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Quality Assurance Project Plan

(Revision 1.1)

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

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June 25, 2020

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1 Introduction

The Environmental Liability and Asset Management Group, LLC (dba The ELAM Group) has prepared this *Quality Assurance Project Plan Revision 1.1* ("QAPPrev1.1") for the Former Cherry Street Cleaners ("Facility") located at 2510 E Cherry Street in Seattle, Washington. The original QAPP was prepared for inclusion in the *Cleanup Action Plan* ("CAP"), which was furnished to the State of Washington Department of Ecology ("Ecology") in accordance with the reporting requirements of the Voluntary Cleanup Program ("VCP"). This QAPPrev1.1 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 Soil and Groundwater	Rachel Johnson Pace Analytical Services, LLC	(612) 607-2307 rachel.johnson@pacelabs.com	Direct and report laboratory procedures and results
Laboratory QAO Air	Jade White Eurofins Environmental Testing Northern California, LLC (Eurofins Air Toxics)	(916) 201-2144 Jade.White@et.eurofinsus.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 the building foundation removed in July of 2013. A heating oil underground storage tank ("HOT") was located on the northern portion of the vacant lot. The HOT was removed from the Facility on 6/7/21.

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
2012	❑ Advanced soil borings SB-1 through SB-11 ❑ Installed monitoring wells MW-12 through MW-17	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
	❑ 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 25th Ave ❑ 711A 25th Ave	
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 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 25th Ave ❑ 2516 E Cherry St ❑ 2518 E Cherry St	ELAM 2017a ELAM 2017b
2018	❑ Conducted VIAs at the following addresses: ❑ 720 25th Ave ❑ 2516 E Cherry St ❑ 2518 E Cherry St	ELAM 2018a ELAM 2018b
2020	❑ Conducted VIAs at the following addresses: ❑ 720 25th Ave ❑ 2516 E Cherry St ❑ 2518 E Cherry St ❑ Advance soil borings for collection of soil to be used in a bench test of combining *in-situ* chemical oxidation/*in-situ* stabilization ("ISCO/ISS") remedy	ELAM 2020a ELAM 2020b ELAM 2020c
2021	❑ Conducted VIAs at the following addresses: ❑ 2516 E Cherry St ❑ 2518 E Cherry St ❑ Advance soil borings for collection of post-remedy soil samples for assessing COC concentrations	ELAM 2022b ELAM 2022c
2022	❑ Conducted VIAs at the following addresses: ❑ 720 25th Ave ❑ Advance soil borings for collection of post-remedy soil samples for assessing leaching potential for observed COC impacts to soil	ELAM 2022a ELAM 2022c

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 2020c
2021	❏ Removed heating oil tank (“HOT”) ❏ Removal and disposal of approximately 296 cubic yards (429 tons) of soil from the surface of the Facility ❏ Mechanically mixed a Klozur SP® sodium persulfate reagent solution and a Portland cement binding agent with approximately 985 cubic yards of soil located between 2 and 10 feet below grade surface	ELAM 2022c
2022	❏ Install and Operate Ozone Injection Treatment System (“OTIS”)	Report In Progress

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 03/01/23).

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.[3] 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 (units)	MTCA Cleanup Level	PCE	TCE	c-DCE	t-DCE	VC
Soil (mg/kg)	Method A / Method B	0.05 / 480	0.03 / 12	NA / 160	NA / 1600	NA / 0.67
Groundwater (µg/L)	Method A / Method B	5.0 / 21	5.0 / 0.54	NA / 16	NA / 160	0.2 / 0.029
Soil Gas (µg/m^3)	Method B / Method C	320 / 1300	11 / 67	610 / 1300	610 / 1300	9.5 / 95
Indoor Air (µg/m^3)	Method B / Method C	9.62 / 40	0.334 / 2.0	18.3 / 40	18.3 / 40	0.284 / 2.84

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

[3] https://fortress.wa.gov/ecy/ezshare/tcp/CLARC/CLARC_Master.xlsx (URL last accessed 5/4/23)

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 is secured electronically through a Corporate cloud-based storage device, and the cloud-based files are backed up on a separate, off-cloud localized storage device secured by the Corporation at an undisclosed location. 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 QAPPrev1.1. 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 Pace Analytical Services, LLC. The point of contact at the laboratory is:

Rachel Johnson
Pace Analytical Services, LLC
1700 Elm Street SE, Suite 200
Minneapolis, MN 55414
Office: (612) 607-1700
Cell: (612) 656-2307
E-mail: rachel.johnson@pacelabs.com

The analytical laboratory retained for analysis of chemicals in air is Eurofins Environment Testing Northern California, LLC (Eurofins Air Toxics). The point of contact at the laboratory is:

Jade White
Eurofins Environment Testing Northern California, LLC *(Eurofins Air Toxics)*
180 Blue Ravine Road, Suite B
FOLSOM, CA 95630
Phone: (800) 985-5955
Cell: (916) 201-2144

Fax: (916) 351-8279
E-mail: Jade.White@et.eurofinsus.com

The laboratory quality assurance plans and standard operating procedures are incorporated into this QAPPrev1.1 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
Eurofins Environment Testing Northern California, LLC *(Eurofins Air Toxics)*	Appendix B

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.
4.

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[4]
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

[4] 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 (Fº)
- ❏ 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

If a photograph is selected for use in a report or other communication, it will be inserted into a document along with the relevant information needed to provide the appropriate context for understanding the subject of 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
- ❏ Indoor Air: IA2:A032423 represents an indoor sample collected from location 2 on 3/24/23
- ❏ Sub-slab Soil Gas: SS2:A032423 represents a sub-slab soil gas sample collected from location 2 on 3/24/23

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.

13 Reference List

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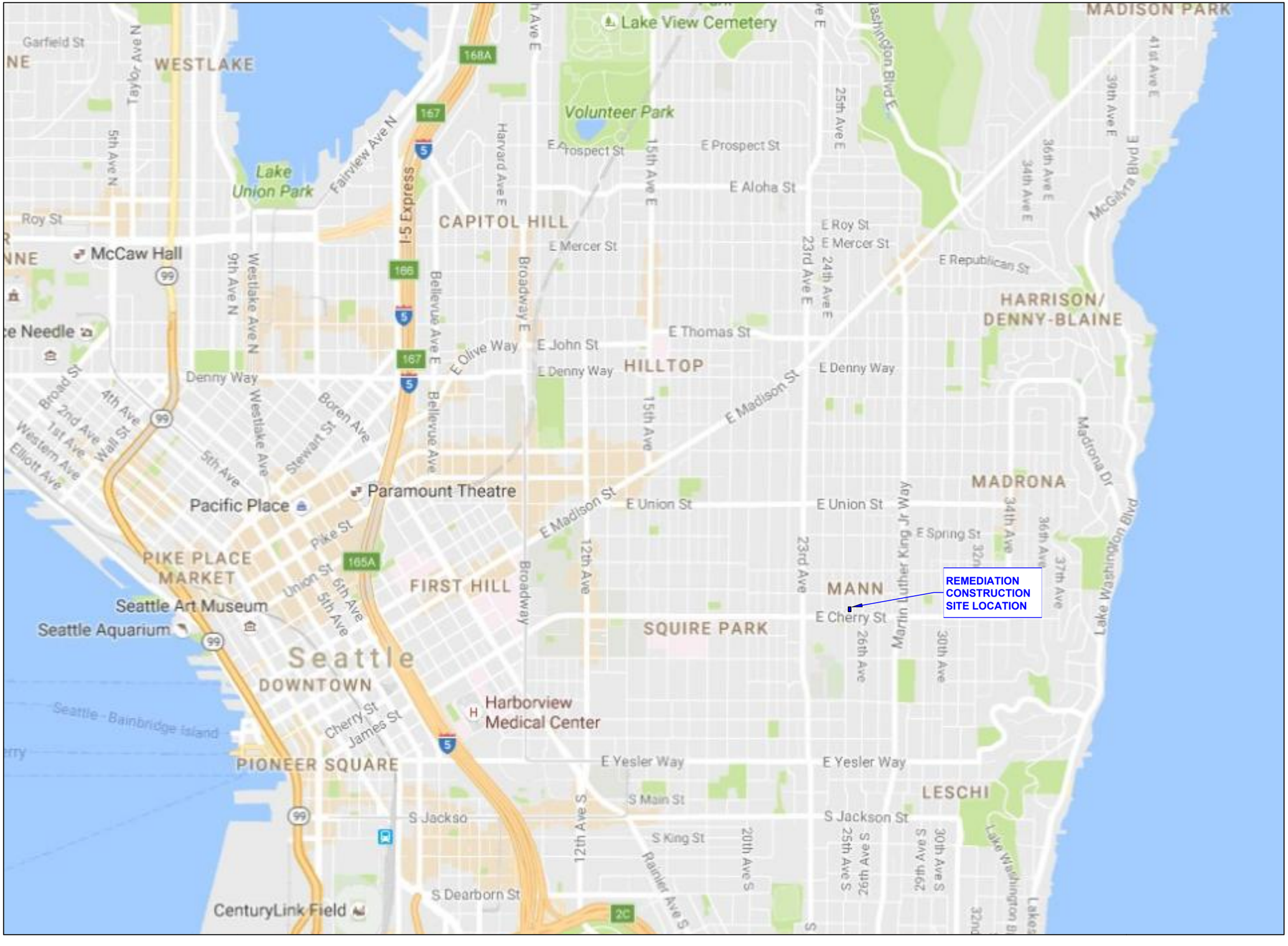
Figures



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LEGEND

Remediation Construction Site

Notes:

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

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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

Adam Haugerud Approved on 12/12/2022 4:21:08 PM
Aileen Stacks Approved on 11/30/2022 10:44:48 AM
Luke Falken Approved on 12/16/2022 4:29:05 PM
Paul Junio Approved on 11/23/2022 2:05:11 PM

Title Page

Quality Manual
Pace Analytical Services, LLC

Prepared for:

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1700 Elm Street SE
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Phone: (612) 607-1700

Pace® Analytical Services, LLC – Minneapolis MN (Satellite Air Laboratory)
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315 Chestnut Street
Virginia, MN 55792-2523
Phone: (612) 607-1700

Signatory Attestation: I attest the application of my electronic signature on this title page affirms my management commitment and responsibility to uphold the requirements of the PAS Quality Management System (QMS) described in this Quality Manual (manual) at each location for which this manual is prepared.

Refer to the Quality Manual Signatory Page to view the job title and physical address for each signatory.

Quality Manual Approval Signatories

The following individuals represent the PAS corporate and local management team responsible for implementing the PAS Quality Management System (QMS) and upholding the requirements of this manual at the location(s) for which this manual was prepared, at the time this version of the manual was made effective, and that correlate with the electronic signatures shown on the title page of this manual.

If these persons(s) change positions, leave the company, or are on extended leave of absence, the approval of this manual automatically transfers to the person replacing the signatory or to the signatory's primary or alternate deputy until the manager is replaced and/or the manager returns to work. The individual replacing the signatory automatically accepts the responsibilities associated with the original signatory's attestation. Refer to Section 4.1.5.1.1 of this manual for the deputies assigned to key personnel job titles.

The manual is not revised and released under an updated version for the sole purpose of updating personnel change(s). Personnel information is updated when the next revision of the manual is released. See manual Sections 1.2.1 and 1.2.2 for more information about how this manual is maintained.

Name	Job Title	Address, City, State, ZIP	Phone
Luke Falken	Vice President of Operations	Wayzata, MN	(218) 213-8642
Adam Haugerud	General Manager	1700 Elm Street SE Minneapolis, MN 55414-2485	(612) 656-2260
Paul Junio	Quality Program Manager	Oconomowoc, WI	(262) 433-0572
Aileen Stacks	Quality Manager	1700 Elm Street SE Minneapolis, MN 55414-2485	(612) 607-6352

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE

1.1 Purpose

This quality manual (manual) outlines the quality management system (QMS) and management structure of Pace® Analytical Services, LLC. Pace® Analytical Services, LLC is referred to by brand name Pace® Analytical Services and by the acronyms PAS or ENV. The acronyms PAS and ENV are interchangeable.

The PAS QMS is also referred to as the quality program throughout this manual and other PAS documents. The phrases "quality management system" and "quality program" are synonymous and are referred to by the acronym QMS.

The QMS is the collection of policies and processes established by the senior leaders of PAS (top management) to ensure the service and products provided by PAS consistently meet relevant requirements and achieves the goal of Pace® to provide customers with high quality, cost-effective, analytical measurements, and services.

The QMS is also planned to establish conformance[1] and compliance with the current published 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 QMS is planned to achieve regulatory compliance with the various federal and state programs for which PAS locations provide compliance testing and/or holds certification or accreditation. Federal or state requirements that do not apply to all PAS locations, 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 location associated with this manual is provided in Appendix A.
- A list of analytical testing capabilities offered by each location associated with this manual is provided in Appendix B.

1.2 Scope and Application

This manual applies to each location listed on the Title Page of this manual, including PAS laboratories, satellite laboratories, service centers, and supporting business functions.

For purposes of the PAS QMS:

- The term "location" used in this manual refers to laboratories and/or service centers.
- The term "laboratory" refers to any PAS location, however named by Pace® that provides testing, collects samples (sampling), or conducts field measurement services in a fixed building, mobile unit, or in-situ (field).

- The phrase "service center" refers to any PAS location, however named by Pace® that does not perform any testing, sampling, or field measurements.
- The phrase "satellite laboratory" refers to a limited-service laboratory affiliated to a larger business unit or location. Some PAS business groups, such as accounting, may refer to a satellite laboratory as a "service center." Irrespective of internal jargon or reference by any group, any PAS location that generates a test result for external use is a "laboratory" and must comply with the requirements specified in this manual for all analytical testing services.

PAS locations are defined by physical address. Laboratories are defined by physical address and certification/accreditation ID except mobile units which may be defined by the address of the location to which they are assigned, by VIN (vehicle identification number), or by certification/accreditation ID. Laboratories that provide sampling and field testing are defined by the physical address of the PAS location to which they are affiliated and that manages these activities.

1.2.1 Quality Manual Template

This manual was prepared using the PAS Quality Manual Template (template) created by the PAS Corporate Quality Director (CQD).

The template, known as document ID ENV-TMP-CORQ-0007, specifies the minimum requirements that every PAS location must abide by, regardless of scope of services or number of personnel, to maintain a quality program that achieves the objectives of the PAS Quality Policy (see Section 4.2.2).

The template is the mechanism used by top management to communicate to PAS personnel their commitment to continuously develop and improve the QMS for effectiveness, to meet customer expectations, and to comply with any statutory and regulatory requirements. Their signature of approval on this template is the mechanism used to document this responsibility.

"Top Management" is the phrase used by the TNI Standard to refer to the leaders of an organization that develop and/or release the PAS Quality Policy Statement and QMS under their authority

For PAS, these managers include the Chief Executive Officer (CEO) and Chief Compliance Officer (CCO) of Pace® and the President, CQD, Senior Vice President of Operations (Sr. VPO), and the Chief Technical Officer (CTO) of PAS.

The template and instructions for use of the template are released by corporate quality personnel to local quality managers responsible for each location (Local QM). The local QM uses the template to prepare the location manual by following the instructions provided to them. The local QM 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 unique to each location are provided in addendum or in documents that supplement the manual.

The template is reviewed by corporate quality personnel annually and updated, if needed. More frequent review and revision may occur to manage change, to maintain conformance and compliance to relevant standards or to improve the QMS.

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

1.2.2 Quality Manual

The quality manual is created from template ENV-TMP-CORQ-0007 by local quality personnel, who are also responsible for maintenance and management of the document.

- PAS locations are not permitted to alter content of the template when preparing their manual, except where specified in the template. Control of content in the manual is necessary to ensure consistency of implementation of the PAS quality program across the network.
- If additions or changes to the manual are needed to maintain regulatory compliance or conformance to relevant standards and these changes cannot be covered by addendum to the manual, the need for change must be raised to the PAS Corporate Quality Director, who will decide how to resolve the need.

The manual is approved for release by the management team listed on the Quality Manual Approval Signatory Page. The manager's electronic signature on the Title Page of the manual affirms their commitment to implement and uphold the requirements, processes, and procedures of the PAS QMS at each location for which the manual was prepared.

The manual is reviewed annually and updated with each release of a new version of the template, and as needed to update appendices and addendum. More frequent review and revision may be necessary when there are significant changes to the capabilities and resources of the laboratory during the calendar year

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 include references to other organization documents that support the QMS such as policies and standard operating procedures (SOPs).

These references may include the document's document control number (DC#) and the document title. This information is subject to change at the discretion of PAS. The manual and/or template are updated to reflect the editorial change during the manual's next scheduled review/revision cycle or the next time a version of the manual is released, whichever is sooner.

Each location maintains a current list of documents used by the location to support the QMS. This list, known as the "Master List", is readily available to personnel for their use and it provides a cross reference to the legacy document ID, where applicable. Parties external to PAS may contact the location of interest to obtain the most current version of the Master List for their use as needed.

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, 2nd Edition 2005-05-15; 3rd Edition 2017-11

  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, 2009 and 2016 versions.
- 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 PAS to support the QMS.

4.0 MANAGEMENT REQUIREMENTS

4.1 Organization

4.1.1 Legal Identity

Pace® Analytical Services, LLC (Pace® Analytical Services) is the responsible entity authorized by the State of Minnesota to do business as a limited liability company, under the parent company, PAS Parent, Inc.

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, PAS management is responsible to notify regulatory authorities of the change within the timeframe 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

PAS management has the responsibility and authority to establish and implement procedures and to maintain resources necessary to assure its activities are carried out in such a way to meet the federal and statutory requirements in addition to the requirements of the PAS QMS. Also See Section 1.1.

4.1.3 Scope of the Quality Management System

The QMS 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.

The permanent and mobile facilities to which this manual applies are listed on the Title Page of this manual.

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 business purpose of PAS is to deliver the highest standard of testing and scientific services in the market. We offer the most advanced solutions in the industry, backed by transparent data, a highly trained team, and the service and support that comes from over four decades of experience.

4.1.4.1 Organization Structure

Each PAS location is led by a management team referred to as local management[1]. Local management is responsible for making day-to-day decisions regarding the operations of the facility and implementing, and sustaining the requirements, policies, and procedures of the PAS quality program.

The roles that make up the local management team include a Vice President of Operations (VPO), a General Manager (GM) or Director of Laboratory Operations (DLO), a Quality Program Manager (QPM), and the Quality Manager (QM).

[1] The term "local management" does not mean "on-site" management. Some of the roles that make up the local management team, work off site or from a different PAS location. Refer to the Quality Manual Approval page at the beginning of this manual for the physical address of each manager that comprises the local management team.

The local management team is supported by department specific supervisors and in some PAS locations, a site supervisor or operations manager.

Local management and supervisors are supported by personnel from functional groups that support the division, such as HR, IT, Sales & Marketing, Finance, and EHS (Environmental Health & Safety).

Technical oversight for each location is provided by local personnel with support and guidance from the PAS Chief Technical Officer (CTO), PAS corporate quality personnel, and the Pace® compliance team. Locations that hold TNI accreditation, also have personnel appointed to serve as the "acting technical manager for TNI, however named" to perform the duties and responsibilities of this designation per the TNI Standard. See Section 4.1.5.2.1 for more information on this TNI requirement.

The reporting relationships and responsibilities of quality personnel are independent of operations in order to safeguard impartiality. See Section 4.1.5.2 for more information.

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

4.1.5 Management Requirements

4.1.5.1 Personnel

Each PAS location is staffed with administrative and/or technical personnel who perform and verify work under the supervision of their direct line supervisor.

All personnel are expected to perform 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. PAS 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 are management positions that have the authority and responsibility to plan, direct, and control activities related to the QMS for the entire division (PAS Corporate), or for one or more PAS locations (Local).

PAS Key Personnel Positions & Deputy Assignments by Role

Job Title	Acronym	Primary / Alternate Deputy
Chief Executive Officer	CEO	President
Chief Compliance Officer	CCO	CQD
President	NA	CEO / Sr. VPO
Corporate Quality Director	CQD	CCO

Job Title	Acronym	Primary / Alternate Deputy
Quality Program Manager	QPM	CQD / Peer QPM
Chief Technical Officer	CTO	CQD / CCO
Sr. VP of Operations	Sr. VPO	President / VPO
Vice President of Operations	VPO	Sr. VPO / Peer VPO
Director of Lab Operations[1]	DLO	VPO / Peer GM or Sr. VPO
Health and Safety Director	NA	CCO
IT Director	NA	CTO
Quality Manager	QM	Direct QPM / Peer QPM
General Manager[1]	GM	VPO / Sr. VPO or Peer GM
Operations Manager[1]	OM	GM / DL or VPO
Technical Manager[1]	TM	CTO / Peer TM
TNI Approved TM[2]	TNI TM	Another Qualified Employee

[1] Position is not in place at all locations.
[2] The TNI TM is not a PAS position. See Section 4.1.5.2.1 for more information.

Some certification and accreditation programs require notification when there is a change in key personnel. Notification requirements and timeframes by agency, are tracked and upheld by the local QM, when these requirements apply.

4.1.5.2 Roles and Responsibilities

The qualifications, duties, and responsibilities for each position at Pace® are detailed in job descriptions maintained by the Pace® Human Resource personnel (HR).

The following sections provide a general overview of various management and supervisory roles and are presented in no particular order.

Chief Executive Officer (CEO): Provides leadership for overall operations; oversight of regulatory and compliance standards; development of growth strategies; and long-range capital and strategic planning for Pace®.

Chief Compliance Officer (CCO): Has overall responsibility for statutory and regulatory compliance and the environmental health and safety programs (EHS) for Pace®.

President: Provides leadership for overall operations; oversight of regulatory and compliance standards; development of growth strategies; and long-range capital and strategic planning for PAS.

Chief Technical Officer (CTO): Provides technical oversight and leadership to all PAS locations. Responsible for innovation and standardization of technical activities.

Corporate Director of Quality (CQD): Responsible for developing the PAS quality program and the policies and procedures that support the QMS. The CQD leads the quality team, establishing functions, responsibilities, duties, and organization structure for PAS.

Corporate Quality Program Manager (QPM): Responsible for helping local management implement, monitor, maintain and improve the PAS quality program for one or more locations in the network and for direct supervision of Quality Manager(s).

Director of Information Technology: Oversees and delivers the systems and processes of information technology used by PAS. These systems include Laboratory Information Management Systems (LIMS); data acquisition, reduction, and reporting software; virus-protection, communication tools, and ensuring the integrity, security of electronic data, and associated policies and procedures.

Sr. Vice President of Operations (Sr VPO): Provides leadership, direction, and insight necessary to achieve strategic initiatives. Develops and improves processes, structure, and allocation of resources for operations for all of PAS.

Vice-President of Operations (VPO): Provides leadership, guidance, and resources, including allocation of personnel, necessary to achieve the strategic goals of the organization and the PAS quality program to one or more PAS locations.

Director of Laboratory Operations (DLO): See description for General Manager.

General Manager (GM): The GM is responsible for overall administration and operation of one or more PAS locations and service centers. Although task duties associated with this responsibility may be delegated, the GM is responsible for ensuring all duties and activities of the locations they oversee comply with the PAS QMS, the PAS EHS program, and with any applicable statutory, regulatory requirements or program requirements.

Any GM of a NELAC/TNI Accredited laboratory is 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 the implementation, compliance, and improvement of the QMS and communicates gaps, deviations, and opportunities for improvement to local and corporate laboratory management. The QM is independent of the operation and analytical activities for which they provide oversight and has the authority to carry out the roles and responsibilities of their position without outside influence.

The QM:

- serves as the focal point for QA/QC protocol decisions and oversees review of QC data for trend analysis;
- evaluates data objectively and performs assessments without outside influence;
- has documented training and experience in QA/QC procedures and the PAS 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 support to technical personnel and may serve as the primary deputy for the acting TNI Technical Manager(s).

Manager-Client Services (CSM): This position is responsible for the training and supervision of project manager(s) and/or shipping, receiving and courier personnel. The primary responsibility of the CSM is to ensure projects are successfully managed to meet the expectations and needs of PAS customers.

Department Managers / Supervisors / Team Lead: These positions are responsible for administrative and operations management and implementation of the QMS 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 QMS; method development, validation and the establishment and implementation of SOPs to assure regulatory compliance and suitability for the 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.

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

4.1.5.2.1 Approved Technical Manager (TNI Accreditation Only):

The requirements in this subsection apply to only to PAS locations that are NELAC/TNI accredited.

The TNI Standard specifies requirements for the qualification and duties of technical personnel. The TNI Standard lists these duties under the reference "technical manager(s), however named."

At PAS, these duties closely correlate with the responsibilities and duties outlined in the PAS job descriptions for managers, supervisors, team leads, and/or scientist. However, these duties do not need to be associated with any specific job title and can be assigned to any one or more PAS employees that meets the qualifications specified in the TNI Standard.

Refer to the applicable version of the TNI Standard to view the required qualifications for each discipline.

PAS locations that are TNI accredited must designate one or more employees to perform these duties and submit these qualifications to the TNI accreditation body (AB) for approval.

Employees approved by the TNI AB, to perform these duties retain their Pace® assigned job title.

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 perform duties of the 'technical manager, however named' as specified in the TNI Standard and not to a PAS job title.

The duties of any approved technical manager for TNI, however named, can be completed in person or remotely. If an employee that is an approved technical manager for TNI is completely absent from work or on a leave of absence for more than 15 calendar days, the duties and responsibilities specified in the TNI Standard are temporarily reassigned to another employee that meets the qualifications for the technology or field of accreditation. If the employee's absence exceeds 35 calendar days, the local QM must formally notify the TNI primary AB of the absence and the details of reassignment of duties in writing.

4.1.5.3 Conflict of Interest

A conflict of interest is a situation where a person has competing interests that may affect impartiality. It is the policy of Pace® to ensure business relationships, decisions and transactions do not place personal interest ahead of the organization, customers, colleagues, job responsibilities or the public we serve. Conflict of interest is avoided by making personnel aware of circumstances that conflict or appear to conflict with impartiality and/or designing process and procedures to include checks and balances to prevent conflict and ensure impartiality.

See the current version of policy COR-POL-0004 *Code of Ethics and Professional Conduct* for more information.

4.1.5.4 Confidentiality

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

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, except when Pace® is required by law to release confidential information to another party, such as a regulatory agency or for litigation purposes. In which case, Pace® will notify the client of the release of information and the information provided, unless notification is prohibited by law.

When Pace® obtains information about the customer from a source other than the customer, Pace® will keep the source of the information confidential unless disclosure is agreed upon by the source.

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

- A Code of Ethics and Professional Conduct policy that covers this topic (COR-POL-0004):
- A Confidentiality Agreement which supervisory and sales personnel and other positions 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; and
- Physical access controls and encryption of electronic data; and

See policy COR-POL-0004 *Code of Ethics and Professional Conduct* 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 people included in the communication gets the point and understands it.

4.1.5.5.1 Workplace Communication

Effective communication in the workplace is necessary to assure work is performed correctly, efficiently, and in accordance with client specifications.

Instructions for how to conduct testing and other work activities are communicated to personnel via written policies, standard operating procedures, and other work instructions.

Information about PAS performance (positive and negative) and ideas for improvement are communicated to personnel 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.

PAS management is responsible for training personnel to communicate in professional and respectful ways to build strong relationships and to avoid misunderstanding.

4.2 Quality Management System

4.2.1 Quality Management System Objectives

The objectives of the PAS QMS 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

PAS achieves and maintains impartiality by establishing an organizational structure that safeguards impartiality (see 4.1.4.1) and implementing and adhering to the policies and processes of the QMS outlined in this manual, which are based on industry accepted standards and methodologies.

PAS procedures for handling nonconforming work (see 4.9), corrective and preventive actions (see 4.11, 4.12) 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 QMS uncertain.

An opportunity is something that has potential positive consequences for the organization.

PAS personnel manage risks and opportunities on a daily basis by following policies, procedures and processes that support the QMS. Some ways in which the QMS 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 the 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 of the QMS.

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 PAS 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. The PAS lean program 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 PAS management to communicate the QMS to personnel.

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

- PAS personnel are required to sign a Read and Acknowledgement Statement to confirm the employee has:

  1) been informed of the manual by 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 QMS. The "how to" implementation of the QMS is provided in policy, SOPs, standard work instructions, and other instructional documents.

- This manual and supporting policies and procedures are made readily accessible to personnel in the area where the work activity is performed.

4.2.2 Quality Policy Statement

The quality policy of PAS is to provide customers with data of known and documented quality fit for their intended purpose. PAS achieves this policy by implementing the QMS 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:

- PAS will provide customers with reliable, consistent, and professional service. This is

accomplished by making sure each PAS location 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.

- PAS maintains a quality program that complies with applicable state, federal, and industry standards for analytical testing and competency.
- PAS management provides training to personnel so that all personnel are familiar with the QMS outlined in this manual and that they understand that implementation of the QMS is achieved by adherence to the Pace® and PAS policies and procedures.
- PAS management continuously evaluates and improves the effectiveness of the QMS 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

Pace® has established a comprehensive ethics and data integrity program that is communicated to all Pace® employees so 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 Pace® Ethics / Data Integrity Program include:

- Ethics Policy (COR-POL-0004);
- Ethics Officer (Chief 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 Pace® 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, primary, secondary and completeness data reviews, internal technical and system audits, data audits, data surveillance, and proficiency testing; and
- Confidential reporting process for alleged ethics and data integrity issues.

All PAS managers and supervisors 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.

Pace® has engaged Lighthouse Services, Inc. to provide personnel with an anonymous reporting process available to them 24 hours per day/7 days per week. The alert line may be used by any employee to report potential violations of the company's ethics and data integrity program. Reports are forwarded to the Pace® Ethics Compliance Officer to investigate and resolve the matter. Investigations concerning data integrity are kept confidential.

See COR-POL-0001 *Compliance Alertline* for more information.

Posters and flyers with the compliance alert line information must be prominently posted in each PAS location for personnel reference.

Compliance Alert Line Information:

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 QMS is provided by the application of their signature of approval to the template and/or manual. Their signature confirms they understand their responsibility to implement the QMS 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 QMS outlined in this manual, implementing the QMS outlined in this manual, and upholding these requirements for all work activities.

4.2.5 Supporting Procedures

References to processes and procedures that support the QMS are included 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 QMS are classified into document types that identify the purpose of the document and establish how the document is managed and /or controlled.

Examples: Types of PAS Internally Created Documents

Document Type	Purpose
Quality Manual	Outlines the PAS QMS and structure and how it works for a system including policy, goals, objectives and detailed explanation of the system and

Document Type	Purpose
	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 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. Assures that activities are performed properly in accordance with applicable requirements.
Standard Work Instruction	Provide step by step visual and/or written instruction to perform 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	Assists users in using a particular product; or a technical interpretation of a method or process by which PAS locations must abide.
Form	Used for a variety of purposes such as to provide a standardized format to record observations, to provide information to supplement an SOP.
Guidance	Non-binding advice used to explain internal policies, procedures, or practices.

Example: Types of External Documents used by PAS

Certificate	Lists parameters, methods, and matrices for which the location 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 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.

These 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 agree with documents of higher rank.

PAS Document Hierarchy

Rank	Document
1	Corporate Manual
2	Corporate Policy
3	Corporate SOP
4	Corporate SWI, Templates, Guides, Forms, Guidance
5	Local Manual
6	Local SOP
7	Local SWI, Templates, Guide, Forms, Guidance

Information and requirements from project documents are not incorporated into PAS policy or SOPs in order to maintain client confidentiality. These documents are managed as external documents and any requirements for work specified is followed

when work for the project is performed. Project Documents are reviewed and maintained as part of the contract/incoming work review process (see Section 4.4). If the project document is less stringent than the PAS QMS, policies, or SOPs, and/or is less stringent than applicable federal or state requirements, PAS locations are still required to meet the minimum requirements of the PAS QMS and any applicable statutory or federal requirements in addition to the requirements specified in the project document.

Reference documents are not ranked because all PAS created documents, processes and procedures must be consistent with the applicable reference document(s) in addition to higher-ranking PAS documents.

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

4.2.6 Roles and Responsibilities

The roles and responsibilities for technical management and the quality manager are provided in section 4.1.5.2.

4.2.7 Change Management

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

4.3 Document Control

4.3.1 General

PAS procedures for document control are provided in SOP ENV-SOP-CORQ-0015 *Document Management and Control.*

PAS locations use electronic document management software (eDMS) to perform the document control procedures of the SOP. This system provides centralized access to all documents used by PAS locations across the network. All PAS locations are required to use the eDMS system established for PAS (presently Qualtrax) unless an exemption has been granted by the PAS Corporate Quality Director.

eDMS automates the process for unique document identification, version control, approval, access, and archival and restricts access to archived documents except to authorized users to prevent the use of obsolete documents.

The local QM maintains a master list of controlled documents used at each location. The master list minimally includes the document control number, document title, and current revision status and is made available to personnel for their reference.

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

4.3.2 Document Approval and Issue

Documents that support the QMS are reviewed by qualified personnel and approved by management prior to release for use.

Only the approved versions of documents are available to personnel for use unless use of a draft document is authorized by management.

The managers responsible for authorization of each document is situation specific.

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 documents are reviewed at least every two years to ensure the documents 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 conduct their work activities. Consequently, any concerns or problems with the document should be caught and brought to the attention of 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.

PAS 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 change in progress form, email, or memorandum.

The document review, revision, and archival process is managed by quality personnel 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

PAS management and/or client service personnel perform thorough reviews of requests and contracts for analytical services to verify the location(s) performing the work has the capability, capacity, and resources necessary to successfully meet the customer's needs. These review procedures are described in SOP ENV-SOP-MIN4-0182 *Review of Analytical Requests*.

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

- The PAS locations performing the work understand 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;
- PAS locations and any external subcontractor(s) have 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;
- Any discrepancies between the PAS QMS, statutory or regulatory requirements and the client request are resolved; 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 PAS locations contracted to perform the work and any internal or external subcontractors hold required certification/accreditation for the test method, matrix, and

analyte and verifies the location 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 locations and any potential subcontractors are able to manage the sample load and deliver work production within the delivery timeframe requested.

Resource review verifies that the location 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 (Internal and External)

The terms 'subcontract' and 'subcontracting' refers to analytical work done by an organization external to Pace® (External Subcontracting) or by a Pace® location with an address different than the address listed on the cover page of the test report (Internal Subcontracting).

The PAS network offers comprehensive analytical capability and capacity to ensure Pace® can meet a diverse range of client needs for any type of project. If a PAS laboratory receives a request for analytical services and it cannot fulfill the project specifications, the location's client services team will collaborate with the client to place the work within the PAS network.

When it is not possible to place the work within network, the location will, with documented 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 location and the client.

Whenever work is subcontracted, the PAS location responsible for management of the project verifies each of these qualifications:

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

External subcontractors selected by Pace® must be pre-qualified by quality personnel to verify their QMS is similar to Pace® and complies with all relevant Standards such, as ISO/IEC 17025 and the TNI Standard(s) and/or federal and state regulatory requirements. The list of approved subcontractors for each location is maintained by local quality personnel. Pre-qualification of a subcontractor does not eliminate the requirement for the PAS location placing work to verify the subcontractor has the certifications, capability, capacity, and resources to perform work on behalf of Pace® on a project-specific basis.

For all subcontracted work, the PAS location placing the work internally or externally is responsible to ensure project specifications are always communicated to and understood by the subcontractor.

4.6 Purchasing Services and Supplies

Vendors that provide services and supplies to PAS are qualified to meet the needs of Pace®. 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. Evidence of this qualification is the availability to purchase services and supplies from the vendor in the corporate purchasing system.

PAS locations may purchase goods and services from any supplier in the purchasing system.

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 local management who is responsible to ensure the services and supplies procured and received are fit for intended use.

4.7 Customer Service

Project details and management is managed by PAS client services personnel.

4.7.1 Commitment to Meet Customer Expectations

PAS personnel collaborate closely with our customers to ensure their needs are met and to establish their confidence in the capability of PAS to meet their needs for analytical services and expectations for service.

The project manager (PM) is the customer's primary point of contact for each analytical service request (work order). 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. Supervisors are expected to keep the PM informed of project status and any delays or key issues, so that the PM can keep the client informed.

PAS encourages customers to visit our locations to learn more about the capabilities, observe performance and to meet personnel.

PAS customers expect confidentiality. Personnel will not divulge or release information to a third party without proper authorization unless the information is required for litigation purposes. See Section 4.1.5.4 of this manual and policy COR-POL-0004 *Code of Ethics and Professional Conduct* for more information on the policy for client confidentiality.

4.7.2 Customer Feedback

PAS actively seeks positive and negative feedback from customers through surveys and direct communication. Information from the client about their experience working with PAS and their satisfaction with work product is used to enhance processes and practices and to improve decision making. Customer feedback is reviewed 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 PAS and used to enhance the QMS.

4.8 Complaints

A complaint is a formal expression of dissatisfaction with the performance of a service or product originating from a party external to Pace®. Complaints provide opportunities to improve processes and/or build stronger working relationships with clients.

The PAS complaint resolution process depends on the situation and the nature of the complaint.

Each complaint received is reviewed to determine if it is valid. If the complaint is valid, it is either addressed immediately by the person receiving the complaint or the nature of the complaint is further reviewed and investigated prior to resolution and follow up with the customer.

Complaints (and compliments) are recorded and reviewed during Annual Management Review (see Section 4.15).

4.9 Nonconforming Work

4.9.1 Definition of Nonconforming Work

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

The discovery of non-conforming work comes 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 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 or service center manages 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 location 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 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 SOPs

Departures from an SOP may sometimes be necessary to correct for an error in an SOP or to resolve a complex problem. For example, to mitigate a complex matrix interference.

An authorized departure from a test method SOP is one that has been reviewed and approved by the department leader, however named, of the work area in which the test method is performed. The leader, when authorizing a departure from an SOP,

accepts full responsibility to ensure the departure does not conflict with Pace® or PAS policy or procedure, does not affect statutory, regulatory or program compliance and does not adversely affect data integrity or usability.

Departure from administrative or process-oriented SOPs must be approved by the local QM.

Documentation of the reason for the SOP departures must be retained with management approval. Approved departures from test method SOPs should be noted in the final test report to advise the data user.

See SOP ENV-SOP-CORQ-0016 *SOP for SOPs and SWI*, for more information.

4.9.1.2 Authorized Departure from Test Methods (Method Modifications)

When test results are associated to a published reference test method, the location'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, wastewater or a certification or accreditation program, such as TNI/NELAC, the SOP must comply with or include these requirements, or the resulting data and test results cannot be used for regulatory compliance purposes.

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 location may establish an SOP that is modified from these reference method or regulatory program and what is considered a modification are specified in ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification.*

Client requests to deviate from the test method are managed as client requests to depart from the test method SOP since it is the SOP that the location follows when performing work.

4.9.1.3 Stop Work Authority

Stop Work Authority provides PAS personnel with capability to stop work when there is a perceived unsafe condition or behavior that may result in an unwanted event.

All personnel have the authority to request a stop work order when necessary to preserve data integrity or safety of workers.

The need for the stop work order and resolution of the problem must be confirmed by subject matter experts and resumption of work must be approved as follows:

- For stop work orders related to environmental health and safety (EHS) and/or waste management, the decision to stop work may be made by any employee. These decisions must often be made in real-time to protect the safety of the worker. The decision to correct the problem, how, and/or to resume work after stop work has been initiated may be made by the Chief Compliance Officer or the EHS Director, or the deputies assigned to these positions.
- Any employee may recommend a stop work order for concerns related to data integrity. The need to stop work must be reviewed and affirmed by quality

personnel to confirm the concern is valid. The decision to uphold the stop work order must minimally include the local QM, the QPM, and the Corporate Quality Director. The President, the Sr. VPO, the VPO, the Chief Compliance Officer and Chief Technical Officer may also be included in the decision making and resolution process depending on the situation and/or needs for correction to ensure protocols for investigation are followed. Resumption of work after correction may be made by the Corporate Quality Director, or the Quality Program Manager assigned to the location for which the stop work order was issued or by the deputies assigned to these positions.

4.10 Continuous Improvement

The PAS QMS is designed to achieve continuous improvement through the implementation of the quality policy and objectives outlined in this manual. Information about laboratory and service center activities and performance is gained from 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 corrective action (see section 4.11) and preventive action (see section 4.12) processes and during annual review of the management system (see section 4.15) to establish goals and objectives for improvement.

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. All activities of 3P and Lean must conform with the requirements of this quality manual and supporting policies and procedures.

4.11 Corrective Action

Corrective action is a process used to eliminate the cause of a detected nonconformity. It is different from a correction. A correction is an action taken to fix an immediate problem but that does not resolve the underlying cause of why the problem occurred. The objective of corrective action 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, is one of the most effective tools used by PAS to prevent nonconforming work, identify risk and opportunity, and improve service to our customers.

PAS has two general processes for corrective action, the application of which process is used depends on the type of nonconformity:

Quality control (QC) exceptions (nonconformance) that occur during routine testing are investigated through troubleshooting and required actions for correction is specified in policies and SOPs. When 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 7-stage corrective action process is used when there is a recurring problem. 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 7 Stage CAPA Process for PAS includes:

1) Identification and Containment
2) Evaluation
3) Investigation
4) Cause Analysis
5) Action Plan
6) Implementation
7) Follow Up and Effectiveness Review

PAS procedures for corrective action, are specified in corporate SOP ENV-SOP-CORQ-0018 *Procedure for Corrective and Preventive Action.* Some key concepts and activities related to the PAS corrective action process is provided in the next three subsections.

4.11.1 Cause Analysis (AKA Root Cause Analysis)

Cause analysis is the process of investigation used to identify the underlying cause(s) of the problem. After causal factors are identified, ways to mitigate the causal factors are identified and action(s) most likely to eliminate these factors are taken.

PAS uses different methods to conduct cause analysis. The most common approach is 5-Why, 4M, Fishbone Diagrams, or brainstorming may be appropriate depending on the situation. The method used is case specific and is documented in the CAPA record.

4.11.2 Effectiveness Review

Monitoring corrective actions taken for effectiveness is an essential part of the corrective action process. Effectiveness means the actions taken were appropriate and sustainable. Appropriate means the action(s) taken prevented recurrence of the problem since the time corrective action was taken and sustainable means the actions taken are still in place.

The data from CAPA records are used by PAS 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 cause analysis and investigation of a problem casts doubt on compliance with PAS policies, procedures, or to regulatory requirements; a special audit of the area of activity may be performed as part of the corrective action process. 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 grave issue or risk to the business is identified.

4.12 Preventive Action

Preventive action(s) are actions taken to eliminate the cause of a potential nonconformity before it happens.

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

- Routine instrument maintenance (Preventative maintenance)
- Addition of Staff and Equipment

- Professional Development Activities
- Implementation of New Technology

PAS looks for opportunities for preventive action from a variety of sources including employee idea's, customer feedback, business partners input, trend analysis, business analytics, management reviews, proficiency testing results, and risk-benefit analysis.

PAS 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 PAS locations. PAS 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.

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 another permanent form. PAS records document activities and provide evidence of conformity to the requirements established in the QMS. These records may be hardcopy or electronic on any form of media.

4.13.1 General Requirements

4.13.1.1 Procedure

PAS requirements for control of records are specified in corporate policy ENV-POL-CORQ-0013 *Record Management*.

The policy is established to assure quality and technical records are identified, retained, indexed, and filed to allow for retrieval during the entire retention timeframe. 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, records fall into three categories: quality, technical, and administrative.

Examples of each are provided in the following table:

Record Type	Includes Records of:
Quality	Document Types listed in SOP ENV-SOP-CORQ-0015 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

Record Type	Includes Records of:
	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 personnel that performed the activity or entered the information. Records are archived and stored in a way that they are retrievable. 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 records 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.

Administrative records are kept for a minimum of 5 years and technical and quality records are kept for 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 record management policy and the location specific SOP for more information. The laboratory's procedure for record management is specified in SOP ENV-SOP-MIN4-0184 *Data and Records Archival.*

4.13.1.3 Security

PAS locations are secure facilities and access to records is restricted to authorized personnel.

4.13.1.4 Electronic Records

The data systems used to store electronic records is backed up in accordance with SOP ENV-SOP-MIN4-0184 *Data and Records Archival.* Access to archived records stored electronically is maintained by personnel responsible for management of the electronic system.

4.13.1.5 Electronic Signature Policy

Work done by PAS locations include activities that require the application of a signature. Some work product is in electronic format and signatures are applied electronically.

The Electronic Signatures in Global and National Commerce Act (E-Sign Act) clarifies that electronic signatures are legally valid and enforceable under United States law.

The PAS policy for use and application of electronic signatures is specified in corporate policy ENV-POL-CORQ-0014 *Electronic Signature Policy*.

All employees of PAS including temporary and contract personnel, must sign an Electronic Signature Agreement to acknowledge that they understand and accept that work activities performed by them may be authenticated with application of an electronic signature and that electronic signature has the same validity as a handwritten signature. Their signed agreement also confirms the individual has read and understands the policy and agrees to abide by the requirements for use of electronic signature stated in the policy.

4.13.2 Technical Records

In addition to the requirements specified in subsections 4.13.1.1 through 4.13.1.5, 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 needs to provide adequate 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. PAS 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 be 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. 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

Quality personnel, or their designees, perform internal systems and technical audits to assess implementation of the QMS, compliance to this manual, policy, and procedures that make up the QMS. Since the processes in this manual are based on the requirements from relevant and applicable Standards for the operation and management of laboratories when operations are assessed against the PAS QMS, compliance with regulatory program requirements and accreditation/certification program requirements are also assessed.

PAS locations are 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 local and corporate management to address deficiencies and to identify opportunities to improve customer service and quality of work, including reliability and usability of data and test results.

Deficiencies, observations, and recommendations from audits are managed by the local QM using the CAPA process. See Section 4.11 for more information.

4.14.1 Internal Audit

The PAS internal audits are conducted to ensure practice matches what we say we do and what we say we do is compliant with the PAS QMS and relevant standards and requirements.

The internal audit program is managed by the local QM who prepares an audit plan at the beginning of each calendar year. The schedule is prepared to assure that all work areas are reviewed over the course of the year and test methods are audited every two years, unless a more frequent test method audit is required by program. Conformance to the schedule is monitored on a monthly basis.

PAS management is responsible to ensure the audit schedule is maintained. PAS supervisors are expected to cooperate with the quality personnel to provide them with complete access to the work area, personnel, and records needed to conduct the audit.

Internal audits may be performed by non-quality personnel when the auditor is approved by the local QM. Non-quality personnel may not audit their own work activities unless it can be demonstrated that an effective and objective audit will be conducted. The person conducting the audit should be trained, qualified, and familiar enough with the objectives and policies of the PAS QMS and knowledgeable with process and test method SOPs related to the activities audited. The auditors should be trained in auditing practices in order to perform a thorough and effective evaluation.

Test method audits include reviews of test reports to verify the product is consistent with customer/project requirements, the work was conducted in accordance with policy and SOPs, the SOP complies with the cited reference method, test results are accurate, and of known and documented quality and properly qualified, when necessary.

Special audits are performed as needed to follow up on 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 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 the location or work area audited.

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

4.14.1.1 Corporate Compliance Audit

PAS locations may also be audited by corporate personnel at discretion. The purpose of the corporate compliance audit is to assess whether the location's practices, processes and procedures conform with the PAS QMS and to identify risk and opportunity.

4.15 Management Review

Local management conducts an annual business review of each location under their purview to assess performance and to establish goals, objectives, and action plans for the upcoming year.

The procedure used to conduct this review is specified in corporate SOP ENV-SOP-CORQ-0005 *Management Review*.

At a minimum, the following topics are reviewed and discussed during annual management review:

- Changes in internal and external issues relevant to the location;
- Fulfillment of objectives and initiatives;
- Suitability of policies and procedures, including EHS and waste management;
- Status of actions from previous performance reviews;
- 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;
- Adequacy of resources;
- Results of risk identification;

- Proficiency testing performance and other measures related to the assurance of validity of test results; other relevant factors, such as QC trends and training status.

The discussion and results of this review are documented in a report prepared by local 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, and any other need for change.

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

4.16 Data Integrity

PAS procedures for the investigation and response to events that may affect data integrity are described in the corporate SOPs for data inquiries and data recall and corrective and preventive action, however named.

Customers whose data are affected by these events are notified in a timely manner, usually within 30 days after the impact of the problem is understood. Some accreditation programs also require notification to the accreditation body (AB) within a certain timeframe from date of discovery when the underlying cause of the issue impacts accreditation. PAS locations must follow any program or project specific client notification requirements for notification, when applicable.

5.0 TECHNICAL REQUIREMENTS

5.1 General

Multiple factors contribute to the correctness and reliability of the technical work performed by PAS. These factors fall under these broad 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 of these factors, PAS accounts for 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 PAS 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 location to communicate to personnel the duties, responsibilities, and authorities of their position. Qualification records may include but are not limited to diploma, transcripts, and curriculum vitae (CV).

The term "personnel" refers to individuals employed by PAS directly as full-time, part-time, or temporary, and individuals employed by PAS 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 location 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.

PAS 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 the required training specified in Section 5.2.2 and documentation of training is complete.

5.2.2 Training (Required)

Pace® training requirements are outlined in Pace® policies COR-POL-0023 *Mandatory Training Policy* and COR-POL-0004 *Code of Ethics and Professional Conduct.*

5.2.2.1 Required Training Requirements

The PAS training program includes these elements:

- Scheduling
- Execution
- Documentation and Tracking
- Evaluation of Effectiveness

Required training is scheduled by corporate training personnel, local quality personnel, and the employee's direct supervisor.

Training on required topics, processes and procedure 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 completion of the employee's required training and for providing adequate time to the employee to complete training assignments. The supervisor and employee are responsible to make sure the employee's training status and training records for all required training is current, complete, and documentation of training is available.

Training status is tracked by the local QM, who provides the status to local management at least monthly or more frequently, as necessary, to ensure required training for personnel is complete and up to date.

The following subsections further describe the required PAS training program for new hire training and on-going training.

The laboratory's procedure for training is specified in SOP ENV-SOP-MIN4-0165 *Orientation and Training Procedures.*

5.2.2.1.1 New Hire Required Training

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

Required new hire training includes training on 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 prepare and 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 without direct supervision of the work activity by the supervisor or a qualified trainer.

All required training must be documented and verified complete by the local QM before the employee is authorized to work independently on client samples. Until then, the employee's direct supervisor is responsible for all work produced by the new employee under their supervision.

5.2.2.1.2 On-Going Required 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
- Changes to Policies & SOPs, relevant to their job activities.
- New Policies & SOPS, relevant to their job activities.
- Technical personnel must also successfully complete on-going demonstration of capability (CDOC) for all test methods performed on an annual basis (see 5.2.2.1.5).

All required training must be documented and verified complete by the local QM with training records readily accessible in accordance with the corporate policy for Record Management (ENV-POL-CORQ-0013).

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 PAS data integrity procedures will result in a detailed investigation that could lead to profound consequences including immediate termination, debarment, or civil/criminal prosecution.

Completion of data integrity training is documented using the mechanism established by Pace® 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 hire and/or during annual refresher training or as specified in the ethics policy. This document clearly identifies inappropriate and questionable behavior. Violations of this document result in profound consequences, including prosecution and termination, if necessary.

Also see SOP-ENV-COR-POL-0004 *Code of Ethics and Professional Conduct* for more information.

5.2.2.1.4 Management System Documents Training

The Quality Manual policies, and SOPs are the documents used by regulatory bodies and Pace® customers to verify 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 (R&A) on record for the quality manual, and the policies and SOPs relating to his/her job responsibilities. This statement, whether 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. 9.1).

See SOP ENV-CORQ-0016 Standard Operating Procedures and Standard Work Instructions for more information.

5.2.2.1.5 Demonstration of Capability (DOC) Requirements

An initial demonstration of capability (IDOC) must be completed and validated prior to authorization for the employee to work independently on client samples for the test method. 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.

Successful DOC is one where the DOC replicate data has been compiled, reviewed, and verified by the employee's supervisor and/or manager to be complete and to have met acceptance criteria and the DOC record has been validated by quality personnel for completeness and compliance, and placed in the employee's training file for accessibility and reference.

Demonstration of capability (DOC) procedures and requirements vary by technology.

For example, a DOC for chemistry test methods where spiking is appropriate, 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.

DOC procedures and requirements must be specified in the laboratory's test method SOP or a stand-alone SOP. Refer to these SOPs for more information.

5.2.2.1.6 Effectiveness of Training

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 QMS, 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.

5.2.2.2 Supplemental Learning

Supplemental learning objectives may be established for newly hired personnel to aid in their development of administrative and technical skills. These learning objectives and materials, referred to as Learning Plans (LP), are created and maintained by the PAS 3P program and managed by the employee's direct supervisor.

Pace® also offers a wide variety of supplemental learning courses that are made available to all employees for professional development. These learning materials,

maintained by Pace® corporate training personnel, are accessed via the company's employee portal, PaceConnect. The learning may be self-initiated based on an employee's interest or may be assigned to the employee at the discretion of management as professional development as part of an employee's annual goals.

Supplemental learning courses and learning plan activities are not prerequisites for competency (Section 5.2.1.1) and are not considered part of the required PAS QMS training program.

5.2.3 Personnel Supervision

Every employee is assigned a direct supervisor, however named, who is responsible for their supervision.

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 conducted in accordance with this quality manual, policies, SOPs, and other documents that support the QMS.

5.2.4 Job Descriptions

Job Descriptions that define the required education, qualifications, experience, skills, roles and responsibilities, and reporting relationships for each Pace® position are established by top management and kept by corporate HR. The job descriptions apply to employees who are directly employed by Pace®, part-time, temporary, technical, and administrative and by those that are under contract with Pace® 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

Technical personnel are authorized by local quality personnel to perform the technical aspects of their position after quality personnel have verified that the employee meets the qualifications for the position, has successfully completed required training (Section 5.2.2.1), and the employee has completed initial demonstrated capability (Section 5.2.2.1.5). 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 location where the employee works.

5.3 Accommodations and Facilities

5.3.1 Facilities

PAS laboratories and service centers are designed to support the correct performance of procedures and to not adversely affect measurement integrity or safety. Access to PAS facilities is controlled by various measures, such as card access, locked doors, staffed main entry.

5.3.2 Environmental Conditions

Each location is equipped with energy sources, lighting, heating, and ventilation necessary to facilitate proper performance of calibrations and tests. The location 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. Operations are stopped if it is discovered that the environmental conditions would jeopardize the integrity of analytical results or other work product.

