fisher Scientific	307C	2018090423462	2009	Unknown	Wet Chem	10WET35	TBD
Incubator	Thermo Forma	3940	300789-1711	2012	Unknown	Wet Chem	10WET60	TBD
Autotitrator	Metrohm	888 Titrando Titrator	1888001004148	2010	Unknown	Wet Chem	10WET6	TBD
Autosampler	Metrohm	778 Sample Processor	1778001003123	2010	Unknown	Wet Chem	10WET6	TBD
probe	Metrohm	778 Sample Processor	263664	2010	Unknown	Wet Chem	10WET6	TBD
AutoClave	Harvey	N/A	12770804/02244	2009	Unknown	Wet Chem	10WET29	TBD
Thermoreactor	Neutec Group Inc.	ECO 25	89543	Unknown	Unknown	Wet Chem	10WET26	TBD
COD Reactor	Bioscience, Inc.	N/A	COD-B0140	1996	Unknown	Wet Chem	10WET11	TBD
Conductivity meter	Oaktom	Con 110 Series	206454	2000	Unknown	Wet Chem	10WET9	TBD
Conductivity meter - probe	Oaktom	Con 110 Series	204/02	2000	Unknown	Wet Chem	10WET9	TBD
Colony Counter	Gallenkamp	Colony Counter	N/A	2004	Unknown	Wet Chem	10WET30	TBD
Colony Counter	Darkfield Quebec	Colony Counter	N/A	Unknown	Unknown	Wet Chem	10WET38	TBD
Water Bath	Fisher Scientific	Isotemp 210	1605680347017	Unknown	Unknown	Wet Chem	10WET27	TBD
Refrigerator	Carroll Coolers LLC	Walk-in	6584	Unknown	Unknown	Wet Chem	C11	TBD
Refrigerator	Sanyo	SR-952	10200716	Unknown	Unknown	Wet Chem	WC3	TBD
Spectrometer	Hach	DR 3900	1811411	Unknown	Unknown	Wet Chem	10WETF	TBD
Hot Plate	Presto	Tilt'n Drain Big Griddle	2608US	2009	Unknown	Wet Chem	10WET34	TBD
Smart Chem Discrete Analyzer	West Co Scientific Instruments	Smart Chem 200	W0902154	2009	Unknown	Wet Chem	10WT36	TBD
Hot Plate	Corning	N/A	440895	Unknown	Unknown	Wet Chem	10WET40	TBD
Stir Plate	Fisher Scientific	N/A	1889080719259	Unknown	Unknown	Wet Chem	10WET41	TBD
Stir Plate	Barnstead/Thermolyne	S46725/Cimarec 2	776940355770	Unknown	Unknown	Wet Chem	10WET42	TBD

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Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Refrigerator	Summit Commercial	SCR485L	A091200156	Unknown	Unknown	Wet Chem	WC2	TBD
BOD meter	Hach	HQ40d	80900024869	2011	Unknown	Wet Chem	10WT54	TBD
BOD/pH probe	Hach	LBOD10101	123213032021	2011	Unknown	Wet Chem	10WT54	TBD
pH probe	HACH	PHC108	191282867899	Unknown	Unknown	Wet Chem	10WT54	TBD
pH/BOD meter/Fluoride	Hach	HQ40d	110300052350	2011	Unknown	Wet Chem	10WT53	TBD
pH/BOD meter/Fluoride - probe	Hach	HQ40d	152392938004	2011	Unknown	Wet Chem	10WT53	TBD
Hot Block	Environmental Express	N/A	N/A	Unknown	Unknown	Wet Chem	10WET55	TBD
Oven	Fisher Scientific	13-247-650G(6905)	611729-434	2012	Unknown	Wet Chem	10WET65	TBD
pH Probe	Hach	PHC301	11662571034	2011	Unknown	Wet Chem	11662571034	TBD
pH Probe	Hach	PHC301	121952571033	2012	Unknown	Wet Chem	121952571033	TBD
pH Probe	Hach	LBOD101	122143032067	2012	Unknown	Wet Chem	122143032067	TBD
pH Probe	Switchcraft	PHW77-SS	712202002	2012	Unknown	Wet Chem	712202002	TBD
Turbidity Meter	Hach	2100Q	11050C0092997	2011	Unknown	Wet Chem	10WT59	TBD
Hand Held Brix Refractometer	Fisher	N/A	Fisher catalog # 13-946-21	2011	Unknown	Wet Chem	10WT60	TBD
Quanti-Tray Sealer Model 2x	Quanti-Tray	89-10894-02	4836	2012	Unknown	Wet Chem	10WET56	TBD
IC	Metrohm	881 Compact IC	1881000121132	2012	Unknown	Wet Chem	10WT61	TBD
Lachat	Quick Chem	8500	120400001409	5/7/2012	Unknown	Wet Chem	10WT62	TBD
Autotitrator	Metromn	905 USB Sample Processor	1814001009181	5/7/2012	Unknown	Wet Chem	10WT63	TBD
Probe	Metromn	905 USB Sample Processor	1281705	5/7/2012	Unknown	Wet Chem	10WT63	TBD
JT Backer Speedisk Expanded Extraction Station	J.T. Baker	Speedisk Expanded Extraction Station	L02N23	2012	Unknown	Wet Chem	10WET66	TBD
Desiccator	Sanplatec Corp	DryKeeper	N/A	Unknown	Unknown	Wet Chem	10WET68	TBD
Desiccator	Boekel	N/A	N/A	Unknown	Unknown	Wet Chem	10WET69	TBD
Desiccator	Boekel	N/A	N/A	Unknown	Unknown	Wet Chem	10WET70	TBD
Desiccator	Boekel	N/A	N/A	Unknown	Unknown	Wet Chem	10WET71	TBD
Desiccator	Boekel	N/A	N/A	Unknown	Unknown	Wet Chem	10WET72	TBD
Desiccator	Boekel	N/A	N/A	Unknown	Unknown	Wet Chem	10WET73	TBD
Desiccator	Boekel	N/A	N/A	Unknown	Unknown	Wet Chem	10WET74	TBD
Desiccator	Boekel	N/A	N/A	Unknown	Unknown	Wet Chem	10WET75	TBD
Meter	Hach	HQ440d	120400069964	7/1/2013	Unknown	Wet Chem	10WETE	TBD
Meter - probe	Hach	PHC20101	172612618021	7/1/2013	Unknown	Wet Chem	10WETE	TBD
Oven	Fisher Isotemp Oven	6905	614389-852	2014	Unknown	Wet Chem	10WT77	TBD
Oven	Fisher Isotemp Oven	6905	614389-853	2014	Unknown	Wet Chem	10WET78	TBD
Hot Plate	Presto	Tilt'n Drain Big Griddle	21-697	2014	Unknown	Wet Chem	10WT81	TBD
Water Bath	Precision Scientific Water Bath	Coliform Incubator Bath	601061689	Unknown	Unknown	Wet Chem	10WT86	TBD
Oven	Fisher Scientific	151030521	41762572	Unknown	Unknown	Wet Chem	10WT88	TBD
Fridge	Danby Designer	DBC120BLS	4315123638037	2016	New	Wet Chem	WC4	TBD
COD Reactor block	HACH	DRB 200	160200C0071	Unknown	Unknown	Wet Chem	10WET57	TBD
Hot Block	Environmental Express	N/A	4952CEC2361	2006	Unknown	Wet Chem	10MET03	TBD
Distillation Block	Midi-Vap 4000	Midi-Vap 4000	4071305	Unknown	Unknown	Wet Chem	10WT89	TBD

7.5.2 PAS-Billings

Equipment List: PAS-Billings

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Balance	Fisher	A200DS	B027060	Unknown	Used	Sulfur Bench	11BAL1	Inorganics bookshelf
Balance	Ohaus	ARC120	G3251202300491	Unknown	New	EPH Prep	11BAL2	SVOA file cabinet
Balance	Ohaus	SP202	B504529759	Unknown	New	VOA Prep	11BAL4	Organics file cabinet
Balance	Mettler-Toledo	ML3002E	B508634908	Unknown	New	Mining	11BAL5	SR file cabinet
Balance	Mettler-Toledo	X5105DU	B525074608	Unknown	New	Solids Room	11BAL6	SR file cabinet
Balance	AND	GF-3000	T0370959	Unknown	New	Wet Chem Prep Bench	11BAL07	Inorganics bookshelf
Balance	Ohaus	STX223	B805364908	Unknown	New	Organics	11BAL08	Organics file cabinet
Autosampler	Hewlett-Packard	18596B	3050A23871	Unknown	Used	SemiVoa Lab	11MT04	SVOA file cabinet
Autosampler	Hewlett-Packard	18594B	3049A23850	Unknown	Used	SemiVoa Lab	11MT04	SVOA file cabinet
SVOA GC	Hewlett-Packard	5890	275A16778	Unknown	Used	SemiVoa Lab	11MT04	SVOA file cabinet
IC Autosampler	Dionex	AS-DV	190815063	8/2019	New	IC Room	11MT05	IC file cabinet
Ion Chromatograph	Dionex	ICS1000	05120175	Unknown	Used	IC Room	11MT05	IC file cabinet
IC Autosampler	Dionex	AS40-1	7101378	Unknown	Used	IC Room	11MT92	IC file cabinet
Ion Chromatograph	Dionex	ICS 2100	04090402	Unknown	Used	IC Room	11MT92	IC file cabinet
Autoanalyzer Autosampler	Astoria Pacific	411	41150160	Unknown	New	Wet Chem	11MT06	Inorganics bookshelf
Autoanalyzer Detector	Astoria Pacific	307	307064	Unknown	New	Wet Chem	11MT06	Inorganics bookshelf
Autoanalyzer Heater Unit	Perstop	303A	303437	Unknown	New	Wet Chem	11MT06	Inorganics bookshelf
Autosampler power supply	Perstorp	509	005766	Unknown	New	Wet Chem	11MT06	Inorganics bookshelf
Autosampler pump	Ismatec	IP	K16004541	Unknown	New	Wet Chem	11MT06	Inorganics bookshelf
Auto dilutor	Dilutus	NA	412115	Unknown	New	Wet Chem	11MT06	Inorganics bookshelf
Spectrophotometer	Thermo Spectronic	Aquamate	104218	Unknown	New	Wet Chem	11MT08	Inorganics bookshelf
Oven	Fisher	Isotemp 255D	1451	Unknown	New	Wet Chem	11MT10	SR file cabinet
Oven	Fisher	Isotemp 630F	20900168	Unknown	New	Wet Chem	11MT11	SR file cabinet
Concentrator	Zymark	TurboVap II	TB9814N8062	Unknown	Used	Organic Prep	11MT13	Organics file cabinet
Concentrator	Zymark	TurboVap II	4082	Unknown	Used	Organic Prep	11MT14	Organics file cabinet
Furnace	Sybron Thermolyne	1300	0479 16654	Unknown	Used	Wet Chem	11MT15	Inorganics bookshelf
N-Evap	Organomation	112	11771	Unknown	Used	Organic Prep	11MT16	Organics file cabinet
Waterbath	Precision Scientific	66586	698100224	Unknown	Used	Wet Chem	11MT17	Inorganics bookshelf
Sonicator	Fisher Scientific	FS60	RUA080390744	Unknown	Used	Voa	11MT19	Organics file cabinet
Furnace	Leco	606-000-300	3167	Unknown	Used	Wet Chem	11MT22	Inorganics bookshelf
Turbidimeter	HF Scientific	Micro 1000	610064	Unknown	New	Wet Chem	11MT23	Inorganics bookshelf
Sonicator	Heat Systems	Sonicator XL	NA	Unknown	Used	Organic Prep	11MT24	Organics file cabinet
Sonicator	Branson	Sonfier 450	B1090019	Unknown	Used	Organic Prep	11MT25	Organics file cabinet