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 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).

Samples known or suspected to contain high concentration of analytes are separated 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 applicable SOPs.

5.3.4 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 potential safety concerns.

5.3.5 Good Housekeeping

PAS locations must maintain good housekeeping practices in work areas to maintain a standard of cleanliness necessary for analytical integrity and personnel health and safety.

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*.

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 items tested, for the intended use of the data, and to conform with applicable federal, statutory, or program requirements.

The test methods offered by PAS are industry accepted methods published by international, regional, or national standards. Each PAS 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 PAS Developed Methods

A PAS 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.

PAS 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 PAS 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; and
- 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 confirmation 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 and repeated when there are major changes to the laboratory procedure.

Results of validation are retained are kept in accordance with method validation SOP and the corporate policy ENV-CORQ-POL-0013 *Record Management.*

5.4.5.3 Validation of Customer Need

The validation process includes review of accuracy, precision, sensitivity, selectivity, linearity, repeatability, reproducibility, robustness, and cross-sensitivity of the procedure against general customer needs to ensure the laboratory's procedure will meet those needs.

The following subsections explain some concepts as they are applied to chemistry. The applications of these same concepts may differ for other technologies such as microbiology, radiochemistry, whole effluent toxicity (WET), and asbestos or other

validation concepts may apply to these disciplines. Refer to the laboratory's test method SOPs for more information.

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 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 specified in SOP ENV-SOP-MIN4-0163 *Determination of LOQ and LOQ*.

For chemistry methodology, the local SOP must comply with the current version of each of the following documents:

- EPA document EPA-821-R-16-006 Definition and Procedure for the Determination of the Method Detection Limit;
- 2016 TNI Standard V1M4; and
- TNI GUID-3-109-Rev. 0, V1M4 2016 Standard Update Guidance on Detection and Quantitation.

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

This section describes these concepts for chemistry. For non-chemistry technologies, such as microbiology, refer to laboratory SOPs.

The LOQ is the minimum level, concentration, or quantity of a target analyte that can be reported with a specified degree of confidence.

The LLOQ is the value of the lowest calibration standard included in the calibration curve. The LLOQ establishes the lower limit of quantitation; it is not the same concept as the LOQ, however, the LOQ and LLOQ may be the same value.

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.

The laboratory's procedures for LOQ determination must be specified in the same SOP for LOD determination, (see Section 5.4.5.3.3) The LLOQ for each method must be specified in the test method SOP.

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 then 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, inorganic test methods sometimes 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 procedure demonstrated acceptable precision and accuracy.

5.4.6 Measurement Uncertainty

The location provides an estimate of uncertainty in testing measurements with analytical results on request, or when required. For example, for radiochemistry uncertainty is always reported with the test result

For chemistry methodologies, the uncertainty of the test method is reflected in the control limits used to evaluate QC performance for the test method (see 5.9.1.1.9). ISO/IEC states that 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 location 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 considered.

5.4.7 Control of Data

PAS 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 performed, 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 PAS policy and procedures for manual integration are provided in corporate 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
- identification of 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, PAS 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 routine use. Commercial off the shelf software is considered sufficiently validated when the location 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 group that performed the validation.

The PAS process for the protection of data stored in electronic systems includes:

- Individual usernames 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
- 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.

5.5 Equipment

5.5.1 Availability of Equipment

Each PAS location 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.

When a regulation, program, or reference test method requires Class A glassware for quantitative measurements, only Class A glassware may be used. Plastic graduated cylinders, even if marketed by the vendor as comparable to Class A glassware, may not be used when Class A glassware is specified because ASTM's definition and tolerances for Class A glass cannot be applied to other materials.

5.5.2 Calibration

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

5.5.2.1 Support Equipment

The location confirms support equipment is in proper working order, uniquely identified, and meets the specifications for use prior to placement in service. Periodic checks are performed to verify tolerance and accuracy are performed thereafter in accordance with a support equipment maintenance scheduled maintained by local quality personnel. 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 conduct and record these checks are outlined in SOP ENV-SOP-MIN4-0161 *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 policy ENV-POL-CORQ-0005 *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 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

Each piece of equipment must be uniquely identified by serial number or any other unique ID system. The identifier is included in the equipment list maintained by the quality department and may not be reused or used interchangeably. New equipment and replacement equipment must be assigned a new unique ID.

5.5.5 Equipment Lists and Records

5.5.5.1 Equipment List

Each PAS location maintains a 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 work area where the equipment is used. 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 E.

5.5.5.2 Equipment Records

In addition to the equipment list, the location 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 SOP ENV-SOP-MIN4-0091 *Preventive, Routine, and Non-Routine Maintenance* or in 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 PAS personnel or by outside service providers.

All maintenance activities performed by PAS 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 service must be maintained and accessible for easy retrieval. The location must provide personnel with unrestricted access to instrument maintenance logs in order to promote good instrument maintenance and recordkeeping practices.

If an instrument must be moved, the location 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 because it no longer meets tolerance specifications, the potential effect of the nonconformance may have had on previously reported analytical results should be evaluated (see Section 4.9).

5.5.7 Calibration Status

The location 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 SOP ENV-SOP-MIN4-0161 *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 an instrument is sent out for service, the location using the equipment ensures that the function and calibration status of the equipment is checked and shown to be satisfactory before the equipment is returned to service.

5.5.9 Intermediate Equipment Checks

The location performs intermediate checks on equipment to verify the on-going calibration status. For example, most test methods 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 SOP ENV-SOP-MIN4-0161 *Support Equipment* for more information.

5.5.10 Safeguarding Equipment Integrity

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

- Adherence to manufacturer'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 location 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 location establishes traceability with the use of reference standards and equipment obtained from competent suppliers that provide

calibration certificates and/or certificates of analysis (COA).

5.6.2 Equipment Correction Factors

When correction factors are used to adjust results the PAS personnel will assure that results in computer software are also updated.

5.6.3 Specific Requirements

5.6.3.1 Requirements for Calibration Laboratories

The laboratory does not offer calibration services to customers; therefore, ISO/IEC and TNI requirements for calibration laboratories do not apply.

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 weights are the weight(s) used for daily balance calibration checks and the working thermometers are used for daily temperature measurements.

Working weights and thermometers must be periodically checked to verify on-going adequacy for use between calibrations performed by an external calibration laboratory using reference standards traceable to SI or a national standard and that are used solely for verification purposes.

For example:

- An acceptable reference standard to check working thermometers against include a NIST Certified Thermometer or a NIST Traceable Thermometer that is not used for any other purpose than to check the adequacy of the working thermometer.
- An acceptable reference standard for the working weights is a set of Class S weights that is not used for any other purpose than to verify the weights used daily.

The working weights must be checked against the reference standard annually and all weight sets must be recertified by an ISO accredited calibration body every 5 years. In this application, "annually" means within thirteen (13) months from the date of the last check.

Working thermometers must be checked against the reference thermometer prior to placement in service to establish a correction factor (CF)[1] and then re-checked annually (±13 months from date of last check) or if battery operated, every three (3) months (±100 days from date of last check).

Exceptions to the 3-month recheck for battery operated sensors are allowed when the sensor is embedded in a unit and the manufacturer/vendor has evidence to show that the accuracy of the sensor is not affected by battery life.

Liquid in Glass NIST Certified reference thermometers must be recertified by an ISO/IEC accredited calibration laboratory every 5 years. If the reference thermometer is NIST Traceable or is a digital NIST Certified thermometer, the reference thermometer must be recertified annually by an ISO/IEC 17025 accredited calibration laboratory or service provider that provides traceability to a national standard.

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 SOP ENV-SOP-MIN4-0161 *Support Equipment* and ENV-SOP-MIN4-0180 *Laboratory Supply Procedures* for more information.

5.6.4.2 Reference Materials

The location purchases chemical reference materials (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.

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 laboratory procedure for traceability and use of these materials is provided in SOP ENV-SOP-MIN4-0180 *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 it is not possible to procure a new standard and the reliability of the expired material is verified and documented by the location using a procedure approved by corporate quality personnel. Otherwise, the expired material is promptly removed from the work area or clearly labeled as acceptable for qualitative/troubleshooting purposes only.
- The second source materials used for verification of instrument calibration are obtained from a different manufacturer or may be a 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 reference standards and materials must be included in test method 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 location 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 each test method SOP or a stand-alone SOP 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 PAS.

5.7.1 Sampling Plans and SOPs

When PAS performs field collection of samples, sampling is carried out in accordance with a written sampling plan and 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 address 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 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

PAS 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 location's procedures for sample management and handling are outlined in SOP ENV-SOP-MIN4-0008 *Sample Management*, ENV-SOP-MIN4-0011 *Internal Chain of Custody*, ENV-SOP-MIN4-0095 *Regulated Soil Handling*.

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 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 location 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 location.

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;

- Sampler's Name or Initials;
- Matrix;
- Type of container, and total number collected for each sample;
- Preservatives;
- Analyses Requested;
- Mode of collection;
- Any special instructions; and
- The date and time and signature of each sample transfer from time of collection to receipt in the location. When the signature field on CoC includes company. Personnel relinquishing and/or receiving samples are expected to record this information. When the COC is transported inside the cooler, independent couriers do not sign the COC and the shipping manifests and/or air bills are the records of possession during transport. The shipping manifest must be retained as part of the COC record and included in the test report when required (see Section 5.10.3).

A complete and legible COC is required. If the location 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 location when requested by customer or when 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 location 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 SOP ENV-SOP-MIN4-0008 *Sample Management* for more information.

5.8.2 Unique Identification

Each sample is assigned a unique identification number (Lab ID) after the sample has been checked and accepted by PAS in accordance with the PAS 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.

The lab ID is linked to the field ID (client ID) in the receipt and log-in 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 location 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 are 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 typically considered acceptable if the measurement is above freezing but <6°C unless otherwise specified by federal, statutory, program or test method requirements. Refer to the location's SOP for sample receipt for specific thermal preservation requirements.

  For samples that are hand-delivered to the location immediately after sample collection, there must be evidence that the chilling process began immediately after sample collection and prior to delivery of the samples to the laboratory or service center, such as arrival of the samples on ice.

- Chemical Preservation
- Holding Time: Sample receiving personnel are trained to recognize 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 location 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

PAS 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 criteria for any one of these conditions, the location 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 criteria:

- 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 method 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; and
- Be received within appropriate temperature ranges unless program requirements or customer contractual obligations mandate otherwise.

Samples that are delivered to the location 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 log-in and these procedures are described in SOP ENV-SOP-MIN4-0008 *Sample Management*. 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; and
- Tests Requested.

5.8.5 Sample Storage, Handling, and Disposal

The location procedures for sample storage, handling and disposal are detailed in SOPs ENV-SOP-MIN4-0008 *Sample Management*, ENV-SOP-MIN-0098 *Waste Handling*, ENV-SOP-MIN4-0095 *Regulated Soil Handling*, ENV-SOP-DUL1-0004 *Waste Handling and Management*, and ENV-SOP-VIR1-0007 *Waste Handling and Management*.

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 location is operated under controlled access protocols to ensure sample and data integrity. Visitors must register at the front desk and be properly escorted while on-site. Samples are taken to the appropriate storage location immediately after sample receipt and log-in 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 location for sample retention and disposal are detailed in SOP ENV-SOP-MIN4-0008 *Sample Management*, ENV-SOP-MIN-0098 *Waste Handling*, ENV-SOP-MIN4-0095 *Regulated Soil Handling*, ENV-SOP-DUL1-0004 *Waste Handling and Management*, and ENV-SOP-VIR1-0007 *Waste Handling and Management*.

In general, unused sample volume and prepared samples such as extracts, digestates, distillates and leachates (samples) are retained by the location for the timeframe necessary to protect the interests of the location 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 location has a 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 location 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 location 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 5.6.4), participation in interlaboratory proficiency testing (see 5.9.1.2), 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 location to monitor performance statistical trends over time and to establish acceptance criteria when no method or regulatory criteria exist (see 5.9.1.1.9).

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 location 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. These concepts may not apply to other technologies and disciplines such as microbiology, radiochemistry, whole effluent toxicity, and/or asbestos. For essential QC for these disciplines, refer to test method SOPs.

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, or from a different lot from the same vendor, when only one vendor is available. It is a positive control used to verify the accuracy of instrument calibration relative to the purity of the standards used for calibration. This check may be referred to in published test methods and quality system standards as the initial calibration verification (ICV) or a 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. The source of the problem should be investigated and corrected prior to further use of the calibration/instrument for sample analysis.

5.9.1.1.2 Continuing Calibration Verification (CCV)

The CCV is used to determine if the analytical response has significantly changed since 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 and correction. Actions taken are technology and method specific.

5.9.1.1.3 Method Blank (MB) / Other Blanks

The MB 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, unless otherwise specified by the test method, is processed with, and carried through all preparation and analytical steps as the associated samples.

The criteria used to assess for contamination depends on the intended use of data. In general, detections in the MB above the RL or ½ the RL

indicate contamination. 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 a 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. Like the MB, unless otherwise specified in the test method, 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)

The MS and MSD are replicates of a client sample that is spiked with known amount of target analyte. Matrix spikes measure the effect the sample matrix has on precision and accuracy of test results.

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, during the same sampling event. Consequently, matrix spikes should be client designated. When there is not a client-specified MS for any sample in the batch, the location 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. However, because the performance of

matrix spikes is matrix-dependent and specific to the customer whose sample was used as the MS/MSD, the results of matrix spikes are not used for quality control on the batch.

5.9.1.1.6 Sample Duplicate (SD)

A sample duplicate is a second replicate of sample that is used to measure precision.

The relative percent difference between replicates are evaluated against the established acceptance 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 location follows specific guidelines for the treatment of internal standard recoveries and further information can be found in the applicable test method 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 location develops acceptance criteria in accordance with recognized industry standards.

Some methods and programs require the location to establish control limits for LCS, MS/MSD, and surrogate evaluation using historical data.

PAS developed limits are referred to as "in-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 SOP ENV-SOP-MIN4 *Control Chart Generation and Trend Analysis* for more information about the procedures used to establish in-house control limits.

5.9.1.2 Proficiency Testing (PT)

PAS locations participate in interlaboratory proficiency testing (PT) studies to measure performance of the test method and to identify or solve analytical problems. PT samples measure location performance through the analysis of unknown samples provided by an external source.

The frequency of PT participation is based on the certification and accreditation requirements held by the laboratory. The PT samples are obtained from accredited proficiency testing providers (PTP) and treated as field samples which means they are included in the location's normal analytical processes and do not receive extraordinary attention due to their nature.

PAS locations do not share PT samples with other PAS locations, does not communicate with other PAS locations 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.

PT results scored unacceptable are investigated and correction action taken, when necessary.

Refer to corporate policy ENV-POL-CORQ-0002 *PT Policy* for more information.

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

PAS locations use 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 SOP ENV-SOP-MIN4-0092 *Data Review Process*. 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 PAS 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 a qualified peer or supervisor. Secondary review is 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

Test reports may be audited by local quality personnel to verify compliance with SOPs and to check for data integrity, technical accuracy, and compliance with the PAS QMS and any applicable federal, statutory, and program requirements. The reports chosen for the data audits are selected at random and these audits are not usually done prior to issuance of the test report to the customer.

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.

5.9.4 Calibration Certificates

PAS does not perform calibration activities for its customers and calibration certificates are

not offered or issued.

5.9.5 Opinions and Interpretations

The location provides objective data and information to its customers of sufficient detail for their interpretation and decision making. Objective data and information are 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 location provide opinion or interpretation to assist them with their decisions about the data.

When opinions and interpretations are included in the test report, the location 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:

- A viewpoint on how a nonconformance impacts the quality of the data or usability of results.
- Recommendations for how the customer should use the test results and information.
- Suggestions or guidance to the customer for improvement.

5.9.6 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.

Test results performed by multiple locations within the PAS network (internal subcontracting) may be merged into a single test report so long as the test report issued clearly identifies the location and address of each network location that performed testing, and which tests each PAS location performed (see 5.10.2).

5.9.7 Electronic Transmission of Results

When test results and/or reports are submitted to the customer through electronic transmission, the procedures established in this manual for confidentiality and protection of data apply.

5.9.8 Format of Test Reports

The test formats offered by PAS are designed to accommodate each type of analytical test method performed and to minimize the possibility of misunderstanding or misuse of analytical results. The format of electronic data deliverables (EDD) follows the specifications for the EDD.

5.9.9 Amendments to Test Reports

Test reports that are revised or amended by the location after date of release of the original 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 location's data verification and review process.

The procedure for report amendments and revision are outlined in SOP ENV-SOP-MIN4-0185 *Final Report and Deliverable Contents*.

5.10 Reporting

5.10.1 General Requirements

PAS offers a wide variety of test report formats to meet project needs of Pace® customers and that comply with federal and state regulatory programs.

The type and level of deliverable, including the electronic data deliverable (EDD) format are established between PAS and the customer during the contracting process. 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

Regardless of deliverable or report requested, every test report issued by the location includes each of the following items:

a) A Title

b) The name and address of the location issuing the test report and for each location where testing was performed if different than address of the location issuing the report. When testing is done at multiple PAS locations, the report must clearly identify which PAS location performed each test method;

c) Unique identification of the test report and on each page an identification number to link each page to the test report, and clear identification of the end of the report.

d) The name and address of the customer

e) Identification of test methods used

f) Cross reference between client sample identification number (Sample ID) and the identification number for the sample (Lab ID) to provide unambiguous identification of samples.

g) 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.

h) Date and times of sample collection, receipt, preparation, and analysis.

i) 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.

j) All chains of custody (COC) including records of internal transfer between locations within PAS,

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 PAS.

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) Shipping manifests / bill of ladings as applicable when common couriers are utilized for shipment of samples,

b) Explanation of departure from test method SOPs including, what the departure was and why it was necessary.

c) Statistical methods used. (Required for Whole Effluent Toxicity)

d) For solid samples, specification that results are reported on a dry weight or wet weight basis.

e) Signed Affidavit, when required by client or regulatory agency.

f) 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.

g) 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.

h) Opinions and Interpretations

i) 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 location 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.

j) Certification Information, including certificate number and issuing body.

For PAS locations accredited to ISO/IEC 17025:2017:

- Data included in the test report provided by a customer should be clearly identified. The test report should also include a statement that the test results apply only to the samples as received.

5.10.3.2 Test Reports: Sampling Information

The following items are included in the test report when samples are collected by PAS 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 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.

6.0 REVISION HISTORY

This Version (Version 2):

Section	Description of Change
Header / All	Added registered trademark after Pace as required by branding guidelines
Header	Updated the years associated with the copyright.
Signature Page	Removed Cover Page applied by MasterControl eDMS
Approval Signatory	Changed name of this page to "Management Personnel" and updated Job Titles.
All	Changed references to "laboratory" with PAS or location, where appropriate.
All	Replaced stand-alone acronym "ENV" with "PAS" except where "ENV" is embedded in document control numbers.
All	Corrected spelling, typographical, and format errors.
Various	Added language to clarify the examples in the manual are provided for chemistry, these examples may not apply in the same way to other disciplines such as radiochemistry, microbiology, asbestos, or whole effluent toxicity (WET).
1.0	Corrected Parent Company Information.
1.2	Added definitions for "location," "laboratory" and "service center" for QMS and compliance purposes.
1.2.1	Updated job titles to match current structure.
1.2.2	Revised language for clarity.
1.2.3	Removed specificity to allow for more options
4.1.4	Updated to describe current scope of organization
4.1.4.1	Updated to describe current organization structure
4.1.5.1.1	Updated to match new organization structure and job titles
4.1.5.2	Updated to match new organization structure and job titles
4.1.5.2.1	Updated to clarify qualifications and meaning of "absent"
4.1.5.3	Updated to clarify impartiality
4.1.5.4	Reorganized section for clarity
4.2.1.1	Added statement that the organization structure is designed to safeguard impartiality
4.2.2.1	Added requirement to post compliance alertline posters in work area.
4.2.1.3	Added requirement for policies and procedures to be available in work area

Section	Description of Change
	(previously implied but not explicitly stated)
4.2.5.1	Clarified hierarchy and application of project documents
4.5	Updated requirements for internal and external subcontracting
4.8	Updated complaint handling requirements to clarify that only valid complaints are acted on with corrective action.
4.9.1.3	Added roles responsible for authorizing return to work after stop work order.
4.11	Main and subsections updated for clarity
4.14	Main and subsections updated for clarity
5.2.2 Subsections	Content reorganized and language related to documentation of training and authorization of personnel revised to clarify expectations. Requirements of DOCs modified to clarify procedure described in manual pertains to chemistry methodology; other approaches to DOC acceptable for other disciplines such as microbiology, radiochemistry, asbestos, whole effluent toxicity.
5.4.5.3.3	Added reference documents for which the local SOP for LOD must comply with.
5.5	Added language to clarify existing requirements.
5.6.4	Clarified requirements for reference standards for working weights and thermometers and defined meaning of terms "annual" and "quarterly." Included examples of acceptable reference standards for adequacy checks.
5.8.1	Added recommendation for Pace® personnel to add "Pace®" next to their signature on the CoC when receiving samples since the CoC form has signature/company, implying the company affiliation must be added.
5.10.3.1	Included ISO/IEC 17025:2017 to add disclaimer to test reports (applies to laboratories accredited to ISO/IEC 17025:2017 only).

This document supersedes the following documents:

Document Number	Title	Version
ENV-TMP-CORQ-0007	Quality Manual Template	01
ENV-MAN-CORQ-0001	Quality Manual	00
ENV-MAN-MIN4-0001	Quality Manual	01
ENV-MAN-NW-0001	Quality Manual	02

7.0 APPENDICES

7.1 Appendix A: Certification / Accreditation Listing

Disclaimer: The certifications / accreditation lists provided in this Appendix are those that were held by the PAS 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. This manual is not updated with each change made. Current certificates are accessible via the eDMS Portal for PAS employees. External parties should contact the location for the most current information.

7.1.1 PAS-Minneapolis MN

Authority	ID	Authority	ID
A2LA (Dept. of Defense)	2926.01	Mississippi State Dept. of Health	MN00064
A2LA (IEC/ISO 17025:2017)	2926.01	Missouri Dept. of Natural Resources	10100
A2LA (Wyoming - UST)	2926.01	Montana Dept. of Public Health and Human Services	CERT0092
Alabama Dept. of Environmental Management	40770	Nebraska Dept. of Health and Human Services	NE-OS-18-06
Alaska Dept. of Environmental Conservation (DW)	MN00064	Nevada Dept. of Conservation & Natural Resources	MN00064
Alaska Dept. of Environmental Conservation (Contaminated Sites)	17-009	New Hampshire Dept. of Environmental Services	2081
Arizona Dept. of Health Services	AZ0014	New Jersey Dept. of Environmental Protection	MN002
Arkansas Dept. of Health (DW)	MN00064	New York State Dept. of Health	11647
Arkansas Dept. of Environmental Quality (WW)	88-0680	North Carolina Dept. of Environmental Quality	530
California ELAP via State Water Resources Control Board	2929	North Carolina Dept. of Health and Human Services (DW)	27700
Colorado Dept. of Public Health & Environment	MN00064	North Dakota Dept. of Environmental Quality	R-036
Connecticut Dept. of Public Health	PH-0256	North Dakota Dept. of Environmental Quality (Waste Characterization)	R-036
Florida Dept. of Health	E87605	Ohio Environmental Protection Agency	41244
Georgia Dept. of Natural Resources	959	Ohio Environmental Protection Agency (VAP – 1700)	CL101
Hawaii Dept. of Health	MN00064	Ohio Environmental Protection Agency (VAP – 1800)	CL110
Idaho Dept. of Health and Welfare (Inorganics)	MN00064	Oklahoma Dept. of Environmental Quality	9507
Idaho Dept. of Health and Welfare (Organics)	MN00064	Oregon ELAP via Health Authority (Primary)	MN300001
Illinois Environmental Protection Agency	200011	Oregon ELAP via Health Authority (Secondary)	MN200001
Indiana State Dept. of Health	C-MN-01	Pennsylvania Dept. of Environmental Protection	68-00563

Authority	ID	Authority	ID
Iowa Dept. of Natural Resources	368	Puerto Rico Dept. of Health	MN00064
Kansas Dept. of Health and Environmental Laboratories	E-10167	South Carolina Dept. of Health and Environmental Control	74003
Kentucky Dept. for Environmental Protection (DW)	KY90062	Tennessee Dept. of Environmental Control	TN02818
Kentucky Dept. for Environmental Protection (WW)	KY90062	Texas Commission on Environmental Quality	T104704192
Louisiana Dept. of Environmental Quality	AI-84596	Utah Dept. of Health	MN00064
Louisiana Dept. of Health (DW)	LA006	Vermont Dept. of Health	VT-027053137
Maine Dept. of Health and Human Resources	MN00064	Virginia Dept. of General Services	460163
Maryland Dept. of the Environment	322	Washington Dept. of Ecology	C486
Michigan Dept. of Environmental, Great Lakes, and Energy	9909	West Virginia Dept. of Environmental Protection	382
Minnesota Dept. of Agriculture	via "Minnesota Dept. of Health ELAP"	West Virginia Dept. of Health & Human Services (DW)	9952 C
Minnesota Dept. of Commerce (Petrofund)	1240	Wisconsin Dept. of Natural Resources	999407970
Minnesota Dept. of Health ELAP	027-053-137		

7.1.2 PAS-Duluth MN

Authority	ID	Authority	ID
Alaska Dept. of Environmental Conservation (Contaminated Sites)	21-002	Nevada Dept. of Conservation & Natural Resources	MN00037
Minnesota Dept. of Agriculture	via "Minnesota Dept. of Health ELAP"	North Dakota Dept. of Environmental Quality	R-105
Minnesota Dept. of Commerce (Petrodfund)	1240	Wisconsin Dept. of Natural Resources	999446800
Minnesota Dept. of Health ELAP	027-137-152	Wisconsin Dept. of Agriculture, Trade and Consumer Protection	480341

7.1.3 PAS-Virginia MN

Authority	ID	Authority	ID
Minnesota Dept. of Commerce (Petrodfund)	1240	Minnesota Dept. of Health ELAP	027-137-445

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 location for the most current information.

Table Legend:

- Air = Air

- 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 MN

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Filters
1,2-Dibromo-3-chloropropane	EPA 8011			X					
1,2-Dibromomethane	EPA 8011			X					
Alaska Diesel Range Organics	AK102 DRO				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 [1]	X				
Alaska Residual Range Organics	AK103 RRO				X				
Alkalinity	SM 2320 B-2011		X	X					
Amenable Cyanide	SM 4500-CN⁻ G-2011		X [1]	X					
Ammonia	EPA 350.1			X					
Apparent Specific Gravity	ASTM D5057-2010			X [1]	X [1]				
Chemical Oxygen Demand	EPA 410.4			X					
Chemical Oxygen Demand	SM 5220 D-2011			X					
Conductivity	EPA 120.1			X					
Conductivity	SM 2510 B-2011		X	X					
Demand (BOD, cBOD)	HACH 10360 Rev 1.2 (2011)			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				
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							

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Filters
Dioxins and Furans	EPA TO-9A	X							
Dioxins and Furans (2,3,7,8-TCDD)	EPA 1613B		X						
Dissolved Oxygen	HACH 10360 Rev 1.2 (2011)			X					
Escherichia coli	SM 9223 B (Colilert®)-2004		X						
Escherichia coli	SM 9223 B-2004			X					
Fecal Coliforms	SM 9222 D (m-FC)-2006			X					
Ferrous Iron	SM 3500-Fe B-2011			X [1]					
Fixed Gases	EPA RSK-175 (GC/FID)			X					
Gasoline Range Organics	EPA 8015C			X	X				
Gasoline Range Organics	NwTPH-Gx			X	X				
Gasoline Range Organics	WI (95) GRO			X	X				
Hexavalent Chromium	SM 3500-Cr B-2011			X					
ICP Metals	EPA 200.7			X					
ICP Metals	EPA 6010C			X	X	X			
ICP Metals	EPA 6010C-SPLP				X	X			
ICP Metals	EPA 6010C-TCLP			X	X	X			
ICP Metals	EPA 6010D (Rev 2018)			X	X	X			
ICP Metals	EPA 6010D (Rev 2018)-SPLP				X	X			
ICP Metals	EPA 6010D (Rev 2018)-TCLP			X	X	X			
ICPMS Metals	EPA 200.8		X	X					
ICPMS Metals	EPA 6020A			X	X	X			
ICPMS Metals	EPA 6020A-SPLP			X	X	X			
ICPMS Metals	EPA 6020B (Rev 2014)			X	X	X			
ICPMS Metals	EPA 6020B (Rev 2014)-SPLP			X	X	X			
Inorganic Anions	EPA 300.0		X	X					
Inorganic Anions	EPA 9056A			X					
Lead in Ambient Air	EPA 6010C	X [1]							
Lead in Ambient Air	EPA 6010C	X [1]							
Mercury	EPA 245.1		X	X					
Mercury	EPA 6020A				X	X			
Mercury	EPA 6020B (Rev 2014)				X	X			

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Filters
Mercury	EPA 7470A			X					
Mercury	EPA 7470A-SPLP			X					
Mercury	EPA 7470A-TCLP			X					
Mercury	EPA 7471A				X	X			
Mercury	EPA 7471B				X	X			
Moisture (Dry Weight)	ASTM D2974-07				X[1]				
Nitrate + Nitrite	EPA 300.0		X						
Nitrate + Nitrite	EPA 353.2		X[1]	X					
Oil & Grease	EPA 1664B			X					
Oil & Grease	EPA 9071B				X				
Orthophosphate	SM 4500-P G-2011			X					
Paint Filter Liquids Test	EPA 9095B			X					
PCB Congeners	EPA 1668A			X	X	X	X	X	
PCB Congeners	EPA 1668C			X	X	X	X	X	
Per- and Polyfluoroalkyl Substances (PFAS)	EPA 537.1		X						
Per- and Polyfluoroalkyl Substances (PFAS)	Isotope Dilution per DoD QSM v5.3			X	X	X	X		
Per- and Polyfluoroalkyl Substances (PFAS)	MPCA Guidance PFAS			X	X	X			
Per- and Polyfluoroalkyl Substances (PFAS)	WIDNR			X[1]	X[1]	X[1]	X[1]		
Pesticides	EPA 8081A			X	X				
Pesticides	EPA 8081B			X	X				
pH	EPA 9045D			X					
pH	SM 4500-H+ B-2011		X	X					
PM-10	EPA Quality Assurance Handbook, Volume II, Part II								X[1]
Polybrominated Diphenyl Ethers	EPA 1614						X[1]		
Polychlorinated Biphenyls	EPA 8082			X	X	X		X	
Polychlorinated Biphenyls	EPA 8082A (Rev 2007)			X	X	X	X	X	
Polychlorinated Biphenyls	EPA 8082A (Rev 2007)-SPLP				X	X			
Reformed Gases	ASTM D1946-90 (Rev 2006)	X[1]							
Sample Appearance	SM 2110-2005		X[1]	X[1]					
Semi-Volatile Organic Compounds	EPA 625.1-RV			X					

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Filters
Semi-Volatile Organic Compounds	EPA 8081A-TCLP			X	X				
Semi-Volatile Organic Compounds	EPA 8081B-TCLP			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 8270D (Rev 2014) SIM-LV			X					
Semi-Volatile Organic Compounds	EPA 8270D (Rev 2014) SIM-SPLP			X	X	X			
Semi-Volatile Organic Compounds	EPA 8270D (Rev 2014)-TCLP			X					
Semi-Volatile Organic Compounds	EPA 8270D WRV			X					
Semi-Volatile Organic Compounds	EPA 8270E			X	X	X			
Semi-Volatile Organic Compounds	EPA 8270E SIM			X	X	X			
Semi-Volatile Organic Compounds	EPA 8270E SIM-LV			X					
Semi-Volatile Organic Compounds	EPA 8270E WRV			X					
Semi-Volatile Organic Compounds	EPA 8270E-TCLP			X	X				
Sodium Absorption Ratio by Calculation	USDA Handbook No. 60			X [1]					
Total Coliforms	SM 9222 B-2006			X					
Total Coliforms	SM 9223 B (Colilert®)-2004		X						
Total Cyanide	SM 4500-CN⁻ E-2011		X	X					
Total Dissolved Solids (TDS)	SM 2540 C-1997		X						
Total Dissolved Solids (TDS)	SM 2540 C-2011			X					
Total Hardness as CaCO3	SM 2340 B-2011			X					
Total Petroleum Hydrocarbon (TPH)	EPA 1664B (SGT-HEM)			X					
Total Petroleum Hydrocarbon (TPH)	EPA 9071B				X				
Total Phosphorus	SM 4500-P F-2011			X					
Total Settleable Solids	SM 2540 F-2011			X					
Total Suspended Particulates (TSP)	EPA Quality Assurance Handbook, Volume II, Part II								X [1]
Total Suspended Solids (TSS)	SM 2540 D-2011			X					
Total Volatile Solids (TVS)	EPA 160.4			X					
Turbidity	EPA 180.1, Rev 2-1993		X	X					
Volatile Organic Compounds	EPA 3C	X							
Volatile Organic Compounds	EPA 624			X					

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Filters
Volatile Organic Compounds	EPA 624.1			X					
Volatile Organic Compounds	EPA 8260D			X	X	X			
Volatile Organic Compounds	EPA 8260D SIM			X					
Volatile Organic Compounds	EPA 8260D-TCLP			X	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-3	X							

[1] = Laboratory does not hold TNI Accreditation for this test method.

7.2.2 PAS-Duluth MN

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Filters
Acidity, as CaCO3	SM 2310 B-2011			X					
Alkalinity	SM 2320 B-2011		X	X					
Amenable Cyanide	SM 4500-CN⁻ G-2011			X					
Ammonia	EPA 350.1 1993			X	X				
Biochemical Oxygen Demand (BOD)	Hach 10360			X					
Carbonaceous Biochemical Oxygen Demand (CBOD)	Hach 10360			X					
Chlorophyll-A	SM 10200 H			X [1]					
Chromium VI	SM 3500-Cr B-2011			X					
Color	SM 2120 B-2011			X					
Conductivity	SM 2510 B		X	X					
Dissolved Organic Carbon (DOC)	SM 5310 C-2011			X					
Dissolved Oxygen	Hach 10360			X					
Escherichia coli (E.coli)	Colisure®		X						
Escherichia coli (E.coli)	SM 9223 B (Colilert®-18)		X						
Escherichia coli (E.coli)	SM 9223 B (Colilert-18 Quanti-Tray)-2004		X	X					
Fecal coliforms	Colilert®-18 (Fecal Coliforms)			X					
Heterotrophic plate count (HPC)	SimPlate®		X						
Humidity Cell Testing	ASTM D5744-13				X				
Inorganic Anions	EPA 300.0		X	X					
Inorganic Anions	EPA 9056A				X				

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Filters
Kjeldahl nitrogen – total (TKN)	EPA 351.2			X	X				
Mercury (low-level)	EPA 1631E			X	X	X			
Mercury (methyl)	EPA 1630			X [1]	X [1]	X [1]			
Nitrate as N	EPA 353.2		X						
Nitrate as N	EPA 353.2 (calc)			X					
Nitrate-Nitrite as N	EPA 353.2		X	X					
Nitrite	EPA 353.2		X	X					
Nitrogen, Amine	ASTM D2327			X [1]					
Organic Nitrogen	EPA 351.2 Minus EPA 350.1			X	X	X			
Orthophosphate	EPA 365.3			X					
Oxidation-Reduction Potential (ORP)	ASTM 1498			X [1]					
Percent Moisture	ASTM D2974				X [1]				
pH	SM 4500-H+ B 2011			X					
Pheophytin	SM 10200 H			X [1]					
Salinity	SM 2520			X [1]					
Sulfide	SM 4500-S2$^{=}$ D-2011			X					
Surfactants - MBAS	SM 5540 C-2011			X					
Total coliforms	Colisure®		X						
Total coliforms	SM 9223 B (Colilert®-18)		X						
Total coliforms	SM 9223 B (Colilert-18 Quanti-Tray)-2004		X						
Total Cyanide	SM 4500-CN^{-} E-2011			X					
Total Dissolved Solids (TDS)	SM 2540 C-2011		X	X					
Total Nitrogen	EPA 351.2 plus EPA 353.2			X	X	X			
Total Organic Carbon (TOC)	EPA 9060A			X	X				
Total Organic Carbon (TOC)	SM 5310 C-2011		X	X					
Total Phenolics	EPA 420.1			X					
Total Phosphorus	EPA 365.1			X	X	X			
Total Phosphorus	EPA 365.3			X					
Total Residual Chlorine	SM 4500-Cl G-2011		X	X					
Total Solids (TS)	SM 2540 B-2011			X	X	X			
Total Suspended Solids (TSS)	SM 2540 D -2011			X					

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Filters
Total Suspended Solids (TSS)	USGS I-3765-85			X		X			
Total Volatile Solids (TVS)	EPA 160.4				X				
Total Volatile Suspended Solids (TVSS)	EPA 160.4			X [1]					
Turbidity	EPA 180.1		X	X					

[1] = Laboratory does not hold TNI Accreditation for this test method.

7.2.3 PAS-Virginia MN

Parameter	Method	Matrices							
		Air	DW	NPW	SCM	Waste	Tissue	Wipes	Filters
Escherichia coli (E.coli)	Colisure®		X						
Escherichia coli (E.coli)	SM 9223 B (Colilert® Quanti-Tray®)-97		X	X					
Escherichia coli (E.coli)	SM 9223 B (Colilert®-18)		X						
Fecal Coliforms	Colilert-18			X					
Heterotrophic plate count (HPC)	SimPlate		X						
Total Coliforms	Colisure®		X						
Total Coliforms	SM 9223 B (Colilert® Quanti-Tray®)-97		X						
Total Coliforms	SM 9223 B (Colilert®-18)		X						

[1] = Laboratory does not hold TNI Accreditation for this test method.

7.3 Appendix C: Glossary

This glossary provides common terms and definitions used by PAS. **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 PAS 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	The continuous improvement program used by PAS that focuses on Process, Productivity, and Performance.
Absence	Inability to perform assigned duties due to lack of physical presence and connectivity.
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.

Term	Definition
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	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.

Term	Definition
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 timeframe 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.

Term	Definition
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.

Term	Definition
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.

Term	Definition
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.

Term	Definition
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.

Term	Definition
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 performs testing.
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.

Term	Definition
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).

Term	Definition
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.
Minimum Reporting Limit (MRL)	the lowest concentration of standard used for calibration – Drinking Water Manual
MintMiner	Commercial software program used to scan 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.

Term	Definition
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).
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.

Term	Definition
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.

Term	Definition
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 sorbent 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 saltwater 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.

Term	Definition
Relative Percent Difference (RPD)	A measure of precision defined as the difference between two measurements divided by the average concentration of the two measurements.
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.

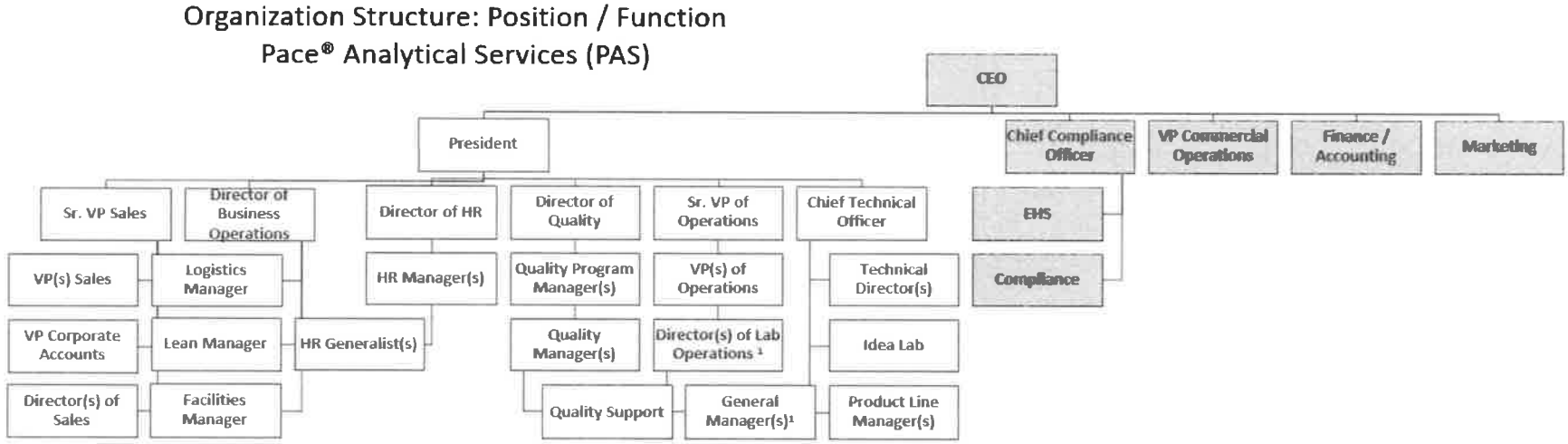
Term	Definition
Source Water	TNI- When sampled for drinking water compliance, untreated water from streams, rivers, lakes, or underground aquifers, which is used to supply private and public drinking water supplies.
Spike	A known mass of target analyte added to a blank sample or sub-sample; used to determine 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 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.

Term	Definition
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.

Term	Definition
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).

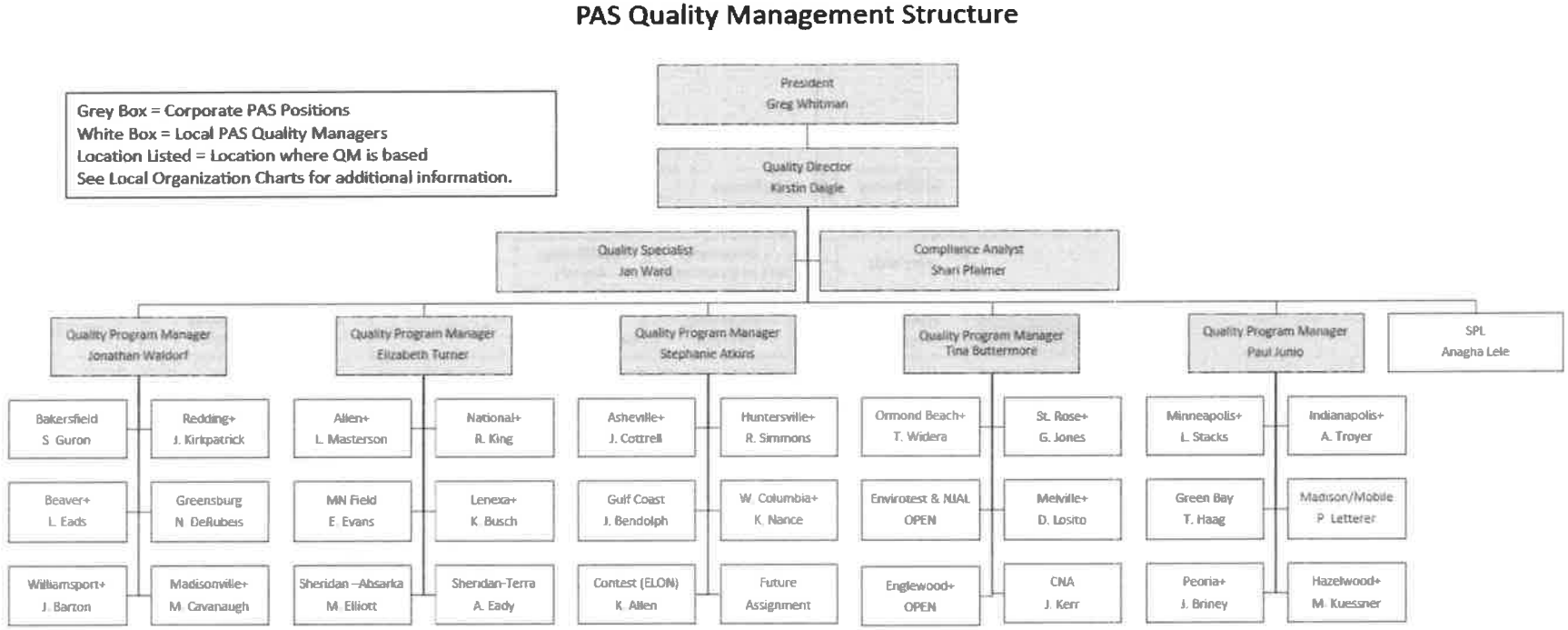
7.4 Appendix D: Organization Chart(s)

7.4.1 PAS Corporate Organization Chart(s)



White Box = PAS Positions / Functions
Grey Box = Pace®Corporate Positions / Functions
1= Positions not Assigned to all Locations – see location specific organization charts

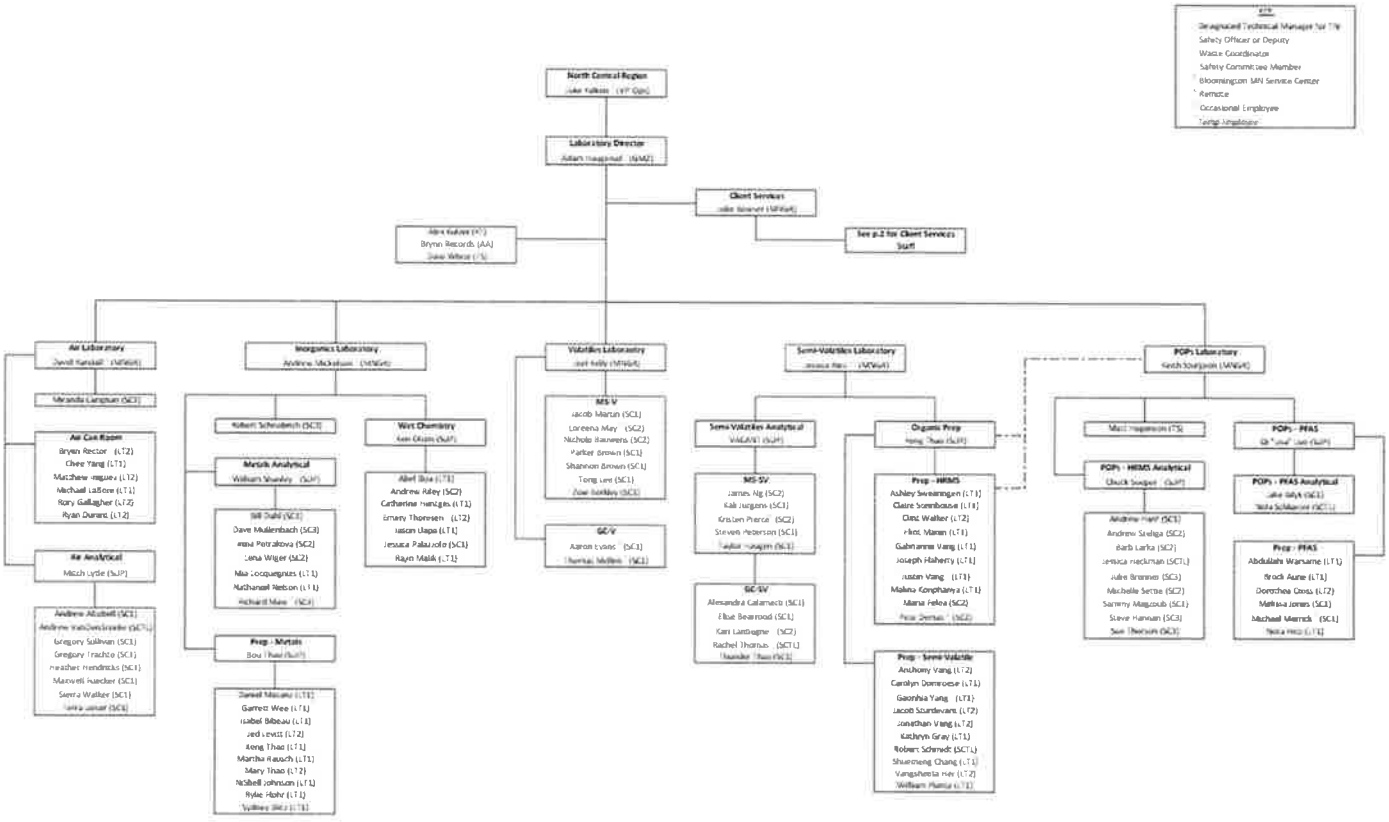
7.4.2 PAS Quality Systems Management Organization Chart



7.4.3 PAS-Minneapolis MN – Organization Chart

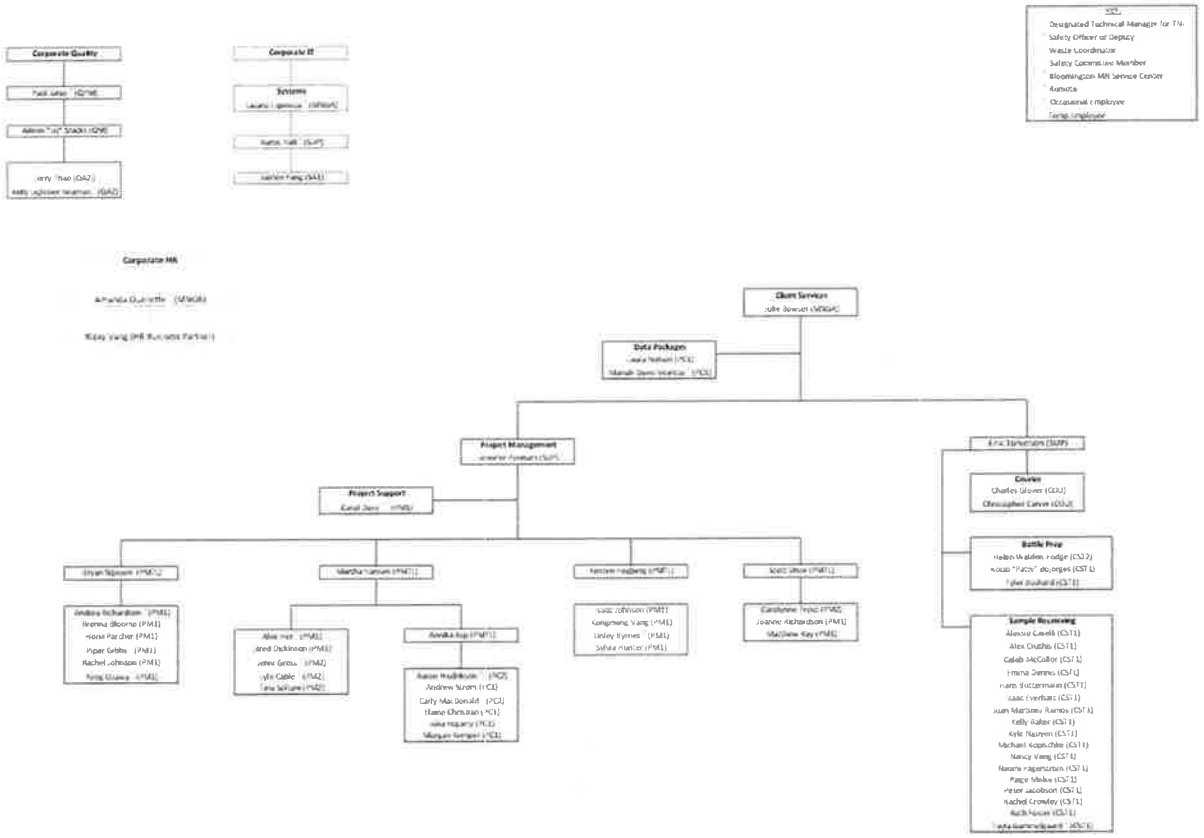
Last Revised: October 26, 2022

Pace-Minneapolis MN Laboratory



Last Revised: October 26, 2022

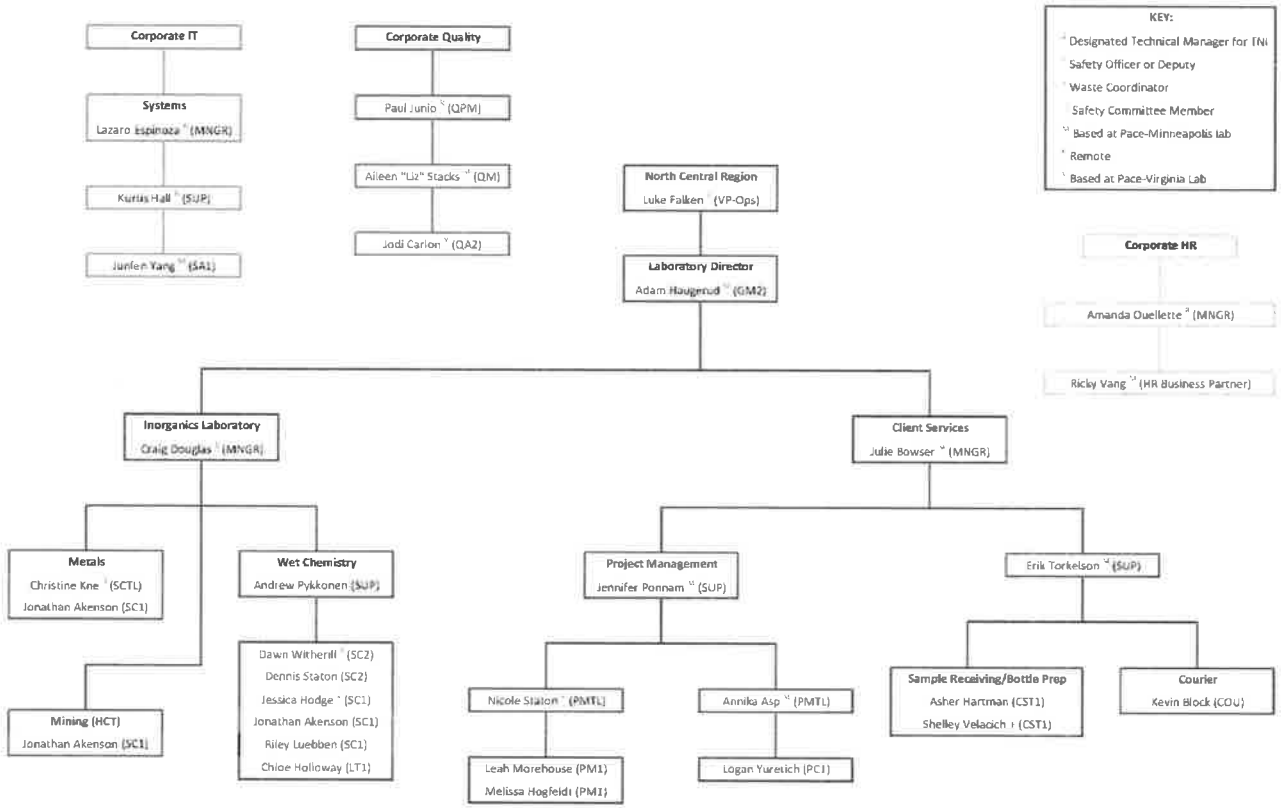
Pace-Minneapolis MN Laboratory



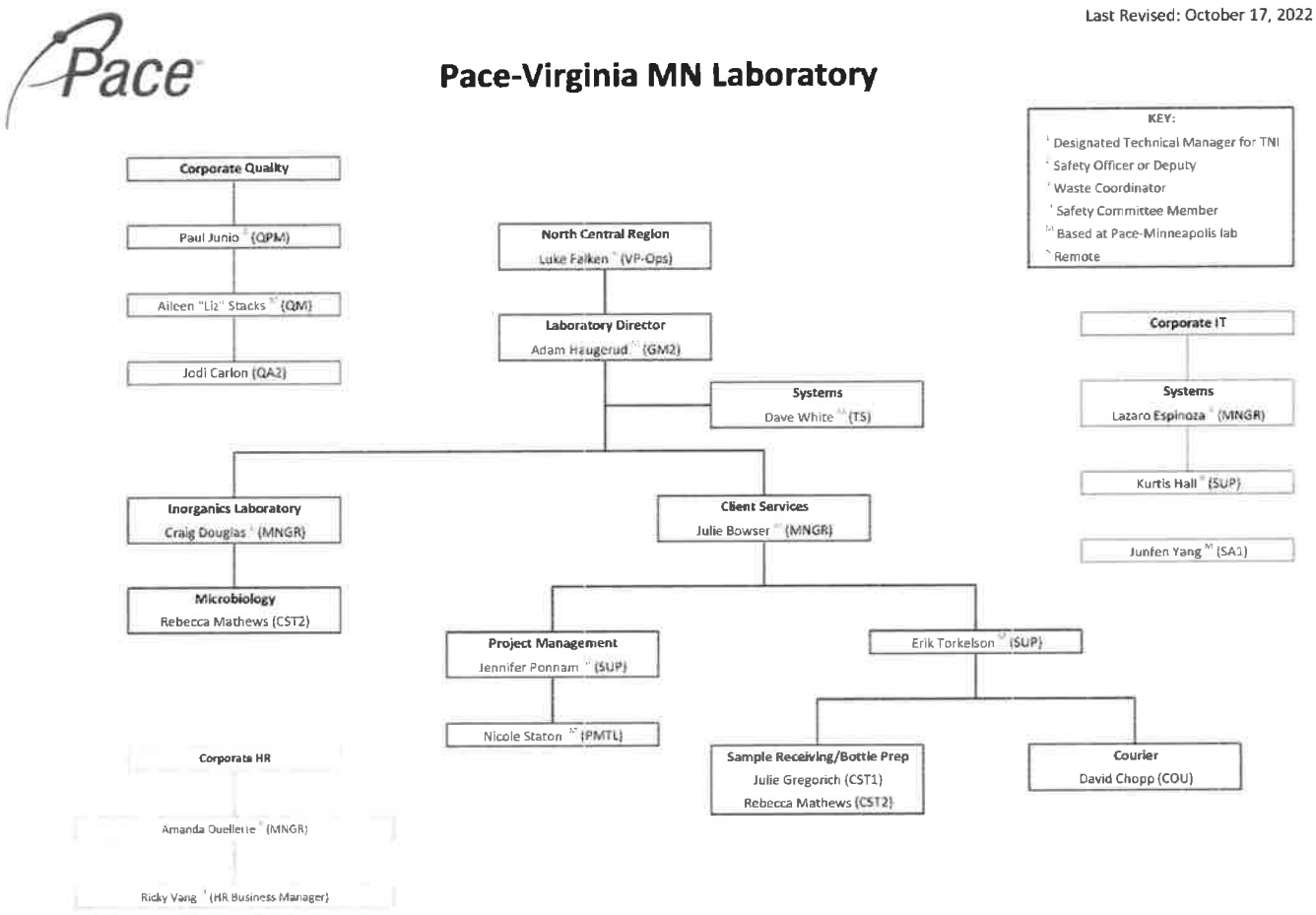
7.4.4 PAS-Duluth MN – Organization Chart