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Concentrator	Tekmar/Dohrmann	3000	96312005	Unknown	Used	Voa Lab	11MT33	Organics file cabinet
GC/GCMS	Aglient	6890	US00009537	Unknown	Used	Voa Lab	11MT33	Organics file cabinet
Autosampler	EST Analytical	Centurion W	CENTW416041012	Unknown	New	Voa Lab	11MT33	Organics file cabinet
Block Digestor	Lachat	BD-46	1800-733	Unknown	New	Wet Chem	11MT34	Inorganics bookshelf
AutoSampler	EST Analytical	Centurion W	CENTW417042312	Unknown	New	Voa Lab	11MT38	Organics file cabinet
Concentrator	EST Analytical	Evolution	EV431073112	Unknown	New	Voa Lab	11MT38	Organics file cabinet
GC System	Agilent	5973	US00032765	Unknown	New	Voa Lab	11MT38	Organics file cabinet
MS Detector	Agilent	5973	US94240027	Unknown	Used	Voa Lab	11MT38	Organics file cabinet
pH meter	Accumet	AB15+	AB92338386	Unknown	New	Wet Chem	11MT40	Inorganics bookshelf
Oven	Fisher	Isotemp 630F	20600109	Unknown	New	Wet Chem	11MT41	SR file cabinet
Oven	Precision Scientific	Thelco 130 DM	9212-016	Unknown	New	Mining	11MT42	SR file cabinet
GC System	Agilent	6890	US00021845	Unknown	Used	Voa Lab	11MT43	Organics file cabinet
Concentrator	Tekmar/Dohrmann	3000	97251005	Unknown	Used	Voa Lab	11MT43	Organics file cabinet
AutoSampler	EST Analytical	Centurion W	CENT-W-416041012	Unknown	New	Voa Lab	11MT43	Organics file cabinet
Flow Analyzer	Lachat	8500	120400001407	Unknown	New	Wet Chem	11MT44	Inorganics bookshelf
For Calculation acodes	NA	NA	NA	NA	NA	NA	11MT45	NA
listed as generic instrument in Epic	NA	NA	NA	NA	NA	NA	11MT46	NA
Sieve Shaker	W.S. Tyler	RX_29	10-2394	Unknown	New	Mining	11MT48	Mining drawer
Concentrator	Zymark	Turbo Vap II	4254	Unknown	Used	Organic Prep	11MT51	Organics file cabinet
Custom Shaker	Custom	NA	NA	Unknown	New	Wet Chem	11MT55	NA
Oven	Fisher Scientific	516G	801N0068	Unknown	New	Garage (VOA)	11MT56	SR file cabinet
Autoclave	ThermoFisher	ST75925	1277081210300	Unknown	Used	Wet Chem	11MT57	Inorganics bookshelf
Autoclave	Fisher	SA-260 FA	FUSA 170822010-030	Unknown	Used	WetChem	11MT113	Inorganics Bookshelf
Metals Block Digester	Environmental Express	SC154	S388CEC2479	Unknown	Used	Metals Hood	11MT58	Inorganics bookshelf
ICP	ThermoFisher	ICAP6500 Duo	20071505	Unknown	Used	Metals Bench	11MT60	Inorganics bookshelf
Autosampler	CETAC	ASX-520	030660A520	Unknown	Used	Mercury Bench	11MT60	Inorganics bookshelf
Chiller	ThermoFisher	ThermoFlex900	111305048	Unknown	Used	Metals Bench	11MT60	Inorganics bookshelf
Centrifuge	Damon	IEC HN-S	34721368	Unknown	Used	Wet Chem	11MT61	Inorganics bookshelf
Block Digestor	Lachat	BD-46	1800-296	Unknown	Used	TKN Hood	11MT62	Inorganics bookshelf
Handheld pH	Thermo Scientific	Star A121	H00013	Unknown	New	Wet Chem	11MT64	Inorganics bookshelf
Spectrophotometer	Thermo Scientific	Evolution 201	5A4S008017	Unknown	New	Wet Chem	11MT65	Inorganics bookshelf
Hood	NA	NA	NA	Unknown	Used	TKN Hood	11MT66	Inorganics bookshelf

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Hood	NA	NA	NA	Unknown	Used	T Phos Hood	11MT67	Inorganics bookshelf
Hood	NA	NA	NA	Unknown	Used	Organic Prep	11MT68	Organics file cabinet
Hood	NA	NA	NA	Unknown	Used	Organic Prep	11MT69	Organics file cabinet
Hood	NA	NA	NA	Unknown	Used	Organic Prep	11MT70	Organics file cabinet
Hood	NA	NA	NA	Unknown	Used	Wet Chem	11MT71	Inorganics bookshelf
Hood	NA	NA	NA	Unknown	Used	Metals	11MT72	Inorganics bookshelf
Hood	NA	NA	NA	Unknown	Used	Voa	11MT73	Organics file cabinet
Oven	Fisher Scientific	116G	972	Unknown	New	Wet Chem	11MT76	SR file cabinet
GC System	Agilent	6890	US10238089	Unknown	Used	SemiVoa	11MT78	SVOA file cabinet
Autosampler	Agilent	G2913A	CN81047578	Unknown	Used	SemiVoa	11MT78	SVOA file cabinet
Autosampler	Agilent	G2913A	CN82750941	Unknown	Used	SemiVoa	11MT78	SVOA file cabinet
Autosampler Tray	Agilent	G2614A	CN21720602	Unknown	Used	SemiVoa	11MT78	SVOA file cabinet
TCLP Rotator A	NA	NA	NA	Unknown	Used	TCLP Area	11MT79	NA
TCLP Rotator B	NA	NA	NA	Unknown	Used	TCLP Area	11MT79	NA
TCLP Rotator C	NA	NA	NA	Unknown	Used	TCLP Area	11MT79	NA
Filter Pump 1.5	Edwards	904160	996305884	Unknown	Used	TDS	11MT80	Inorganics bookshelf
Filter Pump 2	Edwards	E2M2	42396	Unknown	Used	Mining	11MT81	Inorganics bookshelf
pH meter	Thermo Scientific	OrionSTARA2 15	X27760	Unknown	New	pH/Conduc tivity Bench	11MT82	Inorganics bookshelf
pH Meter	ThermoScientifi c	OrionSTARA2 15	X49331	Unknown	New	WetChem Prep	11MT107	Inorganics bookshelf
TKN Digestor	Hatch, Lachat BD40HT	BD-40	1800-808	Unknown	Used	TKN Hood	11MT83	Inorganics bookshelf
Filter Pump 2	Edwards	5KC37NN470 GX	25963	Unknown	Used	SPLP/TCL P	11MT84	Inorganics bookshelf
Oven	ThermoFisher Scientific	Hermathern OGS10	42022678	Unknown	New	Mining	11MT86	SR file cabinet
Drying Cabinet	NA	NA	NA	Unknown	New	Mining	11MT87	NA
Sieve Shaker	Endecotts	Minor200	1217120535J	Unknown	New	Mining	11MT88	Mining drawer
Oven	Fisher Sci 180L	180L	42087930	Unknown	New	Mining	11MT89	SR file cabinet
Muffle Furnace Kiln	Delphi	EZ-Pro 15/6	SN 035988	Unknown	New	Organic Prep	11MT90	Organics file cabinet
IC Autosampler	Dionex	AS,ICS Series, ICS-2100,ICS-3000 DC, ICS-3000 SP	09090574, 09080900, 09100402, 09090060, 09090425	Unknown	Used	IC Room	11MT92	IC file cabinet
IC Autosampler	Dionex	ICS-3000 DC, ICS 3000 SP	9090060, 9090425	Unknown	Used	IC Room	11MT93	IC file cabinet
Metals Block Digester	Smartblock	NA	NA	Unknown	Used	Metals/T Phos hood	11MT94	Inorganics bookshelf
Sieve Shaker	Endecotts	Octagon 200	1218020515	Unknown	New	Mining	11MT95	Mining drawer
Pulverizer	Retsch	RS200	1217170524F	Unknown	New	Mining	11MT96	Mining drawer
pH probe	Orion	013005MD conductivity reli	NA	Unknown	New	Wet Chem	11MT98	Inorganics bookshelf
pH probe	Orion	8107BNUMD Ross Ultra pH/ATC Triode	NA	Unknown	New	Wet Chem	11MT100	Inorganics bookshelf

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
pH probe	Thermo Scientific	8757	NA	Unknown	New	Wet Chem	11MT105	Inorganics bookshelf
Oven	Thermo Scientific	Hermathern OGS100	42296560	Unknown	New	Wet Chem	11MT106	SR file cabinet
Conductivity meter	Thermo Scientific	OrionSTARA2 15	49331	Unknown	New	Wet Chem	11MT107	Inorganics bookshelf
Filter Pump 2	Edwards	E2M2	11934	Unknown	Used	GCMS	11MT108	Inorganics bookshelf
pH probe	Accumet	13-620-530A lot code VWU1	NA	Unknown	New	Wet Chem	11MT109	Inorganics bookshelf
pH Probe	Thermo Scientific	Orion 8107BNUMD	NA	7/25/2019	New	Wet Chem	11MT110	Inorganics bookshelf
pH Probe	Thermo Scientific	Orion 8157BNUMD	NA	11/1/2019	New	Wet Chem	11MT111	Inorganics bookshelf
Conductivity/pH Pen	Fisher Scientific	15-078-201	192323805	11/7/2019	New	Wet Chem	11MT112	Inorganics bookshelf
GC System	Agilent	7890A	US20314075	Unknown	Used	SemiVoa	11MTG1/ G2	SVOA file cabinet
Autosampler Tray	Agilent	7890A	CN10752102	Unknown	Used	SemiVoa	11MTG1/ G2	SVOA file cabinet
Injector	Agilent	7683B	US01913416	Unknown	Used	SemiVoa	11MTG1/ G2	SVOA file cabinet
Injector	Agilent	7683	CN82349867	Unknown	Used	SemiVoa	11MTG1/ G2	SVOA file cabinet
Bottletop Dispenser	Brinkmann	NA	NA	Unknown	New	Wet Chem Hood	BT1	Inorganics bookshelf
Bottletop Dispenser	Dispensette	NA	17L34997	Unknown	New	Wet Chem Hood	BT2	Organics file cabinet
Bottletop Dispenser	Eppendorf	NA	12M10591	Unknown	New	Organic Prep	BT3	SVOA file cabinet
Bottletop Dispenser	Dispensette	NA	07Z7769	Unknown	New	Organic Prep	BT4	SVOA file cabinet
Bottletop Dispenser	Fisher	NA	AF 2153	Unknown	New	Wet Chem Hood	BT5	Inorganics bookshelf
Bottletop Dispenser	Fisher	NA	AF6770	Unknown	New	Metals	BT6	Inorganics bookshelf
Bottletop Dispenser	Fisher	NA	AF6862	Unknown	New	Metals	BT7	Inorganics bookshelf
Bottletop Dispenser	Fisher	NA	AF9468	Unknown	New	Wet Chem Hood	BT8	Inorganics bookshelf
Bottletop Dispenser	Fisher	NA	AG4962	Unknown	New	Wet Chem Hood	BT9	Inorganics bookshelf
Bottletop Dispenser	Fisher	NA	14024979	Unknown	New	Wet Chem Hood	BT10	Inorganics bookshelf
Bottletop Dispenser	Fisher	NA	14024938	Unknown	New	Wet Chem Hood	BT11	Inorganics bookshelf
Bottletop Dispenser	Satorius	EMD	AK6234	Unknown	New	Wet Chem Hood	BT12	Inorganics bookshelf
Bottletop Dispenser	Fisher	NA	14200358	Unknown	New	Wet Chem Hood	BT14	Inorganics bookshelf
Bottletop Dispenser	Brinkmann	NA	75123	Unknown	New	Wet Chem Hood	BT15	Inorganics bookshelf
Bottletop Dispenser	Fisher	NA	17309419	Unknown	New	Wet Chem Hood	BT16	Inorganics bookshelf
Bottletop Dispenser	Fisher	NA	17309419	Unknown	New	Metals Hood	BT17	Inorganics bookshelf
Bottletop Dispenser	Dispensette	NA	17309419	Unknown	New	IC Room	BT18	Inorganics bookshelf
IR Gun	Fisher Scientific	2267-20	160285052	Unknown	New	SR	160285052	SR file cabinet
IR Gun	Omega	NA	OS418-LS	Unknown	New	SR	OS418-LS	SR file cabinet
NIST Thermometer	Fisher Scientific	PT-100	111855001	Unknown	New	QA	111855001	QA file cabinet
NIST Thermometer	Fisher Scientific	PT-100	160283107	Unknown	New	QA	160283107	QA file cabinet

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Refrigerator/ Freezer	Sanyo	SR-170X	9400302476	Unknown	New	Wet Chem	MTC-1	SR file cabinet
Refrigerator	Kenmore	5649901741	920940742	Unknown	New	Organic Prep	MTC-4	SR file cabinet
Refrigerator	Traulsen	G20010	T33587106	Unknown	New	SR	MTC-9	SR file cabinet
Refrigerator	Frigidaire	FRU17B2JW18	WA93300079	Unknown	New	Wet Chem	MTC-11	SR file cabinet
Freezer	SPT	B-PCZ5	A100600186	Unknown	New	Wet Chem	MTC-13	SR file cabinet
Refrigerator	Saturn	549R	A94B200112T	Unknown	New	Garage (VOA)	MTC-14	SR file cabinet
Refrigerator	Centaur Plus	CSD-2DR-BAL	120KENH00159	Unknown	New	Garage (VOA)	MTC-16	SR file cabinet
Refrigerator	Imperial	GMF-600	NA	Unknown	New	Main Walk-in	MTC-18	SR file cabinet
Refrigerator	Kenmore	253.165421	WB64429495	Unknown	New	Garage (SR)	MTC-21	SR file cabinet
Freezer	Arctic King	AFRM016AEB	D80-24154501-16A18-211121	Unknown	New	Wet Chem	MTC-22	SR file cabinet
Freezer	Haier	HF71CW20	B300G7B0600W	Unknown	New	Garage	MTC-24	SR file cabinet
Freezer	Whirlpool	WZF34X16DW04	480308106	Unknown	New	Garage	MTC-25	SR file cabinet
Freezer	Whirlpool	WZF34X18DW02	U80403444	Unknown	New	Garage	MTC-26	SR file cabinet
Freezer	Hisense	BE170	1B0088Z0062JBE170520055	7/12/19	New	VOA	MTC-27	SR file cabinet
Eye Wash Station	Guardian	NA	NA	Unknown	New	Main lab	SE-1	SR file cabinet
Fire Extinguisher	Halon	A355	V-983066	Unknown	New	VOA	FE-1	SR file cabinet
Fire Extinguisher	Ansul Sentry	A10H	ZT-849854	Unknown	New	Garage	FE-2	SR file cabinet
Fire Extinguisher	Ansul Sentry	A02VB	ZU-092145	Unknown	New	Courier van	FE-3	SR file cabinet
Fire Extinguisher	Fire Master	AA05-1	CF-322188	Unknown	New	Main lab back exit	FE-4	SR file cabinet
Fire Extinguisher	Fire Master	AA0S	V-185947	Unknown	New	Organic prep	FE-5	SR file cabinet
Fire Extinguisher	Fire Master	AA10S	BZ-614843	Unknown	New	Mining lab	FE-6	SR file cabinet
Fire Extinguisher	Fire Master	AA10S	BZ-614849	Unknown	New	Mining lab back room	FE-7	SR file cabinet
Fire Extinguisher	Fire Master	AA05-1	CF-322139	Unknown	New	Mining lab back room exit	FE-8	SR file cabinet
Fire Extinguisher	Ansul Sentry	A10H	ZD589859	Unknown	New	Main lab to office	FE-9	SR file cabinet
Fire Extinguisher	Fire Master	AA05S-1	C-93705476	Unknown	New	Front desk	FE-10	SR file cabinet
Fire Extinguisher	Fire Master	AA05S-1	E-62140500	Unknown	New	Break room	FE-11	SR file cabinet
Fire Extinguisher	Ansul Sentry	A10H	ZD-589837	Unknown	New	Garage (hydrogen storage)	FE-12	SR file cabinet
First Aid Kit	ALSCO	E2M2	41032	Unknown	New	Main lab	FA-1	NA
Leak Detector	Restek	22655	117653	Unknown	New	Lab Managers Office	LD-1	QA file cabinet

7.5.3 PAS-Virginia

Equipment List: PAS-Virginia

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
CVAA Mercury Analyzer	Cetac	M-6100	060402 QT6	10/1/2004	New	Metals	12HG1	At instrument
Autosampler	Cetac	ASX-400	070401 ASX 4	Unknown	Unknown	Metals		TBD
Hardware	Venture Systemax	SYX PHM800PRO	106381144	Unknown	Unknown	Metals		TBD
Software	Cetac	Quicktrace Hg Analyzer System V 1.2.1		Unknown	Unknown	Metals		TBD
ICP Atomic Emission Spectrometer	Agilent	5110	MY18260006	9/7/2018	New	Metals	12ICP4	At instrument
Autosampler	Agilent	SPS4	AU18144765	Unknown	Unknown	Metals		TBD
Hardware	Hewlett Packard	HP Z 240	2UA82127HC	Unknown	Unknown	Metals		TBD
Software	Agilent	ICPExpert		Unknown	Unknown	Metals		TBD
ICPMS	Perkin Elmer	ELAN 9000	AJ11920712	3/18/2011	New	Metals	12ICM1	At instrument
Autosampler /pump	ESI Fast System	SC 4DX	X4DX-HS-TSP-16-101109	Unknown	Unknown	Metals		TBD
Recirculator	Agilent	G8481A	1B07-00914	Unknown	Unknown	Metals		TBD
Software	Perkin Elmer	Version 3.4		Unknown	Unknown	Metals		TBD
Hardware	Dell XP	X12-51522		Unknown	Unknown	Metals		TBD
ICPMS	Perkin Elmer	ELAN 9000	AJ3050909	3/1/2016	Used	Metals	12ICM3	At instrument
Autosampler /pump	ESI Fast System	SC 4DX	X4DX-HS-TSP-16-100803	Unknown	Unknown	Metals		TBD
Recirculator	Polyscience	3370	C07B00394	Unknown	Unknown	Metals		TBD
Hardware	Lenovo			Unknown	Unknown	Metals		TBD
Software	Perkin Elmer	Version 3.4		Unknown	Unknown	Metals		TBD
ICPMS	Agilent	7900 ICP-MS	SG19374593	11/4/19	New	Metals	12ICM4	At instrument
Autosampler / pump	Agilent	SPS 4	AU19156702	11/4/19	New	Metals		TBD
Recirculator	Agilent	G3292-80200	1908-02202	11/4/19	New	Metals		TBD
Hardware	Hewlitt Packard		MXL9193WHM	11/4/19	New	Metals		TBD
Software	Agilent	ICPMS Mass Hunter 4.5		11/4/19	New	Metals		TBD
Lachat	Lachat	QC 8500 Series 2	181200002196	1/7/2019	New	Wet Chem	12WTAA	At instrument
Lachat Regenerant Pump	Lachat	RP-150 Series	L18002784	Unknown	Unknown	Wet Chem		TBD
Autosampler	Cetac	ASX-580 XYZ	111839A560	Unknown	Unknown	Wet Chem		TBD
Autodiluter	Zellweger Analytics	PDS 200 Precision Diluter	181200000877	Unknown	Unknown	Wet Chem		TBD
Hardware	Midwest Comp Depot	3035		Unknown	Unknown	Wet Chem		TBD
Software	Omnion	FIA Data System		Unknown	Unknown	Wet Chem		TBD
Lachat	Lachat	QC 8500 Series 2	10070000129	Unknown	New	Wet Chem	12WTAB	At instrument
Reagent Pump	Lachat	RP 150 Series	A82000-1961	Unknown	Unknown	Wet Chem		TBD
Autosampler	Cetac	ASX500 Model 510	010025ASX	Unknown	Unknown	Wet Chem		TBD
Hardware	Hewlitt Packard	HP Compaq		Unknown	Unknown	Wet Chem		TBD
Software	Omnion	FIA Data System		Unknown	Unknown	Wet Chem		TBD
Ion Chromatograph	Metrohm	930 Flex IC		Unknown	New	Wet Chem	12WTAC	Available online
Regenerant Dispenser	Metrohm	IC-05		Unknown	Unknown	Wet Chem		TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Autosampler	Metrohm	Model 850 Sample Processor		Unknown	Unknown	Wet Chem		TBD
Hardware	Dell		CBDUC284-70821-553-OGIP	Unknown	Unknown	Wet Chem		TBD
Software	Metrohm	IC Net 2.3		Unknown	Unknown	Wet Chem		TBD
Ion Chromatograph	Metrohm	Model 881 Advanced Compact IC	1881000122119	Unknown	New	Wet Chem	12WTA7	Available online
Regenerant Dispenser	Metrohm	800 Dosino		Unknown	Unknown	Wet Chem		TBD
Autosampler	Metrohm	Model 858 Advanced Sample Processor		Unknown	Unknown	Wet Chem		TBD
Hardware	Dell	Optiplex 790		Unknown	Unknown	Wet Chem		TBD
Software	Metrohm	IC Net 2.3		Unknown	Unknown	Wet Chem		TBD
Ammonia Distillation Block	Lachat	Micro Dist	081200001033	5/1/2009	New	Wet Chem	12DST1	TBD
TKN Block Digester	Lachat	Model BD-40	TSLA1013511403	8/4/17	New	Wet Chem	12TKN2	TBD
Autotitrator	ManTech	TitraSip	MT-1B5-957	Unknown	New	Wet Chem	12WETD	Available online
Autosampler	ManTech	AutoMax 73 Sampler		Unknown	Unknown	Wet Chem		TBD
Hardware	Hewlitt Packard	Prodesk		Unknown	Unknown	Wet Chem		TBD
Software	ManTech	PC Titrate for Windows v.3		Unknown	Unknown	Wet Chem		TBD
BOD Warmer #1	Thermo Precision		60541072	Unknown	Unknown	Wet Chem		TBD
BOD Incubator #4	Fisher	Model 3720	300007704	Unknown	New	Wet Chem	12BOD4	TBD
BOD Incubator #5	Fisher	Model 3720A	300064399	2/26/16	New	Wet Chem	12BOD5	TBD
BOD Incubator #6	Fisher	Model 3720A	300088990	Unknown	New	Wet Chem	12BOD6	TBD
BOD Reader	Thermo Electron	BOD Auto EZ Reader	10060020/A0074	Unknown	Unknown	Wet Chem	12WET2	At instrument
D.O. Meter	YSI	R5100	02C0340AA	Unknown	Unknown	Wet Chem	12WET0	TBD
BOD Hardware	Lenovo	Think Centre 001XUS	MJ07T8HE	Unknown	Unknown	Wet Chem		TBD
BOD Software		BOD Auto EZ		Unknown	Unknown	Wet Chem		TBD
TOC Analyzer	OI	OI Analyzer	H129732449E	New	Unknown	Wet Chem	12WTA3	At instrument
TOC Autosampler	OI	OI Autosampler	E129788451	Unknown	Unknown	Wet Chem		TBD
TOC Analyzer	OI	OI Solids Analyzer	A1129733824	New	Unknown	Wet Chem	12WTA9	At instrument
Autosampling Module	OI Corporation		621290637-92120	Unknown	Unknown	Wet Chem		TBD
IR Detector	OI Corporation	1030	2A0002T	Unknown	Unknown	Wet Chem		TBD
Hardware	HP	Compaq		Unknown	Unknown	Wet Chem		TBD
Software	OI Corporation	V1.4.2		Unknown	Unknown	Wet Chem		TBD
TOC Analyzer	OI	OI Analyzer	P407730312P	4/1/2014	New	Wet Chem	12WTA8	At instrument
Autosampling Module	OI Corporation	Model 1088 AS		Unknown	Unknown	Wet Chem		TBD
IR Detector	OI Corporation	1030	B622737366	Unknown	Unknown	Wet Chem		TBD
Hardware	Lenovo	Think Centre		Unknown	Unknown	Wet Chem		TBD
Software	OI Corporation	V1.4.2		Unknown	Unknown	Wet Chem		TBD
Bacteria Incubator	Shel Lab	1545	11052906	Unknown	Unknown	Wet Chem	12INC1	TBD
Coliform Incubator Bath	Thermo Fisher	253	202682-185	Unknown	Unknown	Wet Chem	12INC2	TBD
Bacteria Incubator	Shel Lab	1520		Unknown	Unknown	Wet Chem	12INC3	TBD
Coliform Incubator Bath	Thermo Fisher	253	605041072	Unknown	Used	Wet Chem	12INC4	TBD
Microscope	National Optical		446TBL-10	Unknown	Unknown	Wet Chem		TBD
QuantiTray Sealer	IDEXX	89-10894-02	4788	Unknown	Unknown	Wet Chem	12QTS1	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
UV Lamp	Entala	UVL-56		Unknown	Unknown	Wet Chem	12UVL1	TBD
Oven	VWR	1330GM	05039804	Unknown	Unknown	Wet Chem	12O010	TBD
Oven	Fisher	6926	614203-180	Unknown	Unknown	Wet Chem	12OV3	TBD
Oven	Shel Lab	SM05	0405Z114	Unknown	Unknown	Wet Chem	12OV4	TBD
Oven	Fisher	100L	42130594	Unknown	Unknown	Wet Chem	12OV6	TBD
Muffle Furnace	Fisher	IsoTemp	70100004	Unknown	Unknown	Wet Chem		TBD
Metals Digestion Block	CPI	05-C0530	000424	Unknown	Unknown	Metals	12HB1	TBD
Metals Digestion Block	CPI			Unknown	Unknown	Metals	12HB2	TBD
Metals Digestion Block	CAi	SmartBlock 125i		6/27/2016	Used	Metals	12HB3	TBD
Metals Digestion Block	AGS Scientific	Durablock QB17064		Unknown	New	Metals	12HB4	TBD
Balance	AND	GF 1200	10318953	Unknown	Unknown	Metals	12BAL3	TBD
Balance	Sartorius	LA3200D	13407528	Unknown	Unknown	Wet Chem	12BAL4	TBD
Balance	Sartorius	BP1105	50206779	Unknown	Unknown	Metals	12BALB	TBD
Balance	Denver Instruments	A200P	040DCD057	Unknown	Unknown	Wet Chem	12BALC	TBD
Balance	Mettler	XSE 104	B549797353	10/13/2017	Used	Wet Chem	12BALD	TBD
Stir Plate	Thermoline	Type 7200	903971255007	Unknown	Unknown	Wet Chem		TBD
Refrigerator 2R	Sanyo	SR-362OK	051105496	Unknown	Unknown	Metals		TBD
Refrigerator #3	True Mfg Co.	T-49	1-2953805	Unknown	Unknown	Sample Receiving		TBD
Refrigerator #5	True Mfg Co.	T-49	1-3060851	Unknown	Unknown	Metals		TBD
Refrigerator #8	True Mfg Co.	T-35	I-3016399	Unknown	Unknown	Sample Receiving		TBD
Refrigerator /Freezer #10	Gibson	GRT17B3BW1	BA31823513	Unknown	Unknown	Wet Chem		TBD
Refrigeratot #12	Beverage-Air	9029136	KR481AS	Unknown	Unknown	Wet Chem		TBD
Refrigerator #13	US Cooler Walk-in		29716	Unknown	Unknown	Sample Receiving		TBD
Refrigerator #14	SubZero	249R	234547	Unknown	Unknown	Wet Chem		TBD
Mixer	Thermolyne	M37615	376950140798	Unknown	Unknown	Wet Chem		TBD
Rotator	LabLine	1345	1002-1791	Unknown	Unknown	Wet Chem	12RTR1	TBD
Stir/Hotplate	VWR	12365-392	14023	Unknown	Unknown	Wet Chem		TBD
COD Reactor	HACH	45600-00	920600007477	Unknown	Unknown	Wet Chem	COD-R1	TBD
COD Reactor	HACH	16500-10	5944	Unknown	Unknown	Wet Chem	COD-R2	TBD
Dessicator	Labconco			Unknown	Unknown	Wet Chem	12DES1	TBD
Dessicator	Labconco			Unknown	Unknown	Wet Chem	12DES2	TBD
Dessicator	Glass			Unknown	Unknown	Wet Chem	12DES3	TBD
Dessicator	Fisher			Unknown	Unknown	Wet Chem	12DES4	TBD
Dessicator	Boeke;			Unknown	Unknown	Wet Chem	12DES5	TBD
Dessicator	Plas Labs			Unknown	Unknown	Wet Chem	12DES6	TBD
Dessicator	Plas Labs			Unknown	Unknown	Wet Chem	12DES7	TBD
Dessicator	Plas Labs			Unknown	Unknown	Wet Chem	12DES8	TBD
Dessicator	SanPlatec			Unknown	Unknown	Wet Chem	12DES9	TBD
Sonicator	NEY	300 Ultrasonik	NEY010507	Unknown	Unknown	Wet Chem	12SON1	TBD
Centrifuge	Sorvall	RT6000B		Unknown	Unknown	Wet Chem	12CFG2	TBD
Autoclave	Tuttnaur / Brinkman	3545 EP	2105018	Unknown	Unknown	Wet Chem	12CLV2	TBD
pH Meter	OrionStar	A215	X27234	Unknown	Unknown	Wet Chem	12WETG	Available online
Turbidimeter	Orion	AQ3010	3494427	10/4/17	New	Wet Chem	12WETF	At instrument
Spectrophotometer	HACH	DR 5000	1271479	Unknown	New	Wet Chem	12WTA1	At instrument
Flash Point Tester	Koehler	K16200		Unknown	New	Metals	12FP1	TBD
DI Water System	Barnstead Thermolyne	EPure System		Unknown	Unknown	Lab		TBD
LP RO System	Barnstead Thermolyne	D2622	496000209600	Unknown	Unknown	Lab		TBD
Resistivity Meter for RO System	Sybron Barnstead	02770		Unknown	Unknown	Lab		TBD