Last Revised: October 17, 2022

Pace-Duluth MN Laboratory



7.4.5 PAS-Virginia MN – Organization Chart



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 MN

Equipment List: PAS-Minneapolis MN

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
GC	Agilent Technologies	6890N	CN10429060	2005	Unknown	Air	10AIR0	TBD
MS	Agilent Technologies	5973 Network	US43146819	2005	Unknown	Air	10AIR0	TBD
PreConcentrator	Entech Instruments, Inc.	7100A	1299	2017	Unknown	Air	10AIR0	TBD
Canister Autosampler	Entech Instruments, Inc.	7016 CA	1283	Unknown	Unknown	Air	10AIR0	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1587	Unknown	Unknown	Air	10AIR0	TBD
GC	HP	5890	2843A20766	1985	Unknown	Air	10AIR5	TBD
GC	Agilent Technologies	6890N	CN10429056	2004	Unknown	Air	10AIR7	TBD
MS	Agilent Technologies	5973 Network	US43146821	2004	Unknown	Air	10AIR7	TBD
PreConcentrator	Entech Instruments, Inc.	7100A	1611	2018	New	Air	10AIR7	TBD
Canister Autosampler	Entech Instruments, Inc.	7016 CA	1239	Unknown	Unknown	Air	10AIR7	TBD
Canister Autosampler	Entech Instruments, Inc.	7016 CA-2	115	2019	Used	Air	10AIR7	TBD
GC	ALS Ready	6890A	US00034289	2013	Unknown	Air	10AIRA	TBD
Concentrator	Entech Instruments, Inc.	7032 AQ-L	1051	2020	Used	Air	10AIRA	TBD
MS	Agilent Technologies	5973 inert	US44621387	2009	Unknown	Air	10AIRB	TBD
GC	Agilent Technologies	6890	CN10517058	2009	Unknown	Air	10AIRB	TBD
PreConcentrator	Entech Instruments, Inc.	7200	1300	2018	New	Air	10AIRB	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1488	Unknown	New	Air	10AIRB	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1487	Unknown	New	Air	10AIRB	TBD
GC	Agilent Technologies	7890A	CN10742037	2010	New	Air	10AIRD	TBD
MS	Agilent Technologies	5975C	US73317788	2010	New	Air	10AIRD	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
PreConcentrator	Entech Instruments, Inc.	7200	1278	2017	New	Air	10AIRD	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1497	Unknown	New	Air	10AIRD	TBD
Canister Autosampler	Entech Instruments, Inc.	7016 CA	1284	Unknown	New	Air	10AIRD	TBD
MS	Agilent Technologies	5975C	US10407503	2010	New	Air	10AIRE	TBD
GC	Agilent Technologies	7890A	CN10241030	2010	New	Air	10AIRE	TBD
Thermal Desorber	Perkin Elmer	Turbomatrix 650	TD650L1009271	2010	New	Air	10AIRE	TBD
Can Cleaning Rack	Pace	N/A	N/A	Unknown	New	Air	Rack 1	TBD
Can Cleaning Rack	Pace	N/A	N/A	Unknown	New	Air	Rack 2	TBD
Can Cleaning Rack	Pace	N/A	N/A	Unknown	New	Air	Rack 3	TBD
Refrigerator/Freezer	Keystone	KSTRC312AW	DK25BZ	2012	New	Air	A4	TBD
Oven	Despatch	LDB Series	149432	Unknown	Unknown	Air	10AIR10	TBD
Tube Conditioner/Dry Purger	Perkin Elmer	Turbomatrix TC220	820R4051501	2015	New	Air	10AIR24	TBD
GC	Agilent Technologies	6890A	US00040933	2015	Used	Air	10AIRG	TBD
MSD	Agilent Technologies	5973	US10360131	2015	Used	Air	10AIRG	TBD
Thermal Desorber	Perkin Elmer	Turbomatrix 650	TD650L1210081	2015	New	Air	10AIRG	TBD
GC	Agilent Technologies	7890A	CN10803059	2015	New	Air	10AIRH	TBD
MS	Agilent Technologies	5975C	US80848612	2017	New	Air	10AIRH	TBD
Preconcentrator	Entech Instruments, Inc.	7200	1450	2017	New	Air	10AIRH	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1586	2019	New	Air	10AIRH	TBD
Canister Autosampler	Entech Instruments, Inc.	7016D	1579	2017	New	Air	10AIRH	TBD
GC	Agilent	6890N	CN10514046	2017	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
GC	Agilent	8890	US1940A006	2019	New	Air	10AIRJ	At the instrument

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
MS	Agilent	5977B	US1939R003	2019	New	Air	10AIRJ	At the instrument
PreConcentrator	Entech Instruments, Inc.	7200A	00110	2019	New	Air	10AIRJ	TBD
Autosampler	Entech Instruments, Inc.	7016D	1770	2019	New	Air	10AIRJ	TBD
Autosampler	Entech Instruments, Inc.	7016D	1771	2019		Air	10AIRJ	TBD
GC	Agilent	8890	US2012A006	5/12/2020	new	Air	10AIRK	At the instrument
MS	Agilent	5977B	US2014R005	5/12/2020	new	Air	10AIRK	At the instrument
PreConcentrator	Entech Instruments, Inc.	720D	1799	5/15/2020	new	Air	10AIRK	Electronic copy on PC
Autosampler	Entech Instruments, Inc.	7016D	1818	5/15/2020	new	Air	10AIRK	Electronic copy on PC
Autosampler	Entech Instruments, Inc.	7016D	1819	5/15/2020	new	Air	10AIRK	Electronic copy on PC
GC	Agilent	8890	US2210A011	7/14/1905	new	Air	10AIRM	Electronic copy on PC
MS	Agilent	5977B	US2151R037	7/14/1905	new	Air	10AIRM	Electronic copy on PC
Preconcentrator	Entech Instruments, Inc.	7200A	00141	7/14/1905	new	Air	10AIRM	Electronic copy on PC
Canister Autosampler	Entech Instruments, Inc.	7016D	1995	7/14/1905	new	Air	10AIRM	Electronic copy on PC
Canister Autosampler	Entech Instruments, Inc.	7016D	1996	7/14/1905	new	Air	10AIRM	Electronic copy on PC
Refrigerator	Beverage Air	KR48-1AS	5227060	Braun acquisition	new	Blooming ton	Q325	Electronic copy on PC
GC	Agilent	6890	CN10705008	2018	New	HRMS	10MSHR 14	TBD
Autosampler-E	CTC	PAL	412290	2018	New	HRMS	10MSHR 14	TBD
MS	Waters/Micro mass	Autospec	M590	2018	New	HRMS	10MSHR 14	TBD
Freezer	Kenmore	564.285027	80200474	2011	Unknown	HRMS	H2	TBD
Freezer	Dynasty	E-400-C	1206544	2011	Unknown	HRMS	H1	TBD
Fridge	Premium Levella	PFR90DX	3133249	2021	New	HRMS	H3	Online
GC	Agilent	6890N	US10544001	2006	Unknown	HRMS	10MSHR 09	TBD
GCMS	Waters/Micro mass	Autospec Premier	P669	2006	Unknown	HRMS	10MSHR 09	TBD
Autosampler - P	CTC	PAL	161106	Unknown	Unknown	HRMS	10MSHR 09	TBD
GC	Agilent	6890A	US00033386	2000	Unknown	HRMS	10MSHR 06	TBD
GCMS	Waters/Micro mass	Autospec Ultima	M496	2000	Unknown	HRMS	10MSHR 06	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Autosampler - U	CTC	PAL	1212740	Unknown	Unknown	HRMS	10MSHR 06	TBD
GCMS	Waters/Micro mass	Autospec Premier	P808	2015	New	HRMS	10MSHR 12	TBD
Autosampler - Y	CTC	Autospec P808	423629	Unknown	New	HRMS	10MSHR 12	TBD
GC	Agilent	Autospec Premier	CN10471195	2015	New	HRMS	10MSHR 12	TBD
GC	Agilent	6890A	US00036565	2000	Unknown	HRMS	10MSHR 05	TBD
GCMS	Waters/Micro mass	Autospec Ultima	M488	2000	Unknown	HRMS	10MSHR 05	TBD
Autosampler - F	CTC	PAL	423628	Unknown	Unknown	HRMS	10MSHR 05	TBD
GC	Agilent	6890	CN10201169	2020	New	HRMS	10MSHR 15	TBD
AutoSampler - L	Agilent	7683B Series Injector	CN94554262	2020	New	HRMS	10MSHR 15	TBD
MS	Waters/Micro mass	Autospec Premier	P789	2020	New	HRMS	10MSHR 15	TBD
LC-MS/MS	Sciex	API 4000	V23210806	2017	New	PFAS	10LCMS01	TBD
Bin pump	Agilent	G1312A	DE83103146	2018	New	PFAS	10LCMS01	TBD
LC-MS/MS	Sciex	API 4000	V1390304	2017	New	PFAS	10LCMS02	TBD
Bin pump	Agilent	G1312A	DE91604387	2018	New	PFAS	10LCMS02	TBD
Degassing Unit	SHIMADZU	DGU-20A5R	L20705569194 IX	2019	New	PFAS	10LCMS03	TBD
Liquid Chromatograph	SHIMADZU	Nexera X2 LC-30AD	L20555653493 US G	2019	New	PFAS	10LCMS03	TBD
Liquid Chromatograph	SHIMADZU	Nexera X2 LC-30AD	L20555653492 US G	2019	New	PFAS	10LCMS03	TBD
Autosampler	SHIMADZU	Nexera X2 SIL-20AC-XR	L20455250640 US G	2019	New	PFAS	10LCMS03	TBD
Reservoir Tray	SHIMADZU	Reservoir tray (Cat. No. 2258-45041-91)	L20305567270 SL	2019	New	PFAS	10LCMS03	TBD
Liquid Chromatograph	SHIMADZU	LC-20AB	L20125650517 US D	2019	New	PFAS	10LCMS03	TBD
Communications Bus Module	SHIMADZU	CBM-20A	L20235657676 US E	2019	New	PFAS	10LCMS03	TBD
Column Oven	SHIMADZU	Nexera X2 CTO-30A	L20575550727 US	2019	New	PFAS	10LCMS03	TBD
LCMS	SCIEX	QTRAP 5500	EG250621812	2019	New	PFAS	10LCMS03	TBD
LCMS	Agilent	6495 LC/TQ	SG2041D205	2021	New	PFAS	10PFA1	TBD
Column	Agilent	1290 Infinity II Multi Column Thermostat	DEBA406579	2021	New	PFAS	10PFA1	TBD
Multisampler	Agilent	1290 Infinity II Multisampler	DEBAS02792	2021	New	PFAS	10PFA1	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Pump Model	Agilent	MS 120 RVP LCMS High Speed Pump	IT2027N036	2021	New	PFAS	10PFA1	TBD
LCMS	Agilent	6495 LC/TQ	SG2216D203	2022	New	PFAS	10PFA2	TBD
Pump Model	Agilent	G7120A	DEBA206576	2022	New	PFAS	10PFA2	TBD
Multisampler Model	Agilent	G7167B	DEBAS03832	2022	New	PFAS	10PFA2	TBD
Column Oven	Agilent	G7116B	DEBA409759	2022	New	PFAS	10PFA2	TBD
Vortex	Fisher Scientific	cat #02215375	111220005	2018	New	Dioxin Prep	10HR21	TBD
Micro 100 Turbidimeter	Scientific Inc.	Micro 100 Turbidimeter	201309191	2005	Unknown	Dioxin Prep	10HR14	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 Vacuum Manifold	Thermo Scientific	60104233	1632	2017	Unknown	Dioxin Prep	10HR17	TBD
Hypersep Vacuum Manifold	Thermo Scientific	60104233	1552	2017	Unknown	PFAS	10HR16	TBD
Hypersep Vacuum Manifold	Thermo Scientific	60104233	1713-1	2017	Unknown	PFAS	10HR15	TBD
Centrifuge	IEC - International Equipment Company	HNS II	235525200	2018	New	Dioxin Prep	10HR18	TBD
Orbital Shaker	VWR	DS500	416G	2018	New	Dioxin Prep	10HR20	TBD
Oven	Lindberg Blue	GO1340A-1	O06M-568117-RM	2012	Used	Dioxin Prep	DP4	TBD
Oven	Thermo	F6018 (Med Level)	15031960120316	2012	Unknown	Dioxin Prep	DP5	TBD
Oven	Thermo	F6018 (Low Level)	15032170120319	2012	Unknown	Dioxin Prep	DP6	TBD
Oven	Carbolite	LHT/120	21-400729	2014	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	ICE Model CL Centrifuge	428-15985	Unknown	Unknown	Dioxin Prep	10HR24	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Chiller	ThermoFisher Scientific	Thermoflex 2500	0127680201150721	Unknown	Unknown	Dioxin Prep	10HR25	TBD
Chiller	ThermoFisher Scientific	Thermoflex 2500	0145040401120413	Unknown	Unknown	Dioxin Prep	10HR26	TBD
Chiller	ThermoFisher Scientific	Thermoflex 2500	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
1L SPE Station	CPI International	N/A	N/A	2019	New	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	Glas-Col	104A PL120	11312700	Unknown	Unknown	Dioxin Prep	10HR47	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Regulators								
Chiller	ThermoFisher Scientific	ThermoFlex 900	0110204001120820	Unknown	Unknown	Dioxin Prep	10HR48	TBD
Refrigerator	Homelabs	HME030210N	HME030210N-2163	2019	New	Dioxin Prep	10HR49	TBD
Refrigerator	Homelabs	HME030210N	HME030210N-865	2019	New	Dioxin Prep	10HR50	TBD
Low speed Centrifuge	Premiere	XC-2450	C&AU070144	2019	New	Dioxin Prep	10HR51	TBD
SPE manifold	Thermo Scientific	60104233	1848	2019	New	PFAS	10HR52	TBD
SPE manifold	Thermo Scientific	60104233	1833	2019	New	PFAS	10HR53	TBD
ultrasonic bath	Fisher Scientific	FS30H	RTB011069292A	2019	Used	Dioxin Prep	10HR54	TBD
NEVAP	Organomation	112	8213	2019	Used	PFAS	NEVAP 8	TBD
Hypersep Vacuum Manifold	Thermo Scientific	60104233	1848-1	2019	New	PFAS	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	PFAS	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
Shaker	Fisherbrand	88861021	J8CF61021087	1/22/2020	New	Dioxin Prep	10HR61	PFAS area
SPE manifold	Thermo Scientific	60104233	1909	1/22/2020	New	PFAS	10HR62	PFAS area
Fridge	Avanti Fridge	ARBC17T2PG	A5810191178186280 0035	3/5/2020	New	Dioxin Prep	10HR63	Dioxin
SPE manifold	Thermo Scientific	60104-233	238A638-01	3/6/2020	New	PFAS	10HR64	Dioxin
Evaporator	Zymark	Turbovap LV Evaporator	not fully visible	unknown	Used	Dioxin Prep	10HR65	TBD
Evaporator	Zymark	Turbovap LV Concentrator	TV0919N15245	unknown	Used	Dioxin Prep	10HR66	TBD
Freezer	Magic Chef	MCUF3W2	2011000840	4/13/2021	New	Dioxin Prep	DP8	Dioxin
12 position NEVAP	Organomation	NEVAP-111	0625	10/7/2021	Used	Dioxin Prep	NEVAP 9	Dioxin
SPE manifold	Thermo Scientific	60104-233	2012	4/23/2021	New	PFAS	10HR67	PFAS
SPE manifold	Thermo Scientific	60104-233	2027	4/23/2021	New	PFAS	10HR68	PFAS
SPE manifold	Thermo Scientific	60104-233	2009	8/9/2021	New	PFAS	10HR69	PFAS
SPE manifold	Thermo Scientific	60104-233	2033	8/9/2021	New	PFAS	10HR70	PFAS
Freezer	SPT	UF-214W	AS0115A228W20436	unknown	New	PFAS	10HR71	PFAS

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Cryomill	RETSCH	20.749.0001	12211304221	2021	New	PFAS	10HR72	PFAS
Microwave extraction	CEM	MARS 6 230/60	MY2387	1/4/2022	New	Dioxin Prep	10HR73	Dprep
Ultrasonic Bath	Bransonic	CPX8800H	BGS122176990B	2/28/2022	New	PFAS	10HR74	PFAS
ICPMS	Aglient 7700	G3281A	5P13142395	6/1/2013	New	Metals	10ICM8	TBD
ICPMS - autosampler	Teledyne Cetac	ASX520	US011191A520	6/1/2013	New	Metals	10ICM8	TBD
ICPMS - chiller	Agilent	G3292-80000	2U1551028	6/1/2013	New	Metals	10ICM8	TBD
ICPMS - pump	Edwards	G31989	129449393	6/1/2013	New	Metals	10ICM8	TBD
ICPMS	Aglient 7700	G3281A	JP12412084	2014	Used	Metals	10ICM9	TBD
ICPMS - autosampler	Teledyne Cetac	ASX520	US0312120AS520	2014	Used	Metals	10ICM9	TBD
ICPMS - chiller	Agilent	6160T21QR301	3U1621341	2014	Used	Metals	10ICM9	TBD
ICPMS - pump	Edwards	16436540	169436540	2014	Used	Metals	10ICM9	TBD
ICPMS	Agilent ICPM	7800	JP16120262	7/1/2016	New	Metals	10ICMB	TBD
ICPMS - autosampler	Agilent	G8410A	AU19156702	7/1/2016	New	Metals	10ICMB	TBD
ICP	Agilent Technologies	700 Series-ICP-OES	MY14160002	7/2/2016	New	Metals	10ICP4	TBD
ICP - autosampler	Teledyne Cetac	ASX520	12140A520	7/3/2016	New	Metals	10ICP4	TBD
ICP - chiller	Agilent	G8481-80003	1B13C1081	7/4/2016	New	Metals	10ICP4	TBD
ICP	Agilent Technologies	5100 -ICP-OES	MY15180003	2015	New	Metals	10ICP5	TBD
ICP - autosampler	Agilent	SPS4	AU15140009	2018	New	Metals	10ICP5	TBD
ICP - chiller	Agilent	G8481-80003	1A1550426	Unknown	New	Metals	10ICP5	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	N/A	6083CECW2815	2006	New	Metals	10MET04	TBD
Hot Block	Environmental Express	N/A	8031CECW3358	2012	New	Metals	10MET08	TBD
Hot Block	Environmental Express	N/A	8031CECW3346	2012	New	Metals	10MET10	TBD
Hot Block	Environmental Express	SC154	8708CECW3720	2013	New	Metals	10MET23	TBD
Hot Block	Environmental Express	SC154	8793CECW3764	2014	New	Metals	10MET26	TBD
Hot Block	Environmental Express	N/A	8031CECW3342	2012	New	Metals	10MET09	TBD
Hot Plate	Cole Parmer	N/A	N/A	Unknown	New	Metals	10MP03	TBD

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TCLP agitator/tumbler	Analytical Testing Corp	DC-20	0685RKME0010	6/19/2008	New	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	New	Metals	10MP05	TBD
pH meter	Orion Research	Expandable Ion Analyzer EA 940	1343	7/7/1905	Used	Metals	10MP06	TBD
Tumbler	Analytical Testing Corp	42R5BFC1-E3	0685SAMH002	4/1/2015	New	Metals	10MET36	TBD
Tumbler	Analytical Testing Corp	42R5BFC1-E3	0685SGMP0002	2015	New	Metals	10MET38	TBD
Tumbler	Analytical Testing Corp	42R5BFC1-E3	0685SGMQ0006	2015	New	Metals	10MET39	TBD
pH meter	Oakton	pH700	2404439	2015	New	Metals	10MP07	TBD
Temperature probe	Oakton	35613-13 (Lot code: 298)	93X052911	2015	New	Metals	10MP07	TBD
Oven/Desiccator	Fisher Isotemp	Isotemp Oven	903N0075	2017	New	Metals	10MET40	TBD
Oven	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	2017	New	Metals	10MET44	TBD
Oven/Desiccator	Fisher Isotemp	725F	903N0078	2017	New	Metals	10MET41	TBD
Centrifuge	ThermoScientfic	Legend XT	42243876	2018	New	Metals	10MET45	TBD
Turbidity Meter	HACH	TU5200	1808718	2018	New	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
Digestion Block	Environmental Express	SC154	2020CECW5296	2020	New	Metals	10MET49	Hotblock logbook drawer
Digestion Block	Environmental Express	SC154	2020CECW5341	2020	New	Metals	10MET50	Hotblock logbook drawer
Autofill station	Environmental Express	Autofill Station	ABF5000-0420-087	2020	New	Metals	10MET51	Hotblock logbook drawer
Oven	Fisher	151030521	42408312	2019	New	Metals	10MET52	Taped to the side of the oven
Hot Stir Plate	Cole Parmer	HS19 C-P	50010030	2020	New	Metals	10MET53	Hanging above instrument
Hot Block	Environmental Express	SC154	2020CECW5429	2020	New	Metals	10MET54	Hotblock logbook drawer
FIMS400	Perkin Elmer	FIMS400	401S20122101	2021	New	Metals	10HG10	Hotblock logbook drawer
Autosampler	Perkin Elmer	S25	0720032S25	2022	New	Metals	10HG10	Hotblock logbook drawer

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Digestion Block	Environmental Express	SC154	2020CECW5430	2021	New	Metals	10MET55	Hotblock logbook drawer
ICPMS Instrument	Agilent	G8403A	SG19374593	2021	New	Metals	10ICMD	Hotblock logbook drawer
Autosampler SPS4	Agilent	G8410A	AU19156705	2021	New	Metals	10ICMD	Hotblock logbook drawer
Chiller	Agilent	G3929-80200	1908-02202	2021	New	Metals	10ICMD	Hotblock logbook drawer
ICP Instrument	Agilent	5110	MY18260006	2021	New	Metals	10ICP6	Hotblock logbook drawer
Autosampler SPS4	Agilent	G8410A	AU18144765	2021	New	Metals	10ICP6	Hotblock logbook drawer
Recirculating Chiller	Agilent	G8481A	1807-00914	2021	New	Metals	10ICP6	Hotblock logbook drawer
Microwave	CEM	MARS6	MY2191	2021	New	Metals	10MP09	Hotblock logbook drawer
Stir plate	Fisher	3G11	LBKF63001	2022	New	Metals	10MET56	Hotblock logbook drawer
Stir plate	Fisher	0	C2720019041808220	2022	New	Metals	10MET57	Hotblock logbook drawer
Stir plate	Fisher	0	C1931151230188	2022	New	Metals	10MET58	Hotblock logbook drawer
Stir plate	Fisher	0	C3420010022001741	2022	New	Metals	10MET59	Hotblock logbook drawer
Hotblock	Environmental Express	SC154	2020CECW5435	2022	New	Metals	10MET60	Hotblock logbook drawer
Stir plate	N/A	N/A	HA2520222	2022	Used	Metals	10MET61	TBD
UltraSonicator	Branson	8510	RPC10096911F	unknown	New	O-Prep	10OP17	O-Prep - drawer under Muffle Furnace
Sonicator	Misonix	XL 2020	G3914	unknown	New	O-Prep	10OP01	O-Prep - drawer under Muffle Furnace
Sonicator	Misonix	XL 2015	G4180	2007	Unknown	O-Prep	10OP02	O-Prep - drawer under Muffle Furnace
Sonicator	Misonix	Sonicator 3000	R1638	2007	Unknown	O-Prep	10OP04	O-Prep - drawer under Muffle Furnace
N-EVAP	Organomation	112	8169	Unknown	Unknown	O-Prep	10OP10	O-Prep - drawer under Muffle Furnace
N-EVAP (waterbath)	Organomation	112	7537	Unknown	Unknown	O-Prep	10OP11	O-Prep - drawer under Muffle Furnace
N-EVAP (sample tray)	Organomation	112	Not readable	Unknown	Unknown	O-Prep	10OP11	O-Prep - drawer under Muffle Furnace
Refrigerator	Traulsen	G20010	T34931C10	2011	New	O-Prep	OP1	O-Prep - drawer under Muffle Furnace
Centrifuge	IEC	Centra GP8	31210390	Unknown	Unknown	O-Prep	10OP13	O-Prep - drawer under Muffle Furnace
Centrifuge	Damon/IEC Division	N/A	9304	Unknown	Unknown	O-Prep	10OP14	O-Prep - drawer under Muffle Furnace
Centrifuge	International Clinical Centrifuge	CL28899M	28899M	Unknown	Unknown	O-Prep	10OP15	O-Prep - drawer under Muffle Furnace

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Muffle Furnace	Lindberg/Blue M	BF51828C-1	505296	Unknown	Unknown	O-Prep	10OP16	O-Prep - drawer under Muffle Furnace
N-EVAP	Organomation	112	4185	2014	Unknown	O-Prep	10OP18	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-vacuum controller	Buchi Labortenchik Ag	V-855	10000162387	2014	Unknown	O-Prep	10OP21	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-vacuum pump	Buchi Labortenchik Ag	V-700	1000166230	2014	Unknown	O-Prep	10OP21	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-Recirculating Chiller	Buchi Labortenchik Ag	F-108	1019513	2014	Unknown	O-Prep	10OP21	O-Prep - drawer under Muffle Furnace
Buchi Concentrator System	Buchi Labortenchik Ag	Q101	1000167481	2014	Unknown	O-Prep	10OP21	O-Prep - drawer under Muffle Furnace
Microwave extraction	CEM	MarsXpress 230/60	MD3483	7/1/2014	Unknown	O-Prep	10OP19	O-Prep - drawer under Muffle Furnace
Sonicator	Bransonic	B8200R-3	Not readable	2014	Used	O-Prep	10OP23	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-vacuum controller	Buchi Labortenchik Ag	V-855	1000171188	2014	Unknown	O-Prep	10OP24	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-vacuum pump	Buchi Labortenchik Ag	V-700	1000176128	2014	Unknown	O-Prep	10OP24	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-Recirculating Chiller	Buchi Labortenchik Ag	F-108	1000174259	2014	Unknown	O-Prep	10OP24	O-Prep - drawer under Muffle Furnace
Buchi Concentrator System	Buchi Labortenchik Ag	Q101	1000176659	2014	Unknown	O-Prep	10OP24	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-vacuum controller	Buchi Labortenchik Ag	V-855	1000174543	2014	Unknown	O-Prep	10OP25	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-vacuum pump	Buchi Labortenchik Ag	V-700	1000174270	2014	Unknown	O-Prep	10OP25	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-Recirculating Chiller	Buchi Labortenchik Ag	F-108	1000172490	2014	Unknown	O-Prep	10OP25	O-Prep - drawer under Muffle Furnace
Buchi Concentrator System	Buchi Labortenchik Ag	Q101	1000176601	2014	Unknown	O-Prep	10OP25	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-vacuum controller	Buchi Labortenchik Ag	V-855	1000171253	2014	Unknown	O-Prep	10OP26	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-vacuum pump	Buchi Labortenchik Ag	V-700	1000176882	2014	Unknown	O-Prep	10OP26	O-Prep - drawer under Muffle Furnace
Buchi Concentrator-Recirculating Chiller	Buchi Labortenchik Ag	F-108	1000174257	2014	Unknown	O-Prep	10OP26	O-Prep - drawer under Muffle Furnace

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Buchi Concentrator System	Buchi Labortenchik Ag	Q101	1000176658	2014	Unknown	O-Prep	10OP26	O-Prep - drawer under Muffle Furnace
Microwave	Novawave	Model FA	NWX0115110105	2015	New	O-Prep	10OP27	Online
Refrigerator/freeze r	Whirlpool	WH43S1E	T127161605028	2016	New	O-Prep	OP4	O-Prep - drawer under Muffle Furnace
Water Bath	NA	NA	NA	Unknown	Unknown	O-Prep	10OP28	O-Prep - drawer under Muffle Furnace
Water Bath	NA	NA	NA	Unknown	Unknown	O-Prep	10OP29	O-Prep - drawer under Muffle Furnace
NEVAP (sample tray)	Organomation	112	7955	Unknown	Unknown	O-Prep	10OP30	O-Prep - drawer under Muffle Furnace
NEVAP (water bath)	Organomation	112	10185	Unknown	Unknown	O-Prep	10OP30	O-Prep - drawer under Muffle Furnace
NEVAP (delete bath)	Organomation	112	22812	Unknown	Unknown	O-Prep	10OP31	O-Prep - drawer under Muffle Furnace
XcelVap	XcelVap	XcelVap Vaporator System	19-5680	2020	New	O-Prep	10OP32	O-Prep - drawer under Muffle Furnace
XcelVap	XcelVap	XcelVap Vaporator System	19-5681	2020	New	O-Prep	10OP33	O-Prep - drawer under Muffle Furnace
XcelVap	XcelVap	XcelVap Vaporator System	19-5684	2020	New	O-Prep	10OP34	O-Prep - drawer under Muffle Furnace
XcelVap	XcelVap	XcelVap Vaporator System	19-5683	2020	New	O-Prep	10OP35	O-Prep - drawer under Muffle Furnace
XcelVap	XcelVap	XcelVap Vaporator System	19-5682	2020	New	O-Prep	10OP36	O-Prep - drawer under Muffle Furnace
Sonicator	Fisher Scientific	XL2020	F1250	2021	Used	O-Prep	10OP37	O-Prep - drawer under Muffle Furnace
Refrigerator	Crown	Walk-in	Unknown	Unknown	New	SR	C1	TBD
Refrigerator	Beverage Air	KR48-1AS	KR48-1AS 9029136	9/1/2011	New	SR	C17	TBD
Refrigerator	U.S. Cooler	Walk-in/FCL3476 GL1	30692	6/1/2013	New	SR	C18	TBD
Refrigerator	Carroll Coolers LLC	Walk-in	34365	9/24/2013	New	SR	C16	TBD
Refrigerator	TRUE	GDM-47-HC-LD	9199842	2017	New	SR	C22	TBD
Freezer (converted to fridge 03.25.21)	ATOSA	MBF8003	MBF8003079160617 00C40007	2017	New	SR	C23	TBD
Refrigerator	Volition	R49-S	R49S-18010046	12/28/2019	New	SR	C24	TBD
Freezer (converted to fridge)	ATOSA	MBF8003	MBF8003AUS10031 7041900C40004	2018	New	SR	C25	TBD
Refrigerator	Premium	PRF90DX	M8828208666000016 7	2019	New	SR	C27	TBD
Walk-in Freezer	NORLAKE	Walk-In	KL/DP36X78	2020	New	SR	C28	TBD

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Walk-in Cooler	Imperial Brown	Walk-In	21-IB-56205-01	2021	New	SR	C29	TBD
GC System	Agilent	7890A (G3440A)	CN10021030	2010	New	SVOA	10MSSA	TBD
Autosampler Tower	Agilent/HP	7693 Series (G4513A)	CN13460268	2010	New	SVOA	10MSSA	TBD
Autosampler Tray	Agilent/HP	7693 Series (G4513A)	CN10020004	2010	New	SVOA	10MSSA	TBD
MS Detector	Agilent/HP	5975C (G3172A)	US10030005	2010	New	SVOA	10MSSA	TBD
AutoSampler Tower	Agilent	7683B (G2913A)	CN75045773	2010	New	SVOA	10MSSB	TBD
GC/Oven	Agilent	7890A (G3440A)	CN10842006	2010	New	SVOA	10MSSB	TBD
MS Detector	Agilent	5975C (G3172A)	US73317796	2010	New	SVOA	10MSSB	TBD
AutoSampler Tray	Agilent	7683 Series (G2614A)	CN54237163	2010	New	SVOA	10MSSB	TBD
GC	Agilent	6890N (G1530N)	CN10550045	2011	Used	SVOA	10MSSD	TBD
MS	Agilent	5975 (G3172A)	US53931370	2011	Used	SVOA	10MSSD	TBD
Autosampler Tray	Agilent	7683 (G2614A)	CN54337193	2011	Used	SVOA	10MSSD	TBD
Tower 7683B	Agilent	7683B (G2913A)	CN52425737	2011	Used	SVOA	10MSSD	TBD
GC	Agilent	6890N (G1530N)	US10245155	2001	Unknown	SVOA	10MSS6	TBD
Autosampler Tower	Agilent/HP	7683 Series (G2613A)	US82901662	2001	Unknown	SVOA	10MSS6	TBD
MS	Agilent/HP	5973N (G2578A)	US21854348	2001	Unknown	SVOA	10MSS6	TBD
Autosampler Tray	Agilent/HP	7683 Series (G2614A)	US81100461	2001	Unknown	SVOA	10MSS6	TBD
GC	Agilent	6890N (G1530N)	CN10319023	2006	Unknown	SVOA	10MSS7	TBD
Tower 7683	Agilent	7683 Series (G2613A)	CN24728345	2006	Unknown	SVOA	10MSS7	TBD
Tray 7683	Hewlett Packard	7683 Series (G2614A)	US12411901	2006	Unknown	SVOA	10MSS7	TBD
Mass Spec 5973	Agilent	5973N (G2579A)	US21864477	2006	Unknown	SVOA	10MSS7	TBD
AutoSampler Tower	Agilent/HP	7683 Series (G2613A)	US10417469	2008	Unknown	SVOA	10MSS8	TBD
GC/Oven	Agilent	6890N (G1530N)	US10123035	2008	Unknown	SVOA	10MSS8	TBD
MS Detector	Agilent	5973N (G2577A)	US10440794	2008	Unknown	SVOA	10MSS8	TBD
AutoSampler Tray	Agilent/HP	7683 Series (G2614A)	CN53536362	2008	Unknown	SVOA	10MSS8	TBD
GC/Oven	Agilent	6890A (G1530A)	US00033558	1999	Unknown	SVOA	10MSS9	TBD
AutoSampler Tower	Agilent	7683 Series (G2613A)	CN15223766	1999	Unknown	SVOA	10MSS9	TBD
MS Detector	Agilent	5973N (G2577A)	US90440006	1999	Unknown	SVOA	10MSS9	TBD
AutoSampler Tray	Agilent	7683 (G2614A)	US13012239	1999	Unknown	SVOA	10MSS9	TBD
AutoSampler Tray	Agilent	6890 Series (18596M)	3643A43317	7/1/2014	Used	SVOA	10MSSE	TBD
Injector Tower	Agilent	6890 Series (18593B)	3517A42509	7/1/2014	Used	SVOA	10MSSE	TBD

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GC/Oven	Agilent	6890 Series (G1530A)	US00006288	7/1/2014	Used	SVOA	10MSSE	TBD
MS Detector	Agilent	5973 Series (G1098A)	US63810194	7/1/2014	Used	SVOA	10MSSE	TBD
Autosampler Tray	Agilent	7683 Series (G2614A)	CN91252935	7/1/2014	Used	SVOA	10MSSF	TBD
Injector Tower	Agilent	7683B Series (G2913A)	CN54128250	7/1/2014	Used	SVOA	10MSSF	TBD
MS Detector	Agilent	5975C (G3172A)	US91732455	7/1/2014	Used	SVOA	10MSSF	TBD
GC	Agilent	7890A (G3440A)	CN10920003	7/1/2014	Used	SVOA	10MSSF	TBD
GC	Agilent	6890 Series (G1530A)	US00025032	7/1/2014	Used	SVOA	10MSSG	TBD
MS	Agilent	5973 Series (G1098A)	US82311330	7/1/2014	Used	SVOA	10MSSG	TBD
Autosampler Tray	HP	7683 Series (G2614A)	US90403281	7/1/2014	Used	SVOA	10MSSG	TBD
Injector Tower	HP	7683 Series (G2613A)	US95310976	7/1/2014	Used	SVOA	10MSSG	TBD
MS	HP	5977B (G7081B)	US1703R003	2000	Unknown	SVOA	10MSSH	TBD
GC	HP	7890B (G3442B)	CN17013216	2000	Unknown	SVOA	10MSSH	TBD
Autosampler Tray	Agilent/HP	7693 Series (G4514A)	CN16480039	2000	Unknown	SVOA	10MSSH	TBD
Injector Tower	Agilent/HP	7693 Series (G4513A)	CN95203168	2000	Unknown	SVOA	10MSSH	TBD
Autosampler Tower	Agilent/HP	7693A (G4513A)	CN19390131	2019	new	SVOA	10MSSI	TBD
GC System	Agilent/HP	8890 Series (G3540A)	US1951A021	2019	new	SVOA	10MSSI	TBD
MS Detector	Agilent/HP	5977B (G7081B)	US2001R066	2019	new	SVOA	10MSSI	TBD
Autosampler Tray	Agilent/HP	7693A (G4514A)	R01950087	2019	new	SVOA	10MSSI	TBD
GC	Agilent	G3540A (8890),	US2120A017	2021	new	SVOA	10MSSJ	TBD
MS	Agilent	G7081B (5977B	US2116R031	2021	new	SVOA	10MSSJ	TBD
Autosampler	Agilent	G4514A	R021077022	2021	new	SVOA	10MSSJ	TBD
Tower	Agilent	G4513A	R021155026	2021	new	SVOA	10MSSJ	TBD
GC	Agilent	6890N	CN10549055	2011	Unknown	SVOA	10GCSE	TBD
Autosampler Tray	Agilent	G2614A	US14213141	2011	Unknown	SVOA	10GCSE	TBD
Tower	Agilent	G2613A	CN54929639	2011	Unknown	SVOA	10GCSE	TBD
ECD 1	Agilent	G2397A	U8977	2011	Unknown	SVOA	10GCSE	TBD
ECD 2	Agilent	G2397A	U8978	2011	Unknown	SVOA	10GCSE	TBD
GC	Agilent	7890A	CN11201069	2011	Unknown	SVOA	10GCSM	TBD
Autosampler Tray	Agilent	64514A	CN11130097	2011	Unknown	SVOA	10GCSM	TBD
Tower	Agilent	64513A	CN91200383	2011	Unknown	SVOA	10GCSM	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
ECD 1	Agilent	G2397A	U19081	Unknown	Unknown	SVOA	10GCSM	TBD
ECD 2	Agilent	G2397A	U19082	Unknown	Unknown	SVOA	10GCSM	TBD
GC	Agilent	6890 N	US10126008	2004	Unknown	SVOA	10GCSD	TBD
AutoSampler Tray	Agilent/HP	G2614A	US13612659	2004	Unknown	SVOA	10GCSD	TBD
Tower	Agilent/HP	G2613A	US11818906	2004	Unknown	SVOA	10GCSD	TBD
ECD 1	Agilent	G2397A	U33680	Unknown	Unknown	SVOA	10GCSD	TBD
ECD 2	Agilent	G2397A	U33677	Unknown	Unknown	SVOA	10GCSD	TBD
Tower	Agilent	64513A	CN91200383	2009	Unknown	SVOA	10GCS9	TBD
GC	Agilent	7890A	CN10915106	2009	Unknown	SVOA	10GCS9	TBD
Autosampler Tray	Agilent	64514A	CN91100084	2009	Unknown	SVOA	10GCS9	TBD
GC	Agilent	7890B	CN18203068	2018	Unknown	SVOA	10GCSL	TBD
Autosampler - Front	Agilent	G4514A	CN18140044	2018	Unknown	SVOA	10GCSL	TBD
AutoInjector - Front	Agilent	G4513A	CN18160194	2018	Unknown	SVOA	10GCSL	TBD
Autosampler - Rear	Agilent	G4514A	CN18140044	2018	Unknown	SVOA	10GCSL	TBD
AutoInjector - Rear	Agilent	G4513A	CN18160191	2018	Unknown	SVOA	10GCSL	TBD
Freezer	Haier	HUM013E A	BB01H1E0100BHD7 S0358	2019	Unknown	SVOA	SV4	TBD
Refrigerator	Frigidaire	FFTR1814T WG	BA04428653	2020	NEW	SVOA	SV5	Above the unit
Freezer	Frigidaire	FFTR1814T WG	BA04428653	2020	NEW	SVOA	SV5	Above the unit
Autoinjector - Front	Agilent	G2913	CN44659505	7/1/2014	Unknown	SVOA	10GCSF	TBD
Autosampler - Front	Agilent	G2614A	CN00654640	7/1/2014	Unknown	SVOA	10GCSF	TBD
GC	Agilent	7890A	CN10848062	7/1/2014	Unknown	SVOA	10GCSF	TBD
Autoinjector - Rear	Agilent	G2913A	CN91756454	7/1/2014	Unknown	SVOA	10GCSF	TBD
Autosampler - Rear	Agilent	G2614A	CN00654640	7/1/2014	Unknown	SVOA	10GCSF	TBD
GC	Agilent	6890A	US00035764	7/1/2014	Unknown	SVOA	10GCSG	TBD
Autosampler Tray	Agilent	G2614A	CN43530410	Unknown	Unknown	SVOA	10GCSG	TBD
Tower	Agilent	G2613A	US00411307	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
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

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
ECD 1	Agilent	G2397A	U28247	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	CN1170127	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
Refrigerator/Freezer	Frigidaire	FFTR1814TW	BA14129815	11/10/2021	New	SVOA	SV6	Above the unit
Refrigerator/Freezer	Frigidaire	FFTR1814TW	BA14126235	11/10/2021	New	SVOA	SV7	Above the unit
GC	Agilent	G1530A	US00021845	1/5/2022	Used	SVOA	10GCSN	Above the unit
Tower	Agilent	G2613A	US00411307	1/5/2022	Used	SVOA	10GCSN	Above the unit
Tray	Agilent	G2614A	CN21920654	1/5/2022	Used	SVOA	10GCSN	Above the unit
GC	Agilent	G1530A	US00020689	9/19/2022	Used	SVOA	10GCSO	Above the unit
Tower	Agilent	G2613A	CN14222693	9/19/2022	Used	SVOA	10GCSO	Above the unit
Tower	Agilent	G2613A	CN34433512	9/19/2022	Used	SVOA	10GCSO	Above the unit
Tray	Agilent	C2614A	CN81648202	9/19/2022	Used	SVOA	10GCSO	Above the unit
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/ 10MSV9	TBD
GC	Agilent	6890A	US00036184	2006	Unknown	VOA	10MSV6/ 10MSV9	TBD
MS	Agilent	5973	US01140180	2006	Unknown	VOA	10MSV6/ 10MSV9	TBD
AutoSampler	Environmental Sample Tech, Inc.	N/A	cents207121110	2008	Unknown	VOA	10MSV7	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
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
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	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

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
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	10GCVA	TBD
Headspace Sampler	Agilent Technologies	G1888	IT00507022	2005	Used	VOA	10GCVA	TBD
GC	Agilent	8890	US1951A018	2006	Used	VOA	10GCVB	TBD
Autosampler	EST Analytical	Centurion	W695050819	Unknown	Used	VOA	10GCVB	TBD
Concentrator	Tekmar - Dohrmann	3100 Sample Conc.	1064004	Unknown	Used	VOA	10GCVB	TBD
Oven	Thermo Scientific	N/A	6520 6528	Unknown	Unknown	VOA	10VOA03	TBD
Refrigerator	Crown	Walk-In	Unknown	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	LFFH21F7 HWG	WB94954367	2013	Unknown	VOA	V5	TBD
Refrigerator	Norlake Scientific	NSLF482W AW/1	96020404	Unknown	Unknown	VOA	V6	TBD
Oven	Lindberg/Blue M	MO1450PS A-1	U19R-507936-UR	Unknown	Unknown	VOA	10WT56	TBD
Refrigerator/Freezer	Frigidaire	BA7284554 8	FRT8G7HW0	Unknown	Unknown	VOA	V8	TBD
Refrigerator	Amana	ABB2221W EB1	K13809596	7/1/2014	Used	VOA	V7	TBD
Fridge	Danby Designer	DBC120BL S	4316063619504	2016	New	Wet Chem	MP1	TBD
Incubator	Fisher Scientific	Isotemp Incubator	115770704-57744	2006	Unknown	Wet Chem	10WET16	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
Colony Counter	Gallenkamp	CNW-325-030Y	4A 4294	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
Spectrometer	Hach	DR 3900	1811411	2018	New	Wet Chem	10WETF	TBD
Hot Plate	Presto	Tilt'n Drain Big Griddle	2608US	2009	New	Wet Chem	10WET34	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
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
Refrigerator	Summit Commercial	SCR485L	A091200156	2010	New	Wet Chem	WC2	TBD
BOD meter	Hach	HQ40d	80900024869	2011	New	Wet Chem	10WT54	TBD
BOD/pH probe	Hach	LBOD10101	123213032021	2011	New	Wet Chem	10WT54	TBD
pH probe	HACH	PHC108	191282867899	2011	New	Wet Chem	10WT54	TBD
pH/BOD meter/Fluoride	Hach	HQ40d	110300052350	2011	New	Wet Chem	10WT53	TBD
pH/BOD meter/Fluoride - probe	Hach	HQ40d	152392938004	2011	New	Wet Chem	10WT53	TBD
Hot Block	Environmental Express	N/A	N/A	2009	Used	Wet Chem	10WET55	TBD
Oven	Fisher Scientific	13-247-650G(6905)	611729-434	2012	New	Wet Chem	10WET65	TBD
pH Probe	Hach	PHC301	11662571034	2011	New	Wet Chem	11662571034	TBD
pH Probe	Hach	PHC301	121952571033	2012	New	Wet Chem	121952571033	TBD
pH Probe	Hach	LBOD101	122143032067	2012	New	Wet Chem	122143032067	TBD
pH Probe	Switchcraft	PHW77-SS	712202002	2012	New	Wet Chem	712202002	TBD
Turbidity Meter	Hach	2100Q	11050C0092997	2011	New	Wet Chem	10WT59	TBD
Handheld Brix Refractometer	Fisher	N/A	Fisher catalog # 13-946-21	2011	New	Wet Chem	10WT60	TBD
Quanti-Tray Sealer Model 2x	Quanti-Tray	89-10894-02	4836	2012	New	Wet Chem	10WET56	TBD
IC	Metrohm	881 Compact IC	1881000121132	2012	New	Wet Chem	10WT61	TBD
Lachat	Quick Chem	8500	120400001409	5/7/2012	New	Wet Chem	10WT62	TBD
Autotitrator	Metrohm	905 USB Sample Processor	1814001009181	5/7/2012	New	Wet Chem	10WT63	TBD
Probe	Metrohm	905 USB Sample Processor	1281705	5/7/2012	New	Wet Chem	10WT63	TBD
JT Baker Speedisk Expanded Extraction Station	J.T. Baker	Speedisk Expanded Extraction Station	L02N23	2012	New	Wet Chem	10WET66	TBD
Desiccator	Sanplatec Corp	DryKeeper	N/A	2013	Unknown	Wet Chem	10WET68	TBD
Desiccator	Boekel	N/A	N/A	2013	Unknown	Wet Chem	10WET69	TBD
Desiccator	Boekel	N/A	N/A	2013	Unknown	Wet Chem	10WET70	TBD
Desiccator	Boekel	N/A	N/A	2013	Unknown	Wet Chem	10WET71	TBD
Desiccator	Boekel	N/A	N/A	2013	Unknown	Wet Chem	10WET72	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Desiccator	Boekel	N/A	N/A	2013	Unknown	Wet Chem	10WET73	TBD
Desiccator	Boekel	N/A	N/A	2013	Unknown	Wet Chem	10WET74	TBD
Desiccator	Boekel	N/A	N/A	2013	Unknown	Wet Chem	10WET75	TBD
Meter	Hach	HQ440d	120400069964	7/1/2013	New	Wet Chem	10WETE	TBD
Meter - probe	Hach	PHC20101	172612618021	7/1/2013	New	Wet Chem	10WETE	TBD
Meter - probe	Hach	PHC28101	200923042945	5/15/2020	New	Wet Chem	10WETE	TBD
Oven	Fisher Isotemp Oven	6905	614389-852	2014	New	Wet Chem	10WT77	TBD
Oven	Fisher Isotemp Oven	6905	614389-853	2014	New	Wet Chem	10WET78	TBD
Hot Plate	Presto	Tilt'n Drain Big Griddle	21-697	2014	New	Wet Chem	10WT81	TBD
Water Bath	Precision Scientific Water Bath	Coliform Incubator Bath	601061689	2015	Used	Wet Chem	10WT86	TBD
Oven	Fisher Scientific	151030521	41762572	2015	New	Wet Chem	10WT88	TBD
Fridge	Danby Designer	DBC120BLS	4315123638037	2016	New	Wet Chem	WC4	TBD
Hot Block	Environmental Express	N/A	4952CEC2361	2006	Used	Wet Chem	10MET03	TBD
COD Reactor	Environmental Express	B3000	2019CODW130	2019	New	Wet Chem	10WT91	TBD
Instrument	Lachat	QuickChem QC8500 Series 2	191200002263	2020	New	Wet Chem	10WT92	TBD
Autosampler	Lachat	Autosampler ASX560	101951A560	2020	New	Wet Chem	10WT92	TBD
Sep Funnel Tumbler	Analytical Testing Corp	DC-20	5046VMBP0026	2020	New	Wet Chem	10WT93	TBD
Sonicator	Fisher	FB11203	100417056	2020	New	Wet Chem	10WT94	TBD
Instrument	Metrohm	940 Professional IC Vario	1940000031101	2020	New	Wet Chem	10WT95	TBD
UV Lamp	UVP	UVL-56	not visible	unknown	Used	Wet Chem	10WT96	TBD
Water Bath	ThermoScientific	SC150	1121345701190806	2019	Used	Wet Chem	10WT97	TBD
Microscope	Fisher	3000014	20200104649	2021	New	Wet Chem	10WT99	At the instrument
Freezer	Elecwish	US-KC1008BK	UWC200271-2021/01-1042	2021	New	Wet Chem	WC6	At the instrument
Hotblock	CAI	SmartBlock 125i	129002	2022	Used	Wet Chem	10WT100	At the instrument
Conductivity meter	Fisher Scientific	06-662-61 11704226	221128443	2022	New	Wet Chem	10WETH	At the instrument
Oven	Themofisher	Heratherm OMH 180	42947789	2022	New	Wet Chem	10WET79	At the instrument
Instrument	SEAL Analytical	AQ400	41004	2022	New	Wet Chem	10WTA5	At the instrument
Autotitrator	Metrohm	OMNIS	7613337331605	2022	New	Wet Chem	10WTA6	At the instrument