7.5.4 PAS-Duluth

Equipment List: PAS-Duluth

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Balance	Mettler	AT261	M89136	6/26/2018	Used	Bioassay	13BAL8	Electronic copy on Server
Incubator	Precision Scientific	4YW71	605031679	3/12/2019	Unknown	Bioassay	13INC8	Online
pH Meter	Thermo Orion	420	069292	Unknown	Unknown	Bioassay	13WETA	Online
Conductivity Meter	Hach	Sension5	020500007046	Unknown	Unknown	Bioassay	13WETB	Bioassay Lab above chemistry bench
DO Meter/Probe	Hach	HQ30d Flexi	071200016294	Unknown	Unknown	Bioassay	13WETC	Electronic copy on Server
Amperometric Titrator	Hach	19299-00	96090001089	Unknown	Unknown	Bioassay	13WETD	Electronic copy on Server
pH Pen	Fisher	S35927	2812765	1/14/2019	New	Bioassay	13WETN	Bioassay Lab above chemistry bench
Light Box	Hall Productions	1218	N/A	Unknown	Unknown	Bioassay	NA	Online
Light Meter	Fisher	06-662-63, 11774266	181138991	7/3/2018	New	Bioassay	13LM2	Online
Light Timer	Intermatic	E1600	-	Unknown	Unknown	Bioassay	13TIMER1	Bioassay Lab above chemistry bench
Light Timer	Intermatic	E1600	-	Unknown	Unknown	Bioassay	13TIMER2	Bioassay Lab above chemistry bench
Light Timer	Intermatic	E1600	-	Unknown	Unknown	Bioassay	13TIMER3	Bioassay Lab above chemistry bench
Water Filtration/DIW System	Barnstead	B Pure	06810	7/12/2019	Unknown	Bioassay	13DI2	Online
Fridge	TurboAir	TSR49	009495009MR	Unknown	Unknown	Bioassay	13DUL3	Online
Fridge	USBC	564.8993640	900819697	Unknown	Unknown	Bioassay	13DUL4	Online
Water Filtration/DIW System (main)	Culligan	NA	NA	Unknown	Unknown	Glassware Cleaning	13DI1	Online
Balance	Mettler	PC 4400	0145	3/6/19	Used	HCT	13BAL10	Online
pH Meter	Thermo Orion	Star Series	B07284	9/1/2015	Unknown	HCT	13WET6	HCT Desk Drawer
pH/Conductivity Meter	Thermo	Star A215 Benchtop	X45992	9/1/2015	Unknown	HCT	13WETM	Online
Balance	Sartorius	ME4145	13003775	Unknown	Unknown	LL Hg	12BAL5	Online
Oven	Blue-M	MO1440A-1	S175-517150-SS	Unknown	Unknown	LL Hg	13OVN4	Online
Mercury Analyzer	Brooks Rand	Model III CVAFS	1103401	10/19/2017	Unknown	LL Hg	12Hg2	LL Hg Desk Drawer
Autosampler	Brooks Rand	Brooks Rand 17420	4936A14632	5/1/2018	Unknown	LL Hg	-	LL Hg Desk Drawer

Pace Analytical®

LABORATORY QUALITY MANUAL
Pace Analytical Services, LLC

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Total Hg Purge and Trap	Brooks Rand	N/A	11078001	Unknown	Unknown	LL Hg	-	LL Hg Desk Drawer
Hg Speciation Purge and Trap	Brooks Rand	N/A	41107301	Unknown	Unknown	LL Hg	-	LL Hg Desk Drawer
Software	Hg Guru	version 4.1	-	Unknown	Unknown	LL Hg	-	Online
Hood	N/A	N/A	N/A	6/23/2017	Unknown	LL Hg	13HOOD5	Online
Hood	Hamilton	SAFEAIRE II	DLLKA-PTD	Unknown	Unknown	LL Hg	13HOOD6	Online
Hood	ESCO	STL/04-EVC	2001-2764	Unknown	Unknown	LL Hg	DB-1	Online
Distillation Block	Brooks Rand	Distillation Block AB	1021401	Unknown	Unknown	LL Hg	MDS-A	LL Hg Desk Drawer
Distillation Block	Brooks Rand	Distillation Block CD	1034401	Unknown	Unknown	LL Hg	MDS-C	LL Hg Desk Drawer
Water Filtration/DIW System	Barnstead	D4641	1090090938202	Unknown	Unknown	LL Hg	13DI1-A	Online
Fridge	Magic Chef	MCBR445W1	N/A	Unknown	Unknown	LL Hg	13DUL14	Online
Fridge	Absocold	AR101MW13R	951005923	Unknown	Unknown	LL Hg	13DUL15	Online
Fridge	Gibson	RM18F6WS	NG188716/DG19 0389	9/1/2016	Unknown	Sample Receiving	13DUL2	Online
Walk In Cooler	Carroll Coolers	N016898	CL-251150	3/7/2019	New	Sample Receiving	13DUL13	Online
Freezer	Arctic King	WHS-185C1WS	D80-28459101-17105-130313	10/26/17	New	Storage Room	13FRZ2	Online
Balance	Mettler	P1200	304562	Unknown	Unknown	Wet Chem	13BAL1	Online
Balance	Mettler	XSE 204	B551880610	9/1/2015	Unknown	Wet Chem	13BAL5	Online
Balance	Mettler	XSE 104	B549797355	9/1/2015	Unknown	Wet Chem	13BAL7	Online
COD Reactor	Hach	45600-00	950900013204	Unknown	Unknown	Wet Chem	13COD1	Online
Incubator	LabLine	460NS	0469	Unknown	Unknown	Wet Chem	13INC3	Online
Incubator	Thermo	Isotemp	300168083	10/19/2017	New	Glassware Cleaning	13INC5	In drawer under 13BOD1
Incubator	Precision Scientific	66551	9209-113	5/1/2018	Used	Wet Chem	13INC7	Online
Muffle Furnace	Lindberg	51442	899152	Unknown	Unknown	Wet Chem	13MFL1	Online
Oven	VWR	1370G	1200600	Unknown	Unknown	Wet Chem	13OVN1	Online
Oven	Precision Scientific	Thelco Model 28	N/A	Unknown	Unknown	Wet Chem	13OVN2	Online
Oven	ThermoFisher	cat#151030508	42094122	6/23/2017	Unknown	Wet Chem	13OVN5	Online
Spectrophotometer UV VIS	Thermo	9423AQ2100E	HEDN238001	Unknown	Unknown	Wet Chem	13WET1	Online
Lachat	Hach	8500	50100000097	Unknown	Unknown	Wet Chem	13WET3	Online
Lachat Autosampler	Hach	ASX 520	010591A520	Unknown	Unknown	Wet Chem	-	Online
Lachat	Hach	8500	40900000051	Unknown	Unknown	Wet Chem	13WET5	Online
Lachat Autosampler	Hach	ASX 600	A81010-007	Unknown	Unknown	Wet Chem	-	Online
LDO Meter/Probe	Hach	HQ30d Flexi	121000079722	Unknown	Unknown	Wet Chem	13WET7	Online
pH Meter	Orion	720A	13043	Unknown	Unknown	Wet Chem	13WET8	In drawer by pH supplies
pH pen	Sper Scientific	850051	143496	9/1/2016	New	Wet Chem	13WET11	In drawer under 13WET5

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
pH pen	Eutech Instruments	pHTestr 30	68X546501	3/7/2019	New	Wet Chem	13WET13	In drawer under 13WET5
Distillation Unit Microblock	Environmental Express	EMD1920-106	2109	Unknown	Unknown	Wet Chem	13WETE	Online
Distillation Unit Microblock	Lachat	1700-000	2000-209	Unknown	Unknown	Wet Chem	13WETF	Online
Spectrophotometer UV VIS	Hach	DR 3900	1648363	Unknown	Unknown	Wet Chem	13WETJ	Online
pH/Conductivity Meter	Orion	A215	X37428	8/1/2017	New	Wet Chem	13WETK	In drawer by pH supplies
Autoclave	Market Forge	Sterilmatic STM-E	37827	1/1/2018	Unknown	Wet Chem	13CLV1	Online
Autoclave Temperature Gauge	Market Forge	BUILT-IN	-	1/1/2018	Unknown	Wet Chem	13CLV1T	Online
Autoclave Pressure Gauge	Market Forge	BUILT-IN	-	1/1/2018	Unknown	Wet Chem	13CLV1P	Online
Buret, Class A	Kimax	Class-A	0230	Unknown	Unknown	Wet Chem	13BUR1	Online
Buret, Class A	Pyrex	Class-A	2103	Unknown	Unknown	Wet Chem	13BUR2	Online
Buret, Class A	Kimax	Class-A	7249	Unknown	Unknown	Wet Chem	13BUR3	Online
Autodispenser	North Central Labs	DO-250	-	Unknown	Unknown	Wet Chem	13DSP1	Online
Autodispenser	SCILOGEX	Dispense-Mate Plus	JY16291	Unknown	Unknown	Wet Chem	13DSP2	Online
Autodispenser	Hach	2105560 Swifttest	-	1/1/2018	New	Wet Chem	13DSP3	Online
Autodispenser	Hach	2105560 Swifttest	-	1/1/2018	New	Wet Chem	13DSP4	Online
Digester (Phos)	CA1	Smartblock 226	NA	Unknown	Unknown	Wet Chem	13DIG1	Online
Hotblock (TKN)	Technicon	BD 40	CG-052	Unknown	Unknown	Wet Chem	13TKN1	Online
Hotblock (TKN)	Seal Analytical	BD 50 Block	STU6U00860	8/9/2017	Unknown	Wet Chem	13TKN2	In rack by 13WET7
Microscope	American Optical Corp	Forty	814602	Unknown	Unknown	Wet Chem	NA	Online
Stir Plate	Thermolyne	SP18425	757960584897	Unknown	Unknown	Wet Chem	NA	Online
Hot Plate	Thermolyne	Ciramec 3 HP 47135	61920359996	Unknown	Unknown	Wet Chem	13HTP1	Online
Hot Plate	Thermolyne	Ciramec 3 HP 47135-60	1073030511305	Unknown	Unknown	Wet Chem	13HTP2	Online
Sonicator	VWR	Auqasonic 50-T	N/A	Unknown	Unknown	Wet Chem	13SON1	Online
Shaker	Labline Instruments	1345	10021791	Unknown	Unknown	Wet Chem	13SH1	Online
QuantiTray Sealer	IDEXX	2x/89-10894-00	01174	Unknown	Unknown	Wet Chem	13QT1	Online
Sterilizer	EZE	NA	NA	Unknown	Unknown	Wet Chem	13STL1	Online
UV Lamp	UVP, Inc.	UVGL-25	691	Unknown	Unknown	Wet Chem	13UVL1	Online
UV Lamp	UVL	UVGL-58	OCT-2011	Unknown	Unknown	Wet Chem	13UVL2	Online
Hood	LABCONCO	728040010814	031214227 H	Unknown	Unknown	Wet Chem	13HOOD1	Online
Hood	NA	NA	NA	Unknown	Unknown	Wet Chem	13HOOD2	Online
Water Filtration /DIW System	Barnstead	Nanopure II	na	Unknown	Unknown	Wet Chem	13DI1-B	Online
Fridge	TurboAir	M3R47-2	M3R4L43095	Unknown	Unknown	Wet Chem	13DUL5	Online
Fridge	Gibson	RM18F5WX	N/A	Unknown	Unknown	Wet Chem	13DUL6	Online
Fridge	TurboAir	TSR49	01749500MR	Unknown	Unknown	Wet Chem	13DUL7	Online
Freezer	Wood's	CO5BBA	01778768HJ	Unknown	Unknown	Wet Chem	13FRZ1	Online
Incubator	LabLine CO2	3010	12	Unknown	Unknown	Wet Chem 2	13INC4	Online

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Manual Location
Fridge	TurboAir	MSR23NM	MR23101012	Unknown	Unknown	Wet Chem 2	13DUL9	Online
Balance	Denver Instruments	XL-1810	N0088210	Unknown	Unknown	Wet Chem 2	13BAL4	Online
Color Test Kit	Hach	co-1	LOT#A8068	Unknown	Unknown	Wet Chem 2	13WETG	Online
SPE StepSaver 7-station Funnel	Environmental Express	Cat#G1106	NA	6/14/2016	Unknown	Wet Chem 2	13SPE1	Online
SPE StepSaver 7-station Funnel	Environmental Express	Cat#G1106	NA	6/14/2016	Unknown	Wet Chem 2	13SPE2	Online
Evaporator for SPE System	Horizon Technology	Speed Vap III	08-0701	9/1/2015	Unknown	Wet Chem 2	13VAP01	Online
Hood	KEWAUNEE	NA	NA	9/1/2015	Unknown	Wet Chem 2	13HOOD3	Online
Hood	KEWAUNEE	NA	NA	9/1/2015	Unknown	Wet Chem 2	13HOOD4	Online
pH Meter	Orion	301	43996	Unknown	Unknown	Wet Chem 2	13WET9	Online

8.0 ADDENDUM: PROGRAM REQUIREMENTS

Program specific information provided in this addendum supplements the main body of this manual. Each subsection is stand-alone, meaning the requirements for the quality management system in each subsection only apply to the program referenced. Additionally, only program requirements for the quality management system that are more stringent than the content of the main body of the manual are included.