7.5.2 PAS-Duluth MN

Equipment List: PAS-Duluth MN

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Water Filtration/DIW System (main)	Culligan	N/A	N/A	Unknown	Unknown	Glassware Cleaning	13DI1	Online
Fridge	Turbo Air	MSR23NM	MR23NM	Unknown	Unknown	Wet Chem 2	13DUL9	Online
Incubator	Labline CO2	3010	12	Unknown	Unknown	Wet Chem 2	13INC4	Online
pH Meter	Thermo Orion	Star Series	B07284	9/1/2015	Unknown	HCT	DUWT17	HCT Desk Drawer
pH /Conductivity Meter	Thermo	Star A215 Benchtop	X45992	9/24/2018	New	HCT	DUWT19	Online
Mercury Analyzer	Brooks Rand	Model III CVAFS	1103401	10/19/2017	Unknown	LL Hg	DUHG02	LL Hg Desk Drawer
Autosampler	Brooks Rand	Brooks Rand 17420	4936A14632	5/1/2018	Unknown	LL Hg	DUHG02	LL Hg Desk Drawer
Total Hg Purge and Trap	Brooks Rand	N/A	11078001	Unknown	Unknown	LL Hg	DUHG03	LL Hg Desk Drawer
Hg Speciation Purge and Trap	Brooks Rand	N/A	41107301	Unknown	Unknown	LL Hg	DUHG02	LL Hg Desk Drawer
Software	Hg guru	Version 4.1	N/A	Unknown	Unknown	LL Hg	DUHG03	Online
Distillation Block	Brooks Rand	Distillation Block AB	1021401	Unknown	Unknown	LL Hg	DUHG02	LL Hg Desk Drawer
Distillation Block	Brooks Rand	Distillation Block CD	1034401	Unknown	Unknown	LL Hg	13DT01	LL Hg Desk Drawer
Fridge	Magic Chef	MCBR445W1	N/A	Unknown	Unknown	LL Hg	13DT02	Online
Fridge	Absocold	AR101MW13R	951005923	Unknown	Unknown	LL Hg	13DUL15	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
Oven	Blue-M	MO1440A-1	S175-517150-SS	Unknown	Unknown	LL Hg	13OVN4	Online
Water Filtration/DIW System	Barnstead	D4641	1090090938202	Unknown	Unknown	LL Hg	13DI1-A	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	10/26/2017	New	Storage Room	13FRZ2	Online
Autoclave	Market Forge	Sterilmatic STM-E	37827	1/1/2018	Unknown	Wet Chem	13CLV1	Online
Autoclave Pressure Gauge	Market Forge	BUILT-IN	37828	1/1/2018	Unknown	Wet Chem	13CLV1P	Online
Autoclave Temperature Gauge	Market Forge	BUILT-IN	37829	1/1/2018	Unknown	Wet Chem	13CLV1T	Online
Autodispenser	North Central Labs	DO-250	N/A	Unknown	Unknown	Wet Chem	13DSP1	Online
Autodispenser	SCILOGEX	DispenseMate Plus	JY16291	Unknown	Unknown	Wet Chem	13DSP2	Online
Distillation Unit Microblock	Environmental Express	EMD1920-106	2109	Unknown	Unknown	Wet Chem	13WETE	Online

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Distillation Unit Microblock	Lachat	1700-000	2000-209	Unknown	Unknown	Wet Chem	13WETF	Online
Freezer	Wood's	CO5BBA	01778768HJ	Unknown	Unknown	Wet Chem	13FRZ1	Online
Fridge	TurboAir	M3R47-2	M3R4L43095	Unknown	Unknown	Wet Chem	13DUL5	Online
Fridge	Gibson	RM18F5W X	NA	Unknown	Unknown	Wet Chem	13DUL6	Online
Fridge	TurboAir	TSR49	01749500MR	Unknown	Unknown	Wet Chem	13DUL7	Online
Hood	LABCONCO	031214227 H	728040010814	Unknown	Unknown	Wet Chem	13HOOD 1	Online
Hood	NA	NA	NA	Unknown	Unknown	Wet Chem	13HOOD 2	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
Hotblock (TKN)	Lachat	BD 40	TSLA1013511403	Unknown	Unknown	Wet Chem	13HB03	Online
Hotblock (TKN)	Seal Analytical	BD 50 Block	STU6U00860	Unknown	Unknown	Wet Chem	13HB04	In rack by 13WET7
Hotblock (TKN)	Lachat	BD 40 Block	HTLC1015510459	Unknown	Unknown	Wet Chem	13HB05	Online
Incubator	LabLine	460NS	0469	Unknown	Unknown	Wet Chem	13INC3	Online
BOD Incubator	Thermo	Isotemp	300168083	10/19/2017	New	Wet Chem	13IB12	In drawer under 13BOD1
BOD Incubator	Thermo	Precision	601111536	Unknown	Unknown	Wet Chem	13IB13	TBD
Incubator	Precision Scientific	66551	9209-113	5/1/2018	Used	Wet Chem	13INC7	Online
Lachat	Hach	8500	50100000097	Unknown	Unknown	Wet Chem	DUWT05	Online
Lachat Autosampler	Hach	ASX 520	010591A520	Unknown	Unknown	Wet Chem	DUWT06	Online
LDO Meter/Probe	Hach	HQ30d Flexi	121000079722	Unknown	Unknown	Wet Chem	DUWT13	Online
Microscope	American Optical Corp	Forty	814602	Unknown	Unknown	Wet Chem	13MC01	Online
Muffle Furnace	Lindberg	51442	899152	Unknown	Unknown	Wet Chem	10MF1	Online
Oven	VWR	1370G	1200600	Unknown	Unknown	Wet Chem	13OVN1	Online
Oven	Precision Scientific	Thelco #28	N/A	Unknown	Unknown	Wet Chem	13OVN2	Online
Oven	ThermoFisher	Cat #151030508	42094122	6/23/2017	Unknown	Wet Chem	13OVN5	Online
Oven	Shel Lab	SM05	4052114	VM to DUL 5/21/21	Good	Wet Chem	13OV06	TBD
Oven	Fisher	100 L	42130594	VM to DUL 2/25/21	Good	Wet Chem	13OV07	TBD
pH Meter	Orion	720A	13043	Unknown	Unknown	Wet Chem	DUWT18	In Drawer by pH supplies
pH pen	Sper Scientific	850051	143496	9/1/2016	Unknown	Wet Chem	13WET11	In Drawer under 13WET5
pH pen	Eutech Instruments	pHTestr 30	68X546501	3/7/2019	Unknown	Wet Chem	13WET13	In Drawer under 13WET6

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
pH/Conductivity Meter	Orion	A215	X37428	8/1/2017	New	Wet Chem	DUWT20	In Drawer by pH supplies
QuantiTray Sealer	IDEXX	2x/89-10894-00	01174	Unknown	Unknown	Wet Chem	13QT1	Online
Shaker	Labline Instruments	1345	10021791	Unknown	Unknown	Wet Chem	13SH1	Online
Sonicator	VWR	Auqasonic 50-T	N/A	Unknown	Unknown	Wet Chem	13SON1	Online
Spectrophotometer UV VIS	Thermo	9423AQ2100E	HEDN238001	Unknown	Unknown	Wet Chem	DUWT08	Online
Spectrophotometer UV VIS	Hach	DR 3900	1648363	Unknown	Unknown	Wet Chem	DUWT09	Online
Sterilizer	EZE	N/A	N/A	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
Water Filtration/DIW System	Barnstead	Nanopure II	N/A	Unknown	Unknown	Wet Chem	13DI1-B	Online
Color Test Kit	Hach	co-1	LOT#A8068	Unknown	Unknown	Wet Chem 2	DUWT24	Online
Evaporator for SPE System	Horizon Technology	Speed Vap III	08-0701	9/1/2015	Unknown	Wet Chem 2	13VAP01	Online
Hood	Kewaunee	N/A	N/A	9/1/2015	Unknown	Wet Chem 2	13HOOD 3	Online
Hood	Kewaunee	N/A	N/A	9/1/2015	Unknown	Wet Chem 2	13HOOD 4	Online
pH Meter	Orion	301	43996	Unknown	Unknown	Wet Chem 2	DUWT23	Online
SPE StepSaver 7-station Funnel	Environmental Express	Cat#G1106	N/A	6/14/2016	Unknown	Wet Chem 2	13SPE1	Online
SPE StepSaver 7-station Funnel	Environmental Express	Cat#G1106	N/A	6/14/2016	Unknown	Wet Chem 2	13SPE2	Online
Dessicator	Labconco	55300	171400	Unknown	Unknown	Wet Chem	12Des1	TBD
Dessicator	Labconco	55300	232878	Unknown	Unknown	Wet Chem	12Des2	TBD
Dessicator	Glass	N/A	N/A	Unknown	Unknown	Wet Chem	12Des3	TBD
Dessicator	Fisher	Metal	N/A	Unknown	Unknown	Wet Chem	12Des4	TBD
Dessicator	Boekel	Metal	N/A	Unknown	Unknown	Wet Chem	12Des5	TBD
Dessicator	Plas Labs	Plexi glass	N/A	Unknown	Unknown	Wet Chem	12Des6	TBD
Dessicator	Plas Labs	Plexi glass	N/A	Unknown	Unknown	Wet Chem	12Des7	TBD
Dessicator	Plas Labs	Plexi glass	N/A	Unknown	Unknown	Wet Chem	12Des8	TBD
Dessicator	SanPlatec	Dry Keeper	N/A	Unknown	Unknown	Wet Chem	12Des9	TBD
Rotator	Labline	1345	1002-1791	Unknown	Unknown	Wet Chem	12RTR1	TBD
Centrifuge	Sorvall	RT6000B	N/A	Unknown	Unknown	Wet Chem	12CFG2	TBD
Lachat	Lachat	QC 8500 Series 2	181200002196	1/7/2019	New	Wet Chem	DUWT06	TBD
Lachat reagent pump	Lachat	RP-150 Series	L18002784	Unknown	Unknown	Wet Chem	DUWT06	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Autodiluter	Lachat	PDS 200 Precision Diluter	181200000877	Unknown	Unknown	Wet Chem	DUWT06	TBD
Autosampler	Lachat	ASX-580 XYZ	111839A560	Unknown	Unknown	Wet Chem	DUWT06	TBD
Hardware	Dell	3035	N/A	Unknown	Unknown	Wet Chem	DUWT06	TBD
Software	Omnion	FIA Data System	N/A	Unknown	Unknown	Wet Chem	DUWT06	TBD
Lachat	Lachat	Lachat Quikchem 8500 Series 2	10070000129	Unknown	New	Wet Chem	DUWT07	TBD
Lachat Reagent Pump	Lachat	RP 150 Series	A82000-1961	Unknown	Unknown	Wet Chem	DUWT07	TBD
Autosampler	Cetac	ASX-500 Model No 510	010025ASX	Unknown	Unknown	Wet Chem	DUWT07	TBD
Hardware	Hewlett Packard	Compaq	N/A	Unknown	Unknown	Wet Chem	DUWT07	TBD
Software	Omnion	FIA Data System	N/A	Unknown	Unknown	Wet Chem	DUWT07	TBD
Ion Chromatograph	Metrohm	930 Flex IC	1930100006132	Unknown	New	Wet Chem	DUWT04	TBD
Regenerant Dispenser	Metrohm	IC-05	N/A	Unknown	Unknown	Wet Chem	DUWT04	TBD
Autosampler	Metrohm	850 Sample Processor	1858002005627	Unknown	Unknown	Wet Chem	DUWT04	TBD
Hardware	Dell	N/A	CBDUC284-70821-553-OGIP	Unknown	Unknown	Wet Chem	DUWT04	TBD
Software	Metrohm	IC Net 2.3	N/A	Unknown	Unknown	Wet Chem	DUWT04	TBD
Ion Chromatograph	Metrohm	881 Advanced Compact IC	1881000122119	Unknown	New	Wet Chem	DUWT03	TBD
Regenerant Dispenser	Metrohm	800 Dosino	N/A	Unknown	Unknown	Wet Chem	DUWT03	TBD
Autosampler	Metrohm	Model 858 Advanced Sample Processor	N/A	Unknown	Unknown	Wet Chem	DUWT03	TBD
Hardware	Dell	N/A	N/A	Unknown	Unknown	Wet Chem	DUWT03	TBD
Software	Metrohm	IC Net 2.3	N/A	Unknown	Unknown	Wet Chem	DUWT03	TBD
Ammonia Micro Distillation Equipment	Lachat	Lachat MicroDist	081200001033	5/1/2009	New	Wet Chem	12DST1	TBD
TKN Block Digester	Lachat	BD-40	TSLA1013511403	8/4/2017	New	Wet Chem	12TKN2	TBD
Autotitrator	ManTech	TitraSip Sample Module	PC 1300 475	Unknown	New	Wet Chem	DUWT01	TBD
Autosampler	ManTech	AutoMax 73 Sampler	PC 1000-681	Unknown	Unknown	Wet Chem	DUWT01	TBD
Buret Module	ManTech	Burivar 1/2 Buret Module	PC 1104-00	Unknown	Unknown	Wet Chem	DUWT01	TBD
Hardware	Hewlett Packard	Prodesk	N/A	Unknown	Unknown	Wet Chem	DUWT01	TBD
Software		PC Titrate for	N/A	Unknown	Unknown	Wet Chem	DUWT01	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
		Windows v.3						
pH meter	Orionstar	A215	X27234	Unknown	Unknown	Wet Chem	12WETG	at instrument
Turbidimeter	Orion	AQ3010	3494427	10/14/2017	Unknown	Wet Chem	12WETF	at instrument
Autoclave	Tuttnaur/Brinkman	3545 EP	2105018	Unknown	Unknown	Wet Chem	12CLV2	TBD
BOD incubator	Fisher	Model 3720	300007704	Unknown	New	Wet Chem	13IB10	TBD
BOD incubator	Fisher	Model 3720A	300064399	2/26/2016	New	Wet Chem	13IB11	TBD
Drying Oven	Shel Lab	Model SM05	0405Z114	Unknown	Unknown	Wet Chem	13OV06	TBD
Drying Oven	Fisher	Model 100L	42130594	Unknown	Unknown	Wet Chem	12OV06	TBD
TOC Analyzer	OI Corporation	1030	M129732449E	Unknown	Unknown	Wet Chem	DUWT10	at instrument
TOC Autosampler	OI Corporation	1088 AS	E129788451	Unknown	Unknown	Wet Chem	DUWT10	at instrument
Autosampling Module	OI Corporation	N/A	621290637-92120	Unknown	Unknown	Wet Chem	DUWT10	at instrument
TOC Analyzer	OI Corporation	N/A	A1129733824	Unknown	Unknown	Wet Chem	DUWT12	at instrument
IR Detector	OI Corporation	1030	2A0002T	Unknown	Unknown	Wet Chem	DUWT12	at instrument
TOC Analyzer	OI Corporation	1030	P407730312P	Unknown	Unknown	Wet Chem	DUWT11	at instrument
TOC Autosampler	OI Corporation	1088 AS	N/A	Unknown	Unknown	Wet Chem	DUWT11	at instrument
IR Detector	OI Corporation	1030	B622737366	Unknown	Unknown	Wet Chem	DUWT11	at instrument
Pass through fridge	Continental Refrigerator	3RE-PT	16149751	Unknown	New	Sample Receiving	13DUL19	TBD
Pass through fridge	Continental Refrigerator	3RE-PT	16149752	Unknown	New	Sample Receiving	13DUL20	TBD
Fridge	SubZero	249R	234547	Unknown	Unknown	Wet Chem	13DUL21	TBD
Fridge	Hotpoint	HPS15BTH MLWW	FM726711	1/25/2022	Used	Wet Chem	13DUL22	TBD
Micro Incubator	Fisher	3720A	300088990	Unknown	New	Microbiology	13INC8	TBD
Mercury Analyzer	Brooks Rand	Model III CVAFS	12032101	2022	New	LL Hg	DUHG03	at instrument
Mercury Autosampler	Brooks Rand	MERX	6046A62073	2022	New	LL Hg	DUHG03	at instrument
Fecal Water Bath	Thermo Fisher Scientific	TSCOL35	300534649	2022	New	Wet Chem	13INC10	TBD
Freezer	Insignia	NS-CZ70WH0	22B24A01197	2022	New	LL Hg	13FRZ3	TBD
Fridge/Freezer	Insignia	NS-UZ14SS0	22E27C01172	2022	New	LL Hg	13DUL23	TBD

7.5.3 PAS-Virginia MN

Equipment List: PAS-Virginia MN

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Bacteria Incubator	Shel Lab	1545	11052906	2007	Unknown	VM micro	12IB01	TBD

Description	Manufacturer	Model	Serial Number	Service Date	Condition	Location	Internal ID	Location of Manual
Coliform Incubator Bath	Thermofisher	253	202682-185	2007	New	VM micro	12WB02	TBD
Bacteria Incubator	Shel Lab	1520	N/A	1996	New	VM micro	12IB02	TBD
Coliform Incubator Bath	Precision Scientific	183	9205-008	Unknown	Unknown	VM micro	12IB05	TBD
Microscope	National Optical	N/A	446TBL-10	2007	New	VM micro	12MC01	TBD
UV Lamp	Spectroline	EA160	1594366	12/19/2019	Unknown	VM micro	12UV02	TBD
Refrigerator 2R	Sanyo	SR-362OK	051105496	Unknown	Unknown	VM	N/A	TBD
Refrigerator 3	True Mfg. Co	T-49	1-2953805	Unknown	Unknown	VM	N/A	TBD
Refrigerator 5	True Mfg. Co	T-49	1-3060851	Unknown	Unknown	VM	N/A	TBD
Refrigerator 8	True Mfg. Co	T-35	1-3016399	Unknown	Unknown	VM	Refrigerator 8	TBD
Refrigerator 10	Gibson	T-35	BA31823513	Unknown	Unknown	VM	VM SR freezer	TBD
Refrigerator 12	Beverage - Air	9029136	KR481AS	Unknown	Unknown	VM	Refrigerator 12	TBD
Refrigerator 13 (Walk-in)	US Cooler	N/A	29716	Unknown	Unknown	VM	N/A	TBD
QuantiTray Sealer Plus	IDEXX	QuantiTray Sealer Plus	QTP13222602145	2022	New	VM micro	12QTS2	TBD

8.0 ADDENDUM: PROGRAM REQUIREMENTS

Section 8.0 provides additional requirements the locations covered by this manual are required to follow when performing work under the program. Only requirements that are not covered by the main body of the manual are listed in addendum.

8.1 DoD/DOE

PAS-Minneapolis MN 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

In addition to the requirements specified in Section 4.2.5, 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 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 timeframe for notification of the problem and the 30-business day timeframe 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 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 5.4.5.3.3: Limit of Detection

For DoD/DOE the LOD is an estimate of the minimum amount of an analyte that can be reliably detected by an analytical process. For clarification, the LOD is the analyte concentration necessary to distinguish its presence from its absence. The LOD may be used as the lowest concentration for reliably reporting a non-detect (ND). The LOD is specific to each suite of analyte, matrix, and method including sample preparation.

After each DL determination, the laboratory establishes the LOD by spiking a quality system matrix at a concentration of least 2X but no greater than 4X the DL (i.e., 2X DL ≤ LOD Spike ≤ 4X DL). The spike concentration establishes the LOD and the concentration at which the LOD is verified.

The LOD is established during method validation and after major changes to the analytical system or procedure that affects sensitivity of analysis or how the procedure is performed.

An LOD study is not required for any component for which spiking solutions or quality control samples are not available. Additionally, an LOD study is not required if the laboratory does not report data below the LOQ.

The LOD must be verified on a quarterly basis. Each preparation method listed on the scope of accreditation must have quarterly LOD verifications; however, verification of all possible combinations of preparation and clean-up techniques is not required. Where LOD verifications are not performed on all combinations, the LOD verification is based on the worst-case combination (preparation method with all applicable cleanup steps).

The laboratory's procedure for LOD determination and verification is detailed in SOP ENV-SOP-MIN4-0163 *Determination of LOD and LOQ.*

Section 5.4.5.3.4: Limit of Quantitation

For DoD/DOE, the LOQ is established for each analyte-matrix-method combination, including surrogates. When an LOD is determined or verified by the laboratory, the LOQ must be above the LOD [DL<LOD<LOQ].

At a minimum, the LOQ must be verified quarterly; however, verification of all possible combinations of preparation and clean-up techniques is not required. Where LOQ verifications are not performed on all combinations, the LOQ verification on the worst-case combination (preparation method with

all applicable cleanup steps).

The laboratory's procedure for LOQ determination and verification is detailed in laboratory SOP ENV-SOP-MIN4-0163 *Determination of LOD and LOQ*.

Section 5.4.7: Control of Data

The laboratory will ensure 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 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 SOP ENV-SOP-MIN4-0090 *Reagent Water Quality* or applicable test method SOP.

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 consult 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 QMS.

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 5.4.5.3.3 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 5.6.4.2 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 a 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/MSDs 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 B

Eurofins Environment Testing Northern California, LLC *(Eurofins Air Toxics)*

Quality Manual

LABORATORY QUALITY ASSURANCE MANUAL

(LQAM)

Rev. 33

January 10, 2022

Quality Assurance Manager: Melanie Levesque

The Laboratory Quality Assurance Manual is effective as of the date of the signature of the Quality Assurance Manager

EUROFINS AIR TOXICS
180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630
(800) 985-5955
eurofinsus.com

LABORATORY QUALITY ASSURANCE MANUAL

Approvals

Robert Mitzel — 1/11/2022
Robert Mitzel, President — Date

Heidi Hayes — 1/12/2022
Heidi Hayes, Technical Director — Date

SepidehSaeed — 01/11/2022
Sepideh Saeed, Laboratory Director — Date

Melanie Levesque — 01/12/2022
Melanie Levesque, Quality Assurance Manager — Date

REVISION LOG

Revision: 29	**Effective Date: 08-22-2017**	
Section	**Justification**	**Changes**
Sections 1.3, 2.1, 2.6.1, 2.6.3, 2.7.2, 6.3, 6.4.1.2, 6.4.1.3, 6.4.1.5, 6.4.1.6, 7.1, 8.2, 9.1.1, 10.8, 11.2, Appendices A, D, and E.	Update to the most current Corporate procedures SOPs, and NELAP criteria.	Update to current Corporate Ethics Policy statement and required yearly form signature, updated IT department to Corporate IT as well as data system back-up timelines, and archiving procedure to Corporate IT procedures, updated procurement procedure to include the new PtP system, updated management review procedure to reflect the new Corporate form, added procedure for absence of Technical Director that surpasses 15 and 30 consecutive days, added procedure for client notification prior to data records destruction as well as the procedure for lab closure and change in ownership, updated Board of Directors to Eurofins Environment Testing, added procedure for maintaining employee list, updated instrument count, and removed methods (TO-11A and ASTM D-5504) no longer provided.
Revision: 30	**Effective Date: 08-30-2018**	
Section	**Justification**	**Changes**

Sections 2.6.2, 2.11, 3.1, 5.1, 5.4, 6.3, 7.1, 8.2, 10.3, 10.8, 11.4.1, 13.3, Appendices A, C, D, E, and F.	Updated to current laboratory procedures, SOPs, and information.	Updated to include in-house IT, included procedure for notifying clients of data issues, updated square footage of building and office space, updated information sent with media shipments, added sorbent tube media for tracking, updated instrumentation count, updated procurement procedure to include the new COUPA system, updated to include new methods, updated in which documents calculations are kept, removed CD-ROMS for record storage, added methods TO-3, TO-14A, TO-15 and 325B to the PT studies, added reference to subcontracting SOP, added new definitions for MADEP APH and TOF, included new certifications for the state of AK and FL, updated org. chart, document references and company name change throughout.
Revision: 31	**Effective Date: 09-09-2019**	
Section	**Justification**	**Changes**
2.1, 2.11 8th bullet point, 6.3, 8.2, 9.4, 11.4.1 last bullet point, 11.4.2, Appendices A to F.	Updated to current laboratory procedures, SOPs, information, and DoD requirements.	Updated ISO 17025 to the correct reference of ISO/IEC 17025:2017 throughout the LQAM, added Group Leaders as part of management, referenced key managerial personnel to org. chart in Appendix D, included AB to notify for out of compliance

		results and QA-type issues, updated current equipment information, added EO SOP 134 to analytical test methods table, updated ISO/IEC statement on measurement uncertainty, updated QA status report to QA Management Review report and verbiage, removed definitions that are no longer applicable, updated SOP references, added NH to NELAP certifications table, included current org. chart, added carbopack B to 325B tables, removed BTEX from TO-3 method information and tables, removed references to ASE and Soxhlet for TO-13A extractions, updated various RLs for methods TO-14/TO-15 Low Level, SIM and TO-17 Passives SE, updated Table 2 for TO-17 VI, updated.
Revision: 32	**Effective Date: 01-04-2021**	
Section	**Justification**	**Changes**
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		current procedure for CAR and tracking system, added new section for client feedback procedure, updated laboratory certification information, and updated organization chart.
Revision: 33	**Effective Date: 01-10-2022**	
Section	**Justification**	**Changes**
Various sections throughout, 2.3, 2.8, 6.3, 6.4.1.2, Appendices A, C-F.	Updated to current laboratory procedures, SOPs and, information.	Updated laboratory name by removing the LLC portion, Updated laboratory owner name, Updated safety trainings provided through Eurofins Global Learning Center, Updated current major equipment list, Updated password expiration timeline, Added HSS definition, Updated laboratory certification information, Included current organizational chart, Updated method information and added an internal standard for method 325B, Revised various reporting limits and/or analyte lists for methods, TO-15 5&20, QUAD, Low Level and SIM.

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APPENDICES

1. INTRODUCTION

The purpose of the Laboratory Quality Assurance Manual is to provide a framework to outline the quality systems at Eurofins Air Toxics.

1.1 Our Unique Promise of Value

Eurofins Air Toxics is the global leader in the NELAC Institute (TNI) National Environmental Laboratory Accreditation Program (NELAP) for accredited vapor-phase environmental analytical laboratory services, and is also DoD-ELAP accredited for environmental air and emissions testing for key methods.

Eurofins Air Toxics supports public and private sectors, including engineering and consulting firms, manufacturers, industry, government, retailers and others by offering a wide variety of certified air methods. Eurofins Air Toxics provides unmatched quality, capacity, and technical expertise to deliver an outstanding service experience to clients worldwide.

1.2 Mission Statement

Eurofins Air Toxics is an analytical and environmental laboratory specializing in the analysis of vapor-phase contaminants and air quality parameters. Our business is guided by four key principles:

1) Providing unmatched data integrity
2) Establishing long-term relationships
3) Delivering quality client service
4) Exceeding client expectations

1.3 Quality Policy

The Executive Management Group recognizes quality as a key element of the laboratory's standard of service. This group supports the laboratory's commitment to quality as defined by NELAP and ISO/IEC 17025:2017.

The Quality Policy Statement gives employees clear requirements for producing analytical data that is scientifically valid, legally defensible, accurate, impartial, and of known and documented quality, through strict adherence to the Quality Policy Statement. The Quality Policy Statement was written by Corporate Quality Assurance with final approval from the President of Eurofins Environment Testing America. The policy cannot be revised without the Corporate Quality Assurance Director and Quality Assurance Officer's approvals. Employees are trained on

the components of the Quality Policy Statement during their orientation. All employees sign the statement as agreement to implement the policy in all aspects of their work. The statement is as follows:

Quality Policy Statement

We strive to provide the highest quality data achievable by:

- Reading and understanding all of the quality documents applicable to each position and implementing the process in our work.

- Following all recordkeeping requirements; describing clearly and accurately all activities performed; recording "real time" as the task is carried out; understanding that it is never acceptable to "back date" entries and should additional information be required at a later date, the actual date and by whom the notation is made must be documented.

- Ensuring data integrity through the completeness, consistency, and accuracy of the data generated. Complete, consistent, and accurate data should be attributable, legible, contemporaneously recorded, original or a true copy, and accurate (ALCOA). This applies to manual paper documentation and electronic records.

- Providing accountability and traceability for each sample analyzed through proper sample handling, labeling, preparation, instrument calibration/qualification/validation, analysis, and reporting; establishing an audit trail (the who, what, when, and why) that identifies date, time, analyst, instrument used, instrument conditions, quality control samples (where appropriate and/or required by the method), and associated standard material.

- Emphasizing a total quality management process which provides accuracy, and strict compliance with agency regulations and client requirements, giving the highest degree of confidence; understanding that meeting the requirements of the next employee in the work flow process is just as important as meeting the needs of the external client.

- Providing thorough documentation and explanation to qualify reported data that may not meet all requirements and specifications, but is still of use to the client; understanding this occurs only after discussion with the client on the data limitations and acceptability of this approach.

- Responding immediately to indications of questionable data, out-of-specification occurrences, equipment malfunctions, and other types of laboratory problems, with investigation and applicable corrective action;

documenting these activities completely, including the reasons for the decisions made.

- Providing a work environment that ensures accessibility to all levels of management and encourages questions and expression of concerns on quality issues to management.

We each take personal responsibility to provide this quality product while meeting the company's high standards of integrity and ethics, understanding that improprieties, such as failure to conduct the required test, manipulation of test procedures or data, or inaccurate documentation will not be tolerated. Intentional misrepresentation of the activities performed is considered fraud and is grounds for termination.

1.4 Statement of Values

At Eurofins Air Toxics, we strive to be the BEST in everything that we do. Our very existence is based on our continued ability to provide innovative, dependable, and cost-effective environmental services to our clients. We CARE about our clients as well as our co-workers and manage our daily activities to build relationships based on mutual TRUST, HONESTY, and RESPECT. We are LEADERS in our field and accept the risks associated with building new frontiers in our professional lives. Our strength comes from our TEAMS for through them we can achieve our goals.

1.5 Certifications, Accreditations, and Registration

Accreditation/Certification is the process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications and/or standards. It is the one generally accepted method by which a laboratory such as ours can demonstrate its capability of generating acceptable, professional, quality test results in those areas in which it claims competence. To this end, we have actively sought accreditation by organizations offering it in areas relevant to our technical expertise. We strive to ensure that the facility, equipment, procedures, records, and methods used by Eurofins Air Toxics laboratory in the testing of environmental samples are in compliance with the requirements of these standards.

Appendix C lists accreditations held by Eurofins Air Toxics in support of environmental work. Current copies of all scopes of accreditation are kept on file in the Quality Assurance Department.

2. ORGANIZATION AND PERSONNEL

2.1 Organizational Structure

Eurofins Air Toxics' management organization includes six core areas: Operations, Information Technology (IT), Client Services, Research, Sales and Marketing, and Finance and Administration. The management staff includes executives, directors, managers, and supervisors (group leaders). Each operating area is led by a manager and/or a supervisor (group leader). In the absence of a member of the laboratory and operational management team, deputies are appointed as follows:

Position	Deputy
President	Laboratory Director or appointee
Technical Director	Quality Assurance Manager or appointee
Quality Assurance Manager	Technical Director or appointee
Laboratory Director	Technical Director or appointee
Supervisors (Group Leaders)	Laboratory Director

If the Technical Director is absent for more than fifteen consecutive calendar days, the Quality Assurance Manager or designee meeting the qualifications of the Technical Director will temporarily fulfill the role. If the absence is greater than thirty-five consecutive calendar days, the Quality Assurance Manager will notify the primary accreditation body in writing.

Eurofins Air Toxics' management and executive (President)are committed to following and assuring compliance with the TNI Standard as defined in this Laboratory Quality Assurance Manual (LQAM). Each manager is responsible for implementing and maintaining systems as they affect their teams and for participating in their respective role in the management systems as outlined in the LQAM.

Additional key managerial personnel are presented in an Organizational Chart in Appendix D of this manual. This organizational structure is created in a way to avoid any potential for conflicts of interest or undue pressure that might influence the technical judgment of analytical personnel.

2.2 Management Responsibilities

The management team consists of supervisors (group leaders), managers, and directors, and positions above those. The following is a list of management responsibilities:

- Personnel hiring and training
- Supervision of personnel
- Ensuring quality of data produced
- Resources allocation
- Directing daily work operations, including scheduling of work
- Maintaining awareness of technical development and regulatory requirements
- Assessing laboratory capacity and workload
- Contributing to the continuous improvement of the laboratory operation
- Providing resources to ensure a safe work environment
- Providing resources to ensure a work environment free of undue pressures
- Communicating problems and concerns to executive management to enlist a higher level of support for corrections and continuous improvement, ensuring compliance with the requirements of NELAP and ISO/IEC 17025:2017
- Ensuring that corrective actions are carried out in an appropriate and agreed upon time frame

The Quality Assurance Manager ensures that the laboratory's policies and objectives for quality of testing services are documented in this quality manual. The Quality Assurance Manager must assure that the manual is communicated to, and understood and implemented by all personnel concerned.

2.3 Overview of the Quality Assurance Program

The Quality Assurance (QA) Department is responsible for developing planned activities the purpose of which is to provide assurance to all levels of management that a quality program is in place within the laboratory, and that it is functioning in an effective manner that is consistent with the requirements of NELAP and ISO/IEC 17025:2017. Although Eurofins Air Toxics is a wholly owned subsidiary of Eurofins Environment Testing America Holdings, Inc. the Quality Assurance and quality systems described in this manual are specific to Eurofins Air Toxics.

2.3.1 Quality Assurance Manager

The Quality Assurance Manager ensures that the quality system is followed at all times. The QA Manager reports directly to the President in order to maintain independence from business operating units and facilitate communications regarding quality-related issues. The QA Manager has no direct supervisory responsibility for the generation of technical data to avoid any conflict of interest in administrating the QA program. The QA Manager has the final authority to stop work that compromises the laboratory's integrity or data quality. The situation must be investigated and appropriate corrective action must be put in place before the QA Manager will authorize the resumption of work. The specific duties of the QA Manager are communicated in job description format.

2.4 Quality Assurance Responsibilities

The Quality Assurance team is responsible for implementing and maintaining Quality Assurance procedures throughout the laboratory. This is accomplished via coordination and dissemination of internal and external assessment information, review of Standard Operating Procedures (SOPs) to document variances taken to published methods, monitoring of the Quality Assurance Manual to ensure consistency with actual practices, maintenance of an ongoing Corrective Action Program with yearly reports to the senior management team, a leadership role in employee training, data review, and other quality control-related programs.

The QA team is free from any commercial, financial, or production pressures when making assessments or decisions regarding the quality of work produced or effectiveness of the quality systems.

2.5 Communication of Quality Issues to Management

Communication between the Quality Assurance (QA) team and other management teams occurs on a regular basis (typically via monthly status meetings). Information regarding outstanding corrective action items, upcoming assessments, assessment results, and/or general observations are discussed and documented via a database of agenda notes. The QA databases along with the Laboratory Information Management System (LIMS) database are used to compile a Yearly Quality Assurance Status Report (as part of the Management Review System), which is distributed to the senior management team for review.

2.6 Personnel Qualifications and Responsibilities

Full resumes and specific position descriptions for all personnel are located in Corporate Human Resources (HR) Department files. In addition, the Supervisors (Group Leaders) have copies of position descriptions for their staff.

2.6.1 Executive Team

President: Provides leadership that ensures the founding mission and core values of the company are put into practice. The President leads programs relating to the development of long-range strategy, quality systems, financial infrastructure and sales. The President also provides day-to-day leadership and management of programs for overseeing the processes and resources necessary for establishing long-range service objectives, plans, and policies in cooperation with Eurofins Environment Testing America. The President is responsible for the measurement and effectiveness of both internal and external processes by providing accurate and timely feedback on the operating condition of the company. In addition, the President directs the definition and operation of the laboratory production by fostering a success-oriented and accountable environment within the company.

Technical Director: The Technical Director is responsible for developing products and solutions to meet client and industry needs, and also oversees the validation process of current and new products to ensure quality objectives are met and documented as defined.

Laboratory Director: Responsible for managing the operations of the laboratory, profit/loss relating to operations, laboratory efficiency improvement in software and instrument automation, and serves as the primary interface between finance, HR, IT, project management, and sales/marketing. The Laboratory Director has the overall responsibility of ensuring customer satisfaction goals are met while elevating the skill and training of key technical staff as well as assuring that state-of-the-art instrumentation and capital assets are in place to meet global customer needs.

2.6.2 Management Team:

Laboratory management and personnel are free from any commercial, financial, or production pressures when making technical judgments or decisions regarding the quality of work produced.

Corporate and In-House Information Technology (IT) Team: Oversees all aspects of software engineering and development, database administration, and network administration. The Corporate and in-house IT Team is instrumental in designing and implementing model work-flow processes, defining user requirements, and proposing software design and implementation to satisfy long-term company business goals. This role provides established policies and procedures to ensure continuous database and server environment integrity and reliability.

Quality Assurance Manager: Responsible for overseeing the quality systems in the laboratory. Key to the Quality Assurance role is a focus on continuous improvement through effective monitoring of systems and evaluation of non-compliance and corrective actions. To support the quality systems, the Quality Assurance Manager leads the internal and external audit programs, negotiates audit resolution, and oversees the effectiveness of the Corrective Action Report (CAR) program. The QA Manager is tasked with providing timely feedback to front-line managers and bench staff regarding quality programs and also a big-picture assessment to senior management. Additionally, the QA Manager ensures required documentation and certifications are current and accurate, including regulatory accreditations, the LQAM, and SOPs.

Supervisors (Group Leaders): Responsible for day-to-day operations of the laboratory or specific departments. The Supervisors oversee technical operations, sample analysis, data entry, report generation, provision of resources, and other related areas. In addition, they are responsible for employee management and review. Supervisors report directly to the Laboratory Director. Managerial decisions are made by the Laboratory Director in their absence.

2.6.3 Laboratory Staff and Responsibilities

It is the primary responsibility of laboratory staff to produce quality data within the framework of each individual method and within the parameters of the laboratory's quality control guidelines. It is also the responsibility of staff to identify existing problems or inefficiencies, and to improve the processes of the laboratory whenever possible. Duties for these personnel typically include:

- Sample preparations
- Performance of analytical tests
- Calibrations, operation, and maintenance of instruments

- Standard and reagent preparation
- Sample storage
- Data entry
- Data package preparation

Eurofins Air Toxics maintains the confidentiality of the laboratory staff. A list of employee names, initials, and signatures is kept in the QA Department. The list is updated annually and is available for on-site review upon request.

2.7 Training

The experience and training received by personnel is of great importance to Eurofins Air Toxics' clients and regulatory agencies. Accurate training documentation is the responsibility of both employees and their supervisors. On a routine basis, the supervisor reviews and signs training documentation to verify that it is complete and current.

Each laboratory analyst being trained to perform a new analysis is required to perform an initial Demonstration of Capability (DOC) and meet the requirements for accuracy and precision before working independently on the test methods. Typically this is accomplished by the successful analysis of at least four aliquots of a laboratory quality control sample. However, there are certain tests that are not required by the mandated test method or regulation to perform the above procedure (e.g., PM10). In this case, the analyst's proficiency demonstration is satisfied by documentation of having read, understood, and agreed to follow the SOP, specific department or method forms and procedures, and observation by scientist or senior analyst.

Management personnel are responsible for planning ongoing professional growth and development activities for an employee through on-the-job training and/or internal and external training courses so that an employee can maintain a current skill set to match job responsibilities.

An annual performance review based on job accountabilities, objective measures, and pre-defined standards is completed by management personnel for each employee. This assessment is documented and maintained. Input is obtained from other managerial personnel as needed.

2.7.1 New Hire Training

Upon hiring all new employees are assigned mandatory Ethics training through the Eurofins Global Learning Center. Additionally, new employees learn about personnel and safety policies as well as business

strategies through a formal process administered by our Corporate Human Resources Team, Laboratory Director, and the Safety Committee. All new employees are also required to attend the Quality Assurance Orientation. Completion of the orientation is documented in the employee's Training Record. The course outline includes:

- Introduction to QA
- Definitions of SOPs and LQAM
- How to use CARS
- Logbook protocol
- Chain-of-custody procedures
- Training Documentation
- Overview of Eurofins Air Toxics classes including Ethics and Data Integrity courses
- Overall Training Record organization and upkeep

New employee training continues with Data Integrity training, review and signing of the Eurofins' Ethics Policy Statement, a review of the Quality Assurance Manual, and signing of the Quality Orientation Program checklist (I1.32). Upon completion of this training, employees move on to analytical method training if required for their position. Other non-testing training materials may be required by the departments.

In general, the laboratory staff reviews the department's SOPs and/or the regulatory method as well as the instrument manual. The employee will then observe while an experienced analyst prepares samples and operates the instrument. Training includes sample handling and preparation, documentation protocols, calibration procedures, QC requirements, data management, data reporting and troubleshooting.

2.7.2 Ongoing Training

Annual Ethics training is provided by the Eurofins Global Learning Center while Data Integrity training is provided by the Corporate QA team. All employees are required to complete both training sessions. Training is documented with signing of the attendance sheet and Eurofins' Ethics Policy Statement which are maintained in the QA department.

After successful completion of the initial Demonstration of Capability, all laboratory staff must demonstrate continued proficiency. Whenever there is a change in test method, instrument method type, and/or personnel a new DOC must be performed. At least once per year, each analyst must

demonstrate continued proficiency on assigned technical methods. The QA Department notifies personnel via an automated e-mail generated from the document control program, D4, or via personal e-mail whenever a new SOP is generated or a current SOP is updated. Employees responsible for that method or procedure must read the new or updated SOP within 30 days and document the review in the document control program, D4, and in the LIMS SOP Tracker module. In addition, the Laboratory Quality Assurance Manual and the Chemical Hygiene Plan must be annually reviewed by all employees.

Employees are re-trained if an issue or investigation warrants that it is a necessary corrective action. Management provides direction as to when employee re-training is required, and to the extent of the re-training.

2.8 Employee Safety

Laboratory staff may, on occasion, be exposed to handling of solvents, compressed gases, calibration standards, or other hazards. Eurofins Air Toxics designates an assigned Safety Officer and several staff members who comprise the Safety Committee. Some members are 40-hour OSHA-trained and respirator-fitted.

Employee education in the safe handling and disposal of these materials is accomplished as follows:

- Each new employee is given a safety tour of the facility within the first two days of employment. Documentation of this orientation appears in the employee's Training Record.
- The Safety Committee meets frequently to discuss safety concerns and ways of improving safety in the work place.
- Ongoing safety training throughout the year provided through the Eurofins Global Learning Center.
- If special precautions must be taken to perform a method, a safety section is included in the method SOP or in a stand-alone SOP which discusses protocols and other measures for risk reduction through exposure prevention.
- Safety Data Sheets (SDSs), formerly Material Safety Data Sheets (MSDS), are maintained for each chemical used on-site. The SDSs are accessible to personnel in a designated area in the laboratory and/or electronically through the chemical inventory database (CISpro) at all times. SDSs are also accessible on the Internet from product vendors.

- The Safety Committee members are assigned to duties that include hazardous waste disposal, incident or spill management, scheduling staff training, safety site assessments, Chemical Hygiene Plan review Injury Illness Prevention program review, and the overall leadership of the Safety Program.

2.9 Project Management Responsibilities

The Project Management group is responsible for organizing and managing client projects. Clients are assigned a Project Manager who serves as their primary contact. It is the Project Manager's responsibility to act as client advocate by communicating client requirements to laboratory personnel and ensuring that clients provide complete information needed by the laboratory to meet those requirements. All client verbal and electronic communications are documented by the project managers in the LIMS Contacts module. In addition to information management, project management responsibilities include:

- Coordinating and preparing proposals in conjunction with technical staff, including review of project-specific documents and negotiations of variance requests
- Documentation of project requirements
- Coordinating and communicating turnaround-time (TAT) requirements
- Scheduling sample submissions, sample containers, and sample pickup via Eurofins Air Toxics courier service
- Informing clients of deviation from their contract

2.10 Confidentiality

Strict confidentiality is maintained in all of Eurofins Air Toxics dealings with clients. All employees are required to protect company data, including client names and/or test results from disclosure to any third party. This policy is presented to employees in SOP #99 and during their orientation period.

Clients are promptly notified if their data is subpoenaed or requested by a regulatory or legal body.

In order to ensure the confidentiality of our systems and procedures within the laboratory, it is Eurofins Air Toxics' policy to restrict the distribution of our internal procedures to clients. Clients are, however, permitted to review the laboratory's procedures while on-site as part of an audit or visit. Based on this policy, the

laboratory requests that any document viewed is not shared or made available to any third parties without the permission of Eurofins Air Toxics.

2.11 Operational Integrity

All employees sign an Employee Ethics Statement on their first day of employment. Employees responsible for generating, handling, or reviewing laboratory data understand that Eurofins Air Toxics' mission is to perform all work with the highest level of integrity. Shortcuts or generating results to suit a client's purpose, rather than adhering to good scientific practices, is not considered acceptable under any circumstances. Any violation of the laboratory ethics policy results in a detailed investigation that could lead to termination. Examples of violations of data integrity are listed below:

- Knowingly recording inaccurate data
- Fabrication of data without performing the work needed to generate the information; this includes creating any type of fictitious data or documentation
- Time travel or adjusting clocks on computerized systems to make it appear that data was acquired at some time other than the actual time
- Manipulation of data for the express purpose of passing systems suitability or quality control criteria
- Selective use of data generated, or not using data that was legitimately generated to impact the outcome of a test
- Executing significant deviations from approved test methods and procedures without prior approval from Eurofins Air Toxics management and/or the client

If an issue does arise which could compromise data integrity, personnel are instructed to perform the following activities:

- Clearly document the situation and maintain all data generated. There is a big difference between poor judgment and fraud. Fraud usually involves intent to conceal an action taken. Therefore, the more documentation that is maintained the less likely an action is considered fraudulent if further scrutinized. All documentation of the inquiry and subsequent disciplinary actions will be maintained by the Laboratory Director, Supervisor and the Corporate Human Resources Team for at least five years.
- When out-of-specification results or quality control-type issues are detected, all supporting data and relative background information must be documented and presented for management review. The QA Manager or member of the management team will notify the client and the Accreditation Body (AB)

verbally followed by a written memo detailing the issue within 15 business days of discovery. A Corrective Action Report is initiated documenting the root cause and resolution or proposed resolution will also be submitted to the client and AB within 30 days of discovery.

- Any questionable situations and decisions must be reviewed with a supervisor.
- Questionable or uncomfortable issues are brought directly to the QA Manager or a member of the QA Department as part the QA "open door" policy. If an employee desires to remain anonymous, he or she is encouraged to contact our anonymous reporting hotline – Lighthouse Services, Inc. The Lighthouse hotline discusses the situation with the employee and provides a report to the QA Manager while maintaining employee anonymity. A poster with the contact information for Lighthouse Services is displayed in the company's breakroom.

3. BUILDINGS AND FACILITIES

3.1 Facility

The Eurofins Air Toxics laboratory occupies approximately 27,000 square feet of space in Folsom, California, including 2,514 square feet of office space. The single-story building is custom-designed to suit the specifications of an air laboratory. Design criteria included floor plans to accommodate segregation of conflicting tests and provide an environment that is conducive for cross-functional work teams. The main instrumentation laboratory is based on an "open" concept in which walls were removed to promote a sense of community and teamwork. Wide hallways with alcoves were designed to encourage congregation and discussion. The number of private offices was minimized so that barriers between management and staff are absent. Elements of the quality system are evident throughout the facility design. The facility's map is available for review at the laboratory.

3.2 Security

Security at Eurofins Air Toxics is maintained through a controlled access system. Representatives of State, Federal, and private entities have access to the laboratory facility and records during normal business hours. Guests and employees must enter/exit through Sample Receiving or the reception area. All visitors must sign in and out upon arrival and departure. After work hours, the building is secured and linked to a commercial security agency. The security system is equipped with perimeter alarms, motion sensors, and speakers that

monitor background sounds. Heat-activated fire alarms are monitored by an outside agency. A fire alarm also activates the security system. Security and controlled access protocols are described in SOP #30.

4. DOCUMENT CONTROL

4.1 Controlled Documents at Eurofins Air Toxics

It is Eurofins Air Toxics' policy to restrict the distribution of internal procedures to clients, and we discourage the distribution of company confidential documents outside of the facility. Clients are permitted to review our procedures while on-site as part of an audit or visit. Any documents that are distributed are only done so with the approval of QA.

4.1.1 Quality Policy Manual and Company Policies

Eurofins Air Toxics' Quality policies and Quality Systems must comply with all State and Federal requirements for those programs for which the laboratory maintains accreditation.

All Eurofins Air Toxics employees are required to read the Quality Assurance Manual within 30 days of release of the latest version and maintain current documentation in their Training Record binders and in the QA department. The Quality Assurance Manual is available to all employees electronically on a shared server located at O:\QA\LQAM.

4.1.2 Laboratory Standard Operating Procedures (SOPs)

The SOPs at Eurofins Air Toxics detail the work processes used on a regular basis that are to be conducted and followed within the organization. They document the way activities are to be performed to facilitate consistent conformance to technical and quality system requirements and to support data quality. These SOPs can be administrative or technical. All employees should maintain a record of review of the most current SOPs.

4.1.3 Work Instructions (at the department level)

The intent of these procedures or documents is to define in greater detail the specific "how to". The level of detail in these documents must be sufficient so any appropriately trained person can perform the task accurately.

4.1.4 Logbooks, Forms, and Instructions

The intent of these documents is to provide documented evidence to support Eurofins Air Toxics quality systems and operations. They are used as part of regular laboratory operations to record necessary information.

4.2 Document Approval, Issue, Control, and Maintenance

The Quality Assurance Department is responsible for the approval, issue, control, and maintenance of all documents that are part of the laboratory's quality systems including, but not limited to, the Quality Assurance Manual (LQAM), Standard Operating Procedures (SOPs), Logbooks, Forms and Instructions, Certificates of Analysis (C of As), and calibration and training documents.

All documents issued to personnel in the laboratory as part of the quality system shall be reviewed and approved for use at a minimum by the Quality Assurance Manager and as needed by the Technical Director and Laboratory Director prior to use.

The LQAM and SOPs are reviewed to ensure they remain accurate and current. The frequency of review is either annual at the least or as needed, depending on the procedure. Upon generation of new or updated documents, all copies of obsolete documents are removed from the laboratory and its computer network, then archived or destroyed as appropriate. Pertinent staff members are notified of the updates. A new revision number is assigned to the LQAM or SOP at every review that results in updates.

All technical changes must have the approval of the Technical Director, the Laboratory Director, and the Quality Assurance Manager.

Detailed instructions regarding document control and how to write SOPs are available in SOPs #46 and #119.

4.3 Laboratory Logbooks and Forms

Procedures are in place to ensure that all data is traceable, authentic, complete, and retrievable. Logbooks, forms, and instructions are created and distributed by the Quality Assurance Department as needed. Used logbooks are returned to QA for archival. The QA Department maintains a master index to uniquely number and identify each logbook and form distributed. Logbooks can contain blank or preformatted pages. They are bound and uniquely identified, and have sequentially pre-numbered pages.

4.4 Archival and Storage of Documents

The majority of documents at Eurofins Air Toxics are stored electronically. Documents which remain in hard-copy format include chain-of-custody forms (COCs), Data Review Checklists, scanned packets (run logs, spectral defenses, manual integrations, etc.), FedEx/UPS air and freight bills, and most logbooks. All other hard-copy documentation is stored in its specific workorder folder. The hard-copy workorder folder is placed in a bar-coded storage box for long-term storage. Bar codes are maintained in an inventory log. An off-site company archives the boxes using the bar-coding system. The storage company provides one-day retrieval service upon request.

Used logbooks are returned to Quality Assurance for archival and remain in the QA Department for no less than five years.

5. SAMPLE HANDLING

5.1 Sample Collection

It is the responsibility of the client to submit representative and/or homogeneous and properly preserved samples of the system from which they are collected. In all cases, field sampling personnel are ultimately responsible for having expertise and knowledge in air sampling methodology or product/materials collection protocols sufficient to ensure that the defensibility of the data will not be compromised due to deficiencies in the field sampling, handling, or transportation. General information regarding the proper use of sampling media provided by Eurofins Air Toxics is available as a resource for field personnel. The laboratory provides sample containers, chain-of-custody forms, sampling labels, chemical ice packs (if appropriate), shipping containers, and custody seals (per client request).

Air sampling media provided by a qualified vendor or prepared by the laboratory for field use is certified for cleanliness. The laboratory's media cleaning process is typically verified using batch certification protocols. Individually certified canisters are also available per specific client request.

5.2 Sample Receipt and Entry

5.2.1 Sample Receipt

Samples can be received at the laboratory during normal laboratory operating hours. Receipt occurs in one of three ways:

- Commercial courier
- Eurofins Air Toxics courier service
- Personal delivery

Upon arrival at the laboratory, samples are received and inspected following Eurofins Air Toxics' Sample Acceptance Policy as outlined in SOP #50. This SOP establishes specific guidelines for sample acceptance, which are generally accepted practices under U.S. Environmental Protection Agency (USEPA), Department of Defense (DoD), ISO/IEC 17025:2017, and NELAP protocols.

5.2.2 Sample Entry

As soon as is practical after sample receipt, the samples are entered into LIMS. Samples awaiting log-in are stored in temporary holding areas, at appropriate storage conditions to maintain sample integrity.

At the time of entry, the LIMS system assigns a unique laboratory sample number to each sample. This number is sequentially assigned; a label is then generated and is attached to the sample container.

A sample acknowledgment in the form of a Sample Receipt Confirmation prints from LIMS for each sample delivery group (SDG), which is the same number as the workorder. This notification is sent to the client to confirm sample receipt and entry.

5.2.3 Sample Rejection Policy

Any time a sample is received in a condition that does not meet the method requirements, if there is doubt about the suitability of items received, if items do not conform to the description provided, or the testing required is not clear or specified, the condition of the sample is clearly documented on a Sample Discrepancy Report (SDR). The SDR is delivered to the Project Manager for review and communicated to the client as needed. Directions on next steps, which may include canceling the sample or proceeding with qualifiers and/or narrative, are documented on the SDR. Details are outlined in SOP #50.

5.3 Sample Identification and Tracking

A sample label is generated for each sample, and in addition to the assigned Eurofins Air Toxics' sample number the following information is printed on the label: workorder number, laboratory sample ID, and, if needed, a sample release

date. For canister analysis, the label is not affixed directly to the canister but attached with a tag.

To ensure traceability of results, the unique sample number assigned is used to identify the sample in all laboratory data documentation, including logbooks, instrument printouts, and final reports.