8.1 DoD/DOE

PAS-Minneapolis maintains accreditation for DoD/DoE Environmental Laboratory Approval Program (ELAP)

This addendum outlines additional policies and processes established by this laboratory to maintain compliance with DoD/DOE program specific requirements as outlined in the DoD/DOE Consolidated Quality Systems Manual (QSM) for Environmental Laboratories. The QSM incorporates ISO/IEC 17025 and the TNI Standard and includes additional program-specific requirements for laboratories that perform analytical testing services for DoD and DoE and which must be followed for DoD / DoE projects.

Section 4.2.5: Supporting Documents

Technical SOPs used for DoD/DoE testing must also include instructions for equipment and instrument maintenance, computer software/hardware, and troubleshooting.

The review frequency for technical SOPs used for DoD/DoE testing is annual, instead of every 2 years.

Section 4.4: Review of Analytical Service Requests

If the DoD/DoE customer requests a statement of conformity, the standard used for the decision rule must be communicated to and agreed on with the customer and identified in the final test report.

Laboratory requests to deviate from the requirements specified in the DoD/DoE QSM must be requested on a project-basis and include technical justifications for the deviation. These requests are submitted to and approved by the DoD/DoE project chemist or contractor, however name, in addition to the PAS client.

For DoD / DoE projects, will also seek clarification from the customer when the customer has requested an incorrect, obsolete or improper method for the intended use of data; the laboratory needs to depart from its test method SOP in order to meet project-specific data quality objectives; information in project planning documents is missing or is unclear,

Section 4.5: Subcontracting

In addition to written client approval of any subcontractor for testing, the customer is notified of the laboratory's intent to use of a subcontractor for any management system element (such as data review, data processing, project management or IT support) and consent for subcontracting is obtained approved in writing by the DoD/DoE customer and record of consent kept in the project record.

Section 4.6: Purchasing and Supplies

The laboratory procedure for records of receipt of materials and supplies used in testing also include a specification to record the date opened (DoE only).

Section 4.9.3: Nonconforming Work

The laboratory's procedure for client notification includes the 15 business day DoD /DOE time-frame for notification of the problem and the 30 business day time-frame for submission of the corrective action plan or corrective actions taken. This procedure also includes the DoD/DoE requirement for AB notification of discovery.

Section 4.13: Control of Records

Technical Records: The laboratory's procedure for logbooks includes measures to prevent the removal of or addition of pages to the logbook (applies to both hardcopy and electronic). Hardcopy logbooks are version controlled, pre-numbered and bound. Initials and entries and are signed or initialed and dated by the person making the entry and the entry is made at the time the activity is performed and in chronological order. Each page of the logbook must be closed by the last person making the entry on the page. Closure is recorded by the initial and date of the person making the last entry.

Section 5.4.7: Control of Data

The laboratory will assure LIMS passwords are changed at least once per year.

An audit of the LIMS will be incorporated into the laboratory's annual internal audit schedule.

The laboratory will have procedures in place to notify DoD/DoE customers of changes to LIMS software or hardware configurations that may impact the customer's integrity of electronic data

Section 5.9.1: Quality Control

For DoD/DOE, storage blanks are essential QC to monitor the storage of samples for volatile organic analysis (VOA). The laboratory's SOP for storage of VOA samples must include a contamination monitoring program based on the performance of storage blanks. (See QSM 5.3.3)

Section 5.8.5: Sample Disposal

For DoE projects, the record of disposal must also include how the sample was disposed and the name of the person that performed the task.

Appendix E: Support Equipment Calibration

Mechanical Volumetric Pipette: In addition to the quarterly verification check, pipettes used for DoD/DoE projects are checked daily before use using the same procedure and criteria specified for the quarterly check.

Water Purification System: The performance of the water purification system is checked daily prior to use in accordance with laboratory SOP XYZ.

Radiological Survey Equipment: The performance of the radiological survey equipment is checked daily prior to use in accordance with laboratory SOP XYZ.

Additional: (DoE): Section 6.0 of the QSM outlines additional management system requirements for the management of hazardous and radioactive materials management and health and safety practices. The laboratory, if approved for DoE, will work with the PAS Health and Safety Director to establish plans, policies and procedures that conform to these comprehensive specifications and incorporate these documents into the quality management system.

8.2 Ohio VAP

PAS–Minneapolis maintains accreditation for Ohio's Voluntary Action Program (VAP).

This addendum outlines additional policies and processes established by the laboratory to maintain compliance with Ohio's Voluntary Action Program (VAP). Specific requirements outlined in Ohio Administrative Code (OAC) 3745-300-04 include additional program-specific requirements for laboratories that perform analytical testing services for Ohio VAP and which must be followed for Ohio VAP projects.

This addendum is used in conjunction with the main body of the quality manual and with standard operating procedures (SOPs) and other quality management documents used to carry out activities. Only program requirements for the quality management system that are more stringent than the content of the main body of the manual are listed in this addendum.

In addition to the requirements outlined in the main body of the quality manual; the laboratory's procedures for implementation will also include the following:

Section 4.3.2 Document Approval and Issue
The laboratory must seek Ohio VAP review and approval of all SOPs and Quality Manual subsequent modifications prior to implementation.

Section 5.4.5.3.1 Limit of Detection (LOD)
A valid MDL must be in place prior to sample analysis. MDLs must be spiked at or below the reporting limit and will not be accepted if it was spiked higher than the reporting limit.

Section 5.5.2.2 Analytical Instrument Calibration
Samples must be reanalyzed to obtain results within the linear range unless there is insufficient sample volume for reanalysis.

Section 5.6.3.2 Reference Materials

The use of expired standards is prohibited even if they can be verified, with the exception of air standards that are revalidated against unexpired reference material or recertified by the vendor (documentation is required to be kept on file).

Section 5.8.3.2 Sample Acceptance Policy
a. The narrative for any report that includes qualified data must also include a discussion of any bias in the results when requirements outlined in the SOP cannot be performed, for example: insufficient volume for re-extraction/re-analysis, holding time exceedances, and incorrect preservative.
b. The case narrative must also include, at a minimum, discussion of any issues that impact the quality of the data with sample receipt, sample processes, or sample analyses.

Section 5.9.1: Quality Control
a. For Ohio VAP projects, the laboratory must minimize the use of qualified data. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies prior to reporting. When requirements outlined in the SOP cannot be performed, the narrative for any report that includes qualified data must also include a discussion of any bias in the results.
b. In the event of method blank having any reportable contamination, the laboratory is required to reanalyze the associated samples and the method blank if there is sufficient sample remaining. Acceptable method blanks are those that are free of contamination below the reporting limit. If the

method blank fails, appropriate corrective actions may include flagging, elevating reporting limits, or re-preparation of the entire batch, including re-digestion, re-distillation, or re-extraction, as appropriate.

c. In the event of LCS failures, the laboratory is required to reanalyze the associated samples and the LCS for all target compounds if there is sufficient sample remaining. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCS's and the MS may not be used in place of passing LCS. If the LCS fails, appropriate corrective actions may include re-preparation of the entire batch, including re-digestion, re-distillation, or re-extraction, as appropriate.

d. MS/MSD's are optional and will be directed by the Certified Professional. In the case of MS/MSD failures, the laboratory is required to reanalyze the associated samples only when the associated LCS also fails acceptance criteria and if there is sufficient sample remaining. When an LCS is acceptable and the MS results are outside of criteria, and no system anomaly is detected, the samples will be reported with appropriate data qualifiers indicating matrix interference.

e. Sample duplicates are optional and will be directed by the Certified Professional. In the case of duplicate samples exceeding the RPD criteria found in applicable analytical SOPs, the laboratory is required to reanalyze the associated sample and duplicate as long as no sampling error was detected if there is sufficient sample remaining. If the sample and duplicate still do not agree, a comment would be made stating there may be sample non-homogeneity.

f. Surrogates are not evaluated for Ohio VAP samples analyzed via EPA Method TO-15.

g. Samples with internal standard that are outside of method criteria must be reanalyzed to confirm sample matrix effect.

Section 5.8.5: Sample Disposal

All documents and data prepared or acquired in connection to VAP work must be retained for a period of 10 years after the data of reporting. After 10 years, if the laboratory wishes to dispose of the records, the laboratory must notify the VAP agency by certified mail of such intent and provide the agency an opportunity to request the materials from Pace. The documents must not be disposed of until notification has been received in response to the Pace request for disposal.

Section 5.10.3 Test Reports: Supplemental Items

a. Affidavits that summarize any exceptions to what has been reported, including but not limited to, itemizing any analytes or methods that the laboratory is not approved for under the VAP program must be prepared by project, notarized and submitted with each final report. Any analytes reported that are not part of a scope of accreditation or approval program must be clearly identified as such on the final report.

b. The report must be accompanied by a copy of a sample receipt form that records, at a minimum, the following information:

(i) Temperature of samples when received by the laboratory, if the method requires monitoring.

(ii) Date and time samples were received by the laboratory.

(iii) Notation of whether holding times specified in standard operating procedures for sample preparation and analysis were exceeded.

(iv) Any exceptions or special instructions for sample handling, analysis, or reporting.

(v) Notation of whether samples have appropriate labeling, such as the date and time of sample collection and a sample identification notation.

(vi) Notation of whether sample containers contain appropriate sample preservatives, if applicable.

(vii) Description of the general condition of sample containers, including whether any containers are damaged or improperly filled.

Appendix D

Preliminary Proposal for

Ozone Injection Treatment System

PIPER
Environmental Group

September 13, 2019

Delivered via e-mail

Chris Sloffer, CHMM
Elam
161 Lakeview Drive, Suite B
Noblesville, IN 46060

Re: Former Cherry Street Cleaners, 2510 E. Cherry Street, Seattle, WA.

Dear Mr. Sloffer,

Thank you for your interest in Piper Environmental Group, Inc.'s (herein “Piper” or “we”) innovative remediation systems and services. We are pleased to present this proposal for your review. Piper has provided solutions for contaminated process water, soil and groundwater remediation projects since 1993. We are confident that we’re uniquely qualified for this project:

- ✓ We have designed over 800 unique projects in the last 25 years, many of which are similar to your need.
    a. We have been designing and building in-situ ozone applications for 20 years and have extensive experience in your specific application during this time.
    b. Our applications include Wastewater, Ex-situ remediation, and Advanced Oxidation Processes, all similar applications.
    c. We have additional experience in municipal drinking water, food processing, and a variety of industrial applications, specializing in groundwater cleanup with a passion for clean drinking water worldwide.
- ✓ We have proven success eliminating pharmaceutical by-products, pesticides, SVOC’s, VOC’s, RDX, PAH, BTEX solvents such as 1, 4-dioxane, TCE, PCE and their daughter products.
- ✓ Wastewater, process water, food processing, pharmaceutical waste, and all recalcitrant hydrocarbon processes, drinking water, ex-situ remediation, and in-situ remediation, are our primary market focus.
- ✓ With over 25 years of successful experience in the ozone equipment business, we have a proven track record of designing unique, durable industrial equipment. Our design/build systems are capable of long-term operation in challenging environments and extreme conditions, when used with our comprehensive maintenance program.

Piper is a certified 100% woman-owned and woman-managed small business that has been self-financed to date. Our unique partnership with Primozone in Sweden has allowed us to

expand our capabilities here and abroad. For heavily contaminated sites, we utilize Primozone exclusively as they offer compact, energy and oxygen saving ozone generators that produce high concentration ozone (17% concentration by weight). This has proven success with PFOS/PFOA, pesticides, pharmaceutical, and microplastic.

Piper's Certifications include:

- ✓ **ISNetworld: International Safety Network**
- ✓ **EDWOSB: Economically Disadvantage (Self-Certified)**
- ✓ **DBE: Disadvantage Business Enterprise (DOT CUCP)**
- ✓ **WBE: California Women Owned Business Enterprise**
- ✓ **WBENC: Women Business Enterprise National Council**
- ✓ **WOSB: Women Owned Small Business**
- ✓ **CA State: Certification of Good Standing (as needed by date)**
- ✓ **Sam Reg.: Certification Cage 32MG2**

We look forward to fulfilling your design-build ozone needs, providing innovative solutions for your consideration, and creating our successful local partnership.

As a next step in our timely process; please closely consider the details of the following proposal; including the detailed scope of work; the pricing and additional service options, the timeframes, and the terms and conditions.

I recommend we set up a conference call next week to go over any questions, possible changes to the proposal, and decide on next steps. Please contact me at 831-917-5261, or via email with time and dates that would work along with any concerns or questions.

Your Project Team,

Jane Piper
President & CEO
jpiper@peg-inc.com

Contents

1.0 Background

1.1 Ozone Technology Introduction

Ozone is considered a green technology as ozone (O_3) is produced from oxygen (O_2) and electricity. Ozone is made from oxygen and reverts to oxygen. Complex organics break down in the presence of ozone to CO_2 and less persistent and less toxic molecules. The decomposition of ozone leads to oxygenation, which enhances bioremediation of aerobically degradable compounds.

- Ozone is the strongest oxidant available
- Ozone gas is easily distributed through soil
- Ozone is an unstable gas with a half life ranging from seconds to days, dependent upon contaminant load, temperature, and pressure
- Ozone decomposes into oxygen after it reacts with contaminants

Ozone excels with contaminants such at BTEX, TCE, VOC's, MTBE, aliphatic hydrocarbons, heavy hydrocarbons, diesel, chlorinated solvents, etc.

1.2 Ozone at your facility

Your Former Dry Cleaner in Washington State is an ideal candidate for our low cost trailer system providing 5.5 pounds per day at 50 psi output without the need for boost ozone compressors, which are a high maintenance item

From the information provided, we understand "The site has approximately 10 feet of silt soil overlying silty sand, and the water table is approximately 25 feet below grade. The previous consultant injected a lot of EOS (safety data sheet attached) into the water several years ago, and we currently have free product EOS floating on the water surface in several wells. The oil has sequestered a majority of the chlorinated compounds from the groundwater. We are planning to excavate some soil from the surface, and then treat the remaining silt soil with gravity-infiltration of sodium permanganate. We have explored the use of ISCO injection, but have concerns about dosage and releasing the sequestered compounds back into the groundwater. As we discussed, I am interested in ozone sparging to manage dissolved phase, sequestered phase and deeper vadose zone chlorinated impacts, as well as oxidizing the remaining EOS. Regarding an estimate of PCE mass, I believe we are looking at approximately 30 lbs of PCE. Most of which is located in the vadose zone soil (~90%) and the remainder present in the free oil [74 mg PCE / kg of oil] and groundwater [1 mg PCE / liter of water].

Regarding SVE testing, and the estimated ROIs provided in text of remedial investigation:

- upper silt soil = 15 feet
- deeper silty sand = 30 feet
- sparge = 50 feet

Injection points will equal 12 with 6 above the oil level and 6 within the groundwater.

2.0 Proposal Overview

2.1 "Absolute Ozone" Ozone System Overview

This proposal is based on the use of Piper Environmental Group Inc.'s automated PLC controlled trailer or building ozone injection system. Injection gas types are Oxygen/ Sparge Air mix, and Ozone/ Sparge Air mix. Gas types are selected via the touch screen HMI (human machine interface) and controlled by the PLC.

Unique to Piper Environmental Group, Inc.'s integrated ozone remediation systems is the methodology for programming, monitoring, and controlling the injection field sequence. Programming the injection sequence is a simple and intuitive process. For each number of injection valves, there are as many steps. The "steps" are individual screens where the injection gas type for the step being programmed (Oxygen/ Sparge Air mix, and Ozone/ Sparge Air mix), run time duration for that step, and injection valves to be open for that step are chosen. The steps can be enabled or disabled to run once programmed.

At the heart of the control system is a Koyo Direct Logic PLC which monitors and controls all equipment and instrumentation. All facets of programming the run time, injection sequence and alarm notification is accessed through the 6" gray scale touch screen HMI. The selected gas for each individually programmable step is distributed by a multi point stainless steel injection manifold. The manifold is built with stainless steel solenoid valves containing Viton plunger seals. In additional to multiple gas delivery method, the system is equipped with numerous monitoring and safety devices designed for operator safety and equipment protection.

If this option is chosen, a high concentration monitor measures ozone production in % concentration by weight with data logging as an option. As a safety precaution, a low concentration ozone monitor is provided for shutdown of the system in the event of a leak and keeps check on ambient ozone levels inside the enclosure.

In the event any parameter falls out of the programmed operating range during start up or while in operation, the system will set about selectively turning off pre-defined outputs, enter a 90 second purge cycle before shutdown, and display an alarm message on the HMI.

A "Rapid Cycle" program allows the user to select and program a single time base for each valve. This injection sequence program is separate from the main program setup by the operator. When the operator presses "Rapid Cycle Start", the valves cycle sequentially for those valves selected to run. This aids in leak down testing and purging the system of ozone.

2.2 "Absolute Ozone" Ozone System Summary

1. One (1) "Absolute Ozone" ozone generator producing 5.5 lb per day ozone generator, capable of operating at **40 psig.** This is a pressurized system and air cooled. We elected not to use Primozone due to cooling water needs (this is system we talked about on the phone.) This negates the need for a boost ozone compressor, which is suspected to be the primary issue you have with other systems.
2. System capable of a total flow of **2-3 scfm @ 40 psi.**

3. One (1) Atlas Copco rotary screw air compressor, 240 V AC Single Phase.
   3.1. One (1) oxygen generator/concentrator capable of supplying sufficient oxygen at required pressure for above ozone generator – or - upgrade this to an AirSep AS-A in place of smaller oxygen generator required to provide oxygen-feed to ozone generator. It also reduces downtime, replacement of oxygen concentrator.
4. One ozone manifold for 18 injection wells.
5. The ozone system set up with a telemetry package to control the system (turn on, shutdown, and program sequences). Contractor must provide a portable computing device (less than $600) with any and all necessary programs for the telemetry package installed and operating.
   5.1. Note: We utilize web based software, no additional programs are necessary to run our system. A small laptop is not necessary.
   5.2. Note: If using AT&T for telemetry, note that they use a NVG510 modem and we will require a second modem (Linksys). This will cascade to the second modem and allow for port forwarding (necessary for telemetry).
6. Automated touch-screen control panel (human/machine interface or "HMI") capable of opening and closing any individual or any group of up to four solenoids simultaneously in timed "steps" that can be field programmed to allow focused distribution of sparge gas.
   6.1. Required labor to program PLC/HMI.
   6.2. PLC program to have a minimum of 30 steps to allow valve sequence programming flexibility
7. One (1) automated ozone distribution manifold with eighteen ports, including
   7.1. Eighteen (18) ¼" Stainless steel and Viton solenoid valves.
   7.2. Valves supplied with ½" Kynar compression fittings.
8. One (1) ambient ozone monitor (mounted in trailer) interlocked, via the PLC, to shut down the ozone generator in the event of an ozone leak.
9. All required interconnecting wiring to provide power and controls to the equipment with a single power source input line (sub-panels as needed to step down power for various lower-voltage components of the system).
10. One (1) 8,500 BTU/Hr air conditioning unit installed in trailer.
11. Equipment delivery and off-loading. Contractor to provide any additional equipment, such as forklift for off-loading of ozone system.
12. Three (3) days of set up and start up equipment. G&RK to provide labor assistance to unload equipment and placement in final location.

Electrical connection to be made by client:

1. 240 VAC, Single Phase service to trailer, including final hook up to main disconnect on trailer

System price as specified: $ XXXXXXXXXX

3.0 Clarifications

1. Piper Environmental quote includes the labor, assembly, piping and electrical materials for the fabrication of the system as listed above.

2. Proposal is based on using non-union labor to perform our scope of work as outlined herein.
3. Recommended operation and routine maintenance of the system, including, but not limited to:
    a. Service contract with reputable air compressor service company one time every three months to provide preventive maintenance of the equipment
    b. Service compressed air filters as required
    c. Turn on heating and cooling equipment as required maintaining proper ambient temperatures (+40 deg F to 85 deg F) inside the trailer
4. Training for operators is provided once during mobilization and start-up from North Carolina
10. Recommend Quarterly on-site service by Piper Environmental Group, Inc. Telephone support, within reason, will be provided. Within reason is defined as 2 hours per month for three months, after startup. Additional engineering is available at rate of $125.00 per hour.
11. Qualified operation and maintenance personnel are to be provided by client.
12. Any waste liquids generated by the operation or maintenance of the ozone system, such as compressor condensate water or glycol/water mixture will be disposed in a legal manner by client.
13. Regular preventative maintenance of equipment, such as lubrication, filter changes, cleaning, etc is the responsibility of client.
14. All tubing carrying compressed air to be either HDPE (50 PSI and under) or soft annealed copper (over 50 PSI).
15. All tubing carrying ozone to be Stainless Steel or Teflon tubing.
16. All electrical conduits to be chemically welded (glued) PVC. All flexible electrical conduits will be solid PVC with water tight connections. Maximum length of flexible conduit not to exceed 6'.
17. THNN or THWN, or equivalent stranded copper wiring will be used for all circuits and wired per NEC. All insulation will be 600 Vac rated.
18. Obtaining any required site permits (i.e. building) is the responsibility of the customer; Piper is not responsible for any such items.
19. All required site inspectors including but not limited to air quality management, electrical, building and fire are the responsibility of the customer, Piper is not responsible for any such items.
20. Piper General Terms & Conditions are located at the end of quote in Appendix A.
21. Piper Warranty Statement is located at the end of quote in Appendix B.
22. Piper General Qualifications Statement is located at end of quote in Appendix C

4.0 Appendix A – General Terms and Conditions

For Equipment Purchase

General Terms and Conditions will be negotiated with subcontract team.

1. The estimated price for the system, as designed, is $XXXXXXXXX
2. Proposal is based on using non-union labor to perform our scope of work as outlined herein
3. Any and all shipment fees, documentation required from manufacturer to location is $XXXXXXXXXXX.
4. Start up fees are $XXXXXXXXXX
5. Well head connections and injection points are $XXXXXXXX (for 12 injection wells)
6. Lead time is currently 3 months after receipt of order and down-payment dependent upon backlog.
7. Price is valid for 30 days.

In order to maintain our pricing structure, as we have not included “cost of money” to finance this project, we request the following payment schedule be included in the contract:

1. Fifty (50) % down payment with order
2. Thirty (30) % one month prior to start up
3. Ten (10) % upon shipment
4. Ten (10) % upon start-up, acceptance of equipment, or sixty (60) days post shipment, whichever comes first.

Changes to terms may change price above.

Based on our experience, the above terms coincide very closely with our outlay of expenses, including major equipment, time and resources. As an alternate, we can bill based on MS Project completion of tasks and ordering. This would be done at two-week intervals with a report. To do this, extra administrative time would be involved and this was not included in the pricing summary.

If for any reason, equipment is complete and ready to go and is held at our location due to site not being ready, we request Item 4 be paid. We can accommodate “holding” the containers for one month following completion date. After that, we require storage fees, to be negotiated.

5.0 Appendix B – Warranty

Piper Environmental Group, Inc. represents that its equipment and designs are warranted against component failure and workmanship, but under no circumstances can we warrant against site circumstances and operating conditions outside of our control.

Piper Environmental Group, Inc. warrants and guarantees products of its manufacture against defective workmanship or material for a period of one year from the date of shipment.

This warranty is expressly and strictly limited to replacing, without charge, any part or parts which prove to Piper Environmental Group, Inc.'s satisfaction upon examination, to have been defective and which have not been neglected, abused or misapplied, provided the buyer gives Piper Environmental Group, Inc. immediate written notice upon discovery of any claimed defect.

Piper Environmental Group, Inc. also guarantees component parts manufactured by others to the extent of the guarantee made by the manufacturer of such equipment. In any case, guarantees on specific components will be extended a minimum of one year from date of receipt at Piper Environmental Group, Inc's manufacturing facility or upon receipt of equipment at client's facility, whichever the component part manufactured by others allows.

5.1 Warranty Exclusions

Warranty coverage does not include:

1. Freight, labor, travel, living expenses, or coordination time of activities associated with parts replacement or warranty claims
2. Normal maintenance items such as lubrication, fan belts, and cleaning of the equipment

In the event the customer, or any installation contractor employed by the customer, contracts outside of Piper Environmental Group, Inc. for installation work of quoted system without written consent, the customer shall assume full responsibility for said contract.

5.2 Conditions of Warranty

Piper Environmental Group, Inc highly recommends that the system is started by an experienced Piper Environmental Group, Inc startup team to ensure the long term success of your system/project. We understand that this may not always be feasible in which case we require a highly skilled startup technician capable of troubleshooting both mechanical and electrical aspects of a process treatment system to be used. This individual must be familiar with the system manual, experienced with our Ozone Injection Systems and capable of training the end user/owner/operator on operating and maintenance requirements of the treatment system.

The startup checklist provided in the manual must be completed and returned to Piper Environmental Group, Inc to validate equipment warranty.

Appendix E

Environmental Covenant

After Recording Return
Original Signed Covenant to:
CHRISTOPHER MAURER, P.E.
DEPARTMENT OF ECOLOGY
VOLUNTARY CLEANUP PROGRAM
P.O. BOX 47600
OLYMPIA, WA 98504

Environmental Covenant

(For MTCA Sites – August 20, 2015 Version)

Grantor: BENTON, VERA
Grantee: State of Washington, Department of Ecology (hereafter "Ecology")
Brief Legal Description: GAMMA PONCIN ADDITION, LOT 7, BLOCK 6
Tax Parcel Nos.: 6840700205
Cross Reference: N/A

RECITALS

a. This document is an environmental (restrictive) covenant (hereafter "Covenant") executed pursuant to the Model Toxics Control Act ("MTCA"), chapter 70.105D RCW, and Uniform Environmental Covenants Act ("UECA"), chapter 64.70 RCW.

b. The Property that is the subject of this Covenant is part or all of a site commonly known as FORMER CHERRY STREET CLEANERS AND VCP ID: NW2009**.** The Property is legally described in Exhibit A, and illustrated in Exhibit B, both of which are attached (hereafter "Property"). If there are differences between these two Exhibits, the legal description in Exhibit A shall prevail.

c. The Property is the subject of remedial action conducted under MTCA. This Covenant is required because residual contamination remains on the Property after completion of remedial actions. Specifically, the following principal contaminants remain on the Property:

Medium	Principal Contaminants Present
Soil	tetrachlorothene ("PCE"), trichloroethene ("TCE"), *cis*-1,2-dichloroethene ("c-DCE"), and vinyl chloride ("VC")
Groundwater	PCE, TCE, c-DCE, and VC
Surface Water/Sediment	

d. It is the purpose of this Covenant to restrict certain activities and uses of the Property to protect human health and the environment and the integrity of remedial actions conducted at the site. Records describing the extent of residual contamination and remedial actions conducted are available through Ecology.

e. This Covenant grants Ecology certain rights under UECA and as specified in this Covenant. As a Holder of this Covenant under UECA, Ecology has an interest in real property, however, this is not an ownership interest which equates to liability under MTCA or the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. § 9601 *et seq.* The rights of Ecology as an "agency" under UECA, other than its' right as a holder, are not an interest in real property.