5.4 Sample Storage

After entry into LIMS, samples are placed in an assigned and identified storage location until needed for analysis. Room temperature, refrigerated, and freezer storage are available, and samples are stored in accordance with regulatory, method, or client directions. The LIMS system is used to assign storage locations for bar-coded media, which promotes orderly storage of samples. Sample storage locations for sorbent and condensate samples requiring refrigeration are monitored for accurate temperature control.

When a canister, bag, sorbent tube, or product sample is scheduled for analysis, the analyst obtains custody of the sample by scanning the canister tag or sticker bar code as well as the bar-coded destination location of each individual sample. The scanned information is electronically transmitted to LIMS to reflect the custody of canister and bag samples at all times. All other media samples are logged into the Internal Extractable Sample Tracking Logbook and the pertinent storage area.

5.5 Sample Return/Disposal

Samples are released for disposal upon satisfactory completion of analysis unless prior contractual arrangements have been made. The release of samples is electronically documented in the LIMS tracking system via scanning of the canisters and bags. This ensures verification of completion of all analyses including all samples in each workorder. Samples are released following the procedures outlined in SOP #63.

Sample disposal varies based on the sampling media. Whole air samples are vented through a charcoal scrubber, while liquid samples are disposed of according to procedures noted in SOP #24.

5.6 Chain of Custody

Samples received by the laboratory must be documented using a chain-of-custody (COC) form and relinquished following standard EPA-approved guidelines, including the following:

- Unique sample name or number
- Location, date, and time of collection
- Canister number (if applicable)
- Collector's name
- Preservation type (if applicable)
- Matrix or product type
- Any special remarks

Additional information may be required depending on the requested analysis.

A copy of the signed COC will be e-mailed to the client in conjunction with the Sample Receipt Confirmation.

Once a sample is received by the laboratory, the internal chain-of-custody procedure is followed.

Disclaimer: *Eurofins Air Toxics assumes no real or implied responsibility or liability for client-related field sampling and shipping activities. It is the responsibility of the individual client to ensure that referenced methodologies are followed with respect to sample collection and shipment to the laboratory. Air sampling media and equipment should only be used by experienced field engineers. It is the ultimate responsibility of the client to be knowledgeable both in sample preservation requirements as well as relevant State, Federal, and international shipping requirements. Any time a chemical substance is collected using Eurofins Air Toxics media, the client bears sole responsibility for understanding and abiding by the laws involving shipment of potentially hazardous substances by common carrier.*

6. TECHNICAL REQUIREMENTS – TRACEABILITY OF MEASUREMENTS

6.1 Reagents and Solvents

The reliability of Eurofins Air Toxics' analytical results can be directly affected by the quality of reagents used in the laboratory. Procedures are in place to control labeling, storing, and evaluation of these materials. All purchased supplies, reagents, solvents, and standards are verified as acceptable and meeting criteria for analysis prior to use. The Eurofins Air Toxics' Chemical Hygiene Plan (CHP) provides safety information in regard to the storage and handling of laboratory chemicals. All reagent certificates and Safety Data Sheets (SDSs) are retained by the laboratory (see section 2.8).

6.2 Calibration Standards

Written calibration procedures are required, where applicable, for all instruments and equipment used in the laboratory. The source and accuracy of standards used for calibration purposes are integral to obtaining quality data. Requirements for calibration are provided in each analytical method including specifications for the standard used. Calibration measurements made by the laboratory must be traceable to national standard of measurement (e.g., NIST) where available. Certificates of Analysis are maintained for each material, as applicable.

Standards are usually purchased from commercial suppliers either as neat (pure) compounds or as solutions with certified concentrations. The accuracy and quality of these purchased standards are documented on the C of A, and hard-copy certificates are maintained on file in the laboratory. Upon receipt at Eurofins Air Toxics, material is labeled with a date of receipt and stored appropriately.

Stock standard solutions are recorded in the proper standard logbook and are assigned a unique standard code number. When a working standard is prepared, the compound(s), standard code number, date prepared, analyst, expiration date, and solvent are noted in the working standard logbook. All working standards are kept in containers and at temperatures that will not alter their integrity. All containers are clearly labeled with concentrations, unique standard code number, and expiration date. Standards are not to be used in the laboratory past their expiration date.

6.3 Equipment and Instrumentation

The laboratory is equipped with all equipment and instrumentation required for testing the scope of work it supports. All equipment and instrumentation is maintained in proper working order. Eurofins Air Toxics' major equipment capabilities are summarized in the table below:

Major Instrumentation

Number	Instrumentation
34	GC-MS
3	Gas Chromatographs with various detectors (TCD, FID)
1	TOF
4	Entech Air Concentrators
8	Markes Air Auto-Samplers
15	Markes Automated Thermal Desorption Units
3	Liquid Auto-Samplers
1	Extractor

1	Precision Diluter
2	Industrial Air Compressor

6.3.1 General Requirements

- Equipment and instrumentation are assigned a unique identifier designation to identify them within the data documentation.
- An equipment logbook is established in conjunction with installation and is readily available to document all incidents that pertain to the equipment and instruments as they occur.
- All test, measuring, and inspection of laboratory systems, equipment, and instruments used at Eurofins Air Toxics are routinely calibrated and maintained in accordance with applicable Standard Operating Procedures.
- Trained technical staff, or a designated individual, performs routinely scheduled maintenance and calibration of laboratory equipment as required by laboratory procedures. These activities are documented.
- If appropriate standards or expertise for calibration or maintenance are not available in-house, the operation is conducted by an outside service firm.
- All equipment taken out of service is tagged accordingly.

6.3.2 Standard Operating Procedures

Information regarding operation, maintenance, and calibration of equipment and instrumentation are found in respective SOPs. The procedures include a routine schedule for preventative maintenance and calibration as applicable, along with acceptance criteria and remedial action to be taken in the event of failure. These procedures are maintained in the document control system and reviewed on a regular basis to verify they remain current and accurate. Equipment manuals are also available to provide additional information with regard to operations and maintenance.

6.3.3 Maintenance

- Equipment maintenance is performed as either a preventative or corrective operation.
- Preventative maintenance procedures and schedules for each piece of equipment are assigned where applicable. Preventative maintenance operations are performed by an analyst, scientist, senior scientist, service engineer, or contracted manufacturer's representative or service firm personnel. Documentation is maintained

for the procedures performed as part of the preventative maintenance operation. It is the responsibility of Supervisors to ensure that a preventative maintenance schedule is addressed by a procedure where appropriate and is followed.

- A supply of commonly needed replacement parts is maintained by the laboratory.

6.3.4 Calibration

- Calibration is the establishment of, under specified conditions, the relationship between the values/response indicated by a measuring instrument or system and the corresponding known/certified values associated with the standard used. Some types of calibrations are performed within a set of frequency (e.g., daily), while others provide intermediate checks to ensure that the instrument response has not changed significantly.
- All measuring and testing equipment having an effect on the accuracy, precision, or validity of calibrations and tests are calibrated and/or verified on an ongoing and routine basis. Methods for calibration of instruments and equipment vary widely with the nature of the device and the direction given by analytical procedures, department procedures, or manufacturer recommendations. Frequency of calibration can also depend on additional factors, including robustness of the instrument or equipment and the frequency of use.
- Calibration information is recorded in a logbook that is associated with the instrument/equipment and/or a calibration certificate is maintained and/or data printouts are generated to document the activity.
- Calibration measurements are traceable to national standard of measurement (e.g., NIST) where available. Physical standards, such as certified weights or thermometers are re-certified on a routine basis. Calibration certificates are maintained on file, where applicable, to indicate the traceability to national standard of measurement.
- Calibration failures are documented in the logbook for the instrument and/or within the data printouts from the instrument.
- After repair, adjustments, or relocation that could affect instrument response, calibration/verification activities are performed, as applicable, before the unit is returned to service.
- Analytical data is not reported from instrumentation or equipment that fails to meet calibration requirements.

6.4 Computerized Systems and Computer Software

6.4.1 Computer Usage

Eurofins Air Toxics provides computer equipment for employees to use as a tool in performing their work. Computer equipment is the property of Eurofins Air Toxics and is to be used in accordance with defined terms and conditions. The laboratory's goal is to provide standard hardware and software that meets the needs of the user.

6.4.1.1 Physical security of computer systems: It is company policy to protect computer hardware, software, and data documentation from misuse, theft, unauthorized access, and environmental hazards. All of the laboratory servers are housed in a locked office, which maintains favorable environmental conditions to allow for optimal server performance. Access to the laboratory's networks is granted by the Corporate IT Team. Network access is tightly controlled for the entire company. Users maintain individual network accounts and are allowed to access specific areas of the network based on the privileges assigned to them. A user is granted access to only those areas needed to fulfill his or her job function.

6.4.1.2 Passwords: All software used to reduce sample data or generate sample reports is password-protected; users are granted rights to these systems based on a "read/write/none" privilege system. The following procedures apply regardless of what system(s) is being utilized:

- Passwords must be kept confidential.
- Users must log-out of a system when not in use to prevent unauthorized access.
- Forgotten passwords can only be reset by the Corporate IT Team.
- Network passwords automatically expire every 360 days. The computer prompts a user to change the password when the expiration date nears.

Refer to the Corporate Password Policy document EDR: 2-96-IS-POL-0113513 for complete instructions.

6.4.1.3 Computer viruses: The Corporate IT Team continuously monitors its computer network for computer viruses. Anti-virus software is employed to detect viruses on the Windows network. Employees must report any virus concerns to Corporate IT as soon as possible. Employees who share files between their home computer and the laboratory should install anti-virus software on their home computer. If an employee does not have such software, the laboratory can suggest various no-cost anti-virus software products.

6.4.1.4 Internet and e-mail System: The e-mail system is used primarily for Eurofins Air Toxics business purposes. The Employee Handbook provides additional information in regard to system usage. Employee access to the Internet is restricted to those employees who have a business need for it. All employees have access to e-mail. All Internet and e-mail activity is subject to monitoring. All messages created, sent, or received over the Internet are property of Eurofins Air Toxics and can be regarded as public information. E-mail and Website filtering software is utilized.

6.4.1.5 Software Policy:

Eurofins Air Toxics' Software Policy is as follows:

- Copyright laws protect software, and Eurofins Air Toxics' intent is to abide by all software agreements.
- Software purchases must be formally requested and approved by management, Corporate IT, and/or validation personnel, as necessary.
- All software is used in accordance with applicable license agreements.
- Employees are not to install any software on computer(s) unless authorized by Corporate IT.
- Employees must not give software to outsiders (e.g., clients, contractors, etc.), unless approval is granted by management.
- Users must not make copies of any licensed software or related documentation without permission. Any user that illegally reproduces software is subject to civil and criminal penalties including fines and imprisonment.

6.4.1.6 Computer system backup, data restoration, and data archival: All data systems are backed up on a daily, weekly, and 6 month basis using a modified "grandfather-father-son" (GFS) rotation protocol. Specifically, these backups are conducted on the servers responsible for all laboratory production data files and databases (i.e., Project Management files, analytical data, audit trails, Quality Assurance documents, etc.). A daily incremental backup is scheduled to run each night Monday through Saturday. The daily incremental backup is limited to files modified the same day. On Sunday, a weekly full backup of all files on each server is completed. At the end of 6 months, a full backup of each data system is conducted. This monthly backup tape is then placed in permanent storage. The permanent historical backup tapes are stored in an off-site data storage facility. Data is not removed from the server until the server achieves 85% capacity. In addition, before removing data off the server another compressed copy is stored on to another server where this server is duplicated off-site. A more comprehensive description of the laboratory's electronic data archiving system can be found in SOP #55.

6.4.1.7 Remote access to computer systems: With special permissions, employees are able to remotely connect to the laboratory computer network through a VPN system. When logging in, users are authenticated with their Windows account and password.

6.4.2 System and software verification: Before each new computer system or significant modification of an existing system is implemented in the laboratory, the following requirements must be met:

- Required documents – Describe the required system functionality and specification (e.g., Software Development Change Control, Change Control Log, IT Logic New Rule or Rule Update)
- Design documents – System overview, screen design, report layout, data description, system configuration, file structure, and module design
- Testing documentation for system development/verification – structural testing of the internal mechanisms and user testing of the installation and system qualification.

7. PURCHASING EQUIPMENT AND SUPPLIES

7.1 Procurement

The primary materials procured by the laboratory are analytical instrumentation and software, media and reagents including standards, carrier gases and cryogens, miscellaneous laboratory supplies, computer hardware and software, and service contracts.

Control of the purchase of these items and services is maintained using a standard purchase order system described in SOP #105 and briefly outlined below:

- Purchase requests must be approved by a director or manager.
- A request for purchasing through the COUPA system must be completed in order to initiate purchase.
- An evaluation of the supplier is conducted to determine whether it has been deemed a qualified vendor.
- Once the requesting agent completes the order from in the COUPA system, the purchasing agent will place the order with the vendor.
- Requires that upon receipt or delivery of services the product is inspected by the requesting/purchasing agent and compared to the packing slip and/or request for services.
- The Eurofins National Service Center (NSC) purchaser matches each purchasing request with the invoice prior to payment to insure that purchased items or services were delivered as expected.

Purchasing documents are maintained by the Accounting Department, calibration certificates are maintained by the Quality Assurance Department, and Certificates of Analysis for reagents and media are maintained by laboratory personnel.

7.2 Supplier Evaluation

Suppliers and vendors are evaluated in accordance with SOP #105 to assure that the quality of the products purchased meet the quality expectations of Eurofins Air Toxics and do not interfere in the quality of testing. A laboratory database is maintained with a list of approved vendors.

8. ANALYTICAL METHODS

8.1 SCOPE OF TESTING

Soil vapor, indoor and outdoor ambient air, and other types of air-phase samples are analyzed in accordance with official published methods or validated in-house methods. Method modifications made by Eurofins Air Toxics are detailed in a summary of modifications table in the method SOP. Our capabilities extend from trace level measurements required for indoor air testing to identifying and quantifying organics in high-level sources.

The methods used by Eurofins Air Toxics are approved by a broad range of regulatory agencies.

A list of methods covered under the laboratory's NELAP accreditation can be found in the table in section 8.2.

Eurofins Air Toxics specializes in and has expertise with the following types of projects:

- Vapor Intrusion investigations
- Environmental assessments
- Remediation system monitoring (soil vapor extraction)
- Soil vapor
- Ambient air monitoring
- Indoor air quality (IAQ)
- EPA 325-Fenceline Monitoring

Appendix E contains summaries for each commonly performed analytical procedure in the laboratory. Each summary contains the following information:

- A brief method description
- Laboratory variances to method compendium or other regulatory reference methodologies
- Tables containing analyte lists, Reporting Limits (RLs)/Limits of Quantitation (LOQs), and quality control (QC) acceptance criteria
- A table of calibration and QC procedures

This Quality Assurance Manual references methods in a general manner; specific procedures used by the laboratory can be found in the method-specific SOPs.

8.2 Analytical Test Methods

Eurofins Air Toxics' NELAP accredited analytical methods, parameters, instrumentation, sampling media, holding times, and SOP numbers are summarized in the table below:

Method	Parameter	Type	Sampling Container	Holding Time in days	Eurofins Air Toxics SOP #
TO-14A/TO-3	TPH	GC/FID	Summa Canister Tedlar Bag	30 3	43
TO-12	Non-methane Organic Carbon (NMOC)	GC/FID	Summa Canister Tedlar Bag	30 3	36
TO-13A	PAHs/ Semi-volatiles	GC/MS	XAD/PUF	7	10/74
TO-14A/TO-15	VOCs	GC/MS	Summa Canister Tedlar Bag	30 3	6/38/83/91/ 132/134
TO-17	VOCs	GC/MS	Sorbent Tube	30	109/ 112
ASTM D-1946	Fixed Gases, CH_4, C_2+	GC/TCD/FID	Summa Canister Tedlar Bag	30 3	08
ASTM D-1945	Fixed & Natural Gases	GC/TCD/FID	Summa Canister Tedlar Bag	30 3	54
PM10/TSP	Particulate Matter	Mass	Quartz Filter	14	66
EPA 325B	BTEX + Styrene	GC/MS	Sorbent Tube	30	131
TO-17 – Passive Samplers WMS and Radiello 130	VOCs	GC/MS	Sorbent Tube	30	100
TO-15 HSS	VOCs	GC/MS	Summa Canister	30	133

Method	Parameter	Type	Sampling Container	Holding Time in days	Eurofins Air Toxics SOP #
Ethylene Oxide by TO-15 SIM	VOCs	GC/MS	Summa Canister	30	134

8.3 Method Validation

As part of the initial test method evaluation for new standard methods, analytical runs must be performed the same way an analyst would perform an initial Demonstration of Capability (DOC) to evaluate precision and bias along with a Method Detection Limit (MDL) study as applicable.

Non-standard methods, including laboratory-developed methods, standard methods outside their intended scope or application, and requested changes to existing instrumentation will follow a planned process explained in detail in SOP #107 and outlined below:

- Measurement Quality Objectives (MQOs) – should be clearly outlined prior to validation.
- Development of Test Plan – Technical Director and assigned personnel are responsible for the development of such plan.
- Validation – Implementation of the test plan with documentation of all results will be reviewed by the Technical Director.
- Review and Approval – Review of performance against the MQOs, supporting documents, and written procedures is performed by the Technical Director. After approval, the QA Manager reviews for completeness and finalizes the method for production.

8.4 Procedural Deviations

Eurofins Air Toxics communicates and addresses procedural deviations in the following ways:

- Modifications to standard methods made by Eurofins Air Toxics are detailed in a summary of modifications table in the analytical method SOP. The modification table is also included in the laboratory narrative of the final data report.
- Differences between a project request and laboratory standard protocol are documented in a variance table created by the Project Managers, Quality

Assurance Manager or Technical Director for submission with the proposal to the client. Agreement is documented by the client's initials and date in the approval column or with written documentation from the client that all variances have been approved.

- If a sample received did not meet the established criteria for quality testing, the Sample Receiving Department will issue a Sample Discrepancy Report (SDR), and the Project Manager will communicate the discrepancy to the client. If the client still wants the sample to be processed, the discrepancy will be narrated in the final report.
- Other analytical procedural deviations that are within allowable variations established for every method and listed in the method SOPs are discussed with the client, and if accepted the sample results will be reported with a narrative of the deviation and the affected result will be flagged accordingly.
- Analytical procedural deviations that are not within allowable variations and directly affect the sample result will require the initiation of a Corrective Action Report request.

The Corrective Action Program is explained in detail in section 12 of this Quality Manual.

9. INTERNAL QUALITY CONTROL CHECKS

9.1 LABORATORY QUALITY CONTROL SAMPLES AND ACCEPTANCE CRITERIA

9.1.1 Blanks: for the whole air methods for which no sample preparation step is required, a blank is a designated sample designed to monitor for contamination originating from the analytical system. The Laboratory Blank is comprised of clean, humidified air or nitrogen. A Laboratory Blank is analyzed after any applicable standards and prior to the analysis of project samples. A blank is also analyzed in the event saturation-level concentrations are incurred to demonstrate that contamination does not exist. The blank and the field samples are treated with the same internal standards and surrogate standards and carried through the entire analytical procedure. For methods requiring a sample preparation step (e.g., TO-13A), a Laboratory Blank is prepared using un-sampled media and extracted alongside the batch of field samples. Ideally, blanks demonstrate that no artifacts were introduced during the preparation and/or analysis process. The specific acceptance criterion for each test is given in the analytical method and is usually based on the required Reporting Limit (RL).

9.1.2 Surrogates: Surrogates are organic compounds that are chemically similar to the analytes of interest but are not naturally occurring in environmental samples. For GC-MS methods and some GC methods, the recovery of the surrogate standard is used to monitor for unusual matrix effects and gross sample processing errors, and to provide a measure of recovery for every sample matrix. When required by the analytical method, surrogates are spiked into all the field and QC samples to monitor analytical efficiency by measuring recovery on an individual sample basis. The percent recovery is determined and compared to the acceptance criteria. Acceptance criteria limits are set as required by the method or based on a statistical determination from laboratory data.

9.1.3 Matrix Spikes: Matrix spikes are not required QC for whole air samples collected in Summa canisters. Accurately spiking target compounds into an evacuated canister prior to deployment in the field for sample collection or post-sample collection is neither practical nor technically appropriate. Therefore, matrix spiking is performed only on samples submitted as part of a sampling train, such as condensates, or on extractable samples, provided they are submitted in duplicate for matrix spike and in triplicate for the matrix spike duplicate. It is the responsibility of the client to provide additional samples to fulfill any method requirements regarding matrix spikes. When applicable, matrix and matrix duplicate spiking is performed using a subset of target analytes. Recoveries and demonstrated reproducibility values that do not meet the acceptance criteria are flagged and explained in the laboratory narrative.

9.1.4 Laboratory Control Samples: Laboratory control samples (LCS) are samples of known composition that are analyzed with each batch of samples to demonstrate laboratory accuracy. The LCS is prepared by fortifying clean matrix with known target concentrations. In the case of non-extracted batches, the LCS is generally analyzed daily prior to sample analysis, but could also serve as an end check standard. Percent recovery is calculated and compared to acceptance criteria, which are set as required by the method or based on a statistical determination from laboratory data.

9.1.5 Sample Duplicates and Laboratory Control Sample Duplicates: A duplicate is a second aliquot of a sample that is treated identically to the original to determine precision of the test. To compare the values for each compound, the relative percent difference (RPD) is calculated by dividing the difference between the numbers by their average. Precision for analytes that are not typically found in environmental samples is

determined by analyzing a pair of Laboratory Control Samples (LCS), and comparing the RPD for the spiked compounds. The acceptance criteria are described as a maximum for the RPD value as required by the method or based on a statistical determination from laboratory data.

9.1.6 Internal Standards: Internal standards (IS) are organic compounds that are chemically similar to the analytes of interest but are not naturally occurring in environmental samples. For extractable methods and when required by the method, IS are added to every field and QC sample typically after extractions but prior to analysis. For all GC-MS methods an IS blend is introduced into each standard and blank to monitor the stability of the analytical system. Comparison of the peak area of the IS is used for quantitation of target analytes. The IS peak area and retention time also provide a check for changes in the instrument response and chromatographic performance. The acceptance criteria are stipulated in the analytical method.

9.1.7 Second Source Check: A second source check is analyzed using either the Laboratory Control Sample (LCS) and/or an Initial Calibration Verification (ICV). The second source is a standard that is made from a solution or neat compound purchased from a different vendor than that used for the calibration standards. For some organic custom mixes, the same vendor but a different lot and preparation is used. This ensures that potential problems with a vendor supply would be evident in the analysis. Some areas of the laboratory use continuing calibration verification standards as a second source from the initial calibration.

9.2 Quality Control Sample Frequency and Corrective Action

Each analytical method defines the frequency for required quality control (QC) samples. A summary is provided in Appendix E. The corrective action required when a QC result fails to meet acceptance criteria is also given. If the method reference requires the use of specific limits, the laboratory uses the published limits that are documented as part of the analytical method. Many methods require that each laboratory determine their own acceptance criteria based on statistics from performance of the method. In these cases, the limits are available to the analyst and are entered into the laboratory computerized QC system described in SOP #48. Statistically determined acceptance criteria are frequently subject to change as the laboratory recalculates its control limits. Due to their dynamic nature, acceptance criteria are not included in this manual.

9.3 Quality Control Charts

Quality control (QC) results entered into the computer are used to generate control charts that are plotted via computer and can be accessed at any time by all analysts and by the Quality Assurance Department. The system charts results from surrogates and laboratory control samples. These charts provide a graphical method for monitoring precision and bias over time. The computerized quality control system is used to report QC data to clients and to collect data for assessment of precision and accuracy statistical limits.

9.4 Measurement Uncertainty

As stated in ISO/IEC 17025:2017, "All contributions that are of significance, including those arising from sampling shall be taken into account using appropriate methods of analysis" (7.6.1).

This means the laboratory must determine the uncertainty contribution of all steps in the testing process such as equipment, calibration, standards, reagents, preparation, etc. Since, in most methods, the laboratory control sample (LCS) goes through the entire process of preparation to analysis, all factors that would contribute to uncertainty is evident through the LCS results. As such, LCSs are performed with every batch of samples where appropriate for the method.

Measurement uncertainty is calculated as two times the standard deviation of the LCS recoveries for the group and date range of data points selected for all applicable methods. This is reported as a percentage. At this point, it is not necessary to apply or report the uncertainty determination with sample results. When a client requests the measurement uncertainty it is applied by multiplying the determined analyte concentration by the uncertainty percentage.

10. ASSURING QUALITY OF TEST RESULTS

10.1 Data Management

At a minimum, data management is initiated when Eurofins Air Toxics receives samples from the client. More often, the process begins with client communication of their needs and requirements for a specific project and/or testing. The Project Managers are responsible for entering this information into the client services modules of LIMS. Upon receipt of the samples, a unique tracking number is generated based on this information in the project profile. At this point, computer technology becomes an integral part of tracking the samples through laboratory operations.

10.2 Data documentation

Analytical data generated in the laboratory is collected through the associated data system or is manually documented in bound logbooks. Analysts review data as it is generated to determine that the instruments and systems are performing within specifications. If any problems are observed during an analytical run or the testing process, corrective action is taken and documented.

Procedures are in place to ensure that all data is traceable, authentic, and complete. The following general requirements outline the Eurofins Air Toxics' system for logbooks, notebooks, and documentation recording:

- Observations, data, and calculations are recorded at the time they are made and are identifiable to the specific task.
- Entries are legible, signed, and dated.
- Errors are corrected in a manner that does not obliterate the original entry, initialed, and dated.
- Blank pages or substantial portions of pages which are left blank are crossed out to eliminate the possibility of data entry at a later date.
- Logbook pages and instrument printouts are signed and dated to indicate completion.
- At periodic intervals the Quality Assurance Department checks equipment/instrument logbook entries and temperature recordings for completeness, legibility, and conformance to procedures.
- At a minimum, the following is recorded as part of data documentation:
    - Date of analysis/operation
    - Initials/date of analyst performing test/operation
    - Identification of client sample(s) and material(s) analyzed
    - Materials, reagents, and standards used to perform the test/operation
    - Method used to perform test/operation
    - Equipment/instrumentation used to perform test/operation
    - Deviations, planned or unplanned, from the analytical method
    - Signature/date of person reviewing data documentation
- For computer-generated data, the following information is recorded:
    - Samples(s) analyzed/operations performed
    - Date of analysis/operation
    - Unique instrument identification

- Name or initial/date of person operating the instrument
- Name or initial/date of person reviewing data
- Any manual notation, interpretations, or integrations made on instrument printouts are signed, dated, and reviewed.

10.3 Data Calculations

Most instruments either include or are connected to a data system programmed to perform calculations needed to reduce the raw data to a reportable form. All calculations are maintained in the method SOPs and/or work instructions.

In many cases, data from the local instrument system are uploaded directly to LIMS for review and reporting. This direct upload eliminates the need to re-type data and any associated source of transcription errors from the analytical scheme. In those cases, where the raw data from analytical measurements need to be manually entered into the LIMS, the data is transcribed from the logbook or controlled form directly into the LIMS report. Review of the manually entered results is completed if the analyst has not completed training in data review.

Some instruments report data that require application of additional factors before the data is in final form. Analysts input these additional factors into the laboratory sample management system, where final calculations are performed.

10.4 Reporting Limits

It is important to ascertain the Limit of Quantitation (LOQ) that can be achieved by a given method, particularly when the method is commonly used to determine trace levels of analyte. The USEPA has established one method for determining Method Detection Limits (MDLs) from which LOQs can be extrapolated, which is summarized in the laboratory procedures.

MDLs are verified or determined annually on each instrument and are the basis for the LOQ used in the default reporting format. Because MDLs change each time they are re-evaluated, they are not included in this manual but are available at the laboratory and available to clients upon request.

Methods and compounds that are included on the U.S. Department of Defense (DoD) scope of accreditation require quarterly analysis and evaluation of the LOQ and determination of Limit of Detection (LOD). The LOQ evaluation entails the calculation of precision and accuracy at the LOQ or Reporting Limit. The LOD for each compound is determined by analyzing a calibration standard or set of standards between the MDL and LOQ. The LOD is assigned the concentration at which the peak meets the signal-to-noise criteria.

The Reporting Limit used to determine whether a result is significant and reported as detectable is dependent upon agency and client requirements. A variety of formats are available and include use of the MDL, LOD, LOQ, method-specified limits, and project-specific limits.

10.5 Data Review

Final review and verification of the data is performed by a trained analyst or scientist using the sample results and quality control information entered into the laboratory sample management system. Another tool used for data review involves the use of proprietary in-house data validation software to review every data point generated and to alert the reviewer when manual integrations occur. The software is also programmed to report each analyte that does not meet acceptance criteria in the quality control and/or sample(s).

After determining that all necessary requirements for valid data are met, the reviewer electronically approves the data by updating the "Report Approved By" status with their initials. This action applies the electronic signature of the Technical Director. The computer is programmed with a list of approved reviewers for each test, and the system is password-protected to ensure that only qualified individuals verify the data.

10.6 Data Qualification

Data qualifiers are used to provide additional information about the results reported. The most typical use for data qualifiers is for results that fall below the quantitation limit. The data systems used to generate and report results are programmed to flag values in this range as estimated.

Other qualifiers are applied to advise data users of any validation issues associated with the data. The laboratory makes every effort to meet all of the requirements for generation of data. Occasionally, data is generated that does not meet all the method requirements due to sample matrix or other analytical problems. If the test cannot be repeated, or re-analysis would not yield more useable data, qualified data is reported. Qualifiers can be in the form of comments on the analytical report or flags applied to the results.

10.7 Data Reporting

When each analysis is completed, reviewed, and verified, a report is generated. The client receives a copy of the report containing the results of the analysis, plus comments added by the analyst when necessary. The report contains the

electronic signature of the Technical Director. Copies of the reports and associated supporting raw data are retained in the Eurofins Air Toxics' archives.

Eurofins Air Toxics offers a variety of data levels and formats, from a basic report of sample and QC results only (Level II) to a comprehensive data package including all supporting quality control information and raw sample data (Level IV). The client directs the selection of report type. Various electronic formats are also available, formatted to client-specific file structure and sent via e-mail, direct upload, Website access, or commercial courier.

Client confidentiality of Eurofins Air Toxics' Web data is ensured by the use of a secured firewall Internet environment coupled with the use of a user ID and password to gain log-in access to the system.

If amendments to a final report are required due to omissions, errors, or additional requests, a workorder reissue is initiated. All reissues receive a unique workorder number to distinguish them from the original issue. Reissued reports require a reason for the reissue and date of the reissue in the laboratory narrative. The laboratory maintains all supporting documentation for the revision including corrections, additions, or deletions relative to the original report.

10.7.1 Reporting the Results

Analytical reports are printed with a cover page that summarizes all samples in that group. This page lists the Eurofins Air Toxics' assigned sample number and the corresponding client description. The cover page identifies the laboratory contact person's name and the laboratory's phone number in case there is a question about the report. Within this package, each page is uniquely identified and paginated. Analytical test results which meet all the requirements of NELAP and ISO/IEC 17025:2017 are noted as so in the footer of the summary cover page.

10.8 Data Storage, Security, and Archival

Eurofins Air Toxics has documented procedures and instructions for the identification, collection, access, filing, storage, maintenance, and disposal of data records. Records are in the form of hard-copy paper records, electronic data files, and magnetic tape.

Eurofins Air Toxics maintains records to demonstrate conformance to specified requirements and the effective operation of its quality systems. Records are stored and maintained in such a way that they are readily retrievable in facilities that provide a suitable environment to minimize deterioration or damage and

prevent loss. Retention time for the records is in accordance with NELAP's minimum five-year requirement and/or specific procedures or instructions. Prior to the destruction of data/records, and if requested by a client or agency, the laboratory will notify the client/agency that their data is scheduled for destruction so arrangements can be made to have the original data sent to the client.

If specified in client contract(s), archived records are transferred according to their instructions in the event of a change in laboratory ownership or if the laboratory goes out of business. If not specified by the client, the sale agreement must require that archived records be maintained as scheduled by the new owners. In the case of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed.

The laboratory maintains all documentation necessary for historical reconstruction of data, as follows:

- Analysis reports
- Data logbooks
- Instrument printouts
- Correspondence and client files
- Instrument and equipment logbooks
- Quality Assurance records
- Corporate documents
- Electronic records

11. AUDITS AND INSPECTIONS

11.1 Internal Quality Assurance Audits

Internal audits are performed by trained Quality Assurance personnel following a schedule planned yearly by the Quality Assurance Manager or at any time by the request of management. The audits cover all quality systems including but not limited to documentation practices, training, and adherence to current SOPs and methodology.

The following areas are identified to be audited by Quality Assurance:

a. Operations
b. Support Services

c. Sample Receiving and Login
d. Project Management and Sales
e. Information Technology (IT)
f. Quality Assurance

A written report with findings, observations, and/or recommendations is presented to the audited personnel, the Supervisors, and management by the auditor. Responses to findings and observations are then submitted to the Quality Assurance Department within 30 days.

All audit notes, documentation, and reports are either scanned and filed on the QA network drive or maintained as a hard-copy and filed in the QA department.

11.2 Management Review System

A review of the laboratory's systems is performed by senior management on an annual basis to evaluate effectiveness, identify areas requiring improvement, and establish timelines and accountability in addressing agreed-upon action items. This review includes internal assessment of the quality program and laboratory operations and external assessment through client feedback and audits. The management report (Form #F2.28) is generated by management or designated personnel and includes the following:

11.2.1 **Quality Assurance Status:** Summarizes the results of internal and external assessments, the numbers and types of Corrective Action Reports (CARs) generated, status of any outstanding CARs, a summary of client inquiries received, proficiency tests (PT) results, and training.

11.2.2 **Production Status:** Summarizes performance against key metrics such as turnaround time, details changes in sample mix and sample numbers, the number and types of reissued sample reports, outlines resource needs, and equipment performance.

11.2.3 **Client Assessment:** Summarizes feedback from clients based on daily communication with project management and sales team as well as feedback collected by a third party as part of our Client Satisfaction Index (CSI) determination.

The report and record of the meeting is stored on a secure drive with management-only access for a minimum of five years.

11.3 Client Audits and Agency Inspections

Clients may audit our facility as assurance that their objectives are being met and that the laboratory is compliant with all applicable regulations, data quality, and project requirements.

Client audits can range from a laboratory tour to an intensive inspection of technical operations, procedures, regulatory compliance, and/or review of specific projects. Clients can only review data that pertains to their projects, and a non-disclosure agreement must be signed as per SOP #99.

Inspections can be performed by investigators or auditors from the USEPA, DoD, state and other regulatory agencies, third party accreditors (ANAB), or regulatory agencies outside of the U.S.

The Quality Assurance Department is assigned the responsibility of hosting and working with agency and client representatives.

The Quality Assurance role includes:

- Escorting the investigator(s)
- Ensuring all questions are answered promptly and accurately
- Making note of all unresolved issues
- Informing management of the audit status and outcome
- Responding to the audit report
- Ensuring that appropriate corrective action is completed

11.4 Proficiency Testing Program

11.4.1 Proficiency Testing Samples (TNI/DoD)

Proficiency testing (PT) samples are used to measure analytical accuracy, precision, and report completeness. To be accredited under NELAP and DoD-ELAP, the laboratory contracts with an outside approved PT sample provider in each field of testing (FOT). Testing is limited by availability of samples that meet NELAP and DoD-ELAP criteria (noted below). The provider must be a TNI and DoD approved PT provider. It may be necessary to participate in more than one proficiency testing program to be evaluated for multiple interdependent analyte groups. Currently, Eurofins Air Toxics participates in PT programs for EPA Method TO-15, which is ISO/IEC 17025:2017 compliant, TO-15 SIM,

TO-13A, TO-14A, TO-17 and 325B. In each calendar year, the laboratory will complete a minimum of two PT samples for each analyte or interdependent analyte group.

The following policies apply to laboratory PT sample analysis and reporting:

- The samples shall be analyzed and reported to the PT provider within the specific deadline specified by the PT provider.
- The PT sample is received and logged into an electronic sample receiving database in the same fashion as field samples.
- The laboratory must follow the PT provider's instructions for preparing the PT sample.
- The laboratory management and bench chemist ensure that the PT samples are prepared, analyzed, and reported in the same fashion as field samples using the same staff, equipment, and methods.
- Initial and continuing calibrations for the PT sample are analyzed at the same frequency of field samples.
- The PT sample cannot undergo duplicate or replicate analyses that would not ordinarily be performed on field samples. The PT sample result cannot be derived from averaging the results of multiple analyses unless specifically called for in the reference method.
- The PT sample can only be analyzed on equipment leased or owned by the company and handled only by bona fide employees of the company.
- The analysis of PT samples by temporary or contract employees is explicitly forbidden.
- The laboratory shall not subcontract any PT sample or portion.
- The laboratory shall not knowingly receive any PT sample or portion from another laboratory.
- The laboratory shall not communicate in any fashion with another laboratory concerning the PT sample or results.
- The laboratory shall not attempt to obtain the PT sample result prior to reporting.
- The PT sample reporting forms provided by the sample provider will be used to report the results and will be maintained in the laboratory's record system.
- The laboratory shall maintain copies of all written, printed, and electronic records relating the analysis or reporting of the PT sample for a period of five years or as required by the applicable regulatory program.

- A CAR will be generated any time an analyte result fails the PT assessment. A copy of the PT results will be sent to the accrediting agency, and associated corrective action summary will be sent upon request.
- The laboratory authorizes provider to release any PT assessment information to the accrediting agency.
- The QA Manager must document review of the PT results using form F1.62 and, by so doing, attests that the sample was analyzed and reported in the same fashion as a field sample and followed the PT provider instructions for preparation.
- The laboratory must notify its primary accrediting agency and any other agencies under reciprocity that it has enrolled with a particular PT provider.
- The laboratory must notify its primary accrediting agency and any other agencies under reciprocity in the event it wishes to change PT providers.
- For each analyte or interdependent analyte group for which proficiency is not available, the certified laboratory will establish, maintain, and document the accuracy and reliability of its procedures through a system of internal quality management.
- Results of any failed PT samples are summarized in the Yearly Management Review report.

11.4.2 Proficiency Testing Samples (Non-NELAP/DoD)

Occasionally proficiency testing (PT) samples are submitted along with field samples by private clients. The laboratory processes and reports the samples in the same fashion as field samples. When the client notifies the laboratory that one or more analytes appear to have failed, the report is processed through the normal Client Inquiry Corrective Action Process. The QA Manager will carry out an assessment and investigation into the circumstances surrounding the proficiency results, including aspects relating to how the client prepared the sample for submission. The outcome of the assessment will be documented as a CAR and maintained on file for a period of five years. Results of any failed external PT samples are summarized in the Yearly Management Review report.

12. CORRECTIVE AND PREVENTIVE ACTION

12.1 Laboratory Investigations and Corrective Action

The Quality Assurance (QA) Department manages the Corrective Action Program and maintains the Corrective Action tracking database using an internal tracking system. A Corrective Action Report is initiated any time sample results are affected by non-conformance with established SOPs or program requirements, any time an external assessment results in a finding, any time there is a failed proficiency evaluation sample, and when a client inquiry results in a quality finding. The expectation is that any CAR should be resolved within 30 days.

The client is notified if there is an issue that could potentially affect the quality of sample results. The communication with the clients is recorded in the laboratory LIMS.

The internal system tracks all parts of the CAR system: root cause investigation, immediate corrective action, long-term corrective action, and preventive action. It also tracks client communications regarding the incident. The QA Manager reviews all opened CARs for completeness and resolution.

Detailed information about the CAR process is described in SOP #61.

12.2 Client Feedback

The laboratory strives to provide high quality analytical testing services. The data we provide to our clients must be technically complete, accurate, and compliant with applicable requirements and regulations. Complaints may be received via letter, phone, e-mail, or during a face-to-face meeting.

When a complaint is received, it is our responsibility to determine, to the best of our ability, the extent of the issue and what data is in question. The person receiving the complaint, typically a project manager documents this information into the LIMS, initiates a Client Complaint report using an internal tracking system, and promptly forwards it to the appropriate management personnel where the work in question was performed. If a data reporting error is discovered, the final report must be reissued with the correct value(s). In some cases, a CAR is initiated to address and document the situation.

On an annual basis, a client satisfaction survey is sent to all clients. The results of these surveys are compiled, routed to the laboratory President, and laboratory Director, and used to identify areas of improvement for the laboratory.

13. SERVICE TO CLIENTS

The Project Management System is defined in SOP #1. The following are brief descriptions of the elements comprising project management systems.

13.1 Review of Work Requests, Tenders, and Contracts

Eurofins Air Toxics places great importance on understanding client requirements for a project. The laboratory ensures, to the best of our ability, that client and project requirements are outlined and understood prior to acceptance of the project, including required laboratory accreditations and nonstandard work requests. All inconsistencies are discussed and addressed with both the client and the technical laboratory staff before the project is initiated and samples arrive. This is achieved in various ways, including the review of client work plans, Request for Proposals (RFPs) project Quality Assurance Project Plans (QAPPs), requested analytical methods and protocols, business contracts, and quality agreements. A key client contact is assigned to oversee each project. Communication between the client and Eurofins Air Toxics technical staff is coordinated through the Project Managers. The Project Management group relays any project changes or modifications to the Laboratory Director and designated technical staff. They also relay issues encountered by the laboratory back to the client.

13.2 Timely Delivery

Evaluating laboratory capacity, assignment of resources, and ability to perform specific projects is a joint responsibility between the Technical Director and the Laboratory Director. Eurofins Air Toxics recognizes that one of the most important aspects of the services offered is turnaround time.

To ensure timely delivery, many analysts are cross-trained to perform a variety of tests, and there is redundant equipment available in the laboratory creating operation flexibility for routine work. Larger projects are reviewed against capacity estimates before a bid is submitted in order to meet a client's schedule.

Management regularly monitors the status of turnaround time including those projects that have exceeded a current turnaround time. Proactive communication regarding potentially missed deadlines is expected from the laboratory management to the Project Managers to keep the client informed of report delivery status.

Any changes to the established timeline by the client or the laboratory must be communicated to the client or laboratory as soon as possible. Upon

communication of changes, a new timeline is established and agreed upon by both parties.

13.3 Subcontracting

Occasionally, Eurofins Air Toxics subcontracts analyses to other laboratories if the requested testing is not routinely performed in our laboratory. Testing is only subcontracted with the client's knowledge and approval. Subcontract laboratories are selected based on their qualifications. If tests require a specific agency certification, only an appropriately accredited laboratory will be used. Additional details are available in SOP #90.

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LABORATORY QUALITY ASSURANCE MANUAL

(LQAM)

Appendix A

Terms and Definitions

(Seven total pages including this cover)

Current as of January 10, 2022

TERMS AND DEFINITIONS

Accuracy: The degree of agreement between an observed value and an accepted reference value.

Active sampling: The process of collecting a sample using pump or vacuum source to pull a known volume of vapor through a sorbent cartridge, or filter.

Ambient air: Outdoor air (also can include indoor air).

Analyte: The substance or component for which a sample is analyzed to determine its presence or quantity.

APH (air-phase hydrocarbons): Aliphatic and aromatic fractions identified in vapor-phase samples.

Approved: The determination by a state or federal accrediting agency that a certified laboratory may analyze for an analyte under the specified method.

Assessment: The process of inspecting, testing, and documenting findings for purposes of certification or to determine compliance.

ASTM International (formerly known as American Society for Testing and Materials)**:** Organization which develops international voluntary consensus-based standards.

Bag: An air-sampling container consisting of inert polymeric material.

Batch: A group of analytical samples (≤ 20) of the same matrix processed together, including extraction, concentration, and analysis using the same process, staff, and reagents.

BFB (4-Bromofluorobenzene): Compound used to verify that the mass spectrometer meets the tuning requirements of the method. Also can be used as an internal standard or surrogate.

Blank samples: Negative control samples used to assess potential contamination from sampling procedures or analytical processes. They can be field blanks or laboratory blanks.

BTEX: Benzene, toluene, ethylbenzene, and xylenes.

Canister: A stainless steel spherical air-sampling device consisting of Summa polished or glass-lined internal walls and a leak-tight on/off valve.

Certificate of Analysis (C of A): An authenticated document, issued by an appropriate authority, that assures a regulated product has met its product specification and quality.

Chain of Custody (COC): The chronological documentation of the custody of an environmental sample from the time it is taken until it is disposed.

Contamination: The effect caused by the introduction of a target analyte from an outside source into the test system.

Continuing Calibration Verification (CCV): A component of Quality Control used to verify instrument linearity with respect to the Initial Calibration (ICAL). A CCV is analyzed at the beginning of every analytical sequence and then periodically depending on the method. Certain methods also include a CCV in every analytical sequence as an End Check.

Control charts: Statistical tools for monitoring the performance of a particular task on a continuing basis. The control chart is prepared for each test parameter after 20 determinations have been performed. The mean is plotted with the warning limits being ±2s and the control limits being ±3s (s = Standard deviation).

Corrective action: An action taken to eliminate the cause(s) of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence.

Corrective Action Report: See NCCAR.

Data reduction: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality.

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results by a specific method and meet measurement quality objectives.

Detection Limit (DL): The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99% confidence.

%Difference (%D): A measure of precision between the expected value and the actual value, typically used to measure performance of the daily CCV RRF as compared to the Initial Calibration average RRF.

U.S. DoD: U.S. Department of Defense.

Duplicate sample: A sample collected for checking the preciseness of the sampling process. Duplicate samples are collected at the same time and from the same source as the study samples.

Equipment Blank: A sample that is known not to contain the target analyte, used to check the cleanliness of sampling devices. It is collected in a sampling container from a clean sample collection device and returned to the laboratory as a sample.

Field Blank: A sample that is known not to contain the target analyte, used to check for analytical artifacts or contamination introduced by sampling and analytical procedures. It is taken to the sampling site and exposed to sampling conditions, then returned to the laboratory and treated as an environmental sample.

Field Duplicate: A sample collected at the same time from the same source but submitted and analyzed as a separate sample.

GC (gas chromatograph): Analytical instrumentation used to resolve complex mixtures into individual peaks for identification and quantitation. Separation is achieved as chemicals are retained at varying rates by the column phase.

HSS: Analytical instrumentation configuration referred to as TO-15 High/Sensitivity/ Selectivity.

Holding time: The maximum time that a sample may be held prior to preparation or analysis.

Initial Calibration (ICAL): Demonstration of a linear response to different concentrations of calibration standards within a defined range.

Initial Calibration Verification (ICV): Verifies the Initial Calibration using a different source standard from the one used for Initial Calibration.

Initial Demonstration of Analytical Capability: The procedure described in USEPA 40 CFR 136 Appendix A, used to determine a laboratory's accuracy and precision in applying an analytical method.

Instrument Blank: A sample that is known not to contain the target analyte, processed through the instrumental steps of the measurement process and used to determine the absence of instrument contamination prior to analysis of field samples.

Instrument Detection Limit (IDL): The concentration of the analyte that produces a signal greater than five times the signal-to-noise ratio of the instrument.

Interference: The effect on the final result caused by the sample matrix.

Internal Standard (IS): A measured amount of a certain compound added after preparation or extraction of a sample.

Key Personnel: The laboratory director, technical director, quality assurance manager, and supervisor (group leader), all of whom meet the requirements of the NELAP rule.

Laboratory Control Sample (LCS): An independent second source reference standard that goes through the same pretreatment and preparation procedures as the samples. It validates the accuracy of the Initial Calibration.

Laboratory Duplicate: An aliquot of the same sample that is prepared and analyzed at the same time.

Laboratory Information Management System (LIMS): A laboratory's electronic data system that collects, analyzes, stores, and archives records and documents.

Limit of Detection (LOD): The smallest concentration of a substance that must be present in a sample in order to be detected at the DL with 99% confidence.

Limit of Quantitation (LOQ): The smallest concentration that produces a quantitative result with known and recorded precision and bias.

Matrix: The component or substrate (e.g., surface water, drinking water, air, liquid waste) which contains the analyte(s) of interest.

Matrix Spike (MS): A sample prepared to determine the effect of the matrix on a method's recovery efficiency by adding a known amount of the target analyte to a specified amount of matrix sample for which an independent estimate of the target analyte concentration is available. It is used to evaluate accuracy.

Matrix Spike Duplicate (MSD): Duplicate of the matrix spike sample. Results are compared with MS to determine precision.

Mass spectrometer (MS): Analytical instrumentation used to identify and quantify chemicals utilizing spectral fragmentation patterns based on chemical structures.

Measurement uncertainty: Measurement uncertainty is the estimation of potential errors in a measurement process and is expressed as $\pm$ 2X(*s*) of the historical mean of LCS recoveries.

Method Detection Limit (MDL): The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero as determined from analysis of a sample containing the analyte in a given matrix (40 CFR Part 136, Appendix B, July 1995).

NCCAR (Non-conformance/Corrective Action Report): A report that identifies, communicates, tracks, and resolves a non-conformance.

NIST: National Institute of Standards and Technology.

NMOC: Non-methane organic compounds.

OSHA: Occupational Safety and Health Administration.

PAHs (polycyclic aromatic hydrocarbons): Hydrocarbons made up of fused aromatic ring molecules.

Passive sampling: Sample collection conducted without the use of mechanical pumps or vacuums. Collection relies on principle of diffusion.

ppbv: parts per billion by volume.

ppmv: parts per million by volume.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance or a range, in either absolute or relative terms.

Preservation: The temperature control or the addition of a substance to maintain the chemical or biological integrity of the target analyte.

Proficiency Testing (PT): 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 Test (PT) sample: A sample, the composition of which is unknown to the laboratory and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria.

Quality Assurance (QA): An integrated system of activities involving planning, quality control, reporting, and quality assessment and improvement to ensure that the product meets defined standards of quality with a stated level of confidence.

Quality Assurance Project Plan (QAPP): An orderly assemblage of detailed procedures designed to produce data of sufficient quality to meet the data quality objectives for a specific data collection activity.

Quality Control (QC): A procedure or set of procedures intended to ensure that a product or performed service adheres to a defined set of quality criteria.

%R: %Recovery.

Relative Percent Difference (RPD): A measure of precision between two measurements calculated by dividing the absolute value of the difference between the measurements by their average and expressed as a percentage.

Reporting Limit (RL): The smallest concentration of an analyte that can be measured with a stated probability of significance. All Initial Calibrations contain a standard at the Reporting Limit. The Reporting Limit is never less than the Practical Quantitation Limit (PQL).

Reporting Limit verification: A re-quantification of the lowest concentration data point of an Initial Calibration to test the percent recovery of each component. Analyte recovery should be between 50–150% to verify detection limit accuracy.

Relative Standard Deviation (RSD): A measure of precision often used to evaluate linearity of an Initial Calibration. The relative response factor is calculated at each calibration level, and the RSD is calculated by dividing the standard deviation by the average value.

RRF: Relative Response Factor.

RT: Retention Time.

Safety Data Sheet (SDS): A technical document that contains information on the chemical make-up, use, storage, handling, emergency procedures, and potential health effects related to a hazardous material (formerly Material Safety Data Sheets).

Selectivity: The capability of a method or instrument to respond to the target analyte in the presence of other substances or things.

Semivolatile compound (SVOC): An organic compound which has a boiling point higher than water and which may vaporize when exposed to temperatures above room temperature.

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels of a target analyte.

Soil vapor (also referred to as "soil gas"): Vapor-phase volatile compounds that migrate or evaporate from contaminated soil.

Soil vapor extraction (SVE): A physical treatment process for in situ remediation of volatile contaminants in vadose zone (unsaturated) soils.

Standard Operating Procedure (SOP): A written document that details the steps of an operation, analysis, or action, the techniques and procedures for which are thoroughly prescribed and accepted as the procedure for performing certain routine or repetitive tasks.

Surrogate: A substance unlikely to be found in the environment that has properties which mimic the target analyte and that is added to a sample to check for analytical efficiency.

Target analyte: The analyte that a test is designed to detect or quantify.

Technical employee: A designated individual who performs the analytical method and associated techniques.

TIC: Tentatively Identified Compound.

TNMOC: Total non-methane organic compounds.

TOF: Time-of-Flight.

TPH: Total petroleum hydrocarbons.

Trip Blank: A sample known not to contain the target analyte, which is carried to the sampling site and transported to the laboratory for analysis without having been exposed to the sampling procedures.

TVH: Total volatile hydrocarbons.

Vapor intrusion (VI): The process by which vapors originating from contaminated soil or groundwater migrate through the subsurface into nearby buildings, potentially impacting indoor air quality.

VPH: Volatile Petroleum Hydrocarbons.

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Appendix B

Procedure Cross-Reference List

(Three total pages including this cover)

Current as of January 10, 2022

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Appendix C

Certifications and Accreditations

(Two total pages including this cover)

Current as of January 10, 2022

Certifying Agency	Air Toxics Certificate #	Basis of Certification/Approval	Location of Certificate and Parameter List
Alaska DEC's CSLAP	18-006	Primary Certificate and Scope, Approval Program	Laboratory internal network: O:\QA\Certifications
Arizona DHS	AZ0775	Onsite assessment (biennial), LQAM and SOP	Laboratory internal network: O:\QA\Certifications
Florida DOH	E87680	Primary Certificate and Scope, Secondary NELAP	Laboratory internal network: O:\QA\Certifications
Louisiana DEQ	02089	LQAM, SOPs, PT, Secondary NELAP	Laboratory internal network: O:\QA\Certifications
New Hampshire DES	209221	LQAM, SOPs, PT, Secondary NELAP	Laboratory internal network: O:\QA\Certifications
New Jersey DEP	CA016	LQAM, PT, SOPs, Secondary NELAP	Laboratory internal network: O:\QA\Certifications
New York DOH	11291	LQAM, PT, Secondary NELAP	Laboratory internal network: O:\QA\Certifications
Oregon DHS (Primary NELAP)	CA300005-015	Onsite assessment (biennial) LQAM, PT and SOP Review	Laboratory internal network: O:\QA\Certifications
Texas CEQ	T104704434-21-17	LQAM, Secondary NELAP	Laboratory internal network: O:\QA\Certifications
Utah DOH	CA009332021-13	LQAM, PT, Secondary NELAP	Laboratory internal network: O:\QA\Certifications
Virginia DCLS	11626	Secondary NELAP	Laboratory internal network: O:\QA\Certifications
Washington DOE	C935	PT, Secondary NELAP	Laboratory internal network: O:\QA\Certifications
DoD-ELAP_ ISO/IEC 17025:2017	ADE-1451	DOD QSM for Environmental Laboratories v.5.3 Onsite assessment (biennial)	Laboratory internal network: O:\QA\Certifications

All latest certificates and licenses are posted by the laboratory entrance.

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Appendix D

Organizational Charts

(Two total pages including this cover)

Current as of January 10, 2022

Organization Chart

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Appendix E

Analytical Methods

(Eight-nine total pages including this cover)

Current as of January 10, 2022

ANALYTICAL METHODS

ANALYTICAL METHODS

Section 1.0

Method: EPA 325B

Eurofins Air Toxics SOP #131 Revision 17 Effective Date: December 20, 2021 Methods Manual Summary

Description: This method involves measurement of VOCs in ambient air collected passively using standard 3.5 in L x 0.25 in OD inert-coated stainless steel sorbent tubes equipped with a diffusive screen cap and analyzed by thermal desorption GC/MS. These procedures are specifically designed to comply with the EPA's refinery fenceline monitoring provisions in 40 CFR Section 63.658 which require the measurement of benzene over a 14-day period. This method also can be applied to additional VOCs outlined in Table 1 ranging from approximately 0.5 $\mu g/m^3$ to 5 mg/m^3 over sampling durations of up to 4 weeks.

VOCs in the sampling environment pass through a diffusive barrier at a controlled rate and adsorb to the sorbent bed of the passive sampler tube. The tubes are thermally desorbed by heating and purging with UHP Helium. The resulting gaseous effluent is transferred to secondary trap for re-concentration and desorption onto the GC/MS.

To calculate the concentration of the target compound, the mass measured on the sorbent tube is divided by the sampling rate and the sample collection time. The diffusive uptake rate is adjusted based on local temperature and pressure, and the final concentration is expressed at conditions of 25 degrees C and 1 atm. The list of applicable compounds and associated sampling rates are summarized in Tables 1 and 3. The compound list can be extended beyond Table 1 if sampling rates are available for a given sorbent and duration in ISO 16017-2, ASTM D6196, or in a peer-reviewed journal article, and the analytical performance meets the quality requirements outlined in the following tables.

Table 1. Method 325B Reporting Limits and QC Limits (Carbopack X)

Analytes	RL (ng)	ICAL (%RSD)	ICV (%R)	CCV/LCS (%R)	Duplicate Standards (%RPD)
Benzene	5.0	≤30	70-130	70-130	≤20
Toluene	5.0	≤30	70-130	70-130	≤20
Ethyl Benzene	5.0	≤30	70-130	70-130	≤20
m,p-Xylene	5.0	≤30	70-130	70-130	≤20
o-Xylene	5.0	≤30	70-130	70-130	≤20
Styrene	5.0	≤30	70-130	70-130	≤20
1,3-Butadiene	2.5	≤30	70-130	70-130	≤20
Hexane	5.0	≤30	70-130	70-130	≤20
Trichloroethene*	5.0	≤30	70-130	70-130	≤20

*Need to request for approval

Table 2. Internal Standards

Analyte	CCV IS %Recovery	Sample IS %Recovery
1,1-Dichlorofluoroethane	≥60	60-140
1,4-Difluorobenzene	≥60	60-140
Chlorobenzene-d5	≥60	60-140
Bromofluorobenzene*	≥60	60-140

*Bromofluorobenzene can also be utilized as an internal standard for later eluting analytes.

Table 3. Uptake Rates (UR) and Sample Reporting limits (RLs) at 14 days (Carbopack X)

Compound	UR (ml/min)*	RL (ng)	14 day RL(ug/m3)	14 day RL(ppbv)
Benzene	0.67	5.0	0.37	0.12
Toluene	0.52	5.0	0.48	0.13
Ethylbenzene	0.46	5.0	0.54	0.12
m,p-Xylene	0.46	5.0	0.54	0.12
o-Xylene	0.46	5.0	0.54	0.12
Styrene	0.50	5.0	0.50	0.12
1,3-Butadiene	0.45**	2.5	0.28	0.12
Hexane***	0.56	5.0	0.44	0.12
Trichloroethene	0.5	5.0	0.5	0.092

*From Table 12.1 EPA Method 325
** 14-day UR from Martin et al. Atmospheric Environment 39 (2005) 1069-1077
***Uptake rate from Martin et. al, 2010, average of 2% RH conditions

Table 4. Method 325B Reporting Limits and QC Limits (Carbopack B)

Analytes	RL (ng)	ICAL (%RSD)	ICV (%R)	CCV/LCS (%R)	Duplicate Standards (%RPD)
Benzene*	5.0	≤30	70-130	70-130	≤20
Toluene*	5.0	≤30	70-130	70-130	≤20
Ethyl Benzene*	5.0	≤30	70-130	70-130	≤20
m,p-Xylene*	5.0	≤30	70-130	70-130	≤20
o-Xylene*	5.0	≤30	70-130	70-130	≤20
Naphthalene	1.0	≤30	70-130	70-130	≤20

*From Table 12.1 EPA Method 325B

Table 5. Uptake Rates (UR) and Sample Reporting limits (RLs) at 14 days (Carbopack B)

Compound	UR (ml/min)	RL (ng)	14 day RL(ug/m3)	14 day RL(ppbv)
Benzene	0.63	5.0	0.394	0.123
Toluene	0.56	5.0	0.443	0.118
Ethyl Benzene	0.50	5.0	0.496	0.114
m,p-Xylene	0.47	5.0	0.528	0.122
o-Xylene	0.47	5.0	0.528	0.122
Naphthalene*	0.45	1.0	0.11	0.021

*Uptake rate from McAlary et. al., Environmental Science: Processes & Impacts, 17, 2015, 896-905

Table 6. Summary of Calibration and QC Procedures for EPA Method 325B

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
BFB Tune Check	Every 24 hours	EPA 325B Tune Criteria	Correct problem and repeat tune check. Clean source and/or retune MS if needed.
5-point Calibration	Prior to sample analysis and following any significant instrument maintenance or change. ICAL expires after 3 months.	%RSD≤30	Correct problem and repeat initial calibration curve.
Desorption Efficiency Check	After each initial calibration curve	>95% Desorption Efficiency	Evaluate Thermal desorption parameters, and adjust as needed. Recalibrate after parameter changes.
Initial Calibration Verification (ICV)	After each initial calibration curve.	70-130% recovery	Verify accuracy of standard. Re-prepare ICV or primary calibration standard if necessary. If calibration curve and/or system is identified as the problem, re-calibrate.
Initial Continuing Calibration Verification (CCV)	After the tune check at the start of each sequence. ***The RRF of the initial daily CCV is used for sample quantitation.***	70-130%.	If the beginning CCV does not meet criterion, re-prepare CCV and re-analyze. If still fails, then re-calibrate.
Ongoing Calibration Checks using Laboratory Control Sample (LCS)	Every 10 field samples after the initial daily CCV and at the end of the batch.	70-130%	If the mid-check or end check fails, re-analyze samples analyzed after the last passing check unless the recovery was high and no detections

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
			were measured. If re-analysis is not possible, then flag and narrate affected samples.
CCV-Recollection(CCV-R)	After each initial calibration curve and daily after the CCV to insure re-collection feature is working.	See criteria in SOP section 8.5.6. If these ranges are met, the 20% RPD criterion will be met.	Evaluate analytical unit and re-collection feature. Re-prepare CCV and CCV-R to verify after evaluation.
Laboratory Blank	After the beginning CCV.	Beginning lab blank < RL	Re-analyze the lab blank. If still above criterion, flag data accordingly.
Field Blanks	If 2 are submitted with a set of samples, run one at the beginning of the field samples and one at the end.	Less than 1/3 the measured sample target analyte or compliance limit.	Flag and narrate all sample results noting that the associated results are estimated with a high bias due to field blank background.
Field Duplicates	Per method, a frequency of 10%, run with field samples.	≤30%RPD	Apply relevant 'P' flag to data set and narrate discrepancy.
Internal Standard (IS)	Added to each sample and QC sample at the time of desorption.	Initial CCV: ≥60% mid-point ICAL area counts; within 20s of mid-point in ICAL. Blanks, samples and mid- and end checks: IS areas must be ± 40% of the initial CCV IS areas. RT within ±0.33 min as compared to the daily CCV.	CCV: Inspect and correct system prior to sample analysis. Blanks: inspect the system and re-analyze the blank. Samples: Re-analyze the samples. If the IS is still out, flag the associated data and narrate. If the IS recovery is recovering high in samples and on-going CCVs, evaluate recovery of target analytes in affected CCVs to determine if accuracy is impacted or if IS response increase reflects an overall increase in sensitivity.

ANALYTICAL METHODS

Section 2.0

Method: Aliphatic and Aromatic Volatile Petroleum Hydrocarbons (VPH) Fractions by GC/MS

Eurofins Air Toxics SOP #103 Revision 10.1 Effective Date: December 3,2021 Methods Manual Summary

Description: The WSDE VPH method outlines procedures to estimate the concentrations of gaseous phase Aliphatic and Aromatic ranges in ambient air and soil gas collected in stainless steel Summa canisters. The volatile Aliphatic hydrocarbons are collectively quantified within the C5 to C6 range, C6 to C8 range, C8 to C10 range, and the C10 to C12 range. Additionally, the volatile Aromatic hydrocarbons are collectively quantified within the C8 to C10 range and the C10 to C12 range. The Aromatic ranges refer to the equivalent carbon (EC) ranges.

Data is acquired using standard TO-15 GC/MS instrumentation. Procedures are largely based on the hydrocarbon ranges and calibration reference compounds defined by the Washington State Department of Ecology (WSDE) Method for the Determination of Volatile Petroleum Hydrocarbons (VPH) Fractions, dated June 1997. Additionally, the WSDE VPH calibration and quantitation procedures for the Aromatic fraction have been enhanced to more effectively isolate the compounds of interest. The Aromatic fraction measurement is based on a modification of the Massachusetts Department of Environmental Protection (MADEP) Air Phase Hydrocarbon Method (2009).

Eurofins Air Toxics performs a modified version of the WSDE VPH method. The method modifications, standard target analyte list, reporting limit (RL) or Limit of Quantitation (LOQ), QC criteria, and QC summary can be found in the following tables.

Table 1. Summary of Method Modifications for WSDE VPH

Requirement	VPH	Eurofins Air Toxics Modifications
Detector	Tandem GC/FID/PID	GC/MS
Matrix	Soil, water, and sediments	Whole air samples
C6-C8 Reference Compound	Octane	Heptane
Surrogate	2,5-Dibromotoluene	Bromochloromethane, 1,2-Dichloroethane-d4, Toluene-d8, Chlorobenzene-d5, and 4-Bromofluorobenzene
%RSD for Reference Compounds	≤ 20% RSD	≤ 30% RSD with the exception of Decane, Dodecane, 1,2,4,5-Tetramethylbenzene, and Naphthalene at ≤ 40% RSD
%D for the CCV	±20%D	±30%D with one allowed out not to exceed ±40%. Decane, Dodecane, 1,2,4,5-Tetramethylbenzene, and Naphthalene at ±40%D with one allowed out not to exceed ±50%.
Laboratory Control Spike	Matrix Spiking Solution	Independently prepared source performed

Requirement	VPH	Eurofins Air Toxics Modifications
		after initial calibration, 70–130% recovery, with the exception of Decane, Dodecane,1,2,4,5-Tetramethylbenzene, and Naphthalene at 60–140%.
CCV Frequency	Before and after every 10 samples	Daily before sample analysis.
IDOC	4 Replicates of a CCV at ±20%D; %RSD ≤ 20%	Not performed for this method; TO-15 IDOC performed on the same instrument.

Table 2. VPH Standard Target Analyte List (Note: TO-15 analytes can also be included.)

Analyte	Standard RL (ppbv)	5&20 RL (ppbv)	Acceptance Criteria		
			ICAL %RSD	ICV (%R)	CCV (%D)
Pentane	NA	NA	≤ 30%	70-130	≤ 30%
Hexane	NA	NA	≤ 30%	70-130	≤ 30%
C_5-C_6 Aliphatics Pentane + Hexane	**10**	**50**	**≤ 30%**	**70-130**	**≤ 30%**
C_6-C_8 Aliphatics ref. to Heptane	**10**	**50**	**≤ 30%**	**70-130**	**≤ 30%**
C_8-C_{10} Aliphatics ref. to Decane	**10**	**50**	**≤ 40%**	**60-140**	**≤ 40%**
C_{10}-C_{12} Aliphatics ref. to Dodecane	**10**	**50**	**≤ 40%**	**60-140**	**≤ 40%**
Ethyl benzene	2	10	≤ 30%	70-130	≤ 30%
m/p-Xylene	2	10	≤ 30%	70-130	≤ 30%
o-Xylene	2	10	≤ 30%	70-130	≤ 30%
1,2,3-Trimethylbenzene	NA	NA	≤ 30%	70-130	≤ 30%
C_8-C_{10} Aromatics	**10**	**50**	**≤ 30%**	**70-130**	**≤ 30%**
Naphthalene	2	10	≤ 40%	60-140	≤ 40%
1,2,4,5-Tetramethylbenzene	NA	NA	≤ 40%	60-140	≤ 40%
C_{10}-C_{12} Aromatics	**10**	**50**	**≤ 40%**	**60-140**	**≤ 40%**

Table 3. Internal Standard Acceptance Criterion – Aliphatic Fraction

Analyte	Recovery Limits (%R)
1,4-Difluorobenzene	50 – 200%

Table 4. Internal Standard Acceptance Criterion – Aromatic Fraction

Analyte	Recovery Limits (%R)
Chlorobenzene-d_5	60 – 140%

Table 5. Summary of WSDE VPH Calibration and QC Procedures

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Every 24 hours	Compendium of Methods for Toxic Organic Air Pollutants, Method TO-15, January 1999	Correct problem then repeat tune.
Initial Calibration (ICAL)	Prior to sample analysis	Minimum of 5 levels. %RSD ≤ 30% for VPH Target Analyte List with exceptions for 1,2,4,5-Tetramethylbenzene and Naphthalene, which are ≤40%	Correct problem then repeat initial calibration curve.
Initial Calibration Verification (ICV)	After each initial calibration curve	Recoveries for VPH target compounds 70–130%, or 60–140% for 1,2,4,5-Tetramethylbenzene and Naphthalene. If recovery of any compound is above 130%, analyze samples as long as compound is not detected.	Check the system and re-analyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met.
Continuing Calibration Verification (CCV)	At the start of each analytical clock after the tune check	%D ≤ 30% for VPH target compounds with the exceptions for 1,2,4,5-Tetramethylbenzene and Naphthalene which are ≤40%. One compound is allowed to be out as long as it is ≤ 50%D. If recovery of any compound is above 150% the instrument must be re-calibrated.	Perform maintenance and repeat test. If the CCV still fails, perform maintenance and a new calibration curve.
Laboratory Blank	After the CCV	Results less than the laboratory RL.	Inspect the system and re-analyze the blank.
Internal Standard (IS)	As each standard, blank, and sample is being loaded.	Retention time (RT) for the blanks and samples must be within ±0.33 min of the RT in the CCV. For the aliphatic fraction using the total ion area, the IS area must be within -50% to 200% of the CCV's IS area for the blanks and samples. For the aromatic fraction using extracted ion areas, the IS area must be within -40% to +40% of the CCV's extracted ion IS area.	**For blanks:** Inspect the system and re-analyze the blank **For samples:** If there is not obvious interference with the internal standard, re-analyze the sample. If the ISs are within limits in the re-analysis, report the second analysis. Dilution of the sample to get IS areas within limits may be used if the RL is being obtained.
Laboratory Duplicates	One per analytical batch; since VPH analysis occurs with TO-15 analysis, the Duplicate is reported from the daily TO-15 LCS/LCSD pair. The	RPD ≤ 25% for detections >5X's the RL.	Re-analyze the sample a third time. If the limit is exceeded again, investigate the cause and bring the system back to working order. If no problem is found with the system, narrate.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
	result is not reported with the VPH fraction.		

ANALYTICAL METHODS

Section 3.0

Method: ASTM D1945 – Fixed Gases & C1-C6

Eurofins Air Toxics SOP #54 Revision 25 Effective Date: April 15, 2021 Methods Manual Summary

Description: This method involves gas chromatograph (GC) analysis of soil gas, landfill gas, ambient air, or stack gas collected in Summa™ canisters, Tedlar bags, or any vessel that has been demonstrated to be clean and leak free. Samples are analyzed for Methane and fixed gases and can be used to speciate individual light hydrocarbons up to C6. This method is also used to provide an estimation of the heating value of the gas by method ASTM D3588. Because the sample is withdrawn from the vessel by positive pressure, rigid containers are first filled to positive pressure using UHP Helium or Nitrogen. Samples are then analyzed using a GC equipped with a Flame Ionization Detector (FID) and a Thermal Conductivity Detector (TCD).

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. Unless otherwise directed, the laboratory reports these non-standard compounds with partial validation. Validation includes a 5-point calibration with the lowest concentration defining the reporting limit (RL), no second source verification is analyzed, and no method detection limit study is performed unless previous arrangements have been made. In addition, stability of the non-standard compounds during sample storage is not validated. Full validation may be available upon request.

Since the protocols in the ASTM D1945 standard were designed for the analysis of natural gas, the laboratory has made modifications in order to apply the method to environmental samples covering a wide concentration range and to implement standard NELAP and EPA calibration criteria. The method modifications, standard target analyte list, RL, Quality Control (QC) criteria, and QC summary can be found in the following tables.

Table 1. Summary of Method Modifications for ASTM D1945

Requirement	ASTM D1945	Eurofins Air Toxics Modifications
Sample Injection Volume	0.50 mL to achieve Methane linearity.	1.0 mL
Calibration	A single point calibration is performed using a reference standard closely matching the composition of the unknown. Standard is analyzed such that 2 consecutive runs meet method repeatability requirements.	A minimum 5-point calibration curve is performed. Quantitation is based on the initial calibration response factor. A single run of a mid-level calibration standard is used to verify the initial calibration and may or may not resemble the composition of the associated samples.
Sample Analysis	Equilibrate samples to 20-50° F above source temperature at field sampling.	No heating of samples is performed.
Sample Calculation	Response factor is calculated using peak height for C5 and lighter compounds.	Peak areas are used for all target analytes to quantitate concentrations.
Normalization	Sum of original values should not differ from 100.0% by more than 1.0%.	Sum of original values may range between 85–115%; normalization of data not performed unless client requested.

Table 2. ASTM Method D1945 Compound List and QC Limits

Analyte	Reporting Limit (%)	QC Acceptance Criteria		
		ICAL (%RSD)	CCV/LCS/ICV (%R)	Precision* (%RPD)
Carbon Dioxide	0.01	≤ 15%	± 15%	≤ 25%
Carbon Monoxide	0.01	≤ 15%	± 15%	≤ 25%
Ethene	0.001	≤ 15%	± 15%	≤ 25%
Ethane	0.001	≤ 15%	± 15%	≤ 25%
Acetylene	0.001	≤ 15%	± 15%	≤ 25%
Isobutane	0.001	≤ 15%	± 15%	≤ 25%
Isopentane	0.001	≤ 15%	± 15%	≤ 25%
Methane	0.0001	≤ 15%	± 15%	≤ 25%
n-Butane	0.001	≤ 15%	± 15%	≤ 25%
Neopentane	0.001	≤ 15%	± 15%	≤ 25%
n-Pentane	0.001	≤ 15%	± 15%	≤ 25%
Nitrogen**	0.10	≤ 15%	± 15%	≤ 25%
NMOC (C6+)	0.01	≤ 15%	± 15%	≤ 25%
Oxygen	0.10	≤ 15%	± 15%	≤ 25%
Propane	0.001	≤ 15%	± 15%	≤ 25%
Hydrogen***	0.01	≤ 15%	± 15%	≤ 25%
Helium	0.05	≤ 15%	± 15%	≤ 25%

* For detections at > 5X the Reporting Limit.
**For canisters that have been pressurized with Nitrogen, the amount of Nitrogen in the sample is determined by subtraction.
***For canisters that have been pressurized with Helium, the Reporting Limit is 1.0%.

Note: Results are reported in units of mol %. If required to report volume % or ppmV, a compressibility factor of 1 for all gases will be assumed. As a result, mol % is assumed to be equivalent to volume %. This assumption may result in a bias for highly compressible gases at high concentrations and pressures.

Table 3. Summary of Calibration and QC Procedures for Mod. ASTM Method D1945

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial Calibration (ICAL)	Prior to sample analysis and annually	≤ 15% RSD	Correct problem, then repeat Initial Calibration.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS)	After each Initial Calibration and once per analytical batch.	85–115% Recovery If specified by the project, in-house generated control limits may be used.	Check the system and re-analyze the standard. Re-prepare the standard if necessary. If the primary standard is found to be in error, re-prepare the primary and calibrate the instrument.
Continuing Calibration Verification (CCV)	Daily prior to sample analysis, and can be used as an End Check.	± 15% Difference	Check the system and re-analyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met. If the closing CCV fails, the system is checked and the standard is re-analyzed. Re-prepare the standard if necessary. If the second analysis fails, identify and correct the problem, then re-analyze all samples since the last acceptable CCV.
Laboratory Blank	After analysis of standards and prior to sample analysis, or when contamination is present.	Results less than the laboratory Reporting Limit	Inspect the system and re-analyze the Laboratory Blank.
Laboratory Duplicates-Laboratory Control Spike Duplicate (LCSD)	One per analytical batch	RPD ≤ 25%	Narrate exceedances. Investigate the cause and perform maintenance as required and re-calibrate as needed.

ANALYTICAL METHODS

Section 4.0

Method: ASTM D1946 – Atmospheric Gases

Eurofins Air Toxics SOP #8 Revision 29 Effective Date: April 15, 2021 Methods Manual Summary

Description: This method involves gas chromatograph (GC) analysis of soil gas, landfill gas, ambient air, or stack gas collected in Summa™ canisters, Tedlar bags, or any vessel that has been demonstrated to be clean and leak free. Samples are analyzed for Methane, fixed gases, and Non-Methane Organic Carbon (NMOC) using modified ASTM D1946 protocols. Because the sample is withdrawn from the vessel by positive pressure, rigid containers are first filled to positive pressure using UHP Helium or Nitrogen. Samples are then analyzed using a GC equipped with a FID and a TCD.

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. Unless otherwise directed, the laboratory reports these non-standard compounds with partial validation. Validation includes a 3-point calibration with the lowest concentration defining the reporting limit, no second source verification is analyzed, and no method detection limit study is performed unless previous arrangements have been made. In addition, stability of the non-standard compound during sample storage is not validated. Full validation may be available upon request.

Since the protocols in the ASTM D1946 standard were designed for the analysis of reformed gas, the laboratory has taken modifications to apply the method to environmental samples covering a wide concentration range and to implement standard NELAP and EPA calibration criteria. The method modifications, standard target analyte list, reporting limits (RL), Quality Control (QC) criteria, and QC summary can be found in the following tables.

Table 1. Summary of Method Modifications for ASTM D1946

Requirement	ASTM D1946	Eurofins Air Toxics Modifications
Calibration	A single-point calibration is performed using a reference standard closely matching the composition of the unknown.	A minimum 5-point calibration curve is performed. Quantitation is based on the initial calibration, which may or may not resemble the composition of the associated samples.
Reference Standard	The composition of any reference standard must be known to within 0.01 mol % for any component.	The standards used by Eurofins Air Toxics are blended to a ≥ 95% accuracy.
Sample Injection Volume	Components whose concentrations are in excess of 5% should not be analyzed by using sample volumes greater than 0.5 mL.	The sample container is connected directly to a fixed volume sample loop of 1.0 mL. Linear range is defined by the calibration curve. Bags may be loaded by vacuum or by positive pressure.
Normalization	Normalize the mole percent values by multiplying each value by 100 and dividing by the sum of the original values. The sum of the original values should not differ from 100% by more than 1.0%.	Results are not normalized. The sum of the reported values can differ from 100% by as much as 15%, either due to analytical variability or an unusual sample matrix.

Requirement	ASTM D1946	Eurofins Air Toxics Modifications
Precision	Precision requirements established at each concentration level.	Duplicates should agree within 25% RPD for detections >5X the RL.

Table 2. ASTM D1946 Method Compound List and QC Limits

Compound	Reporting Limit (%)	ICAL Criteria (%RSD)	ICV/LCS Criteria (%R)	CCV Criteria (%D)	Precision Limits (RPD)**
Carbon Dioxide	0.010	≤ 15%	85 – 115	± 15%	± 25%
Carbon Monoxide	0.010	≤ 15%	85 – 115	± 15%	± 25%
Methane	0.00010	≤ 15%	85 – 115	± 15%	± 25%
Ethene	0.0010	≤ 15%	85 – 115	± 15%	± 25%
Ethane	0.0010	≤ 15%	85 – 115	± 15%	± 25%
Nitrogen	0.10	≤ 15%	85 – 115	± 15%	± 25%
NMOC	0.010	≤ 15%	85 – 115	± 15%	± 25%
Oxygen	0.10	≤ 15%	85 – 115	± 15%	± 25%
Helium	0.050	≤ 15%	85 – 115	± 15%	± 25%
Hydrogen	0.010*	≤ 15%	85 – 115	± 15%	± 25%

*Reporting limit is 1.0% when sample is pressurized with Helium.
**For detections greater than 5 times the reporting limit.

Note: Results are reported in units of mol %. If required to report volume % or ppmV, a compressibility factor of 1 for all gases will be assumed. As a result, mol % is assumed to be equivalent to volume %. This assumption may result in a bias for highly compressible gases at high concentrations and pressures.

Table 3. Summary of Calibration and QC Procedures for Mod. ASTM Method D1946

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial Calibration Curve (ICAL)	Prior to sample analysis	RSD ≤ 15%	Correct problem then repeat Initial Calibration.
Second Source Verification (LCS)	All analytes: once per Initial Calibration, and with each analytical batch	%R between 85–115%	Check the system and re-analyze the standard. Verify the accuracy of standards as needed. Re-prepare erroneous standards and/or re-calibrate the instrument if the criteria cannot be met.
Continuing Calibration Verification (CCV)	Daily prior to sample analysis and after every 20 reportable samples.	%D ±15%	Check the system and re-analyze the standard. Re-calibrate the instrument if the criteria cannot be met.
Laboratory Blank (He) (N_2 for He and H_2 analysis)	After each daily check standard and prior to sample analysis, or when contamination is present.	Results below the RL	Inspect the system and re-analyze the Blank.
End Check	At the end of analytical sequence. It can be primary (CCV) or Independent Source (LCS).	%R between 85–115%	Check system and re-analyze the standard. If the 2nd analysis fails, identify and correct the problem. Samples analyzed after the last acceptable CCV are re-analyzed.
Sample Duplicates - Laboratory Control Spike Duplicate (LCSD)	One per analytical batch	RPD ≤ 25%	Narrate exceedances. Investigate the cause and perform maintenance as required and re-calibrate as needed.

ANALYTICAL METHODS

Section 5.0

Method: PM10/TSP – Particulate Matter

Eurofins Air Toxics SOP #66 Revision 19.1 Effective Date: March 12, 2021 Methods Manual Summary

Description: This method involves equilibrating quartz filters in a conditioning environment of a specified temperature and humidity range and weighing the filters before and after field sampling. Samples are analyzed for method PM_{10} using 40 CFR Part 50 Appendix J or for Total Suspended Particulate (TSP) using 40 CFR Part 50 Appendix B. An analytical balance with 0.1 mg resolution is used to measure the filter weights. The corresponding change in mass represents the TSP or PM_{10} result, expressed in µg or µg/m^3. The reporting limit is typically 1000 µg. Sampling volumes are required to calculate results in units of µg/m^3.

Table 1. Conditioning Environment Criteria for Methods PM10 and TSP

Method	Conditioning Environment Temperature (°F)	Conditioning Environment Relative Humidity (%)
PM10	59°F – 86°F ± 5°F	20% – 45% ± 5%
TSP	59°F – 86°F ± 5°F	≤ 50% ± 5%

Table 2. Summary of Calibration and QC Procedures for Methods PM10 and TSP

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Calibration	Calibration checks of 3.00 grams (g) and 5.00 g are weighed to bracket the expected filter weight of ~4.5 g prior to sample analysis and at the end of the analytical batch.	Accuracy limits of 3.00 g weight: 2.997 g – 3.003 g Accuracy limits of 5.00 g weight: 4.995 g - 5.005 g	Correct problem then repeat calibration.
Laboratory Duplicates	Unexposed filters: One per analytical batch Exposed filters: One duplicate per work order	Unexposed filters: Weights of the clean filters should be within ±0.0028 g of the original value. Exposed filters: ≤ 25% RPD and weights must be within ±0.005 g	Re-condition the filter and re-weigh.
Laboratory Blanks	Immediately after the calibration checks	Post-weight of Lab Blank is less than pre-weight and the difference is < 0.0028 g.	Confirm the weight difference and narrate.

ANALYTICAL METHODS

Section 6.0

Method: EPA Methods TO-3 and TO-14A (TPH)

Eurofins Air Toxics SOP #43 Revision 27 Effective Date: January 13, 2022 Methods Manual Summary

Description: This method involves GC analysis of whole air samples collected in Summa canisters or Tedlar bags. Samples are analyzed for Total Petroleum Hydrocarbons (TPH). Either modified EPA Method TO-3 or Method TO-14A or can be used to reference laboratory protocols. TPH is measured using a Flame Ionization Detector (FID). Depending on the client's request, TPH is analyzed and referenced to either gasoline or jet fuel.

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. Unless otherwise directed, the laboratory reports these non-standard compounds with partial validation. Validation includes a 3-point calibration with the lowest concentration defining the reporting limit, no second source verification is analyzed, and no method detection limit study is performed unless previous arrangements have been made. In addition, stability of the non-standard compound during sample storage is not validated. Full validation may be available upon request.

Eurofins Air Toxics performs a modified version for these methods. The method modifications, standard target analyte list, reporting limit (RL), QC criteria, and QC summary can be found in the following tables.

Table 1. Summary of Method Modifications for TO-14A

Requirement	EPA Method TO-14A	Eurofins Air Toxics Modifications
Sample Drying System*	Nafion Dryer	Multi-bed sorbent
Sample collection containers	Specially treated stainless steel canisters	Method TO-14A is validated for samples collected in specially treated canisters. As such, the use of Tedlar bags for sample collection is outside the scope of the method and not recommended for ambient or indoor air samples. Associated results are considered qualified.

*The pre-concentrator modification implemented for sample analysis allows for superior performance over the water management and concentration procedures outlined in Method TO-14A. This multi-bed sorbent approach used in EPA Method TO-15 demonstrates superior performance by minimizing carryover issues that can be problematic using the Nafion dryer scenario described in Method TO-14A.

Table 2. Summary of Method Modifications for TO-3

Requirement	EPA Method TO-3	Eurofins Air Toxics Modifications
Sample Collection	In-line field method	Collection of sample in specially treated canisters or alternative containers for transport to and analysis by an off-site laboratory.
Preparation of Standards	Levels achieved through dilution of gas mixture	Levels achieved through loading various volumes of the gas mixture.
Initial Calibration Calculation	4-point calibration using a linear regression model	5-point calibration using average Response Factor
Initial Calibration Frequency	Weekly	When daily calibration standard recovery is outside 75–125%, or upon significant changes to the procedure or instrumentation.
Daily Calibration Standard Frequency	Prior to sample analysis and every 4-6 hrs	Prior to sample analysis and at the end of sample analysis. End checks can be demonstrated by use of CCV and/or LCS standards.
Minimum Detection Limit (MDL)	Calculated using the equation DL = A+3.3S, where A is intercept of calibration line and S is the standard deviation of at least 3 reps of low level standard.	40 CFR Part 136, App. B
Sample pre-concentration and moisture management	Cyrogenic pre-concentrator with a Nafion dryer	Multi-bed sorbent system

Table 3. Method Compound List and QC Limits

Analyte	RL (ppmv)	Acceptance Criteria		
		ICAL (%RSD)	LCS/CCV (%R)	Precision* (%RPD)
TPH (Gasoline Range) MW = 100	0.025	≤ 30	± 25	≤ 25
TPH (JP-4 Range) MW = 156	0.025	≤ 30	± 25	≤ 25

*For detections > 5 X RL

Table 4. Surrogate QC Limits

Surrogate	FID Accuracy (%R)
Fluorobenzene	75–150%

Table 5. Summary of Calibration and QC Procedures for TO-3/TO-14A (TPH)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
5-Point Initial Calibration (ICAL)	Prior to sample analysis and annually	%RSD ≤ 30	Correct problem, then repeat the calibration.
Initial Calibration Verification and Laboratory Control Sample (ICV/LCS)	With each initial calibration, and with each analytical batch.	±25% of the expected value	Check the system and re-analyze the standard. Re-prepare the standard or re-calibrate the instrument if the criteria cannot be met.
Continuing Calibration Verification (CCV)	Daily prior to sample analysis and can be used as an End Check	±25% of the expected value	**For initial CCV:** Check the system and re-analyze the standard. Re-calibrate the instrument if the criteria cannot be met. **For Mid- and End Checks:** Check system and re-analyze the standard. If the second analysis fails, identify and correct the problem, then re-analyze all samples since the last acceptable CCV.
Laboratory Blank	In between analysis of standards and project samples	Results less than the laboratory Reporting Limit	Inspect the system and re-analyze the Laboratory Blank.
Surrogate	As each standard, blank, and sample is being loaded	75–150% on the FID	Low surrogate recovery results in re-analysis (at a higher dilution if high levels of moisture are present). If recovery is out and still low, report the analysis with the better recovery and flag. Because of TPH interference, high surrogate recoveries do not result in re-analysis. Data is flagged to note high recovery.
Laboratory Duplicate - Laboratory Control Spike Duplicate (LCSD)	One per analytical batch	RPD ≤ 25% for detections > 5 X RL	Narrate exceedances. Investigate the cause, perform maintenance as required, and re-calibrate as needed.

ANALYTICAL METHODS

Section 7.0

Method: EPA Method TO-12 (Non-methane Organic Compounds)

Eurofins Air Toxics SOP #36 Revision 22 Effective Date: December 2, 2020 Methods Manual Summary

Description: This method involves gas chromatograph analysis of whole air samples collected in Summa™ canisters or Tedlar bags. Samples are analyzed for Non-Methane Organic Compounds (NMOC) using EPA Method TO-12 protocols. After concentration on a sorbent bed, samples are analyzed using a Flame Ionization Detector (FID). This method is used when speciation is not required.

NMOC concentrations are quantified using the response factor of heptane. As required by the project, NMOC results referenced to heptane can be converted to units of ppmC (parts per million of Carbon). Additionally, hydrocarbon ranges can be provided based on the elution time of the normal alkanes on the GC column.

Eurofins Air Toxics performs a modified version for each of these methods. The method modifications, standard target analyte list, RL, QC criteria, and QC summary can be found in the following tables.

Table 1. Summary of Method Modifications for TO-12

Requirement	EPA Method TO-12	Eurofins Air Toxics Modifications
Reporting Limit	0.02 ppmC	0.050 ppmv
Initial Calibration	Five levels: Each level three runs with %RSD < 3%; linearity criterion not specified	Minimum of five single levels; %RSD ≤ 30%.
Sample Analysis Frequency	Duplicate analysis with RPD<5%; report average results of two analyses.	Single analysis. Duplicate performed per project specifications with RPD ≤ 25% for detections > 5X the RL.
Column*	GC column not used.	GC column used for analysis.
Sample concentration	Cyrogenic concentration	Multibed sorbent concentration

* The column modification implemented for sample analysis allows for additional characterization based on carbon ranges.

Table 2. Method Compound List and QC Limits

Analyte	RL (ppmv)	Acceptance Criteria			
		ICAL (%RSD)	CCV (%D)	LCS (%R)	Precision (%RPD)
Total NMOC ref. to Heptane	0.050	≤ 30	±25%	75-125%	≤ 25 for > 5X RL

Table 3. Summary of Calibration and QC Procedures for TO-12 (NMOC)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial Calibration Curve (ICAL)	Prior to sample analysis and/or annually	% RSD ≤ 30	Repeat the calibration.
Laboratory Control Sample (LCS)	With each initial calibration and analytical batch	75–125% of the expected value	Check the system and re-analyze the standard. Re-calibrate the instrument if the criteria cannot be met.
Continuing Calibration Verification (CCV)	Daily prior to sample analysis and after every 20 samples or at the end of the analytical sequence	% Difference ± 25 of expected value	Check the system and re-analyze the standard. Re-calibrate the instrument if the criteria cannot be met. Re-analyze all samples since the last acceptable CCV.
Laboratory Blank	In between analysis of standards and project samples	Results less than laboratory reporting limit	Repeat the Laboratory Blank. If the re-analysis of the Lab Blank contains above but at less than 5X the reporting limit, sample analysis may proceed and the associated sample results will be reported with a B flag.
Laboratory Duplicates/ Laboratory Control Spike Duplicate (LCSD)	One per analytical batch	RPD ≤ 25%	Narrate exceedances. Investigate the cause and perform maintenance as required and re-calibrate as needed.

ANALYTICAL METHODS

Section 8.0

Method: EPA Method TO-13A PAHs (Full Scan and SIM)

Eurofins Air Toxics SOP #10	Revision 28	Effective Date: April 13, 2021	Methods Manual Summary
Eurofins Air Toxics SOP #74	Revision 17	Effective Date: March 12, 2021	Methods Manual Summary

Description: This method involves drawing a measured volume of air through a filter and sorbent cartridge to collect Polychlorinated Biphenyls (PAHs) in the vapor and particulate phases. The cartridge can be PUF/XAD2 or XAD2 only. While TO-13A describes the use of a high-volume sampling pump, which allows for up to 300 cubic meters (m^3) of air to be collected over a 24-hour period, the method can also be applied to low-volume sample applications suitable for indoor air or soil gas. The sample media is extracted in the laboratory using pressurized fluid extraction (PFE). The concentrated extracts are analyzed for PAHs using a quadrupole gas chromatograph/mass spectrometer (GC/MS) in full scan or SIM mode by TO-13A protocol. Eurofins Air Toxics performs a modified version of this method. The method modifications, standard target analyte list, Limit of Quantitation (LOQ), QC criteria, and QC summary can be found in the following tables.

In relation to the prescribed media, sampling and collection efficiencies for compounds not listed in TO-13A have not been evaluated. However, if non-standard compounds are required for a project, the laboratory reports these compounds with partial validation. Validation includes a 3-point calibration with the lowest concentration defining the reporting limit, no second source verification is analyzed, and no method detection limit study is performed unless previous arrangements have been made. In addition, stability of the non-standard compound during sample storage is not validated. Full validation may be available upon request.

Required Field QC: EPA Method TO-13A requires at least one field blank per sampling episode. Matrix spikes are referenced, but not definitively required in the routine QA specifications.

Table 1. Summary of Method Modifications for TO-13A/TO-13A SIM

Requirements	EPA Method TO-13A	Eurofins Air Toxics Modifications
Filter Cleaning and Certification	TO-13A: Baked @ 400°C for 5 hours; extracted with DCM	Bake quartz fiber filters for at least 4 hrs at approximately 500°C, then extract one filter from a lot by Buchi E-914 with DCM. GC/MS analysis for TO-13A requirement of no target compound hits above RL.
XAD-2 Cleaning and Certification	TO-13A: DCM 2 X 16 hours. Extract cartridge.	Start with recycled XAD-2. Soak in Methanol for approximately 24 hours, (see section 7.1.2 for raw XAD-2 cleaning procedure) followed by extraction for a total time of at least 8 hours with solvent exchange after 4 hours. Approximately 20 mL of XAD-2 is placed in an extraction cell, and extracted by Buchi E-914 for 20 – 25 min.

Requirements	EPA Method TO-13A	Eurofins Air Toxics Modifications
PUF Cleaning and Certification	TO-13A: Acetone for 16 hours. Compound hits < 10 ng for TO-13A	Soak in Methanol for approximately 24 hours, followed by extraction for a minimum of 8 hours with solvent exchange after 4 hours. GC/MS analysis for TO-13A requirement of no target compound hits above the RL.
TO-13A Media Set-Up	TO-13A: Utilize PUF as primary sorbent; if Naphthalene, Acenaphthylene, and Acenaphthene needed then XAD is sorbent.	TO-13A: PUF/XAD-2 sandwich + filter. (PUF/XAD sandwich only for low-volume samples).
Extraction Solvent	PUF sorbent requires use of 10% Ether in Hexane; XAD sorbent requires use of DCM. Final extract in Hexane.	PUF/XAD-2 cartridge is used as sorbent with DCM as extraction solvent. Final extract in DCM.
Extraction Technique	Soxhlet apparatus extractor	Buchi E-914
Extract cleanup	Elute extract through silica gel prior to analysis.	No clean up used, experience shows that step does not improve method performance for typical air samples.
Pre-spike Surrogate	Requires 1.0 µg of Fluoranthene-d_{10} and 1.0 µg of Benzo(a)pyrene-d_{12} spiked on media prior to sampling.	Lab pre-spikes media for all TO-13A methods. For full scan analysis, a concentration of 50 µg is used. For SIM analysis, a concentration of 1.0 µg is used.
Media Certification	Extract one cartridge; criteria is <500 ng/cartridge for Naphthalene; <200 ng total/cartridge for rest of PAHs.	Filters, XAD-2, PUFs extracted and certified in pairs or individually; criteria is < RL for all target analytes.
Glassware Cleaning	Muffle furnace is utilized	Solvent cleaning procedure is used
Solvent Process Blank	One each analytical batch	Each solvent lot is certified
MS Detection Mode	Full Scan	Full Scan or SIM
Target Compound List	PAH list	See Table 2; Additional non-PAH semivolatile compounds can be analyzed; however, sample collection efficiencies have not been evaluated. These compounds are outside the laboratory's NELAP scope of accreditation
Initial Calibration	0.1–2.5 µg/mL in Hexane	1.0–500 µg/mL in methylene chloride for standard (quad) or 0.1–40 µg/mL for SIM
Method Blank	< MDL	< Reporting Limit
Quantitation	Use RRF of CCV RRT ± 0.01 unit of the ICAL or CCV	TO-13A SIM: Use average RRF of the ICAL Absolute RT ± 0.06 min of CCV

Requirements	EPA Method TO-13A	Eurofins Air Toxics Modifications
Surrogate Recoveries	60-120%	50-150% for Field Surrogates Fluoranthene-d10 and Benzo(a)pyrene-d12

Table 2. Modified Method TO-13A/TO-13A SIM Analyte List and Reporting Limits

Analyte	SIM RL (µg)	RL (µg)	Minimum ICAL RRF	ICAL (%RSD)	ICV (%R)	CCV (%D)	Precision (%RPD)
2-Chloronaphthalene*	0.1	1.0	NA	≤ 30	± 30	± 30	≤ 25%
2-Methylnaphthalene*	0.1	1.0	NA	≤ 30	± 30	± 30	≤ 25%
Acenaphthylene	0.1	1.0	1.3	≤ 30	± 30	± 30	≤ 25%
Acenaphthene	0.1	1.0	0.8	≤ 30	± 30	± 30	≤ 25%
Anthracene	0.1	1.0	0.7	≤ 30	± 30	± 30	≤ 25%
Benzo(a)anthracene	0.1	1.0	0.8	≤ 30	± 30	± 30	≤ 25%
Benzo(e)pyrene**	0.1	1.0	NA	≤ 30	± 30	± 30	≤ 25%
Benzo(a)pyrene	0.1	1.0	0.7	≤ 30	± 30	± 30	≤ 25%
Benzo(b)fluoranthene	0.1	1.0	0.7	≤ 30	± 30	± 30	≤ 25%
Benzo(g,h,i)perylene	0.1	1.0	0.5	≤ 30	± 30	± 30	≤ 25%
Benzo(k)fluoranthene	0.1	1.0	0.7	≤ 30	± 30	± 30	≤ 25%
Chrysene	0.1	1.0	0.7	≤ 30	± 30	± 30	≤ 25%
Dibenz(a,h)anthracene	0.1	1.0	0.4	≤ 30	± 30	± 30	≤ 25%
Fluoranthene	0.1	1.0	0.6	≤ 30	± 30	± 30	≤ 25%
Fluorene	0.1	1.0	0.9	≤ 30	± 30	± 30	≤ 25%
Indeno(1,2,3-c,d)pyrene	0.1	1.0	0.5	≤ 30	± 30	± 30	≤ 25%
Naphthalene	0.1	1.0	0.7	≤ 30	± 30	± 30	≤ 25%
Phenanthrene	0.1	1.0	0.7	≤ 30	± 30	± 30	≤ 25%
Pyrene	0.1	1.0	0.6	≤ 30	± 30	± 30	≤ 25%

* Non-standard analyte. Not included in the TO-13A method.
**No minimum requirement per EPA TO-13A.

The following compounds can be analyzed upon client request:

Analyte*	SIM RL (µg)	RL (µg)	Minimum ICAL RRF	ICAL (%RSD)	ICV (%R)	CCV (%R)	Precision (%RPD)
Perylene	1.0	1.0	0.5	≤ 30	± 30	± 30	≤ 25%
Coronene	1.0	1.0	0.7	≤ 30	± 30	± 30	≤ 25%
1-Methylnaphthalene	1.0	1.0	N/A	≤ 30	± 30	± 30	≤ 25%

*Additional compounds may be available upon client request.

Table 3. Surrogates

Pre-Spike/Field Surrogates	Accuracy (%R)
Fluoranthene-d_{10}	50 – 150
Benzo(a)pyrene-d_{12}	50 – 150

Extraction Surrogates	Accuracy (%R)*
Fluorene-d_{10}	60 – 120
Pyrene-d_{10}	60 – 120

Table 4. Internal Standards

Analyte	Accuracy (%R)
Acenaphthene-d_{10}	-50 to +100
Chrysene-d_{12}	-50 to +100
1,4-Dichlorobenzene-$_{d4}$	-50 to +100
Naphthalene-d_8	-50 to +100
Perylene-d_{12}	-50 to +100
Phenanthrene-d_{10}	-50 to +100

Table 5. Extracted Laboratory Control Samples for TO-13A (PAHs) in Full Scan and SIM

Analyte	(%R)*
Naphthalene	60 – 120
Acenapthylene	60 – 120
Acenaphthene	60 – 120
Fluorene	60 – 120
Phenanthrene	60 – 120
Anthracene	60 – 120
Fluoranthene	60 – 120
Pyrene	60 – 120
Benzo(a)anthracene	60 – 120
Chrysene	60 – 120
Benzo(b)fluoranthene	60 – 120
Benzo(k)fluoranthene	60 – 120
Benzo(a)pyrene	60 – 120
Indeno(1,2,3-cd)pyrene	60 – 120
Dibenzo(a,h)anthracene	60 – 120
Benzo(g,h,i)perylene	60 – 120
2-Methylnaphthalene**	60 - 120
2-Chloronaphthalene**	60 – 120

*The LCS and Surrogate limits are derived from Compendium Method TO-13A, Sections 13.3.7.4 and 13.4.6.3 (January 1999). These limits only apply to samples that are extracted by Eurofins Air Toxics. When sample extracts are sent to the lab for analysis only, limits of 50-150 % are applied.
**These analytes are in addition to the mandated EPA TO-13A list and are required per NELAP to be included in the LCS spiking solution over a 2-year period.

Table 6. Summary of Calibration and QC Procedures for EPA Method TO-13A/TO-13A SIM

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Prior to calibration and at start of every 12 hours	TO-13A tuning criteria	Correct problem then repeat tune.
Initial 5-Point Calibration	Prior to sample analysis	ICAL criteria in Table 2	Correct problem then repeat initial calibration.
ICV	All analytes: Once per initial calibration	All target compound recoveries must be between 70 – 130%	Determine the source of discrepancy between standards. Re-calibrate if needed.
Continuing Calibration Verification (CCV)	At the start of every clock immediately after the DFTPP tune check	PAHs list: Meet Table 2 Min. RRF requirement; %D ≤ 30%	Investigate and correct the problem, up to and including re-calibration if necessary. High bias associated with non-detects in samples will not result in re-analysis.
Internal Standards (IS)	Injected into each standard, blank, and sample extract prior to analysis	**For CCV:** Area count within 50% to 200% of the midpoint of ICAL. **For blanks, samples, and non-CCV QC checks:** retention times within ± 0.33 minutes (20 seconds) and area counts within 50% to 200% of the CCV.	**For CCVs:** Investigate and correct the problem before proceeding with sample analysis. **For blanks:** Inspect the system and re-analyze the blank. **For samples and non-CCV QC:** Unless there is obvious matrix effect, re-analyze the samples and dilute the sample until the ISs meet the criteria; narrate the data to indicate interference.
Surrogates	Field Surrogates: Blank cartridges prior to transport to field for sampling and lab QC prior to extraction. Extraction Surrogates: All samples and lab QC prior to extraction.	See Table 3.	A new aliquot of the extract is analyzed. If Surrogate recoveries are out-of-control a second time, data is flagged and narrated. Re-analysis is not necessary for obvious matrix effects (data is flagged for out-of-control surrogate recoveries). Air samples cannot be re-extracted.
Extracted Laboratory Control Samples (LCS)	With each set of up to 20 extracted samples	See LCS criteria in Table 5.	Re-aliquot and re-analyze the extract. If within limits, report the re-analysis. Otherwise, narrate.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Laboratory Blank	With each set of up to 20 extracted samples	Results less than laboratory reporting limit (Table 2).	Re-aliquot and re-analyze the extract. If less than reporting limit, report the re-analysis. Otherwise, narrate and flag the data.
Solvent Blank	When samples that are extracted together are analyzed on different analytical shifts	All target compounds below the reporting limit (Table 2).	Re-aliquot and re-analyze the solvent. If less than reporting limit, report the re-analysis. Identify the source of contamination, and perform maintenance as needed. If maintenance required, restart the analytical clock.
Laboratory Duplicates – Laboratory Control Spike Duplicates (LCSD)	One per analytical batch	RPD ≤ 25%	Re-analyze duplicate. Investigate the cause and perform maintenance as required and re-calibrate as needed. Narrate exceedances if no error is identified.

ANALYTICAL METHODS

Section 9.0

Method: EPA Method TO-14A/TO-15 Volatile Organic Compounds (5&20 ppbv)

Eurofins Air Toxics SOP #91 Revision 21 Effective Date: November 29, 2021 Methods Manual Summary

Description: This method involves full scan gas chromatograph/mass spectrometer (GC/MS) analysis of whole air samples collected in evacuated stainless steel canisters. Samples are analyzed for volatile organic compounds (VOCs) using EPA Method TO-14A/TO-15 protocols. An aliquot of up to 0.05 liters of air is withdrawn from the canister utilizing a volumetric syringe or mass flow controller. This volume is loaded onto a hydrophobic multibed sorbent trap to remove water and carbon dioxide and to concentrate the vapor sample. The focused sample is then flash-heated onto a GC/MS for compound separation and detection.

Eurofins Air Toxics maintains a suite of TO-14A/TO-15 methods, each optimized to efficiently meet the data objectives for a wide range of targeted concentration ranges. The methods, their reporting limits, and typical applications are summarized in the table below. This method summary describes TO-14A/TO-15 (5&20). The 5&20 analytical configuration is designed to directly measure ppmv concentrations with minimal offline dilutions due to its wide dynamic calibration range.

Eurofins Air Toxics Method	Base Reporting Limits	Typical Application
TO-14A/TO-15 (5&20)	5 – 20 ppbv	Soil gas and ppmv range vapor matrices
TO-14A/TO-15 (Standard or Quad)	0.5 – 5.0 ppbv	Ambient air, soil gas, and ppbv level vapor matrices
TO-15 (Extended)	0.2 – 5.0 ppbv	Ambient air and ppbv level vapor matrices
TO-14A/TO-15 (Low-level)	0.1 – 1.0 ppbv	Indoor and outdoor air
TO-14A/TO-15 SIM	0.01 – 0.5 ppbv	Indoor and outdoor air
TO-15 HSS	0.01 – 0.1 ppbv	Soil gas and other high concentration matrices

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. Unless otherwise directed, Eurofins Air Toxics reports these non-routine compounds with partial validation. Validation may include a 3-point calibration with the lowest concentration defining the reporting limit, no second source verification analyzed, and no method detection limit study performed unless previous arrangements have been made. In addition, stability of the non-standard compound during sample storage is not validated. Full validation may be available upon request.

Eurofins Air Toxics takes no modifications of technical significance to Method TO-15 for the "5&20" configuration. Since Eurofins Air Toxics applies TO-15 methodology to all Summa canisters regardless of whether TO-14A or TO-15 is specified by the project, the laboratory performs a modified version of method TO-14A as detailed in Table 1. Please note that Methods TO-14A and TO-15 were validated for specially treated canisters. As such, the use of Tedlar bags for sample collection is outside the scope of the method and not recommended for

ambient air samples. It is the responsibility of the data user to determine the usability of TO-14A and TO-15 results generated from Tedlar bags.

Table 1. Summary of TO-14A Method Modifications

Requirement	TO-14A	ATL Modifications
Sample Drying System	Nafion Drier	Multibed hydrophobic sorbent
Blank acceptance criteria	< 0.2 ppbv	< RL
BFB ion abundance criteria	Ion abundance criteria listed in Table 4 of TO-14A	Follow abundance criteria listed in TO-15
BFB absolute abundance criteria	Within 10% when comparing to the previous daily BFB	CCV internal standard area counts are compared to ICAL; corrective action when recovery is less than 60%.
Initial Calibration	≤ 30% RSD for listed 39 VOCs	≤ 30% RSD with 2 of Eurofins Air Toxics' 62 standard compounds allowed out to ≤ 40%

The standard target analyte list, reporting limit (RL), also referred to as Limit of Quantitation (LOQ), QC criteria, and QC summary can be found in Tables 2 through 5.