COVENANT

VERA BENTON, as Grantor and FEE SIMPLE owner of the Property hereby grants to the Washington State Department of Ecology, and its successors and assignees, the following covenants. Furthermore, it is the intent of the Grantor that such covenants shall supersede any prior interests the GRANTOR has in the property and run with the land and be binding on all current and future owners of any portion of, or interest in, the Property.

Section 1. General Restrictions and Requirements.

The following general restrictions and requirements shall apply to the Property:

a. Interference with Remedial Action. The Grantor shall not engage in any activity on the Property that may impact or interfere with the remedial action and any operation, maintenance, inspection or monitoring of that remedial action without prior written approval from Ecology.

b. Protection of Human Health and the Environment. The Grantor shall not engage in any activity on the Property that may threaten continued protection of human health or the environment without prior written approval from Ecology. This includes, but is not limited to, any activity that results in the release of residual contamination that was contained as a part of the remedial action or that exacerbates or creates a new exposure to residual contamination remaining on the Property.

c. Continued Compliance Required. Grantor shall not convey any interest in any portion of the Property without providing for the continued adequate and complete operation, maintenance and monitoring of remedial actions and continued compliance with this Covenant.

d. Leases. Grantor shall restrict any lease for any portion of the Property to uses and activities consistent with this Covenant and notify all lessees of the restrictions on the use of the Property.

e. Preservation of Reference Monuments. Grantor shall make a good faith effort to preserve any reference monuments and boundary markers used to define the areal extent of coverage of this Covenant. Should a monument or marker be damaged or destroyed, Grantor shall have it replaced by a licensed professional surveyor within 30 days of discovery of the damage or destruction.

Section 2. Specific Prohibitions and Requirements.

In addition to the general restrictions in Section 1 of this Covenant, the following additional specific restrictions and requirements shall apply to the Property:

a. Land Use.

Commercial Land Use: The remedial action for the Property is based on a cleanup designed for commercial property. As such, the Property shall be used in perpetuity only for commercial land uses as that term is defined in the rules promulgated under Chapter 70.105D RCW. Prohibited uses on the Property include but are not limited to residential uses, childcare facilities, K-12 public or private schools, parks, grazing of animals, and growing of food crops.

b. Containment of Soil/Waste Materials.

The remedial action for the Property is based on containing contaminated soil under a cap consisting of approximately one and one-half feet of clean soil and located as specified in **Exhibit A** and as illustrated in **Exhibit B.** The primary purpose of this cap is to minimize the potential for contact with contaminated media and prevent runoff from contacting contaminated media. As such, the following restrictions shall apply within the area illustrated in **Exhibit B**:

Any activity on the Property that will compromise the integrity of the cap including: drilling; digging; piercing the cap with sampling device, post, stake or similar device; grading; excavation; installation of underground utilities; removal of the cap; or, application of loads in excess of the cap load bearing capacity, is prohibited without prior written approval by Ecology. The Grantor shall report to Ecology within forty-eight (48) hours of the discovery of any damage to the cap. Unless an alternative plan has been approved by Ecology in writing, the Grantor shall promptly repair the damage and submit a report documenting this work to Ecology within thirty (30) days of completing the repairs.

The Grantor covenants and agrees that it shall annually, or at another time as approved in writing by Ecology, inspect the cap and report within thirty (30) days of the inspection the condition of the cap and any changes to the cap that would impair its performance.

c. Stormwater facilities.

To minimize the potential for mobilization of contaminants remaining in the soil and groundwater on the Property, no stormwater infiltration facilities or ponds shall be constructed on the Property. All stormwater catch basins, conveyance systems, and other appurtenances located within this area shall be of water-tight construction.

d. Vapor controls.

The residual contamination on the Property includes volatile chemicals that may generate harmful vapors. As such, the following restrictions shall apply on the Property to minimize the potential for exposure to these vapors:

1. No building or other enclosed structure shall be constructed on the Property unless approved by Ecology.
2. If a building or other enclosed structure is approved, it shall be constructed with a sealed foundation and a vapor control system that is operated and maintained to prevent the migration of vapors into the building or structure, unless an alternative approach is approved by Ecology.

e. Groundwater Use.

The groundwater beneath the Property remains contaminated and shall not be extracted for any purpose other than temporary construction dewatering, investigation, monitoring or remediation. Drilling of a well for any water supply purpose is strictly prohibited. Groundwater extracted from the Property for any purpose shall be considered potentially contaminated and any discharge of this water shall be done in accordance with state and federal law.

f. Monitoring.

Several groundwater monitoring, vapor probes and injection wells are located on the Property to monitor the performance of the remedial action. The Grantor shall maintain clear access to these devices and protect them from damage. The Grantor shall report to Ecology within forty-eight (48) hours of the discovery of any damage to any monitoring device. Unless Ecology approves of an alternative plan in writing, the Grantor shall promptly repair the damage and submit a report documenting this work to Ecology within thirty (30) days of completing the repairs.

f. Slab-on-Grade Construction.

No buildings or structures of any kind shall be constructed on the property with a sub-grade foundation deeper than surface grade.

Section 3. Access.

a. The Grantor shall maintain clear access to all remedial action components necessary to construct, operate, inspect, monitor and maintain the remedial action.

b. The Grantor freely and voluntarily grants Ecology and its authorized representatives, upon reasonable notice, the right to enter the Property at reasonable times to evaluate the effectiveness of this Covenant and associated remedial actions, and enforce compliance with this Covenant and those actions, including the right to take samples, inspect any remedial actions conducted on the Property, and to inspect related records.

c. No right of access or use by a third party to any portion of the Property is conveyed by this instrument.

Section 4. Notice Requirements.

a. Conveyance of Any Interest. The Grantor, when conveying any interest in any part of the Property including but not limited to title, easement, leases, and security or other interests, must:

1. Provide written notice to Ecology of the intended conveyance at least thirty (30) days in advance of the conveyance.
2. Include in the conveying document a notice in substantially the following form, as well as a complete copy of this Covenant:

NOTICE: THIS PROPERTY IS SUBJECT TO AN ENVIRONMENTAL COVENANT GRANTED TO THE WASHINGTON STATE DEPARTMENT OF ECOLOGY ON _____ AND RECORDED WITH THE KING COUNTY AUDITOR UNDER RECORDING NUMBER _____. USES AND ACTIVITIES ON THIS PROPERTY MUST COMPLY WITH THAT COVENANT, A COMPLETE COPY OF WHICH IS ATTACHED TO THIS DOCUMENT.

3. Unless otherwise agreed to in writing by Ecology, provide Ecology with a complete copy of the executed document within thirty (30) days of the date of execution of such document.

b. Reporting Violations. Should the Grantor become aware of any violation of this Covenant, Grantor shall promptly report such violation in writing to Ecology.

c. Emergencies. For any emergency or significant change in site conditions due to Acts of Nature (for example, flood or fire) resulting in a violation of this Covenant, the Grantor is authorized to respond to such an event in accordance with state and federal law. The Grantor must notify Ecology in writing of the event and response actions planned or taken as soon as practical but no later than within 24 hours of the discovery of the event.

d. Notification procedure. Any required written notice, approval, reporting or other communication shall be personally delivered or sent by first class mail to the following persons. Any change in this contact information shall be submitted in writing to all parties to this Covenant. Upon mutual agreement of the parties to this Covenant, an alternative to personal

delivery or first class mail, such as e-mail or other electronic means, may be used for these communications.

Vera Benton ***P.O. Box 145*** ***Grand Coulee, WA 99133*** ***(509) 633-1147***	Environmental Covenants Coordinator Washington State Department of Ecology Toxics Cleanup Program P.O. Box 47600 Olympia, WA 98504 – 7600 (360) 407-6000 ToxicsCleanupProgramHQ@ecy.wa.gov

Section 5. Modification or Termination.

a. Grantor must provide written notice and obtain approval from Ecology at least sixty (60) days in advance of any proposed activity or use of the Property in a manner that is inconsistent with this Covenant. For any proposal that is inconsistent with this Covenant and permanently modifies an activity or use restriction at the site:

i. Ecology must issue a public notice and provide an opportunity for the public to comment on the proposal; and

ii. If Ecology approves of the proposal, the Covenant must be amended to reflect the change before the activity or use can proceed.

b. If the conditions at the site requiring a Covenant have changed or no longer exist, then the Grantor may submit a request to Ecology that this Covenant be amended or terminated. Any amendment or termination of this Covenant must follow the procedures in MTCA and UECA and any rules promulgated under these chapters.

c. By signing this agreement, per RCW 64.70.100, the original signatories to this agreement, other than Ecology, agree to waive all rights to sign amendments to and termination of this Covenant.

Section 6. Enforcement and Construction.

a. This Covenant is being freely and voluntarily granted by the Grantor.

b. Within ten (10) days of execution of this Covenant, Grantor shall provide Ecology with an original signed Covenant and proof of recording and a copy of the Covenant and proof of recording to others required by RCW 64.70.070.

c. Ecology shall be entitled to enforce the terms of this Covenant by resort to specific performance or legal process. All remedies available in this Covenant shall be in addition to any and all remedies at law or in equity, including MTCA and UECA. Enforcement of the terms of this Covenant shall be at the discretion of Ecology, and any forbearance, delay or omission to exercise its rights under this Covenant in the event of a breach of any term of this Covenant is not a waiver by Ecology of that term or of any subsequent breach of that term, or any other term in this Covenant, or of any rights of Ecology under this Covenant.

d. The Grantor shall be responsible for all costs associated with implementation of this Covenant. Furthermore, the Grantor, upon request by Ecology, shall be obligated to pay for Ecology's costs to process a request for any modification or termination of this Covenant and any approval required by this Covenant.

e. This Covenant shall be liberally construed to meet the intent of MTCA and UECA.

f. The provisions of this Covenant shall be severable. If any provision in this Covenant or its application to any person or circumstance is held invalid, the remainder of this Covenant or its application to any person or circumstance is not affected and shall continue in full force and effect as though such void provision had not been contained herein.

g. A heading used at the beginning of any section or paragraph or exhibit of this Covenant may be used to aid in the interpretation of that section or paragraph or exhibit but does not override the specific requirements in that section or paragraph.

[GRANTOR'S SIGNATURE BLOCK FOR ORIGINAL COVENANTS]

The undersigned Grantor warrants she holds the title to the Property and has authority to execute this Covenant.

EXECUTED this _____ day of _____, 20___.

_____ [SIGNATURE]

by: _____ [PRINTED NAME]

Title: _____

INDIVIDUAL ACKNOWLEDGMENT

STATE OF
COUNTY OF

On this___ day of _____, 20__, I certify that _____ personally appeared before me, acknowledged that she is the individual described herein and who executed the within and foregoing instrument and signed the same at her free and voluntary act and deed for the uses and purposes therein mentioned.

_____
Notary Public in and for the State of Washington

Residing at _____

My appointment expires _____

[ECOLOGY'S SIGNATURE BLOCK]

The Department of Ecology**,** hereby accepts the status as GRANTEE and HOLDER of the above Environmental Covenant.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

_____ [SIGNATURE]

by: _____ [PRINTED NAME]

Title: _____

Dated: _____

STATE ACKNOWLEDGMENT

STATE OF

COUNTY OF

On this _____ day of _____, 20__, I certify that _____ personally appeared before me, acknowledged that **he/she** is the_____ of the state agency that executed the within and foregoing instrument, and signed said instrument by free and voluntary act and deed, for the uses and purposes therein mentioned, and on oath stated that **he/she** was authorized to execute said instrument for said state agency.

_____
Notary Public in and for the State of Washington

Residing at _____

My appointment expires _____

Exhibit A

Legal Description

Lot 7, Block 6, Gamma Poncin Addition, according to the plat thereof recorded in volume 20 of Plats, Page 51, records of King County, Washington.
SITUATE in the County of King, State of Washington.
Commonly known as: 2510 E. Cherry Street, Seattle, WA 98122

20080902000821
HECKER WAKEFIE NTS 45.00
PAGE001 OF 004
09/02/2008 10:53
KING COUNTY, WA

WHEN RECORDED RETURN TO

Name Hecker Wakefield & Feilberg, P.S.
Address 321 First Avenue West
City, State, Zip Seattle, WA 98119

NOTICE OF TRUSTEE'S SALE
PURSUANT TO THE REVISED CODE OF WASHINGTON CHAPTER 61.24, ET. SEQ.