Table 2. Method TO-14A/TO-15 Analyte List (5&20)

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
1,1,2,2-Tetrachloroethane	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,1,2-Trichloroethane	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,1-Dichloroethane	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,1-Dichloroethene	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,2,4-Trichlorobenzene	20	≤ 30%	70 – 130	70 – 130	± 25
1,2,4-Trimethylbenzene	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dibromoethane (EDB)	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichlorobenzene	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichloroethane	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichloropropane	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,3,5-Trimethylbenzene	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,3-Dichlorobenzene	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,4-Dichlorobenzene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Benzene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Bromomethane	20	≤ 30%	70 – 130	70 – 130	± 25
Carbon Tetrachloride	5.0	≤ 30%	70 – 130	70 – 130	± 25

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
Chlorobenzene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Chloroethane	20	≤ 30%	70 – 130	70 – 130	± 25
Chloroform	5.0	≤ 30%	70 – 130	70 – 130	± 25
Chloromethane	20	≤ 30%	70 – 130	70 – 130	± 25
Chlorotoluene (Benzyl Chloride)	5.0	≤ 30%	70 – 130	70 – 130	± 25
cis-1,2-Dichloroethene	5.0	≤ 30%	70 – 130	70 – 130	± 25
cis-1,3-Dichloropropene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Dichloromethane (Methylene Chloride)	20	≤ 30%	70 – 130	70 – 130	± 25
Ethylbenzene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Freon 11 (Trichlorofluoromethane)	5.0	≤ 30%	70 – 130	70 – 130	± 25
Freon 113 (Trichlorotrifluoroethane)	5.0	≤ 30%	70 – 130	70 – 130	± 25
Freon 114	5.0	≤ 30%	70 – 130	70 – 130	± 25
Freon 12 (Dichlorodifluoromethane)	5.0	≤ 30%	70 – 130	70 – 130	± 25
Hexachlorobutadiene	20	≤ 30%	70 – 130	70 – 130	± 25
m,p-Xylene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Methyl Chloroform (1,1,1-Trichloroethane)	5.0	≤ 30%	70 – 130	70 – 130	± 25
o-Xylene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Styrene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Tetrachloroethene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Toluene	5.0	≤ 30%	70 – 130	70 – 130	± 25
trans-1,3-Dichloropropene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Trichloroethene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Vinyl Chloride	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,3-Butadiene	5.0	≤ 30%	70 – 130	70 – 130	± 25
1,4-Dioxane	20	≤ 30%	70 – 130	70 – 130	± 25
2-Butanone (Methyl Ethyl Ketone)	20	≤ 30%	70 – 130	70 – 130	± 25
2-Hexanone	20	≤ 30%	70 – 130	70 – 130	± 25
4-Ethyltoluene	5.0	≤ 30%	70 – 130	70 – 130	± 25
4-Methyl-2-Pentanone (MIBK)	5.0	≤ 30%	70 – 130	70 – 130	± 25
Acetone	20	≤ 30%	70 – 130	70 – 130	± 25
Bromodichloromethane	5.0	≤ 30%	70 – 130	70 – 130	± 25
Bromoform	5.0	≤ 30%	70 – 130	70 – 130	± 25

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
Carbon Disulfide	20	≤ 30%	70 – 130	70 – 130	± 25
Cyclohexane	5.0	≤ 30%	70 – 130	70 – 130	± 25
Dibromochloromethane	5.0	≤ 30%	70 – 130	70 – 130	± 25
Ethanol	25	≤ 30%	70 – 130	70 – 130	± 25
Heptane	5.0	≤ 30%	70 – 130	70 – 130	± 25
Hexane	5.0	≤ 30%	70 – 130	70 – 130	± 25
Isopropanol	25	≤ 30%	70 – 130	70 – 130	± 25
Methyl t-Butyl Ether (MTBE)	5.0	≤ 30%	70 – 130	70 – 130	± 25
Tetrahydrofuran	5.0	≤ 30%	70 – 130	70 – 130	± 25
trans-1,2-Dichloroethene	5.0	≤ 30%	70 – 130	70 – 130	± 25
2,2,4-Trimethylpentane	5.0	≤ 30%	70 – 130	70 – 130	± 25
Cumene	5.0	≤ 30%	70 – 130	70 – 130	± 25
Propylbenzene	5.0	≤ 30%	70 – 130	70 – 130	± 25
3-Chloroprene	20	≤ 30%	70 – 130	70 – 130	± 25
Naphthalene*	20	≤ 40%	60 – 140	60 – 140	± 25
TPH (Gasoline) **	500	1- Point Calibration	NA	ICV only: 60 – 140	± 25
NMOC (Hexane/Heptane)**	100	1- Point Calibration	NA	NA	± 25

*Due to its low vapor pressure, Naphthalene may exceed TO-15 performance requirements. The wider QC limits reflect typical performance. Although Naphthalene is not on Eurofins Air Toxics "standard" TO-15 list, it is commonly requested and included in Table 2.

**TPH and NMOC are not on Eurofins Air Toxics' "standard" TO-15 list, but are included in Table 2 due to common requests.

Table 2 is the list of Standard compounds, reporting limits and QC acceptance criteria. Each project may be customized as needed. Additional compounds and different reporting limits may be obtainable and/or achieved upon request.

Table 3. Internal Standards

Analyte	Accuracy (% R)
Bromochloromethane	60 – 140
1,4-Difluorobenzene	60 – 140
Chlorobenzene-d_5	60 – 140

Table 4. Surrogates

Analyte	Accuracy (% R)
1,2-Dichloroethane-d_4	70 – 130
Toluene-d_8	70 – 130
4-Bromofluorobenzene	70 – 130

Table 5. Summary of Calibration and QC Procedures for Methods TO-14A/TO-15 (5&20)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Every 24 hours.	TO-15 ion abundance criteria	Correct problem then repeat tune.
Minimum 5-Point Initial Calibration (ICAL)	Prior to sample analysis.	% RSD ≤ 30 with 2 compounds allowed out to ≤ 40% RSD	Correct problem then repeat Initial Calibration Curve.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS)	After each Initial Calibration curve, and daily prior to sample analysis	Recoveries for 85% of "Standard" compounds must be 70-130%. No recovery may be <50%. ICV evaluated on a full list basis at the time of calibration. If specified by the project, in-house generated control limits may be used.	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS) for Non-standard compounds	Per client request or specific project requirements only.	Recoveries of compounds must be 60–140%. No recovery may be <50%.	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Continuing Calibration Verification (CCV)	At the start of each analytical clock after the tune check.	70–130%	Compounds exceeding this criterion and associated data will be flagged and narrated with the exception of high bias associated with non-detects. If more than two compounds from the standard list recover outside of 70-130% or > 10% of VOCs if short list is used (20 compounds or less), corrective action will be taken. If any compound exceeds 60-140%, samples are not analyzed unless data meets project needs. Check the system and reanalyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Laboratory Blank	After analysis of standards and prior to sample analysis, or when contamination is present.	Results less than the laboratory reporting limit	Inspect the system and re-analyze the blank. "B"-flag data for common contaminants.
Internal Standard (IS)	As each standard, blank, and sample is being loaded	Retention time (RT) for blanks and samples must be within ±0.33 min of the RT in the CCV and within ±40% of the area counts of the daily CCV internal standards.	**For blanks:** Inspect the system and reanalyze the blank. **For samples:** Re-analyze the sample. If the ISs are within limits in the re-analysis, report the second analysis. If ISs are out-of-limits a second time, dilute the sample until ISs are within acceptance limits and narrate.
Surrogates	As each standard, blank, and sample is being loaded.	70–130% If specified by the project, in-house generated control limits may be used.	**For blanks:** Inspect the system and reanalyze the blank. **For samples:** re-analyze the sample unless obvious matrix interference is documented. If the %Rs are within limits in the re-analysis, report the second analysis. If %Rs are out-of-limits a second time, report data from first analysis and narrate.
Laboratory Duplicates – Laboratory Control Spike Duplicates (LCSD)	One per analytical batch	RPD ≤25%	Narrate exceedances. If more than 5% of compound list is outside criteria or if compound has >40%RPD, investigate the cause and perform maintenance as required. If instrument maintenance is required, calibrate as needed.

ANALYTICAL METHODS

Section 10.0

Method: EPA Method TO-14A/TO-15 Volatile Organic Compounds (Standard/Quad)

Eurofins Air Toxics SOP #6 Revision 44 Effective Date: April 12, 2021 Methods Manual Summary

Description: This method involves full scan gas chromatograph/mass spectrometer (GC/MS) analysis of whole air samples collected in evacuated stainless steel canisters. Samples are analyzed for volatile organic compounds (VOCs) using EPA Method TO-14A/TO-15 protocols. An aliquot of up to 0.5 liters of air is withdrawn from the canister utilizing a volumetric loop or mass flow controller. This volume is loaded onto a hydrophobic multibed sorbent trap to remove water and carbon dioxide and to concentrate the vapor sample. The focused sample is then flash-heated to sweep adsorbed VOCs onto a secondary trap for further concentration and/or directly onto a GC/MS for separation and detection.

Eurofins Air Toxics maintains a suite of TO-14A/TO-15 methods, each optimized to efficiently meet the data objectives for a wide range of targeted concentration ranges. The methods, their reporting limits, and typical applications are summarized in the table below. This method summary describes TO-14A/TO-15 (Standard or Quad).

Eurofins Air Toxics Method	Base Reporting Limits	Typical Application
TO-14A/TO-15 (5&20)	5 – 20 ppbv	Soil gas and ppmv range vapor matrices
⇨ TO-14A/TO-15 (Standard or Quad)	0.5 – 5.0 ppbv	Ambient air, soil gas, and ppbv level vapor matrices
TO-15 (Extended)	0.2 – 5.0 ppbv	Ambient air and ppbv level vapor matrices
TO-14A/TO-15 (Low-level)	0.1 – 1.0 ppbv	Indoor and outdoor air
TO-14A/TO-15 SIM	0.01 – 0.5 ppbv	Indoor and outdoor air
TO-15 HSS	0.01 – 0.1 ppbv	Soil gas and other high concentration matrices

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. Unless otherwise directed, Eurofins Air Toxics reports these non-routine compounds with partial validation. Validation may include a 3-point calibration with the lowest concentration defining the reporting limit, no second source verification analyzed, and no method detection limit study performed unless previous arrangements have been made. In addition, stability of the non-standard compound during sample storage is not validated. Full validation may be available upon request.

Eurofins Air Toxics takes no modifications of technical significance to Method TO-15 for the "Quad" configurations. Since Eurofins Air Toxics applies TO-15 methodology to all Summa canisters regardless of whether TO-14A or TO-15 is specified by the project, the laboratory performs a modified version of method TO-14A as detailed in Table 1. Please note that Methods TO-14A and TO-15 were validated for specially treated canisters. As such, the use of Tedlar bags for sample collection is outside the scope of the method and not

recommended for ambient or indoor air samples. It is the responsibility of the data user to determine the usability of TO-14A and TO-15 results generated from Tedlar bags.

Table 1. Summary of TO-14A Method Modifications

Requirement	TO-14A	Eurofins Air Toxics Modifications
Sample Drying System	Nafion Drier	Multibed hydrophobic sorbent.
Blank acceptance criteria	≤ 0.2 ppbv	≤ RL
BFB ion abundance criteria	Ion abundance criteria listed in Table 4 of TO-14A	Follow abundance criteria listed in TO-15.
BFB absolute abundance criteria	Within 10% when comparing to the previous daily BFB	CCV internal standard area counts are compared to ICAL; corrective action when recovery is less than 60%.
Initial Calibration	≤ 30% RSD for listed 39 VOCs	Follow TO-15 requirements of ≤ 30% RSD with 2 of Eurofins Air Toxics' 62 standard compounds allowed out to ≤ 40% RSD

The standard target analyte list, reporting limit (RL) also referred to as Limit of Quantitation, QC criteria, and QC summary can be found in Tables 2 through 6.

Table 2. Method TO-14A/TO-15 Analyte List (Quad)

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
1,1,2,2-Tetrachloroethane	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,1,2-Trichloroethane	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,1-Dichloroethane	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,1-Dichloroethene	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,2,4-Trichlorobenzene	2.0	≤ 30%	70 – 130	70 – 130	± 25
1,2,4-Trimethylbenzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dibromoethane (EDB)	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichlorobenzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichloroethane	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichloropropane	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,3,5-Trimethylbenzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,3-Dichlorobenzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,4-Dichlorobenzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Benzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Bromomethane	5.0	≤ 30%	70 – 130	70 – 130	± 25

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
Carbon Tetrachloride	0.5	≤ 30%	70 – 130	70 – 130	± 25
Chlorobenzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Chloroethane	2.0	≤ 30%	70 – 130	70 – 130	± 25
Chloroform	0.5	≤ 30%	70 – 130	70 – 130	± 25
Chloromethane	5.0	≤ 30%	70 – 130	70 – 130	± 25
Chlorotoluene (Benzyl Chloride)	0.5	≤ 30%	70 – 130	70 – 130	± 25
cis-1,2-Dichloroethene	0.5	≤ 30%	70 – 130	70 – 130	± 25
cis-1,3-Dichloropropene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Dichloromethane (Methylene Chloride)	5.0	≤ 30%	70 – 130	70 – 130	± 25
Ethylbenzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Freon 11 (Trichlorofluoromethane)	0.5	≤ 30%	70 – 130	70 – 130	± 25
Freon 113 (Trichlorotrifluoroethane)	0.5	≤ 30%	70 – 130	70 – 130	± 25
Freon 114	0.5	≤ 30%	70 – 130	70 – 130	± 25
Freon 12 (Dichlorodifluoromethane)	0.5	≤ 30%	70 – 130	70 – 130	± 25
Hexachlorobutadiene	2.0	≤ 30%	70 – 130	70 – 130	± 25
m,p-Xylene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Methyl Chloroform (1,1,1-Trichloroethane)	0.5	≤ 30%	70 – 130	70 – 130	± 25
o-Xylene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Styrene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Tetrachloroethene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Toluene	0.5	≤ 30%	70 – 130	70 – 130	± 25
trans-1,3-Dichloropropene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Trichloroethene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Vinyl Chloride	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,3-Butadiene	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,4-Dioxane	2.0	≤ 30%	70 – 130	70 – 130	± 25
2-Butanone (Methyl Ethyl Ketone)	2.0	≤ 30%	70 – 130	70 – 130	± 25
2-Hexanone	2.0	≤ 30%	70 – 130	70 – 130	± 25
4-Ethyltoluene	0.5	≤ 30%	70 – 130	70 – 130	± 25
4-Methyl-2-Pentanone (MIBK)	0.5	≤ 30%	70 – 130	70 – 130	± 25
Acetone	5.0	≤ 30%	70 – 130	70 – 130	± 25
Bromodichloromethane	0.5	≤ 30%	70 – 130	70 – 130	± 25

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
Bromoform	0.5	≤ 30%	70 – 130	70 – 130	± 25
Carbon Disulfide	2.0	≤ 30%	70 – 130	70 – 130	± 25
Cyclohexane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Dibromochloromethane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Ethanol	5.0	≤ 30%	70 – 130	70 – 130	± 25
Heptane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Hexane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Isopropanol	2.0	≤ 30%	70 – 130	70 – 130	± 25
Methyl t-Butyl Ether (MTBE)	2.0	≤ 30%	70 – 130	70 – 130	± 25
Tetrahydrofuran	0.5	≤ 30%	70 – 130	70 – 130	± 25
trans-1,2-Dichloroethene	0.5	≤ 30%	70 – 130	70 – 130	± 25
2,2,4-Trimethylpentane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Cumene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Propylbenzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
3-Chloroprene	2.0	≤ 30%	70 – 130	70 – 130	± 25
Naphthalene*	1.0	≤40%	60 – 140	60 – 140	± 25
TPH (Gasoline) **	50	1-Point Calibration	N/A	ICV only; 60 – 140	± 25
NMOC (Hexane/Heptane)**	10	1-Point Calibration	N/A	NA	± 25

*Due to its low vapor pressure, Naphthalene may exceed TO-15 performance requirements. The wider QC limits reflect typical performance. Although Naphthalene is not on Eurofins Air Toxics "standard" TO-15 list, it is commonly requested and included in Table 2.

**TPH and NMOC are not on Eurofins Air Toxics' "standard" TO-15 list, but are included in Table 2 due to common requests.

Table 2 is the list of Standard compounds, reporting limits and QC acceptance criteria. Each project may be customized as needed. Additional compounds and different reporting limits may be obtainable and/or achieved upon request.

Table 3. Method TO-15 Additional Analyte List (Quad)

Analyte	RL/LOQ (ppbv)	QA Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
1,2,3-Trichloropropane	0.4	≤30%	70 – 130	70 – 130	± 25
1,2,3-Trichlorobenzene	0.8	≤30%	70 – 130	70 – 130	± 25

Analyte	RL/LOQ (ppbv)	QA Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
2-Chlorotoluene	0.4	≤30%	70 – 130	70 – 130	± 25
4-Isopropyltoluene (p-Cymene)	0.8	≤30%	70 – 130	70 – 130	± 25
Butane	2.0	≤30%	70 – 130	70 – 130	± 25
Butyl Benzene	0.4	≤30%	70 – 130	70 – 130	± 25
Dibromomethane	0.4	≤30%	70 – 130	70 – 130	± 25
Ethyl Acetate	2.0	≤30%	70 – 130	70 – 130	± 25
Ethyl Ether	0.8	≤30%	70 – 130	70 – 130	± 25
Freon 22 (Chlorodifluoromethane)	0.8	≤30%	70 – 130	70 – 130	± 25
Methyl Methacrylate	0.8	≤30%	70 – 130	70 – 130	± 25
n-Butanol (1-Butanol)	0.8	≤30%	70 – 130	70 – 130	± 25
Nonane	0.8	≤30%	70 – 130	70 – 130	± 25
n-Pentane	0.8	≤30%	70 – 130	70 – 130	± 25
Octane	0.4	≤30%	70 – 130	70 – 130	± 25
sec-Butylbenzene	0.8	≤30%	70 – 130	70 – 130	± 25
tert-Butyl Alcohol	2.0	≤30%	70 – 130	70 – 130	± 25
tert-Butyl Benzene	0.8	≤30%	70 – 130	70 – 130	± 25
Vinyl Acetate	0.8	≤30%	70 – 130	70 – 130	± 25
Vinyl Bromide	0.8	≤30%	70 – 130	70 – 130	± 25

Table 3 is the list of additional Method TO-15 compounds that may be requested upon request with full QC – 5-point calibration, second source calibration verification, continuing calibration verification, laboratory control spike, and method detection limit study.

Table 4. Internal Standards

Analyte	Accuracy (% R)
Bromochloromethane	60 – 140
1,4-Difluorobenzene	60 – 140
Chlorobenzene-d_5	60 – 140

Table 5. Surrogates

Analyte	Accuracy (% R)
1,2-Dichloroethane-d_4	70 – 130
Toluene-d_8	70 – 130
4-Bromofluorobenzene	70 – 130

Table 6. Summary of Calibration and QC Procedures for Methods TO-14A/TO-15

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Every 24 hours	TO-15 ion abundance criteria	Correct problem then repeat tune.
Minimum 5-Point Initial Calibration (ICAL)	Prior to sample analysis	% RSD ≤ 30 with 2 compounds allowed out to ≤ 40% RSD	Correct problem then repeat Initial Calibration curve.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS)	After each Initial Calibration curve, and daily prior to sample analysis	Recoveries for 85% of "Standard" compounds must be 70–130%. No recovery may be < 50%. ICV evaluated on a full list basis at the time of calibration. If specified by the project, in-house generated control limits may be used.	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS) for Non-standard compounds	Per client request or specific project requirements only	Recoveries of compounds must be 60–140%. No recovery may be <50%.	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Continuing Calibration Verification (CCV) for Standard compounds	At the start of each analytical clock after the tune check	70–130%	Compounds exceeding this criterion and associated data will be flagged and narrated with the exception of high bias associated with non-detects. If more than two compounds from the standard list recover outside of 70–130% or > 10% of VOCs if short list is used (20 compounds or less), corrective action will be taken. If any compound exceeds 60–140%, samples are not analyzed unless data meets project needs. Check the system and reanalyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Continuing Calibration Verification (CCV) for Non-standard Compounds	Per client request or specific project requirements only.	Recoveries of compounds must be 60–140%. No recovery may be <50%.	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Laboratory Blank	After analysis of standards and prior to sample analysis, or when contamination is present.	Results less than the laboratory reporting limit	Inspect the system and re-analyze the blank. "B"-flag data for common contaminants.
Internal Standard (IS)	As each standard, blank, and sample is being loaded	Retention time (RT) for blanks and samples must be within ±0.33 min of the RT in the CCV and within ±40% of the area counts of the daily CCV internal standards.	**For blanks:** Inspect the system and reanalyze the blank. **For samples:** Re-analyze the sample. If the ISs are within limits in the re-analysis, report the second analysis. If ISs are out-of-limits a second time, dilute the sample until ISs are within acceptance limits and narrate.
Surrogates	As each standard, blank, and sample is being loaded	70–130% If specified by the project, in-house generated control limits may be used.	**For blanks:** Inspect the system and reanalyze the blank. **For samples:** Re-analyze the sample unless obvious matrix interference is documented. If the %Rs are within limits in the re-analysis, report the second analysis. If %Rs are out-of-limits a second time, report data from first analysis and narrate.
Laboratory Duplicates – Laboratory Control Spike Duplicates (LCSD)	One per analytical batch	RPD ≤25%	Narrate exceedances. If more than 5% of compound list is outside criteria or if compound has >40%RPD, investigate the cause and perform maintenance as required. If instrument maintenance is required, calibrate as needed.

ANALYTICAL METHODS

Section 11.0

Method: EPA Method TO-15 Volatile Organic Compounds (Extended)

Eurofins Air Toxics SOP #132 Revision 9 Effective Date: January 27, 2021 Methods Manual Summary

Description: This method involves full scan gas chromatograph/mass spectrometer (GC/MS) analysis of whole air samples collected in evacuated stainless steel canisters. Samples are analyzed for volatile organic compounds (VOCs) using EPA Method TO-15 protocols. An aliquot of up to 0.5 liters of air is withdrawn from the canister utilizing a mass flow controller. This volume is loaded onto a hydrophobic multibed sorbent trap to remove water and carbon dioxide and to concentrate the vapor sample. The focused sample is then flash-heated to sweep adsorbed VOCs onto onto a GC/MS for separation and detection.

Eurofins Air Toxics maintains a suite of TO-15 methods, each optimized to efficiently meet the data objectives for a wide range of targeted concentration ranges. The methods, their reporting limits, and typical applications are summarized in the table below. This method summary describes TO-15 (Extended).

Eurofins Air Toxics Method	Base Reporting Limits	Typical Application
TO-14A/TO-15 (5&20)	5 – 20 ppbv	Soil gas and ppmv range vapor matrices
TO-14A/TO-15 (Standard or Quad)	0.5 – 5.0 ppbv	Ambient air, soil gas, and ppbv level vapor matrices
TO-15 (Extended)	0.2 – 5.0 ppbv	Ambient air and ppbv level vapor matrices
TO-14A/TO-15 (Low-level)	0.1 – 1.0 ppbv	Indoor and outdoor air
TO-14A/TO-15 (SIM)	0.01 – 0.5 ppbv	Indoor and outdoor air
TO-15 HSS	0.01 – 0.1 ppbv	Soil gas and other high concentration matrices

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. Unless otherwise directed, Eurofins Air Toxics reports these non-routine compounds with partial validation. Validation may include a 3-point calibration with the lowest concentration defining the reporting limit, no second source verification analyzed, and no method detection limit study performed unless previous arrangements have been made. In addition, stability of the non-standard compound during sample storage is not validated. Full validation may be available upon request.

The laboratory performs a modified version of method TO-15 as detailed in Table 1. Please note that Method TO-15 was validated for specially treated canisters. As such, the use of Tedlar bags for sample collection is outside the scope of the method and not recommended for ambient or indoor air samples. It is the responsibility of the data user to determine the usability of TO-15 results generated from Tedlar bags.

Table 1. Summary of TO-15 (Extended) Method Modifications

Requirement	TO-15	EATL Modifications
Initial Calibration	≤ 30% RSD with 2 compounds allowed out to ≤40%RSD	Due to the large number of target compounds, the acceptance criterion is ≤30%RSD with 5 out ≤ 40%RSD for the list of 110 certified compounds. Acetaldehyde and 1,4-Dioxane are evaluated against ≤50%RSD and cannot exceed this criterion. Methanol is calibrated as a one-point.
Daily Continuing Calibration Verification (CCV)	±30% Difference	±30% D for a specified list of compounds with 5 compounds allowed outside this criteria up to ±40% D. Compounds with ±40%D or ±50%D criteria cannot exceed these limits.
Sample Internal Standard Recovery	±40% of CCV IS Area	±50% of CCV IS Area

The standard target analyte list, reporting limit (RL) also referred to as Limit of Quantitation, QC criteria, and QC summary can be found in Tables 2 through 5.

Table 2. Method TO-15 Analyte List (Extended) and QC Limits

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%D)	ICV/LCS* (%R)	Precision Limits (Max. RPD)
Ethylene	0.5	≤30%	≤50	50 - 150	± 25
Acetylene	0.5	≤30%	≤50	50 - 150	± 25
Ethane	0.5	≤30%	≤50	50 - 150	± 25
Propylene	0.2	≤30%	≤30	70 - 130	± 25
Propane	0.2	≤30%	≤30	70 - 130	± 25
Dichlorodiluoromethane/Fr12	0.2	≤30%	≤30	70 - 130	± 25
Chloromethane	0.2	≤30%	≤30	70 - 130	± 25
Isobutane	0.2	≤30%	≤30	70 - 130	± 25
Freon 114	0.2	≤30%	≤30	70 - 130	± 25
Acetaldehyde	2.0	≤50%	≤50	50 - 150	± 50
Vinyl Chloride	0.2	≤30%	≤30	70 - 130	± 25
1-Butene/Isobutene*	0.2	≤30%	≤30	70 - 130	± 25
1,3-Butadiene	0.5	≤30%	≤30	70 - 130	± 25
Butane	0.2	≤30%	≤30	70 - 130	± 25
Methanol (non-certified compound)	15.0	N/A	≤50	N/A	N/A
trans-2-Butene	0.2	≤30%	≤30	70 – 130	± 25
Bromomethane	0.2	≤30%	≤30	70 – 130	± 25
cis-2-Butene	0.2	≤30%	≤30	70 – 130	± 25

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%D)	ICV/LCS* (%R)	Precision Limits (Max. RPD)
Chloroethane	0.5	≤30%	≤30	70 – 130	± 25
Dichlorofluoromethane/Fr21	0.2	≤30%	≤30	70 – 130	± 25
Vinyl Bromide	0.2	≤30%	≤30	70 – 130	± 25
3-Methyl-1-Butene	0.2	≤30%	≤30	70 – 130	± 25
Acetonitrile	2.0	≤30%	≤50	50 – 150	± 25
Isopentane	0.2	≤30%	≤30	70 – 130	± 25
Trichlorofluoromethane/Fr11	0.2	≤30%	≤30	70 – 130	± 25
1-Pentene	0.2	≤30%	≤30	70 – 130	± 25
Pentane	0.2	≤30%	≤30	70 – 130	± 25
Acrylonitrile	2.0	≤30%	≤40	60 – 140	± 25
Isoprene	0.2	≤30%	≤30	70 – 130	± 25
trans-2-Pentene	0.2	≤30%	≤30	70 – 130	± 25
1,1-Dichloroethene	0.2	≤30%	≤30	70 – 130	± 25
cis-2-Pentene	0.2	≤30%	≤30	70 – 130	± 25
Methylene Chloride	0.2	≤30%	≤30	70 – 130	± 25
2-Methyl-2-Butene	0.2	≤30%	≤30	70 – 130	± 25
Freon 113	0.2	≤30%	≤30	70 – 130	± 25
2,2,-Dimethylbutane	0.2	≤30%	≤30	70 – 130	± 25
Cyclopentene	0.2	≤30%	≤30	70 – 130	± 25
trans-1,2-Dichloroethene	0.2	≤30%	≤30	70 – 130	± 25
4-Methyl-1-Pentene	0.2	≤30%	≤30	70 – 130	± 25
1,1-Dichloroethane	0.2	≤30%	≤30	70 – 130	± 25
Cyclopentane	0.2	≤30%	≤30	70 – 130	± 25
2,3-Dimethylbutane	0.2	≤30%	≤30	70 – 130	± 25
Methyl tert Butyl Ether/MTBE	0.2	≤30%	≤30	70 – 130	± 25
2-Methylpentane	0.2	≤30%	≤30	70 – 130	± 25
Vinyl Acetate	2.0	≤30%	≤40	60 – 140	± 25
2-Butanone	2.0	≤30%	≤40	60 – 140	± 25
3-Methylpentane	0.2	≤30%	≤30	70 – 130	± 25
Chloroprene	0.2	≤30%	≤30	70 – 130	± 25
cis-1,2-Dichloroethene	0.2	≤30%	≤30	70 – 130	± 25
Bromochloromethane	0.2	≤30%	≤30	70 – 130	± 25
Hexane	0.2	≤30%	≤30	70 – 130	± 25

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%D)	ICV/LCS* (%R)	Precision Limits (Max. RPD)
Chloroform	0.2	≤30%	≤30	70 – 130	± 25
trans-2-Hexene	0.2	≤30%	≤30	70 – 130	± 25
Cis-2-Hexene	0.2	≤30%	≤30	70 – 130	± 25
Methylcyclopentane	0.2	≤30%	≤30	70 – 130	± 25
1,2-Dichloroethane	0.2	≤30%	≤30	70 – 130	± 25
2,4-Dimethylpentane	0.2	≤30%	≤30	70 – 130	± 25
1,1,1-Trichloroethane	0.2	≤30%	≤30	70 – 130	± 25
Benzene	0.2	≤30%	≤30	70 – 130	± 25
Carbon Tetrachloride	0.2	≤30%	≤30	70 – 130	± 25
Cyclohexane	0.2	≤30%	≤30	70 – 130	± 25
2-Methylhexane	0.2	≤30%	≤30	70 – 130	± 25
2,3-Dimethylpentane	0.2	≤30%	≤30	70 – 130	± 25
3-Methylhexane	0.2	≤30%	≤30	70 – 130	± 25
1,2-Dichloropropane	0.2	≤30%	≤30	70 – 130	± 25
Bromodichloromethane	0.2	≤30%	≤30	70 – 130	± 25
Trichloroethene	0.2	≤30%	≤30	70 – 130	± 25
2,2,4-Trimethylpentane	0.2	≤30%	≤30	70 – 130	± 25
1,4-Dioxane	0.5	≤50%	≤50	50 – 150	± 50
Heptane	0.2	≤30%	≤30	70 – 130	± 25
cis-1,3-Dichloropropene	0.2	≤30%	≤30	70 – 130	± 25
4-Methyl-2-pentanone	0.5	≤30%	≤40	60 – 140	± 25
Methylcyclohexane	0.2	≤30%	≤30	70 – 130	± 25
trans-1,3-Dichloropropene	0.2	≤30%	≤30	70 – 130	± 25
1,1,2-Trichloroethane	0.2	≤30%	≤30	70 – 130	± 25
2,3,4-Trimethylpentane	0.2	≤30%	≤30	70 – 130	± 25
Toluene	0.2	≤30%	≤30	70 – 130	± 25
2-Methylheptane	0.2	≤30%	≤30	70 – 130	± 25
3-Methylheptane	0.2	≤30%	≤30	70 – 130	± 25
Dibromochloromethane	0.2	≤30%	≤30	70 – 130	± 25
1,2-Dibromoethane	0.2	≤30%	≤30	70 – 130	± 25
Octane	0.2	≤30%	≤30	70 – 130	± 25
Tetrachloroethene	0.2	≤30%	≤30	70 – 130	± 25
Chlorobenzene	0.2	≤30%	≤30	70 – 130	± 25

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%D)	ICV/LCS* (%R)	Precision Limits (Max. RPD)
Ethylbenzene	0.2	≤30%	≤30	70 – 130	± 25
m,p-Xylene	0.2	≤30%	≤30	70 – 130	± 25
Bromoform	0.2	≤30%	≤30	70 – 130	± 25
Styrene	0.2	≤30%	≤40	60 – 140	± 25
1,1,2,2,-Tetrachloroethane	0.2	≤30%	≤30	70 – 130	± 25
o-Xylene	0.2	≤30%	≤30	70 – 130	± 25
Nonane	0.2	≤30%	≤30	70 – 130	± 25
Cumene	0.2	≤30%	≤30	70 – 130	± 25
Propylbenzene	0.2	≤30%	≤30	70 – 130	± 25
4-Ethyltoluene	0.2	≤30%	≤30	70 – 130	± 25
1,3,5-Trimethylbenzene	0.2	≤30%	≤30	70 – 130	± 25
1,2,4-Trimethylbenzene	0.2	≤30%	≤30	70 – 130	± 25
2-Ethyltoluene	0.2	≤30%	≤30	70 – 130	± 25
3-Ethyltoluene	0.2	≤30%	≤30	70 – 130	± 25
alpha-Chlorotoluene	0.2	≤30%	≤50	50 – 150	± 25
Decane	0.5	≤30%	≤30	70 – 130	± 25
1,3-Dichlorobenzene	0.2	≤30%	≤30	70 – 130	± 25
1,4-Dichlorobenzene	0.2	≤30%	≤30	70 – 130	± 25
1,2,3-Trimethylbenzene	0.2	≤30%	≤30	70 – 130	± 25
1,2-Dichlorobenzene	0.2	≤30%	≤30	70 – 130	± 25
1,3-Diethylbenzene	0.2	≤30%	≤30	70 – 130	± 25
1,4-Diethylbenzene	0.2	≤30%	≤30	70 – 130	± 25
Undecane	0.2	≤30%	≤30	70 – 130	± 25
1,2,4-Trichlorobenzene	0.2	≤30%	≤50	50 – 150	± 25
Hexachlorobutadiene	0.2	≤30%	≤50	50 – 150	± 25

* 1-Butene and Isobutene co-elute. The response of 1-Butene will be used to report the compounds.

Table 3. TO-15 (Extended) Non-Standard Compounds and QC Limits

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria	
		ICAL (%RSD)	ICV (%R)
Freon 134a	0.2	≤40%	60 – 140
Freon 22 (Chlorodifluoromethane)	0.2	≤40%	60 – 140
Neopentane	0.2	≤40%	60 – 140

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria	
		ICAL (%RSD)	ICV (%R)
Ethanol	2.0	≤40%	60 – 140
Acrolein	2.0	≤40%	60 – 140
Acetone	2.0	≤40%	60 – 140
2-Propanol	2.0	≤40%	60 – 140
Diethyl Ether (Ethyl Ether)	2.0	≤40%	60 – 140
3-Chloroprene	0.2	≤40%	60 – 140
Carbon Disulfide	0.2	≤40%	60 – 140
1-Propanol	2.0	≤40%	60 – 140
cis-4-Methyl-2-pentene	0.2	≤40%	60 – 140
trans-4-Methyl-2-pentene	0.2	≤40%	60 – 140
Butyraldehyde (Butanal)	2.0	≤40%	60 – 140
1-Hexene/2-Methyl-1-pentene	0.4	≤40%	60 – 140
2-Ethyl-1-Butene	0.2	≤40%	60 – 140
cis-3-Hexene	0.2	≤40%	60 – 140
2-Methyl-2-pentene	0.2	≤40%	60 – 140
cis-3-Methyl-2-pentene	0.2	≤40%	60 – 140
Tetrahydofuran	2.0	≤40%	60 – 140
Methylcyclopentene	0.2	≤40%	60 – 140
1-Butanol (n-Butanol)	2.0	≤40%	60 – 140
Cyclohexene	0.2	≤40%	60 – 140
1-Heptene	0.2	≤40%	60 – 140
2-Chloropentane	0.2	≤40%	60 – 140
trans-3-Heptene	0.2	≤40%	60 – 140
cis-3-Heptene	0.2	≤40%	60 – 140
Trans-2-Heptene	0.2	≤40%	60 – 140
2,4,4-Trimethyl-1-pentene	0.2	≤40%	60 – 140
2,4,4-Trimethyl-2-pentene	0.2	≤40%	60 – 140
2,5-Dimethylhexane	0.2	≤40%	60 – 140
2,2,3-Trimethylpentane	0.2	≤40%	60 – 140
1-Methylcyclohexene	0.2	≤40%	60 – 140
2-Hexanone	0.2	≤40%	60 – 140
Hexanal	0.2	≤40%	60 – 140
2,2,5-Trimethylhexane	0.2	≤40%	60 – 140
1-Octene	0.2	≤40%	60 – 140

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria	
		ICAL (%RSD)	ICV (%R)
cis-2-Octene	0.2	≤40%	60 – 140
Butyl Acrylate	2.0	≤40%	60 – 140
Heptanal	0.2	≤40%	60 – 140
1-Nonene	0.2	≤40%	60 – 140
cis-4-Nonene	0.2	≤40%	60 – 140
trans-4-Nonene *	0.2	≤40%	60 – 140
Benzaldehyde	0.2	≤40%	60 – 140
2-,3-Chlorotoluene	0.4	≤40%	60 – 140
4-Chlorotoluene	0.2	≤40%	60 – 140
beta-Pinene	0.2	≤40%	60 – 140
Alpha-Pinene **	0.2	≤40%	60 – 140
1-Decene	0.2	≤40%	60 – 140
tert-Butylbenzene	0.2	≤40%	60 – 140
Isobutylbenzene	0.2	≤40%	60 – 140
4-Isopropyltoluene (p-Cymene)	0.2	≤40%	60 – 140
d-Limonene	0.2	≤40%	60 – 140
Indane (Indan)	0.2	≤40%	60 – 140
Indene	0.2	≤40%	60 – 140
Butylbenzene	0.2	≤40%	60 – 140
1-Undecene	0.2	≤40%	60 – 140
Naphthalene	0.2	≤40%	60 – 140

* Standard not available. The Response from cis-4-Nonene is used to calculate concentrations.
** Standard not available. The Response from beta-Pinene is used to calculate concentrations.

Table 4. Internal Standards

Analyte	Accuracy (% R)
1,4-Difluorobenzene	50 – 150
Chlorobenzene-d_5	50 – 150

Table 5. Surrogates

Analyte	Accuracy (% R)*
2-Bromo-1,1,1-Trifluoroethane	70 – 130
Fluorobenzene	70 – 130
Toluene-d_8	70 – 130
1,4-Dichlorobutane	70 – 130
4-Bromofluorobenzene	70 – 130

* In-house generated control limits may be used.

Table 6. Summary of Calibration and QC Procedures for Method TO-15 (Extended)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Every 24 hours	TO-15 ion abundance criteria	Correct problem then repeat tune.
Minimum 5-Point Initial Calibration (ICAL); One-point calibration for Methanol only.	Prior to sample analysis	% RSD ≤ 30 with 5% of compounds allowed out to ≤ 40% RSD; Compounds with ±40% RSD and ±50% RSD criteria must be within these limits.	Correct problem then repeat Initial Calibration Curve.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS)	After each Initial Calibration curve, and daily prior to sample analysis; No ICV or LCS requirement for Methanol	Recoveries for 85% of "Standard" compounds must be 70–130%. No recovery may be < 50%. If specified by the project, in-house generated control limits may be used.	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS) for Non-standard compounds	After each initial calibration curve.	Recoveries of compounds must be 60–140% for 85% of the compounds. No recovery may be <50%.	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Continuing Calibration Verification (CCV) for Standard compounds	At the start of each analytical clock after the tune check	70–130% (See Tables above for exceptions.)	Compounds exceeding this criterion and associated data will be flagged and narrated with the exception of high bias associated with non-detects. If more than 5% of the compounds from the standard list recover outside of 70–130% and/or if certified compounds , with criteria of 60-140% and 50-150% recover outside these limits samples are not analyzed unless data meets project needs. Corrective action must be taken if project needs are not met. Check the system and reanalyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met. For Methanol re-calibrate the one-point calibration using the daily CCV for the calibration if criterion of ≤50% D is not met.
Continuing Calibration Verification (CCV) for Non-standard Compounds	Per client request or specific project requirements only.	Recoveries of compounds must be 60–140% for 85% of the compounds. No recovery may be <50%.	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Laboratory Blank	After analysis of standards and prior to sample analysis, or when contamination is present.	Results less than the laboratory reporting limit	Inspect the system and re-analyze the blank. "B"-flag data for common contaminants.
Internal Standard (IS)	As each standard, blank, and sample is being loaded	Retention time (RT) for blanks and samples must be within ±0.33 min of the RT in the CCV and within ±50% of the area counts of the daily CCV internal standards.	**For blanks:** Inspect the system and reanalyze the blank. **For samples:** Re-analyze the sample. If the ISs are within limits in the re-analysis, report the second analysis. If ISs are out-of-limits a second time, evaluate impact on data and narrate.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Surrogates	As each standard, blank, and sample is being loaded	70–130% Or in-house generated control limits may be used.	**For blanks:** Inspect the system and reanalyze the blank. **For samples:** Re-analyze the sample unless obvious matrix interference is documented. If the %Rs are within limits in the re-analysis, report the second analysis. If %Rs are out-of-limits a second time, report data from first analysis and narrate.
Laboratory Duplicates – Laboratory Control Spike Duplicates (LCSD)	One per analytical batch; No LCSD requirement for Methanol	RPD ≤25%	Narrate exceedances. If more than 5% of compound list is outside criteria or if compound has >40%RPD, investigate the cause and perform maintenance as required. If instrument maintenance is required, calibrate as needed.

ANALYTICAL METHODS

Section 12.0

Method: EPA Method TO-14A/TO-15 Volatile Organic Compounds (Low-Level)

Eurofins Air Toxics SOP #83 Revision 24 Effective Date: November 29, 2021 Methods Manual Summary

Description: This method involves full scan gas chromatograph/mass spectrometer (GC/MS) analysis of whole air samples collected in evacuated stainless steel canisters. Samples are analyzed for volatile organic compounds (VOCs) using EPA Method TO-14A/TO-15 protocols. An aliquot of up to 400 mL of air is withdrawn from the canister utilizing a mass flow controller. This volume is loaded onto a hydrophobic multibed sorbent trap to remove water and carbon dioxide and to concentrate the vapor sample. The focused sample is then flash-heated to sweep adsorbed VOCs onto a GC/MS for separation and detection. Compounds are detected using a mass spectrometer operating in full scan mode.

Eurofins Air Toxics maintains a suite of TO-14A/TO-15 methods, each optimized to efficiently meet the data objectives for a wide range of targeted concentration ranges. The methods, their reporting limits, and typical applications are summarized in the table below. This method summary describes TO-14A/TO-15 (Low-Level).

Eurofins Air Toxics Method	Base Reporting Limits	Typical Application
TO-14A/TO-15 (5&20)	5 – 20 ppbv	Soil gas and ppmv range vapor matrices
TO-14A/TO-15 (Standard or Quad)	0.5 – 5.0 ppbv	Ambient air, soil gas, and ppbv level vapor matrices
TO-15 (Extended)	0.2 – 5.0 ppbv	Ambient air and ppbv level vapor matrices
⇨ TO-14A/TO-15 (Low-level)	0.1 – 1.0 ppbv	Indoor and outdoor air
TO-14A/TO-15 (SIM)	0.01 – 0.5 ppbv	Indoor and outdoor air
TO-15 HSS	0.01 – 0.1 ppbv	Soil gas and other high concentration matrices

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. Unless otherwise directed, Eurofins Air Toxics reports these non-routine compounds with partial validation. Validation may include a 3-point calibration with the lowest concentration defining the reporting limit, no second source verification analyzed, and no method detection limit study performed unless previous arrangements have been made. In addition, stability of the non-standard compound during sample storage is not validated. Full validation may be available upon request.

Since Eurofins Air Toxics applies TO-15 methodology to all Summa™ canisters regardless of whether TO-14A or TO-15 is specified by the project, Eurofins Air Toxics performs a modified version of method TO-14A as detailed in Table 1. Please note that Methods TO-14A and TO-15 were validated for specially treated canisters. As such, the use of Tedlar bags for sample collection is outside the scope of the method and is not recommended for ambient or indoor air samples. It is the responsibility of the data user to determine the usability of TO-14A and TO-15 results generated from Tedlar bags.

All samples submitted for TO-15 Low-Level are screened prior to analysis. If samples contain high concentrations of target and/or non-target VOCs, samples may be analyzed by an alternative TO-15 method (i.e., Standard or 5&20) with a higher dynamic calibration range.

Table 1. Summary of TO-14A Method Modifications

Requirement	TO-14A	Eurofins Air Toxics Modifications
Sample Drying System	Nafion Dryer	Multibed hydrophobic sorbent
Blank acceptance criteria	< 0.2 ppbv	< RL
BFB ion abundance criteria	Ion abundance criteria listed in Table 4 of TO-14A	Follow abundance criteria listed in TO-15.
BFB absolute abundance criteria	Within 10% when comparing to the previous daily BFB	CCV internal standard area counts are compared to ICAL; corrective action taken when recovery is less than 60%.
Blanks and standards	Zero Air	UHP Nitrogen provides a higher purity gas matrix than zero air for trace level measurements.
Initial Calibration	≤ 30% RSD for listed 39 VOCs	≤ 30% RSD with 4 compounds allowed out to ≤ 40%

Table 2. Summary of Method TO-15 Modifications

Requirement	TO-15	Eurofins Air Toxics Modifications
Initial Calibration	≤ 30% RSD with 2 compounds allowed out to < 40% RSD	≤ 30% RSD with 4 compounds allowed out to ≤ 40%
Blanks and standards	Zero Air	UHP Nitrogen provides a higher purity gas matrix than zero air for trace level measurements.

The standard target analyte list, reporting limits (RL), also referred to as Limit of Quantitation (LOQ), Quality Control (QC) criteria, and QC summary can be found in tables 3 through 6.

Table 3. Method TO-14A/TO-15 Standard Analyte List (Low-Level) and QC Limits

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS* (%R)	Precision Limits (Max. RPD)
1,1,2,2-Tetrachloroethane	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,1,2-Trichloroethane	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,1-Dichloroethane	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,1-Dichloroethene	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,2,4-Trichlorobenzene	0.5	≤ 30%	70 – 130	70 – 130	± 25
1,2,4-Trimethylbenzene	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dibromoethane (EDB)	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichlorobenzene	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichloroethane	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichloropropane	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,3,5-Trimethylbenzene	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,3-Dichlorobenzene	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,4-Dichlorobenzene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Benzene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Bromomethane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Carbon Tetrachloride	0.1	≤ 30%	70 – 130	70 – 130	± 25
Chlorobenzene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Chloroethane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Chloroform	0.1	≤ 30%	70 – 130	70 – 130	± 25
Chloromethane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Chlorotoluene (Benzyl Chloride)	0.1	≤ 30%	70 – 130	70 – 130	± 25
cis-1,2-Dichloroethene	0.1	≤ 30%	70 – 130	70 – 130	± 25
cis-1,3-Dichloropropene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Dichloromethane (Methylene Chloride)	0.2	≤ 30%	70 – 130	70 – 130	± 25
Ethylbenzene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Freon 11 (Trichlorofluoromethane)	0.1	≤ 30%	70 – 130	70 – 130	± 25
Freon 113 (Trichlorotrifluoroethane)	0.1	≤ 30%	70 – 130	70 – 130	± 25
Freon 114	0.1	≤ 30%	70 – 130	70 – 130	± 25
Freon 12 (Dichlorodifluoromethane)	0.5	≤ 30%	70 – 130	70 – 130	± 25
Hexachlorobutadiene	0.5	≤ 30%	70 – 130	70 – 130	± 25
m,p-Xylene	0.1	≤ 30%	70 – 130	70 – 130	± 25

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS* (%R)	Precision Limits (Max. RPD)
Methyl Chloroform (1,1,1-Trichloroethane)	0.1	≤ 30%	70 – 130	70 – 130	± 25
o-Xylene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Styrene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Tetrachloroethene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Toluene	0.1	< 30%	70 – 130	70 – 130	± 25
trans-1,3-Dichloropropene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Trichloroethene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Vinyl Chloride	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,3-Butadiene	0.1	≤ 30%	70 – 130	70 – 130	± 25
1,4-Dioxane	0.1	≤ 30%	70 – 130	70 – 130	± 25
2-Butanone (Methyl Ethyl Ketone)	0.5	≤ 30%	70 – 130	70 – 130	± 25
2-Hexanone	0.5	≤ 30%	70 – 130	70 – 130	± 25
4-Ethyltoluene	0.1	≤ 30%	70 – 130	70 – 130	± 25
4-Methyl-2-Pentanone (MIBK)	0.1	≤ 30%	70 – 130	70 – 130	± 25
Acetone	1.0	≤ 30%	70 – 130	70 – 130	± 25
Bromodichloromethane	0.1	≤ 30%	70 – 130	70 – 130	± 25
Bromoform	0.1	≤ 30%	70 – 130	70 – 130	± 25
Carbon Disulfide	0.5	≤ 30%	70 – 130	70 – 130	± 25
Cumene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Cyclohexane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Dibromochloromethane	0.1	≤ 30%	70 – 130	70 – 130	± 25
Ethanol	1.0	≤ 30%	70 – 130	70 – 130	± 25
Heptane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Hexane	0.5	≤ 30%	70 – 130	70 – 130	± 25
Isopropanol	1.0	≤ 30%	70 – 130	70 – 130	± 25
Methyl tert-Butyl Ether (MTBE)	0.1	≤ 30%	70 – 130	70 – 130	± 25
Propylbenzene	0.1	≤ 30%	70 – 130	70 – 130	± 25
Tetrahydrofuran	0.5	≤ 30%	70 – 130	70 – 130	± 25
trans-1,2-Dichloroethene	0.1	≤ 30%	70 – 130	70 – 130	± 25
2,2,4-Trimethylpentane	0.5	≤ 30%	70 – 130	70 – 130	± 25
3-Chloroprene	0.5	≤ 30%	70 – 130	70 – 130	± 25
Naphthalene**	0.5	≤ 40%	60 – 140	60 – 140	± 25

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS* (%R)	Precision Limits (Max. RPD)
TPH (Gasoline)***	10	1- Point Calibration	N/A	ICV only: 60 – 140	± 25
NMOC (Hexane/Heptane)***	2.0	1- Point Calibration	N/A	N/A	± 25

*See Table 6.

**Due to its low vapor pressure, Naphthalene does not meet TO-15 performance requirements. The wider QC limits reflect typical performance. Although Naphthalene is not on Eurofins Air Toxics "standard" TO-15 list, it is commonly requested and therefore included in Table 3.

***TPH and NMOC are not on Eurofins Air Toxics' standard TO-15 list, but are included in Table 3 due to common requests.

Table 3 is the list of Standard compounds, reporting limits and QC acceptance criteria. Each project may be customized as needed. Additional compounds and different reporting limits may be obtainable and/or achieved upon request

Table 4. Internal Standards

Analyte	Accuracy (% R)
Bromochloromethane	60 – 140
1,4-Difluorobenzene	60 – 140
Chlorobenzene-d_5	60 – 140

Table 5. Surrogates

Analyte	Accuracy (% R)
1,2-Dichloroethane-d_4	70 – 130
Toluene-d_8	70 – 130
4-Bromofluorobenzene	70 – 130

Table 6. Summary of Calibration and QC Procedures for Methods TO-14A/TO-15 Low-Level

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Every 24 hours	TO-15 ion abundance criteria	Correct problem then repeat tune.
Minimum 5-Point Initial Calibration (ICAL)	Prior to sample analysis	% RSD ≤ 30 with 4 compounds allowed out to ≤ 40% RSD	Correct problem then repeat Initial Calibration curve.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS)	After each Initial Calibration curve, and daily prior to sample analysis	Recoveries for 85% of Standard compounds must be 70–130%. No recovery may be < 50%. ICV is evaluated on a full list basis at the time of calibration. If specified by the project, in-house generated control limits may be used.	Check the system and re-analyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS) for Non-standard Compounds	Per client request or specific project requirements only	Recoveries of compounds must be 60–140%. No recovery may be <50%.	Check the system and re-analyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Continuing Calibration Verification (CCV) for Standard compounds	At the start of each analytical clock (24-hours) after the tune check	70–130%	Compounds exceeding this criterion and associated data will be flagged and narrated with the exception of high bias associated with non-detects. If more than 4 compounds from the standard list recover outside of 70–130% or >10% of VOCs if short list is used (40 compounds or less), corrective action will be taken. If any compound exceeds 60–140%, samples are not analyzed unless data meets project needs. Check the system and re-analyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Continuing Calibration Verification (CCV) for Non-Standard compounds	Per client request or specific project requirements only	Recoveries of compounds must be 60–140%. No recovery may be <50%.	Check the system and re-analyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Laboratory Blank	After analysis of standards and prior to sample analysis, or when contamination is present	Results less than the laboratory reporting limit	Inspect the system and re-analyze the blank. "B"-flag data for common contaminants.
Internal Standard (IS)	As each standard, blank, and sample is being loaded	Retention time (RT) for blanks and samples must be within ±0.33 min of the RT in the CCV and within ± 40% of the area counts of the daily CCV internal standards.	**For blanks:** Inspect the system and reanalyze the blank. **For samples:** Re-analyze the sample unless obvious matrix interference is documented. If the ISs are within limits in the re-analysis, report the second analysis. If ISs are out-of-limits a second time, report data from first analysis and narrate.
Surrogates	As each standard, blank, and sample is being loaded	70–130% R If specified by the project, in-house generated control limits may be used.	**For blanks:** Inspect the system and re-analyze the blank **For samples:** Re-analyze the sample unless obvious matrix interference is documented. If the %Rs are within limits in the re-analysis, report the second analysis. If %Rs are out-of-limits a second time, report data from first analysis and narrate.
Laboratory Duplicates - Laboratory Control Spike Duplicate (LCSD)	One per analytical batch	RPD ≤25%	Narrate exceedances. If more than 5% of compound list is outside criteria or if compound is >40% RPD, investigate the cause and perform maintenance as required. If instrument maintenance is required, calibrate as needed.

ANALYTICAL METHODS

Section 13.0

Method: EPA Method TO-14A/TO-15 Volatile Organic Compounds by SIM

Eurofins Air Toxics SOP #38 Revision 26 Effective Date: December 16, 2021 Methods Manual Summary

Description: This method involves Selective Ion Monitoring (SIM) gas chromatograph/mass spectrometer (GC/MS) analysis of whole air samples collected in evacuated stainless steel canisters. Samples are analyzed for volatile organic compounds (VOCs) using EPA Method TO-14A/TO-15 protocols. An aliquot of the sample is withdrawn from the canister through a mass flow controller and concentrated onto a hydrophobic drying system that removes water from the sample stream. The sample is then focused onto a cryogenic-cooled column prior to analysis by GC/MS in the SIM mode.

Mass spectrometer detectors can be set to acquire both SIM and full scan data simultaneously. This generates two separate data files in the analytical software. One file contains full scan data and the other contains SIM data for selected compounds. The results for each sample in a report will be from two separate data files originating from the same analytical run. The two data files have the same base file name and are differentiated with a "sim" extension on the SIM data file.