Reference # (If Applicable)
Grantors (Seller) (1) Vera E. Benton

Grantees (Buyer) (1) Evergreen Moneysource Mortgage Company

Legal Description (abbreviated): GAMMA PONCIN ADD., LOT 7, BLK 6
Assessor's Tax Parcel ID#: 684070-0205

TO: Vera E. Benton
2510 E. Cherry Street
Seattle, WA 98122

AND TO: Occupant(s)
2510 E. Cherry Street
Seattle, WA 98122

AND TO: Joe E. Benton/John Doe Benton
and/or Unknown Domestic Partner of Vera E. Benton
2510 E. Cherry Street
Seattle, WA 98122

AND TO: Vera E. Benton
732 South Wanapum Drive
Moses Lake, Washington 98837

AND TO: Vera E. Benton
738 South Wanapum Drive
Moses Lake, Washington 98837

AND TO: John J. Houlihan, Jr.
3401 Evanston Avenue North
Suite C
Seattle, WA 98103

I

NOTICE IS HEREBY GIVEN that the undersigned Trustee will on the 19th day of December, 2008, at the hour of 10:00 o'clock, a.m., on the Front Steps of the King County Administrative Building, First Floor Outer Lobby, 500 Fourth Avenue, in the City of Seattle, State of Washington, sell at public auction to the highest and best bidder, payable at the time of sale, the following described real property, situated in the County (ies) of King, State of Washington, to-wit:

Lot 7, Block 6, Gamma Poncin Addition, according to the plat thereof recorded in Volume 20 of Plats, Page 51, records of King County, Washington.

SITUATE in the County of King, State of Washington

Commonly known as: 2510 E. Cherry Street, Seattle, WA 98122

which is subject to the certain Deed of Trust dated, July 19, 2007, recorded on July 20, 2007 under Auditor's/Recorder's No. 20070720002019, records of King County, Washington from as Grantor to Hecker Wakefield & Feilberg, P.S., as Trustee, to secure an obligation in favor of Evergreen Moneysource Mortgage Company, as beneficiary.

II

No action commenced by the Beneficiary of the Deed of Trust is now pending to seek satisfaction of the obligation in any Court by reason of the Borrower's or Grantor's default on the obligation secured by the Deed of Trust.

III

The Beneficiary alleges default of the Deed of Trust for failure to pay the following amounts now in arrears and/or other defaults.

Failure to make balloon principal payment on January 21, 2008:	75,000.00
Interest at 12% per annum from June 20, 2007 through January 21, 2008:	5,301.37
2% fee for thirty (30) day extension from October 20, 2007 through November 20, 2007.	1,500.00
2% fee for thirty (30) day extension from November 20, 2007 through December 20, 2007:	1,500.00
2% fee for thirty (30) day extension from December 22, 2007 through January 21, 2008:	1,500.00
Default interest at the rate of 18% per annum on principal and extension fees ($79,500.00) from January 22, 2008 through August 29, 2008:	8,626.20
TOTAL DEFAULT OTHER THAN FAILURE TO MAKE MONTHLY PAYMENTS:	**$93,427.57**

IV

The sum owing on the obligation secured by the Deed of Trust is: **Principal $75,000.00, together with interest as provided in the note or other instrument secured from the 19th day of July, 2007, and such other costs and fees as are due under the note or other instrument secured, and as are provided by statute TOGETHER** with the amounts listed as charges costs and fees on the two (2) Deeds of Trust being foreclosed herewith simultaneously (i.e.: approximately $4,670.00 on August 29, 2008 and $6,690.00 on December 8, 2008).

V

The above described real property will be sold to satisfy the expense of sale and the obligation secured by the Deed of Trust as provided by statute. The sale will be made without warranty, expressed or implied, regarding title, possession, or encumbrances on the 19th day of December, 2008. The default(s) referred to in paragraph III must be cured by the 8th day of December, 2008 (11 days before the sale) to cause a discontinuance of the sale. The sale will be discontinued and terminated if at any time on or before the 8th day of December, 2008 (11 days before the sale) the default(s) as set forth in Paragraph III is/are cured and the Trustee's fees and costs are paid. The sale may be terminated any time after the 8th day of December, 2008 (11 days before the sale date), and before the sale by the Borrower, Grantor, any Guarantor, or the Holder of any recorded junior lien or encumbrance paying the entire principal and interest secured by the Deed of Trust, plus costs, fees, and advances, if any, made pursuant to the terms of the obligation and/or Deed of Trust and curing all other defaults.

VI

A written notice of default was transmitted by the Beneficiary or Trustee to the Borrower and Grantor at the following addresses:

TO: Vera E. Benton
2510 E. Cherry Street
Seattle, WA 98122

AND TO: Occupant(s)
2510 E. Cherry Street
Seattle, WA 98122

by both first class and certified mail on the 27th day of June, 2008, proof of which is in the possession of the Trustee; and the Borrower and Grantor were personally served on 29th day of June, 2008, with said written notice of default or the written notice of default was posted in a conspicuous place on the real property described in paragraph I above, and the Trustee has in possession of proof of such service or posting.

VII

The Trustee whose name and address are set forth below will provide in writing to anyone requesting it, a statement of all costs and fees due at any time prior to the sale.

VIII

The effect of the sale will be to deprive the Grantor and all those who hold by, through or under the Grantor of all their interest in the above described property.

IX

Anyone having any objections to this sale on any grounds whatsoever will be afforded an opportunity to be heard as to those objections if they bring a lawsuit to restrain the sale pursuant to RCW 61.24.130. Failure to bring such a lawsuit may result in a waiver of any proper grounds for invalidating the Trustee's sale.

X

Notice to Occupants or Tenants

The Purchaser at the Trustee's Sale is entitled to possession of the property on the 20th day following the sale, as against the Grantor under the Deed of Trust (the owner) and anyone having an interest junior to the Deed of Trust, including occupants and tenants. After the 20th day following the sale the purchaser has the right to evict occupants and tenants by summary proceedings under the unlawful detainer act, chapter 59.12 RCW.

HECKER WAKEFIELD & FEILBERG, P.S.,
TRUSTEE

DATED: August 29, 2008

By: Jordan M. Hecker
Address: 321 First Avenue West
Seattle, Washington 98119
(206) 447-1900

This is an attempt to collect a debt and any information obtained will be used for that purpose.

STATE OF WASHINGTON)
) ss.
COUNTY OF KING)

On this 28th day of August, 2008, before me, the undersigned, a Notary Public in and for the State of Washington, duly commissioned and sworn, personally appeared **Jordan M. Hecker** to me known to be the President of **Hecker Wakefield & Feilberg, P.S.**, the corporation that executed the foregoing instrument, and acknowledged the said instrument to be the free and voluntary act and deed of said corporation, for the uses and purposes therein mentioned, and an oath stated that he is authorized to execute the said instrument.

Witness my hand and official seal hereto affixed the day and year first above written.

K. Boyker

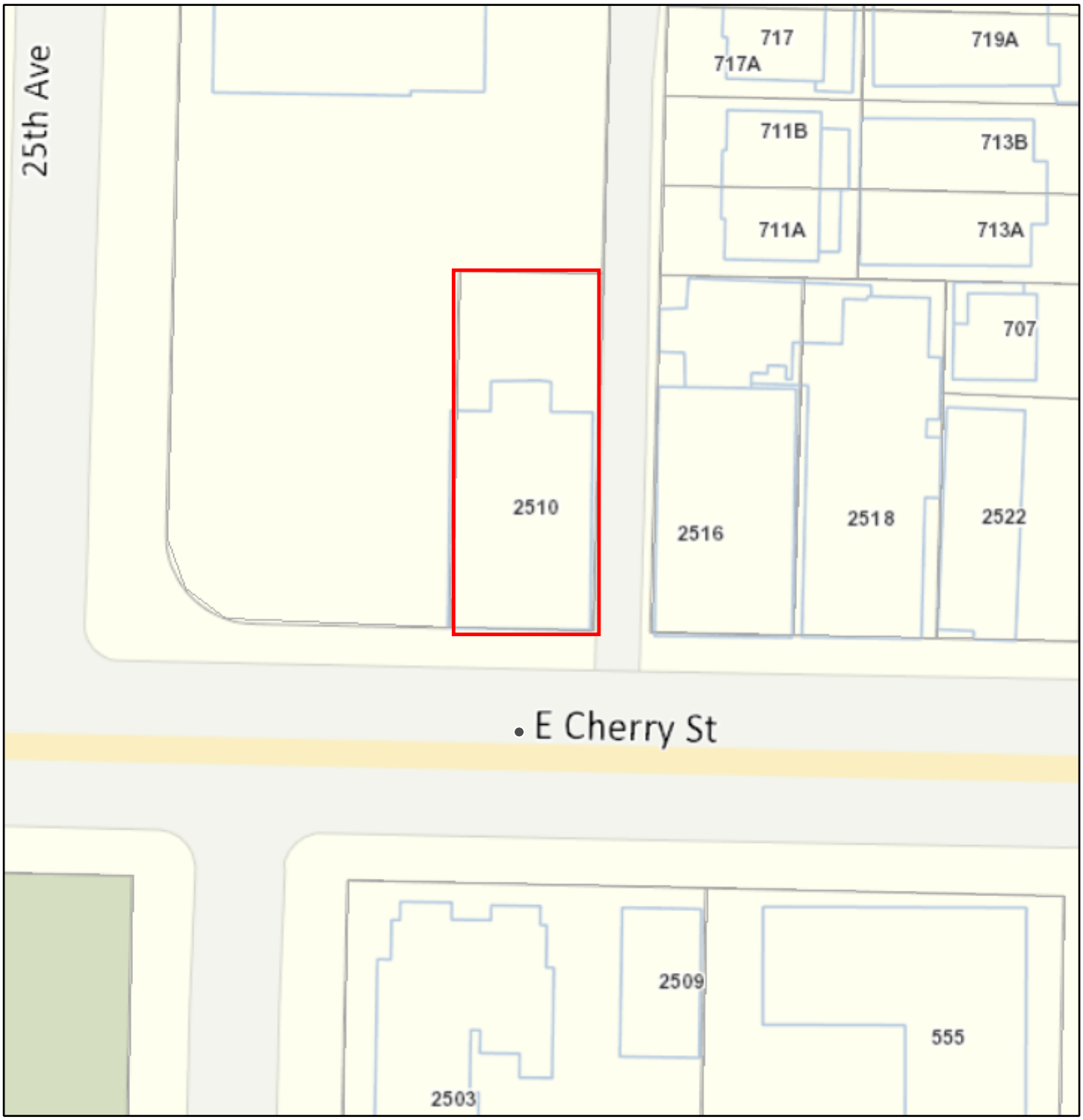
Print Name: Kelly L. Boyker
Notary Public in and for the State of Washington, residing at Seattle
My commission expires 4/17/12

KELLY L. BOYKER NOTARY PUBLIC COMMISSION EXPIRES 04-17-12 STATE OF WASHINGTON

Exhibit B

PROPERTY MAP

(Required)



LEGEND

Approximate Property Boundary

N

0 20 40 feet

STATE:	Washington
COUNTY:	King
PARCEL:	6840700250
TOWNSHIP LINE:	T25N
RANGE LINE:	R4E
SECTION:	33
CITY:	Seattle
ADDRESS:	2510 E Cherry Street
UTM Coordinates:	10T 552637m E 5272993m N

Source: http://seattlecitygis.maps.arcgis.com

EXHIBIT B
Title: PROPERTY MAP
Scale: 1:480 (1 in = 40 ft)
Project No: WAKS2510C
Report: Draft EC
Drawn by: The ELAM Group
Date: 3/29/19
TheELAMGroup

Exhibit C

SUBORDINATION AGREEMENT

KNOW ALL PERSONS, That __ [HOLDER'S NAME] __, the owner and holder of that certain __[INSTRUMENT – E.G. EASEMENT/ROW/MORTGAGE/ETC.]__ bearing the date the _____ day of __[MONTH]__, __ [YEAR] __, executed by __[NAME OF PERSON THAT GRANTED THE INTEREST BEING SUBORDINATED] __, __[LEGAL STATUS OF ORIGINAL GRANTOR – E.G. LANDOWNER, CORPORATE OFFICER, ETC.]__, and recorded in the office of the County Auditor of __[COUNTY]__ County, State of Washington, on __[DATE]__, under Auditor's File Number _____, does hereby agree that said Instrument shall be subordinate to the interest of the State of Washington, Department of Ecology, under the environmental (restrictive) covenant dated __[DATE]__, executed by __[NAME OF PERSON SIGNING THIS SUBORDINATION AGREEMENT]__, and recorded in __[COUNTY]__ County, Washington under Auditor's File Number _____.

_____ [SIGNATURE] _____

by: _____ [PRINTED NAME] _____

Title: _____

Dated: _____

Insert one of the following, as applicable. See example format on next page:

INDIVIDUAL ACKNOWLEDGMENT
CORPORATE ACKNOWLEDGMENT
REPRESENTATIVE ACKNOWLEDGEMENT

INDIVIDUAL ACKNOWLEDGMENT

STATE OF
COUNTY OF

On this day of , 20__, I certify that _____ personally appeared before me, acknowledged that **he/she** is the individual described herein and who executed the within and foregoing instrument and signed the same at **his/her** free and voluntary act and deed for the uses and purposes therein mentioned.

_____
Notary Public in and for the State of Washington
Residing at _____
My appointment expires _____

CORPORATE ACKNOWLEDGMENT

STATE OF
COUNTY OF

On this day of , 20__, I certify that
personally appeared before me, acknowledged that **he/she** is the
of the corporation that executed the within and foregoing instrument, and signed said instrument by free and voluntary act and deed of said corporation, for the uses and purposes therein mentioned, and on oath stated that **he/she** was authorized to execute said instrument for said corporation.

_____
Notary Public in and for the State of Washington
Residing at _____
My appointment expires _____

REPRESENTATIVE ACKNOWLEDGEMENT

STATE OF
COUNTY OF

On this day of , 20__, I certify that
personally appeared before me, acknowledged that **he/she** signed this instrument, on oath stated that **he/she** was authorized to execute this instrument, and acknowledged it as the _____ [TYPE OF AUTHORITY] of _____ [NAME OF PARTY BEING REPRESENTED] to be the free and voluntary act and deed of such party for the uses and purposes mentioned in the instrument.

_____
Notary Public in and for the State of Washington
Residing at _____
My appointment expires _____