Eurofins Air Toxics maintains a suite of TO-14A/TO-15 methods, each optimized to efficiently meet the data objectives for a wide range of targeted concentration ranges. The methods, their reporting limits, and typical applications are summarized in the table below. This method summary describes TO-14A/TO-15 SIM.

Eurofins Air Toxics Method	Base Reporting Limits	Typical Application
TO-14A/TO-15 (5&20)	5 – 20 ppbv	Soil gas and ppmv range vapor matrices
TO-14A/TO-15 (Standard or Quad)	0.5 – 5.0 ppbv	Ambient air, soil gas, and ppbv level vapor matrices
TO-15 (Extended)	0.2 – 5.0 ppbv	Ambient air and ppbv level vapor matrices
TO-14A/TO-15 (Low-level)	0.1 – 1.0 ppbv	Indoor and outdoor air
⇨ TO-14A/TO-15 SIM	0.01 – 0.5 ppbv	Indoor and outdoor air
TO-15 HSS	0.01 – 0.1 ppbv	Soil gas and other high concentration matrices

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. If full validation of the required compound(s) is not available, the laboratory will present Quality Control (QC) options to the client based on the project objectives.

Please note that Methods TO-14A and TO-15 were validated for specially treated canisters. As such, the use of Tedlar bags for sample collection is outside the scope of the method and not recommended for ambient or indoor air samples. It is the responsibility of the data user to determine the usability of TO-14A and TO-15 results generated from Tedlar bags.

All samples submitted for TO-15 SIM are screened prior to analysis. If samples contain high concentrations of target and/or non-target VOCs, samples may be analyzed by an alternative TO-15 method (i.e. Standard or 5&20) with a higher dynamic calibration range.

Eurofins Air Toxics performs a modified version of TO-15 SIM as detailed in Table 1. Additionally, since Eurofins Air Toxics applies TO-15 methodology to all Summa™ canisters regardless of whether TO-14A or TO-15 is specified by the project, Eurofins Air Toxics performs a modified version of method TO-14A as described in Table 2. The default SIM target list, reporting limits (RL), QC criteria and QC summary may be found in tables 3 through 7.

Table 1. Summary of TO-15 SIM Method Modifications

Requirement	TO-15	Eurofins Air Toxics Modifications
Blank and standards	Zero Air	UHP Nitrogen provides a higher purity gas matrix than zero air for trace level measurements.

Table 2. Summary of TO-14A SIM Method Modifications

Requirement	TO-14A	Eurofins Air Toxics Modifications
Sample Drying System	Nafion Dryer	Multibed hydrophobic sorbent
ICAL %RSD acceptance criteria	≤ 30% RSD for listed 39 VOCs	Follow TO-15 requirements of ≤ 30%RSD with 2 of standard compound list allowed out to ≤ 40%RSD
Blank and standards	Zero air	UHP Nitrogen provides a higher purity gas matrix than zero air for trace level measurements.
BFB ion abundance criteria	Ion abundance criteria listed in Table 4 of TO-14A	Follow abundance criteria listed in TO-15.
BFB absolute abundance criteria	Within 10% when comparing to the previous daily BFB	CCV internal standard area counts are compared to ICAL; corrective action when recovery is less than 60%

Table 3. Method TO-14A/TO-15 Standard Analyte List (SIM) and QC Limits

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
Dichlorodifluoromethane (Fr12)	0.020	≤ 30%	70 – 130	70 – 130	± 25
Freon 114	0.020	≤ 30%	70 – 130	70 – 130	± 25
Chloromethane	0. 50	≤ 30%	70 – 130	70 – 130	± 25
Vinyl Chloride	0.010	≤ 30%	70 – 130	70 – 130	± 25
Chloroethane	0.050	≤ 30%	70 – 130	70 – 130	± 25
Freon 11	0.02	≤ 30%	70 – 130	70 – 130	± 25
Freon 113	0.02	≤ 30%	70 – 130	70 – 130	± 25
1,1-Dichloroethene	0.010	≤ 30%	70 – 130	70 – 130	± 25
Trans-1,2-Dichloroethene	0.100	≤ 30%	70 – 130	70 – 130	± 25
Methyl tert-Butyl Ether	0.100	≤ 30%	70 – 130	70 – 130	± 25
1,1-Dichloroethane	0.020	≤ 30%	70 – 130	70 – 130	± 25
cis-1,2-Dichloroethene	0.020	≤ 30%	70 – 130	70 – 130	± 25
Chloroform	0.020	≤ 30%	70 – 130	70 – 130	± 25
1,1,1-Trichloroethane	0.020	≤ 30%	70 – 130	70 – 130	± 25
Carbon Tetrachloride	0.020	≤ 40%	60 - 140	60 - 140	± 25
Benzene	0.050	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dichloroethane	0.020	≤ 30%	70 – 130	70 – 130	± 25
Trichloroethene	0.020	≤ 30%	70 – 130	70 – 130	± 25
Toluene	0.050	≤ 30%	70 – 130	70 – 130	± 25
1,1,2-Trichloroethane	0.020	≤ 30%	70 – 130	70 – 130	± 25
Tetrachloroethene	0.020	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dibromoethane	0.020	≤ 30%	70 – 130	70 – 130	± 25
Ethyl Benzene	0.020	≤ 30%	70 – 130	70 – 130	± 25
m,p-Xylene	0.040	≤ 30%	70 – 130	70 – 130	± 25
o-Xylene	0.020	≤ 30%	70 – 130	70 – 130	± 25
1,1,2,2-Tetrachloroethane	0.020	≤ 30%	70 – 130	70 – 130	± 25
1,4-Dichlorobenzene	0.020	≤ 30%	70 – 130	70 – 130	± 25
Naphthalene	0.050	≤ 40%	60 – 140	60 – 140	± 25

Table 3 is the list of Standard compounds, reporting limits and QC acceptance criteria. Each project may be customized as needed. Additional compounds and different reporting limits may be obtainable and/or achieved upon request.

Table 4. Method TO-15 Extended Analyte List (SIM) and QC Limits

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
1,2-Dichlorobenzene	0.050	≤30%	70 - 130	70 - 130	± 25
1,3-Dichlorobenzene	0.100	≤30%	70 - 130	70 - 130	± 25
Chlorobenzene	0.020	≤30%	70 - 130	70 - 130	± 25
trans-1,3-Dichloropropene	0.020	<30%	70 - 130	70 - 130	± 25

Table 4 is the list of additional Method TO-15 SIM compounds that may be requested upon request with full QC – 5-point calibration, second source calibration verification, continuing calibration verification, laboratory control spike, and method detection limit study.

Table 5. Internal Standards

Analyte	Accuracy (% R)
Bromochloromethane	60 – 140
1,4-Difluorobenzene	60 – 140
Chlorobenzene-d_5	60 – 140

Table 6. Surrogates

Analyte	Accuracy (% R)
1,2-Dichloroethane-d_4	70 – 130
Toluene-d_8	70 – 130
4-Bromofluorobenzene	70 – 130

Table 7. Summary of Calibration and QC Procedures for Methods TO-14A/TO-15 by SIM

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Every 24 hours	TO-15 Ion Abundance criteria	Correct problem then repeat tune.
Multi-point Calibration (Minimum of 5 points)	Prior to sample analysis	≤ 30% for standard compounds with 2 compounds allowed out to ≤ 40% RSD	Correct problem then repeat Initial Calibration Curve.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS)	After each initial calibration curve, and daily prior to sample analysis	Recoveries for 85% of standard compounds must be 70–130% 60–140% for Carbon Tetrachloride and Naphthalene). No recovery may be < 50%. ICV evaluated on a full list basis at the time of calibration. If specified by the project, in-house generated control limits may be used.	Check the system and re-analyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS) for Non-Standard Compounds	Per client request or specific project requirements only	Recoveries of compounds must be 60–140%. No recovery may be < 50%.	Check the system and re-analyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Continuing Calibration Verification (CCV)	At the start of each day after the BFB tune check	70–130%D; 60-140% D for Carbon Tetrachloride and Naphthalene.	Compounds exceeding this criterion and associated data will be flagged and narrated with the exception of high bias associated with non-detects. If more than two compounds from the standard list recover outside of 70–130%, corrective action will be taken. If any compound exceeds 60–140%, samples are not analyzed unless data meets project needs. Check the system and re-analyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Continuing Calibration Verification (CCV) for Non-Standard Compounds	Per client request or specific project requirements only	Recoveries of compounds must be 60–140%. No recovery may be < 50%.	Check the system and re-analyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Laboratory Blank	After analysis of standards and prior to sample analysis, or when contamination is present.	Results less than the laboratory reporting limit (Tables 3 and 4) or project required reporting limit.	Inspect the system and re-analyze the blank. "B" flag data for common contaminants.
Internal Standard (IS)	As each standard, blank, and sample is being loaded	Retention time (RT) for blanks and samples must be within ±0.33 min of the RT in the CCV and within ±40% of the area counts of the daily CCV internal standards.	**For blanks:** Inspect the system and re-analyze the blank. **For samples:** Re-analyze the sample. If the ISs are within limits in the re-analysis, report the second analysis. If ISs are out-of-limits a second time, dilute the sample until ISs are within acceptance limits and narrate.
Surrogates	As each standard, blank, and sample is being loaded	70–130% If specified by the project, in-house generated control limits may be used.	**For blanks:** Inspect the system and re-analyze the blank. **For samples:** Re-analyze the sample unless obvious matrix interference is documented. If the %Rs are within limits in the re-analysis, report the second analysis. If %Rs are out-of-limits a second time, report data from first analysis and narrate.
Laboratory Duplicates - Laboratory Control Spike Duplicate (LCSD)	One per analytical batch	RPD ≤ 25%	Narrate exceedances. If more than 5% of compound list outside criteria or if compound is > 40%RPD, investigate the cause and perform maintenance as required. If instrument maintenance is required, calibrate as needed.

ANALYTICAL METHODS

Section 14.0

Method: EPA Method TO-15 Volatile Organic Compounds High Selectivity/Sensitivity (HSS)

Eurofins Air Toxics SOP #133 Revision 6 Effective Date: April 15, 2021 Methods Manual Summary

Description: This method involves gas chromatograph/mass spectrometer (GC/MS) analysis of whole air samples collected in evacuated specially treated stainless steel canisters. Samples are analyzed for volatile organic compounds (VOCs) in compliance with EPA Method TO-15 QA/QC protocols. Using the TO-15 air interface, up to 0.05 liters of the vapor sample is concentrated on a multi-bed trap. After removal of air and water and addition of internal standards, the trap is heated and the VOCs are transferred to a customized GC for separation. This customized GC relies on a sequence of chromatographic separations and timed heart-cuts to remove matrix and isolate the target VOC for final detection by MS. The TO-15 HSS utilizes a Time-of-Flight MS for detection in order to generate full scan spectra with SIM-level sensitivity.

Eurofins Air Toxics maintains a suite of TO-14A/TO-15 methods, each optimized to efficiently meet the data objectives for a wide range of targeted concentration ranges and matrices. The methods, their reporting limits, and typical applications are summarized in the table below. This method summary describes TO-15 HSS which is designed for measuring select VOC(s) at trace levels in high concentration matrices.

Eurofins Air Toxics Method	Base Reporting Limits	Typical Application
TO-14A/TO-15 (5&20)	5 – 20 ppbv	Soil gas and ppmv range vapor matrices
TO-14A/TO-15 (Standard or Quad)	0.5 – 5.0 ppbv	Ambient air, soil gas, and ppbv level vapor matrices
TO-15 (Extended)	0.2 – 5.0 ppbv	Ambient air and ppbv level vapor matrices
TO-14A/TO-15 (Low-level)	0.1 – 1.0 ppbv	Indoor and outdoor air
TO-14A/TO-15 SIM	0.01 – 0.5 ppbv	Indoor and outdoor air
⇨ TO-15 HSS	0.01 – 0.1 ppbv	Soil gas and other high concentration matrices

Modifications to EPA Method TO-15 using this application are summarized in Table 1. As a note, TO-15 was published in 1999 when laboratory options were largely limited to linear quadrupole and ion trap MS detection since the TOF-MS technology had not yet developed as an economical or practical platform for commercial environmental laboratories. While TOF-MS is called out as a modification to TO-15 since only linear quadrupole and ion trap are described, the TOF-MS meets all spectral performance requirements outlined in the method and provides full scan data consistent with quadrupole MS systems and NIST reference spectral libraries.

Table 1. Summary of TO-15 HSS Method Modifications

Requirement	TO-15	Eurofins Air Toxics Modifications
Detector	Linear quadrupole or ion trap mass spectrometer	Time-of-Flight mass spectrometer (meets all method spectral performance requirements)
Internal standards	Bromochloromethane, 1,4-Difluorobenzene, Chlorobenzene-d5	Deuterated analogues of the target compounds or suitable deuterated compounds eluting closely with the target compounds through the series of columns

The standard target analyte list, reporting limit (RL) also referred to as Limit of Quantitation, QC criteria, and QC summary can be found in Tables 2 through 4.

Table 2. Method TO-15 HSS Analyte List

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
1,2-Dichloroethane (EDC)	0.05	≤ 30%	70 – 130	70 – 130	± 25
1,2-Dibromoethane (EDB)	0.01	≤ 30%	70 – 130	70 – 130	± 25
1,4-Dioxane	0.05	≤ 30%	70 – 130	70 – 130	± 25
Naphthalene	0.05	≤ 30%	70 – 130	70 – 130	± 25
Benzene	0.25	≤ 30%	70 – 130	70 – 130	± 25
Hexachlorobutadiene	0.05	≤ 30%	70 – 130	70 – 130	± 25

Table 3. Internal Standards

Internal Standard (IS)	IS Conc (ppbv)	%D compared to CCV	Target Compound
1,2-Dichloroethane-d4	0.25	±40%	1,2-Dichloroethane
1,2-Dibromoethane-d4	0.25	±40%	1,2-Dibromoethane
1,4-Dioxane-d8	1.0	±40%	1,4-Dioxane
Naphthalene-d8	1.0	±40%	Naphthalene
Naphthalene-d8	1.0	±40%	Hexachlorobutadiene
Benzene-d6	1.0	±40%	Benzene

Table 4. Summary of Calibration and QC Procedures for Method TO-15 HSS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Every 24 hours	TO-15 ion abundance criteria	Correct problem then repeat tune.
Minimum 5-Point Initial Calibration (ICAL)	Prior to sample analysis	≤ 30% RSD	Correct problem then repeat Initial Calibration curve.
Initial Calibration Verification and Laboratory Control Spike (ICV and LCS)	After each Initial Calibration curve, and daily prior to sample analysis	Recovery must be 70-130%	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Continuing Calibration Verification (CCV)	At the start of each analytical clock after the tune check	≤ 30% D	Check the system and reanalyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met.
Laboratory Blank	After analysis of standards and prior to sample analysis, or when contamination is present.	Results less than the laboratory reporting limit	Inspect the system and re-analyze the blank.
Internal Standard (IS)	As each standard, blank, and sample is being loaded	Retention time (RT) for blanks and samples must be within ±0.33 min of the RT in the CCV and within ±40% of the area counts of the daily CCV internal standards.	**For blanks:** Inspect the system and reanalyze the blank. **For samples:** Re-analyze the sample. If the ISs are within limits in the re-analysis, report the second analysis. If ISs are out-of-limits a second time, dilute the sample until ISs are within acceptance limits and narrate.
Laboratory Duplicates – Laboratory Control Spike Duplicates (LCSD)	One per analytical batch	RPD ≤25%	Investigate the cause and perform maintenance as required. If instrument maintenance is required, calibrate as needed.

ANALYTICAL METHODS

Section 15.0

Method: EPA Method TO-15 Analysis of Ethylene Oxide in Specially Treated Canisters by GC/MS Selective Ion Monitoring

Eurofins Air Toxics SOP #134 Revision 8 Effective Date: July 14, 2021 Methods Manual Summary

Description: This method involves the collection of ethylene oxide in ambient air using specially treated evacuated canisters. Up to 0.5 liters of air is withdrawn from the canister using a mass flow controller and concentrated on a series of traps designed to remove water from the sample stream. The sample is then focused onto a cryogenic-cooled column prior to analysis by GC/MS in the Selected Ion Monitoring (SIM) mode.

The mass spectrometer is set to acquire both SIM and full scan data simultaneously. This generates two separate data files in the analytical software. One file contains full scan data and the other contains SIM data for selected compounds. Ethylene oxide is quantified using the SIM file and the full scan data file is used if needed to assist to aid in confirmation and identification of potential interfering compounds.

The reporting limits and QC acceptance criteria are summarized in Table 1. The summary of calibration and QC procedures are summarized in Tables 2 and 3.

Table 1. Reporting Limits and QC Acceptance Criteria

Analyte	RL/LOQ (ppbv)	QC Acceptance Criteria			
		ICAL (%RSD)	CCV (%R)	ICV/LCS (%R)	Precision Limits (Max. RPD)
Ethylene Oxide	0.050	≤30%	70 - 130	70 - 130	± 25

Table 2. Internal Standard

Analyte	Accuracy (%R)
2-Bromo-1,1,1-trifluoroethane	60 - 140

Table 3. Summary of Calibration and QC Procedures for Method TO-15 SIM

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Every 24 hours.	TO-15 Ion Abundance criteria	Correct problem then repeat tune.
Multi-Point Calibration (minimum of 5 points)	Prior to sample analysis.	≤30% RSD.	Correct problem then repeat Initial Calibration Curve.
Initial Calibration Verification and Laboratory Control Sample (ICV and LCS)	After each initial calibration curve, and daily, prior to sample analysis.	70-130%	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Re-calibrate the instrument if the primary standard is found to be in error.
Continuing Calibration Verification (CCV)	At the start of each day after the BFB Tune check.	≤30%D	Check the system and reanalyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met.
Laboratory Blank	After analysis of standards and prior to sample analysis, or when contamination is present.	Results less than the laboratory reporting limit Table 1.	Inspect the system and re-analyze the blank. Re-analyze the blank. B-flag data for common contaminants.
Internal Standard (IS)	As each standard, blank, and sample is being loaded.	Retention time (RT) for blanks and samples must be within ±0.33 min of the RT in the CCV and within ±40% of the area counts of the daily CCV internal standards.	**For blanks:** inspect the system and reanalyze the blank. **For samples:** re-analyze the sample. If the ISs are within limits in the re-analysis, report the second analysis. If ISs are out-of-limits a second time, dilute the sample until ISs are within acceptance limits and narrate.
Laboratory Duplicates - Laboratory Control sample Duplicate (LCSD)	One per analytical batch.	RPD ≤25% for sample concentrations greater than 5 times the reporting limit.	Investigate the cause including canister pressure and flow rates. Re-prepare standard if needed and re-analyze LCSD. If instrument maintenance is required, calibrate as needed.
LOQ Performance Check	Weekly, and after maintenance	60-140%	Check system and re-analyze standard. Re-prepare standard if necessary, perform maintenance and/or re-calibrate instrument if the criteria cannot be met.

ANALYTICAL METHODS

Section 16.0

Method: Modified EPA TO-17 VOCs and SVOCs – Tenax TA and Vapor Intrusion Applications by GC/MS (Full Scan)

Eurofins Air Toxics SOP #109 Revision 22 Effective Date: November 5, 2021 Methods Manual Summary

Description: This method is an alternative to the canister-based sampling and analysis methods that are presented in EPA Compendium Methods TO-14A and TO-15 as well as an alternative to PUF/XAD sampling for semivolatile compounds as described by EPA Compendium TO-13A. The Tenax TA tube is well-suited for compounds in the C5 to greater than C22 range and the multi-bed VI tube provides sufficient retention of light VOCs such as Vinyl Chloride while providing an efficient desorption of semi-volatile compounds up to 2-Methylnaphthalene.

Samples are collected by drawing a measured volume of air through the sorbent tubes. Collection is performed using a low flow vacuum pump or a volumetric syringe attached to the outlet side of the tube. Analysis is accomplished by heating the sorbent tube and sweeping the desorbed compounds onto a secondary "cold" trap for water management and analyte refocusing. The secondary trap is heated for efficient transfer of compounds onto the gas chromatograph (GC) for separation followed by detection using mass spectrometry (MS) in the full scan mode.

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. Unless otherwise directed, the laboratory reports these non-standard compounds with partial validation. Validation includes a 3-point calibration with the lowest concentration defining the reporting limit, no second source verification is analyzed, and no method detection limit study is performed unless previous arrangements have been made. In addition, stability of the non-standard compound during sample storage, safe sampling volume, and desorption efficiency are not validated. Full validation may be available upon request.

Since the TO-17 application significantly extends the scope of target compounds addressed in EPA Method TO-15 and TO-17, specifically for the multi-bed VI tube, the laboratory has implemented several method modifications outlined in Table 1.

Table 1. EPA TO-17 Method Modifications

Requirement	TO-17	Eurofins Air Toxics Modifications
Audit Accuracy	70-130%	Second source recovery limits for Fluoranthene and Pyrene = 60-140%.
Verification of Safe Sampling Volume	Collection of distributed volume pairs at uncharacterized sites and/or utilize field test method to evaluate breakthrough by sampling tubes in series at different air volumes.	Field surrogates are spiked onto each tube prior to deployment in the field. Recoveries are used to monitor method performance from sample collection through analysis for each sample tube.
Analytical Precision	≤20%RPD	≤30% RPD for 3- and 4-ringed PAHs

The standard target analyte list, reporting limit (RL), QC criteria, and QC summary can be found in Tables 2 through 7.

Table 2. Method TO-17 VOCs (Tenax TA) Reporting Limits and QC Limits

Analytes	Reporting Limit (ng)	QC Acceptance Criteria		
		ICAL (%RSD)	ICV/LCS (% R)	CCV (%D)
Benzene	10	30	70 – 130	30
Toluene	5.0	30	70 – 130	30
Ethylbenzene	5.0	30	70 – 130	30
Naphthalene	5.0	30	70 – 130	30
m,p-Xylene	10	30	70 – 130	30
o-Xylene	5.0	30	70 – 130	30
2-Methylnaphthalene	5.0	30	70 – 130	30
1-Methylnaphthalene	5.0	30	70 – 130	30
Acenaphthylene	5.0	30	70 – 130	30
Acenaphthene	5.0	30	70 – 130	30
Fluorene	5.0	30	70 – 130	30
Phenanthrene	5.0	30	70 – 130	30
Anthracene	5.0	30	70 – 130	30
Fluoranthene	10	30	60 – 140	40
Pyrene	10	30	60 – 140	40
2-Propanol*	50	30	50 – 150	50

*2-Propanol is poorly retained on Tenax; Safe sampling volume of 0.2 L has been verified by the lab. Volumes greater than 0.2 L are considered screening values only. Compound is calibrated using a 3-point calibration with no MDL study.

Table 3. Method TO-17 VOCs (VI) Reporting Limits and QC Limits

Volatile Organic Compounds	Reporting Limit(ng)	Acceptance Criteria			
		ICAL (%RSD)	ICV (% R)	CCV (%D)	LCS (%R)
Freon 114	14	30	70 – 130	30	70 – 130
Vinyl Chloride	5.1	30	70 – 130	30	70 – 130
1,3-Butadiene	2.2	30	70 – 130	30	70 – 130
Isopentane	5.9	30	70 – 130	30	70 – 130
Freon 11	11	30	70 – 130	30	70 – 130
1,1-Dichloroethene	4.0	30	70 – 130	30	70 – 130
Methylene Chloride	21	30	70 – 130	30	70 – 130
Freon 113	7.7	30	70 – 130	30	70 – 130
Trans-1,2-Dichloroethene	4.0	30	70 – 130	30	70 – 130
1,1-Dichloroethane	4.0	30	70 – 130	30	70 – 130
Cis-1,2-Dichloroethene	4.0	30	70 – 130	30	70 – 130
Hexane	35	30	70 – 130	30	70 – 130
Chloroform	4.9	30	70 – 130	30	70 – 130
1,2-Dichloroethane	4.0	30	70 – 130	30	70 – 130
1,1,1-Trichloroethane	5.4	30	70 – 130	30	70 – 130
Benzene	6.4	30	70 – 130	30	70 – 130
Carbon Tetrachloride	6.3	30	70 – 130	30	70 – 130
Cyclohexane	6.9	30	70 – 130	30	70 – 130
1,2-Dichloropropane	4.6	30	70 – 130	30	70 – 130
Trichloroethene	5.4	30	70 – 130	30	70 – 130
1,4-Dioxane	11	30	70 – 130	30	70 – 130
2,2,4-Trimethylpentane	9.4	30	70 – 130	30	70 – 130
Heptane	12	30	70 – 130	30	70 – 130
Methylcyclohexane	8.0	30	70 – 130	30	70 – 130
1,1,2-Trichloroethane	5.4	30	70 – 130	30	70 – 130
Methyl isobutyl ketone	8.2	30	70 – 130	30	70 – 130
Toluene	7.5	30	70 – 130	30	70 – 130
Methylbutylketone	8.2	30	70 – 130	30	70 – 130
Tetrachloroethene	6.8	30	70 – 130	30	70 – 130
Chlorobenzene	4.6	30	70 – 130	30	70 – 130
Ethylbenzene	4.3	30	70 – 130	30	70 – 130
m,p-Xylene	8.7	30	70 – 130	30	70 – 130
o-Xylene	8.7	30	70 – 130	30	70 – 130
Styrene	8.5	30	70 – 130	30	70 – 130
Cumene	9.8	30	70 – 130	30	70 – 130
n-Propylbenzene	9.8	30	70 – 130	30	70 – 130
4-Ethyltoluene	9.8	30	70 – 130	30	70 – 130
1,3,5-Trimethylbenzene	9.8	30	70 – 130	30	70 – 130
1,2,4-Trimethylbenzene	29	30	70 – 130	30	70 – 130
1,3-Dichlorobenzene	6.0	30	70 – 130	30	70 – 130
1,4-Dichlorobenzene	6.0	30	70 – 130	30	70 – 130
1,2-Dichlorobenzene	6.0	30	70 – 130	30	70 – 130
1,2,4-Trichlorobenzene	15	30	70 – 130	30	70 – 130
Hexachlorobutadiene	21	30	70 – 130	30	70 – 130

Volatile Organic Compounds	Reporting Limit(ng)	Acceptance Criteria			
		ICAL (%RSD)	ICV (% R)	CCV (%D)	LCS (%R)
Chloroethane†	16	30	70 – 130	30	70 – 130
Isopropyl alcohol†	49	30	70 – 130	30	70 – 130
Carbon Disulfide†	6.2	30	70 – 130	30	70 – 130
MTBE†‡	22	30	70 – 130	30	70 – 130
Methyl Ethyl Ketone†	59	30	70 – 130	30	70 – 130
1,1,2,2-Tetrachloroethane*	6.9	40	60 – 140	40	60 – 140
Polyaromatic Hydrocarbons	**Reporting Limit(ng)**	**Acceptance Criteria**			
		ICAL (%RSD)	ICV (% R)	CCV (%D)	LCS (%R)
Naphthalene	1.0	30	70 – 130	30	70 – 130
2-Methylnaphthalene	1.0	30	70 – 130	30	70 – 130
1-Methylnaphthalene	1.0	30	70 – 130	30	70 – 130

†Non-routine compounds by special request only.
‡Poor recovery performance when dry purge is applied for sample collection volumes greater than 1-L.
* Compound by special request. Erratic recoveries on the VI tube sorbent. Literature confirms lab observations.

Table 4. Commonly requested TPH parameters (Tenax TA and VI)

TPH	Reporting Limit (ng)	ICAL (%RSD)	ICV (% R)	CCV (%D)	LCS (%R)
GRO (Gasoline Range)	1000	30	60 – 140	40	60 – 140
DRO (C10-C22 Diesel Range)	1000	30	60 – 140	40	60 – 140

Table 5. Internal Standard (Tenax TA and VI)

Analyte	CCV IS % Recovery	Sample IS % Recovery
Bromochloromethane*	>60	60 – 140
1,4-Difluorobenzene	>60	60 – 140
Chlorobenzene-d5	>60	60 – 140
Bromofluorobenzene	>60	60 – 140

*BCM may not be required for Tenax TA list based on the requested VOC list.

Table 6. Field Surrogate Recoveries (Tenax TA and VI)

Analyte	% Recovery
1,2-Dichloroethane-d4	50 – 150
Benzene-d6	50 – 150
Toluene-d8	50 – 150
Naphthalene-d8	50 – 150

Table 7. Summary of Calibration and QC Procedures for TO-17 General Application

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
BFB Tune Check	Before initial and daily calibration. Check is valid for 24 hours.	TO-15 tune criteria	Correct problem then repeat tune.
5-Point Calibration	Prior to sample analysis	%RSD ≤ 30% with 2 compounds exceeding up to 40%RSD	Correct problem then repeat Initial Calibration Curve.
Initial Calibration Verification (ICV)	After each initial Calibration Curve	See tables 2 and 3; 20% of the compounds are allowed to exceed criterion.	Determine if the exceedance is due to an inaccurate calibration standard or inaccurate ICV standard. Recalibrate with an accurate standard or re-prepare the ICV as necessary. If any VOC exceeds 50-150% recovery, system is checked and the ICV is reanalyzed. For compounds with recoveries greater than 150% and no positive detections in the samples, approval to proceed will be granted on a case-by-case basis.
Continuing Calibration Verification (CCV)	At the start of each 24-hour clock after the Tune Check	70 – 130 %; 60-140% for Fluoranthene and Pyrene (see table 3)	If project-specified risk drivers exceed these criteria, more than 5% of the compounds exceed these criteria, or any VOC exceeds 50–150% recovery, maintenance is performed and the CCV test repeated. If the system still fails the CCV, perform a new 5-point Calibration Curve.
Laboratory Blank	After the CCV, before samples and at the end of the sequence	Results less than the laboratory RL.	Inspect the system and re-analyze the Blank. Flag associated data as appropriate.
Laboratory Control Spike (LCS)	Each analytical batch	Recovery 70 – 130%; 60-140% Fluoranthene and Pyrene; Or as noted in table 3; 20% of the compounds may exceed criteria before corrective action is required.	Verify accuracy of standard. Re-prepare LCS if necessary. If calibration curve and/or system is found to be out of control, perform maintenance and re-calibrate. If any VOC exceeds 50-150% recovery, maintenance is performed and the LCS test is repeated. For compounds with recoveries greater than 150% and no positive detections in the samples, approval to proceed will be granted on a case by case basis.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Laboratory Control Spike Duplicate (LCSD)	Once per analytical batch –(reanalysis of LCS)	≤20%RPD for all compounds with exception of Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene,TPH and 2-Propanol (Tenax only) which must be ≤30%RPD	Verify accuracy of standard. Re-prepare LCSD if necessary. If calibration curve and/or system is found to be out of control, perform maintenance and re-calibrate. If any VOC exceeds 50-150% recovery, maintenance is performed and the LCSD test is repeated. For compounds with recoveries greater than 150% and no positive detections in the samples, approval to proceed will be granted on a case by case basis.
Internal Standard (IS)	As each QC sample and sample are being loaded	**CCVs:** area counts >60% recovery, RT w/in 20 sec of mid-point in ICAL **Blanks and samples**: Retention time (RT) must be within ±0.33 minutes of the RT in the CCV. The IS area must be within ±40% of the CCV's IS area for the Blanks and samples.	**CCV:** Inspect and correct system prior to sample analysis. **Blanks:** Inspect the system and re-analyze the Blank. **Samples:** Investigate the problem by verifying the instrument is in control by running a Lab Blank. Re-analyze recollected samples to verify recovery. Report the run with acceptable IS recovery. If both runs are unacceptable, narrate and flag associated data. If sample matrix is causing a systematic change in internal standard response with each successive run, an End Check spiked at the CCV concentration can help to assess the impact on target compound accuracy.
Field Surrogates	Added to each tube prior to shipment to field. Added to QC samples prior to analysis	50 – 150%	**Blanks:** Inspect the system and re-analyze the Blank. **Samples:** Review data to determine whether sample collection parameters or matrix interference resulted in the exceedances. If so, narrate and flag recovery. If no cause is evident, verify the instrument is in control by running a Lab Blank. Re-analyze recollected sample to verify recovery.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Field Blank	Project dependent	Artifact levels should be less than the reporting limit or less than 10% of the mass measured on the sampled tubes, whichever is less	Flag associated results and evaluate tube conditioning and storage procedures.
Distributed Pairs	Project dependent	%RPD ≤ 25%	Narrate discrepancy

ANALYTICAL METHODS

Section 17.0

Method: ANALYSIS OF VOCS BY GC/MS COLLECTED ON CHARCOAL-BASED PASSIVE SAMPLERS USING MODIFIED EPA TO-17

Eurofins Air Toxics SOP #100 Revision 18 Effective Date: April 19, 2021 Methods Manual Summary

Description: This method involves gas chromatograph/mass spectrometer (GC/MS) analysis of volatile organic compounds (VOCs) collected using charcoal-based passive samplers. These passive samplers include the Radiello® 130, SKC badges (575 and Ultra), and the Waterloo Membrane Samplers (WMS™). Passive samplers are used to measure vapor-phase VOCs in a variety of gaseous matrices including indoor air, outdoor air, and soil gas. VOCs in the sampling environment pass through the diffusive barrier or permeable membrane of the sampler at a known, controlled rate (defined as the sampling rate) and adsorb to the charcoal-based sorbent pad of the sampler.

The sorbent is extracted using a volume of carbon disulfide, and the extract is directly injected into a GC equipped with an MS. The retention time and spectral pattern of a compound are compared with that of known standard. Concentrations of the analytes are calculated from the average relative response factors of calibration curves obtained from analysis of standard solutions. The results are reported in units of μg/sample or μg/m^3 if the sampling rate and duration is known. To minimize a low bias in the subsurface soil gas μg/m^3 concentration due to starvation effects, the WMS-Low Uptake version (WMS-LU) is recommended. Starvation effects occur when the uptake rate of the sampler exceeds the delivery rate of vapors from the surrounding soil.

There are currently no EPA methods for the preparation and analysis of charcoal-based passive samplers for environmental monitoring of VOCs in air. The reference method used for this procedure is EPA TO-17, which describes the collection of VOCs in ambient air using sorbents and analysis by GC/MS. Because TO-17 describes active sample collection using a pump and thermal desorption as the preparation step, several modifications are required. Specifically, the extraction steps using carbon disulfide and internal standard addition are based on the recommended procedures published by Radiello (FSM). The modifications taken to EPA Method TO-17 are outlined in Table 1.

Table 1. Summary of Method TO-17 Modifications

Requirement	TO-17	EATL Modifications
Sample collection	Pump pulls measured air volume through sorbent tube	VOCs in air adsorbed onto sorbent bed passively through diffusion
Sample preparation	Thermal extraction	Solvent extraction
Sorbent tube conditioning	Condition newly packed tubes prior to use	Charcoal-based sorbent is a single use media and conditioning is conducted by vendor

Requirement	TO-17	EATL Modifications
Instrumentation	Thermal desorption system	Liquid injection system
Internal Standard	Gas-phase internal standard introduced on the tube or focusing trap during analysis	Liquid-phase internal standard introduced on the tube at the time of extraction
Media and sample storage	<4 deg C, 30 days	Media shelf life is determined by vendor; sample hold-time is 30 days for RAD130 and WMS. Sample preservation requirements are storage in a cool, solvent-free refrigerator and optional use of ice during shipping
Internal Standard Recovery	+/-40% of daily CCV area	-50% to +100% of daily CCV area

Tables 2 through 4 list the target analytes routinely calibrated, along with the reporting limits and QC acceptance criteria. Tables 5 through 8 list the reporting limit for each sampler type in units of mass and the sampling rate. The sampling rates for the WMS sampler are maintained as proprietary and are not published as part of this document. To calculate the sample reporting limit in terms of $\mu g/m^3$, the compound sampling rate and the sample duration are required. Please consult with the laboratory to determine the appropriate sampler to meet project objectives.

Table 2. Target Analytes Reporting Limits and QC Criteria

Analytes	Reporting Limit (µg/mL)	Acceptance Criteria			
		ICAL (%RSD)	ICV (% R)	LCS (%R)	CCV (%D)
Chloromethane	0.2	30	70 – 130	50 – 140	≤ 40%
Vinyl Chloride	0.2	30	50 – 140	50 – 140	≤ 40%
Ethanol	0.5	30	70 – 130	50 – 130*	≤ 30%
1,1-Dichloroethene	0.2	30	70 – 130	70 – 130	≤ 30%
MTBE	0.05	30	70 – 130	70 – 130	≤ 30%
trans-1,2-Dichloroethene	0.1	30	70 – 130	70 – 130	≤ 30%
Hexane	0.05/0.20***	30	70 – 130	70 – 130	≤ 30%
1,1-Dichloroethane	0.05	30	70 – 130	70 – 130	≤ 30%
Ethyl Acetate	0.2	30	70 – 130	70 – 130	≤ 30%
2-Butanone	0.10	30	70 – 130	70 – 130	≤ 30%
cis-1,2-Dichloroethene	0.05	30	70 – 130	70 – 130	≤ 30%
Chloroform	0.05	30	70 – 130	70 – 130	≤ 30%
Cyclohexane	0.05	30	70 – 130	70 – 130	≤ 30%
1,1,1-trichloroethane	0.05	30	70 – 130	70 – 130	≤ 30%
Carbon Tetrachloride	0.05	30	70 – 130	70 – 130	≤ 30%
Benzene	0.2	30	70 – 130	70 – 130	≤ 30%
1,2-Dichloroethane	0.05	30	70 – 130	70 – 130	≤ 30%
Heptane	0.05	30	70 – 130	70 – 130	≤ 30%
Trichloroethene	0.05	30	70 – 130	70 – 130	≤ 30%
4-Methyl-2-pentanone	0.1	30	70 – 130	70 – 130	≤ 30%
Toluene	0.05	30	70 – 130	70 – 130	≤ 30%
1,1,2-Trichloroethane	0.05	30	70 – 130	70 – 130	≤ 30%

Analytes	Reporting Limit (µg/mL)	Acceptance Criteria			
		ICAL (%RSD)	ICV (% R)	LCS (%R)	CCV (%D)
Tetrachloroethene	0.05	30	70 – 130	70 – 130	≤ 30%
Chlorobenzene	0.05	30	70 – 130	70 – 130	≤ 30%
Ethylbenzene	0.05	30	70 – 130	70 – 130	≤ 30%
m,p-Xylene	0.05	30	70 – 130	70 – 130	≤ 30%
o-Xylene	0.05	30	70 – 130	70 – 130	≤ 30%
Styrene	0.05	30	70 – 130	20-100*	≤ 30%
1,1,2,2-Tetrachloroethane	0.05	30	70 – 130	60 – 130	≤ 30%
Propylbenzene	0.05	30	70 – 130	70 – 130	≤ 30%
1,3,5-Trimethylbenzene	0.05	30	70 – 130	70 – 130	≤ 30%
1,2,4-Trimethylbenzene	0.05	30	70 – 130	70 – 130	≤ 30%
1,3-Dichlorobenzene	0.05	30	70 – 130	50 – 110**	≤ 30%
1,4-Dichlorobenzene	0.05	30	70 – 130	50 – 110**	≤ 30%
1,2-Dichlorobenzene	0.05	30	70 – 130	50 – 110**	≤ 30%
Naphthalene	0.05	30	70 – 130	5-80*	≤ 30%

*Acceptance limits based on desorption efficiency studies
**60 – 130% for WMS, RL for WMS

Table 3. Internal Standard

Analyte	CCV IS (%R)	Sample IS (%)R
2-Fluorotoluene	-50 to +200	-50 to +200

Table 4. Surrogate

Analyte	%R
Toluene-d8	70-130

Table 5. Reporting Limits and Sampling Rates for "Standard" target compounds (RAD 130)

Analytes	Reporting Limit (µg/sampler)	Sampling Rates for Radiello 130 Sampler
Vinyl Chloride**	0.4	90*
Ethanol	1.0	102
1,1-Dichloroethene	0.4	76*
MTBE	0.1	65
trans-1,2-Dichloroethene	0.2	60*
Hexane	0.1	66
1,1-Dichloroethane	0.1	63*
Ethyl Acetate	0.4	78
2-Butanone	0.2	79
cis-1,2-Dichloroethene	0.1	62*
Chloroform	0.1	75
Cyclohexane	0.1	54
1,1,1-trichloroethane	0.1	62
Carbon Tetrachloride	0.1	67
Benzene	0.4	80
1,2-Dichloroethane	0.1	77

Analytes	Reporting Limit (µg/sampler)	Sampling Rates for Radiello 130 Sampler
Heptane	0.1	58
Trichloroethene	0.1	69
4-Methyl-2-pentanone	0.2	67
Toluene	0.1	74
1,1,2-Trichloroethane	0.1	66*
Tetrachloroethene	0.1	59
Chlorobenzene	0.1	68
Ethylbenzene	0.1	68
m,p-Xylene	0.1	70
o-Xylene	0.1	65
Styrene	0.1	61
1,1,2,2-Tetrachloroethane	0.1	60*
Propylbenzene	0.1	57
1,3,5-Trimethylbenzene	0.1	53*
1,2,4-Trimethylbenzene	0.1	50
1,3-Dichlorobenzene	0.1	59*
1,4-Dichlorobenzene	0.1	51
1,2-Dichlorobenzene	0.1	58*
Naphthalene	0.1	25

*Estimated using the diffusion coefficient in air and the geometric constant 14.145 cm ('white' diffusive body, code 120).

**Vinyl chloride is included in the calibration standard; however, it is not a "standard" compound as it is not recommended on the RAD130 cartridge due to poor retention. Applications using the RAD130 for VC measurements for extended durations (>8 hours) will result in significant low bias using the theoretical uptake rate. All lab reports with vinyl chloride reported must have the appropriate narration regarding poor retention and potential low bias.

Table 6. Reporting Limits and Sampling Rates for "Standard" target compounds (SKC 575/Ultra)

Analytes	Reporting Limit (µg/sampler)	Sampling Rates for Indoor Air Applications 'Zero Face velocity'	Sampling Rates for Outdoor/worker exposure (ml/min)
Vinyl Chloride	0.4	17.4*	21.2*
Ethanol	1.0	11.7	20.0
1,1-Dichloroethene	0.4	9.74	12.3
MTBE	0.1	9.84	13.6
trans-1,2-Dichloroethene	0.2	10.2	14.8
1,1-Dichloroethane	0.1	13.14	12.3
Ethyl Acetate	0.4	9.26	13.75
2-Butanone	0.1	6.27	17.1
cis-1,2-Dichloroethene	0.1	11.54*	14.8*
Chloroform	0.1	10.14	13
Cyclohexane	0.1	7.76	15.6
1,1,1-trichloroethane	0.1	9.40	14.1
Carbon Tetrachloride	0.1	10.41	14.1
Benzene	0.4	10.69	16
1,2-Dichloroethane	0.1	11.79	14.2
Heptane	0.1	9.38	13.9
Trichloroethene	0.1	11.47	14.9
4-Methyl-2-pentanone	0.2	7.29	13.5
Toluene	0.1	8.90	14.5
1,1,2-Trichloroethane	0.1	9.64	12.5
Tetrachloroethene	0.1	10.02	13.1
Chlorobenzene	0.1	8.23*	18.74*
Ethylbenzene	0.1	9.02	12.9
m,p-Xylene	0.1	8.1	12.65
o-Xylene	0.1	8.11	11.9
Styrene	0.1	9.04	13.7
1,1,2,2-Tetrachloroethane	0.1	9.98	11.8
Propylbenzene	0.1	6.41*	11.69*
1,3,5-Trimethylbenzene	0.1	7.29*	12.1*
1,2,4-Trimethylbenzene	0.1	9.92*	12.1*
1,3-Dichlorobenzene	0.1	5.79*	12.7*
1,4-Dichlorobenzene	0.1	10.74*	12.7*
1,2-Dichlorobenzene	0.1	4.97*	12.6*
Naphthalene	0.1	2.71*	13.7*

*Calculated by SKC: (Concentrations reported using a calculated rate will be qualified with a C-flag to indicate an estimated value. Compounds which are poorly retained on the sorbent over the planned duration will be biased low).

Table 7. Summary of Calibration and QC Procedures

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tuning Criteria	Prior to calibration and at the start of every 12-hour clock	Method TO-17 tuning criteria	Correct problem then repeat tune.
Initial 5-Point Calibration (ICAL)	Prior to sample analysis	Compound criteria in Table 2	Correct problem then repeat initial calibration. Analysis may proceed if no more than 2 VOCs exceed criteria or 5% of VOCs if short list is used. Narrate exceedances.
Initial Calibration Verification (ICV)	Once per initial calibration	See Table 2	Verify concentrations and standard preparation. Analysis may proceed if no more than 2 VOCs exceed criteria or 5% of VOCs if short list is used. Narrate exceedances.
Continuing Calibration Verification (CCV)	At the start of every shift immediately after the BFB tune check	See "CCV criteria" column in Table 2	Investigate and correct the problem, up to and including recalibration if necessary. Analysis may proceed if no more than 2 VOCs exceed criteria or 5% of VOCs if short list is used. Associated results are flagged.
Internal Standards (IS)	IS is added at the time of extraction to all samples and QC samples.	**For CCVs:** Area counts 50 –200%; RT w/in 30 seconds of midpoint in ICAL **For blanks, samples and non-CCV QC checks:** Area counts 50 – 200%; RT within 20 seconds of RT in CCV	**CCV:** Inspect and correct system prior to sample analysis. **For blanks:** Inspect the system and re-analyze the blank. **For samples:** Re-analyze; if out again, flag data.
Surrogate	Surrogate is added at the time of extraction to all samples and QC samples.	70–130%	Same as for Internal Standards.
Solvent Blanks	Immediately after the calibration standard or after samples with high concentrations	Results less than laboratory reporting limit (see Table 2)	Re-aliquot and re-analyze solvent blank. If detections remain, flag concentrations in associated samples.
Extracted Laboratory Blank	Each set of up to 20 samples	Results less than the reporting limit	Flag sample concentrations in associated extraction batch.
Extracted Laboratory Control Spike (LCS)	Each set of up to 20 samples	See Table 2.	Analysis may proceed if no more than 2 VOCs exceed criteria (or 5% for short list exceed criteria). Re-aliquot and re-analyze the extract. If within limits, report the re-analysis. Otherwise, narrate.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Extracted Laboratory Control Spike Duplicate (LCSD)	Each set of up to 20 samples	%RPD ≤ 25%	Analysis may proceed if no more than 2 VOCs exceed criteria (or 5% for short list exceed criteria). Narrate as appropriate.

ANALYTICAL METHODS

Section 18.0

Method: Modified EPA TO-17 Volatile Organic Compounds (Passive Sample Collection)

Eurofins Air Toxics SOP #112 Revision 13 Effective Date: June 29, 2021 Methods Manual Summary

Description: This method involves gas chromatograph/mass spectrometer (GC/MS) analysis of volatile organic compounds (VOCs) collected using the Radiello passive sampler. The Radiello sample is paired with thermally desorbable sorbent. This sampler is used to measure vapor-phase VOCs in a variety of gaseous matrices including indoor air, outdoor air, and soil gas. The VOCs in the sampling environment pass through a diffusive barrier at a controlled rate and adsorb to the sorbent bed of the sampler.

The Radiello sampler consists of a sorbent cartridge and a diffusive body. The diffusive body is cylindrical and is designed for the cartridge to slide in its center.

The sorbent is transferred to an empty tube, if needed, and the tubes are thermally desorbed by heating and purging with UHP Helium. The resulting gaseous effluent is transferred to secondary trap for re-concentration and desorption onto the gas chromatograph equipped with a mass spectrometer. The retention time (RT) and spectral pattern of a compound are compared with that of a known standard. Concentrations of the analytes are calculated from the average relative response factors of calibration curves obtained from analysis of standard solutions. Results are reported in ng/sample or ug/m3 if the sampling rate and duration are known. Sampling rates can be estimated to provide semi-quantitative concentration results. Concentrations derived from estimated rates are flagged as estimated values.

Certain compounds are not included in Eurofins Air Toxics' standard target analyte list. These compounds are communicated at the time of client proposal request. Unless otherwise directed, the laboratory reports these non-standard compounds with partial validation. Validation includes a 3-point calibration with the lowest concentration defining the Reporting Limit (RL), no second source verification is analyzed, and no method detection limit study is performed unless previous arrangements have been made. In addition, stability of the non-standard compound during sample storage as well as desorption efficiency are not validated. Full validation may be available upon request.

The analysis is performed using the analytical protocols of EPA Method TO-17. The significant deviation from the TO-17 method is that the samples are collected using passive samplers as opposed to the method-defined procedure of using a pump to actively pull vapors through the sorbent.

Table 1. Summary of Method TO-17 Modifications

Requirement	TO-17	Eurofins Air Toxics Modifications
Sample collection	Active	Passive

The standard target analyte lists, Reporting Limits (RLs), Limit of Quantitation (LOQ), and Quality Control (QC) criteria are presented in tables 2 through 4. Table 5 summarizes the calibration and QC procedures.

Table 2. Carbograph 4 (Radiello 145 cartridge) Analyte List and QC Limits

Sampling parameter	Recommended			
Exposure period	<3 days with 1 day ideal if the C2 chlorinated VOCs are included; Vendor cites 7 to 14 days; however, high sampling rate means high mass loading with extended period. Less retained VOCs can be displaced resulting in a low bias.			
Sample matrix	<2000 ug/m3 total VOCs			
Analytes	**Reporting Limit (ng)**	**Acceptance Criteria**		
		ICAL (%RSD)	**ICV/LCS (% R)**	**CCV (%R)**
1,1,1-Trichloroethane	10	≤40	60 – 140	70 – 130
Benzene	20	≤30	70 – 130	70 – 130
Ethyl Benzene	10	≤30	70 – 130	70 – 130
m,p-Xylene	20	≤30	70 – 130	70 – 130
o-Xylene	10	≤30	70 – 130	70 – 130
Tetrachloroethene	5.0	≤30	70 – 130	70 – 130
Toluene	50	≤30	70 – 130	70 – 130
Trichloroethene	5.0	≤30	70 – 130	70 – 130
Cyclohexane	10	≤30	70 – 130	70 – 130
Styrene	10	≤30	70 – 130	70 – 130
1,1-Dichloroethene	5.0	≤30	70 – 130	70 – 130
Freon 113	5.0	≤30	70 – 130	70 – 130
trans-1,2-Dichloroethene	5.0	≤30	70 – 130	70 – 130
1,1-Dichloroethane	5.0	≤30	70 – 130	70 – 130
cis-1,2-Dichloroethene	5.0	≤30	70 – 130	70 – 130
Chloroform	5.0	≤30	70 – 130	70 – 130
1,2-Dichloroethane	5.0	≤30	70 – 130	70 – 130
1,1,2-Trichloroethane	5.0	≤30	70 – 130	70 – 130

Compounds in **bold** indicate that the associated Sampling Rate is calculated. A "C" flag will be applied to these results, as they should be considered as estimated.

Table 3. Internal Standards for Carbograph 4 (Radiello 145 cartridge)

Analyte	CCV IS % Recovery	Sample IS % Recovery
Bromochloromethane	≥60	60 – 140
1,4-Difluorobenzene	≥60	60 – 140
Chlorobenzene-d_5	≥60	60 – 140

Table 4. Analytical Surrogate for Carbograph 4 (Radiello 145 cartridge)

Analyte	% Recovery
4-Bromofluorobenzene	70 – 130

Table 5. Summary of Calibration and QC Procedures for EPA Method TO-17-Passive Sorbent Sampling

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
BFB Tune Check	Every 24 hours	TO-15/TO-17 tune criteria.	Correct problem then repeat tune check.
5-Point Calibration	Prior to sample Analysis.	%RSD ≤ 30%, 2 allowed out up to 40%	Correct problem then repeat Initial Calibration Curve.
LCS/ICV	After each initial Calibration Curve and daily prior to analysis.	Recovery 70-130% or as indicated in Table 2, 20% of compound list may exceed criterion before corrective action is required. Also, if any VOC exceeds 50-150%, corrective action is required. For compounds with recoveries greater than 150% and no positive detections in the samples, approval to proceed will be granted on a case-by-case basis by QA or management.	Verify accuracy of standard. Re-prepare LCS if necessary. If calibration curve and/or system is found to be out of control, perform maintenance and re-calibrate.
LCSD	Each analytical batch – reanalysis of LCS	See LCS recovery acceptance criterion; %RPD ≤ 20%	Evaluate whether the precision outlier is due to recollection failure of the TDU. If so, correct system and re-start analytical sequence with the BFB.
Continuing Calibration Verification (CCV)	At the start of each analytical clock	70 – 130 %	Two compounds are allowed to exceed criterion up to ±40%D prior to initiation of corrective action. If more than 2 VOCs exceed the ±30% D criterion or > 10% of VOCs if short list is used (20 compounds or less), the CCV tube is re-spiked and the test repeated. If the system still fails the CCV, the system is evaluated. As necessary, a new initial calibration curve is analyzed. CCV recoveries >140% may be approved by QA or management after evaluation of project objectives and risk drivers.
Laboratory Blank	After the CCV and at the end of the analytical batch.	Results less than the laboratory RL.	Inspect the system and re-analyze the Blank. No corrective action for Lab Blank at end of batch.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Internal Standard (IS)	As each standard, Blank, and sample is being loaded.	**CCVs:** area counts ≥60% and RT w/in 20 sec of mid-point in ICAL. **Blanks and samples**: Retention time (RT) must be within ±0.33 minutes of the RT in the CCV. The IS area must be within ±40% of the CCV's IS area for the Blanks and samples.	**CCV:** inspect and correct system prior to sample analysis. **Blanks:** inspect the system and re-analyze the Blank. **Samples:** Analyze re-collected samples to confirm internal standard recoveries. If recovery is out of acceptance criteria in the initial and recollected sample, the initial sample is reported and associated data is qualified if appropriate. If sample matrix is causing a systematic change in internal standard response with each successive run, an End Check spiked at the CCV concentration can help to assess the impact on target compound accuracy.
Analytical Surrogate	Each passive sampler and Lab Blank and QC samples during sample desorption	70-130%	**For blanks:** inspect the system and re-analyze the Blank. **For samples:** If no obvious reason can be ascertained after evaluation of the data, the sample should be reanalyzed to verify out of control recovery. If recovery is out of acceptance criteria in both the initial and recollected sample, the initial sample is reported with the surrogate flagged.

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LABORATORY QUALITY ASSURANCE MANUAL

(LQAM)

Appendix F

References

(Two total pages including this cover)

Current as of January 10, 2022

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