

December 15, 2021

Snohomish County Airport  
3220 100<sup>th</sup> Street SW, Suite A  
Everett, WA 98204

Attn: Andrew Rardin, Environmental and Wildlife Manager

Transmitted via email to: [andrew.rardin@co.snohomish.wa.us](mailto:andrew.rardin@co.snohomish.wa.us)

**Re: Site Investigation Report  
Building C-19 Indoor Air Evaluation and Monitoring Well Installation  
Former TECT Aerospace Leasehold Area  
Snohomish County Airport  
Everett, Washington  
LAI Project No. 0222057.030**

Dear Mr. Rardin:

At the request of Snohomish County Airport (Airport), Landau Associates, Inc. (LAI) has prepared this report to document the results of implementing the scope of work included in the Interagency Agreement between the Washington State Department of Ecology (Ecology) and the Airport (IAA No. C2100062) to support a remedial investigation/feasibility study (RI/FS) of the TECT Aerospace Everett site (Site) in Everett, Washington (Figure 1). LAI has been conducting an RI at the Site on behalf of the Airport since November 2018 in accordance with the RI/FS work plan (LAI 2018) and a subsequent RI work plan addendum (LAI 2019a). RI activities continued through December 2019 and are documented in a data report (LAI 2019b).

On June 17, 2021, the Airport entered into an Interagency Agreement (IAA; Ecology 2021b) with Ecology that would allow the Airport to use agency grant funds to support the ongoing RI and inform the subsequent FS. The scope of work as defined in the IAA consists of three main tasks:

- Task 1: Cultural Resources Review Support
- Task 2: Building C-19 Indoor Air Evaluation
- Task 3: Monitoring Well Installation and Surveying.

Task 2, Building C-19 indoor air evaluation, is the primary task conducted under the IAA grant and preparation of this report is a required deliverable under the IAA scope of work. Additional tasks that are included in the IAA are preparation of and adherence to an Inadvertent Discovery Plan (IDP) and installation and development of two shallow groundwater monitoring wells near former Building C-27. The IDP presents procedures to identify and respond to any cultural resources encountered during IAA field activities. The completion of each of the three tasks is described below.

## **Task 1: Cultural Resources Review Support**

Task 1 included preparation of an IDP and, if needed, one Site visit to respond to and document an inadvertent discovery during work for Tasks 2 and 3. The IDP was prepared and submitted to Ecology and later approved by Ecology. A copy of the IDP is provided in Attachment 1. No artifacts or other culturally significant items were discovered during field work and therefore a Site visit to document a discovery was not needed.

## **Task 2: Building C-19 Indoor Air Evaluation**

Building C-19 is located within the boundaries of the former TECT Aerospace (TECT) Site as shown on Figures 1 and 2. Volatile organic compounds (VOCs) were detected in soil and groundwater beneath a portion of Building C-19 during the RI and during investigations conducted prior to the RI. As a result, the Airport proposed testing indoor air within Building C-19 for the presence of VOCs. Additional background information on the presence of VOCs in the subsurface around Building C-19 was provided in the Indoor Air Sampling and Analysis Plan (Attachment 2), which detailed the Building C-19 indoor air evaluation activities.

Task 2 included the following major activities:

- Conduct a building walk-through (building survey) to determine current Site activities and identify building operations and/or features that may impact or influence indoor air quality.
- Prepare a work plan consisting of a sampling and analysis plan (SAP) and quality assurance project plan (QAPP) documenting the building survey, planned sampling locations and methodology, and action levels that would trigger an immediate response action. The SAP and QAPP were approved by Ecology on October 20, 2021 (Wooten 2021).
- Install one sub-slab vapor pin near the former degreaser sump
- Conduct differential pressure monitoring using the sub-slab vapor pin
- Collect time-integrated indoor air samples and one ambient air sample, and one sub-slab soil vapor grab sample
- Submit air samples to an accredited laboratory for VOC analysis
- Prepare this report.

The building survey was conducted on September 1, 2021, the results of which were reported in the SAP/QAPP (Attachment 2). The building survey generally indicated that there were no Site activities or operations that would impact the indoor air quality or have the potential to interfere with sample collection, with the exception of the following:

- It was determined that there are women of childbearing age working in Building C-19 and that comparing sampling results to the short-term action levels established in Ecology's Implementation Memorandum No. 22 (Ecology 2019) would be warranted upon receipt of analytical results.

- Bay #3 is currently vacant but being used to store tenant items such as household-sized gasoline cans, and gasoline-powered engines.

A soil vapor pin was installed below the concrete slab of Bay #3 in Building C-19 on October 18, 2021 and differential pressure data were logged using the vapor pin. Indoor air samples were collected in Bays #2 and #3 of Building C-19 on October 22, 2021, and soil vapor and ambient air sampling was also conducted. Installation and sampling activities were conducted in accordance with the SAP (Attachment 2).

Building C-19 monitoring and sampling locations are shown on Figure 3. Additional detail on Building C-19 indoor air sampling is provided below.

### **Differential Pressure Monitoring**

A differential pressure datalogger was installed at the soil vapor pin sampling port to continuously monitor the difference between the indoor air pressure and the pressure just below the concrete slab in Bay #3, as described in the SAP. An Omniguard 4 Differential Pressure Monitor logged pressure differences continuously and reported the maximum and minimum differential readings every 15 minutes. The differential pressure datalogger began logging pressure data in inches water column (in WC) immediately following installation of the vapor pin and continued logging data for approximately 4 days, up until the time that the soil vapor sample was collected from the same monitoring point. The pressure data were reviewed following 2 days of logging to determine the optimal 8-hour sampling window that would best capture indoor air VOC concentrations if present. The Airport ambient barometric pressure history for October 18 through October 22, 2021 was downloaded from the National Weather Service web page (NWS; accessed October 23, 2021). The ambient barometric pressure history and the results of the sub-slab differential pressure datalogging are presented on Figure 4. The differential pressure readings shown on Figure 4 represent the mean of the maximum and minimum pressure readings over each 15-minute interval.

### **Sample Collection**

Air samples were collected from three locations inside Building C-19 (IA01, IA02, and IA03), one from the vapor pin installed below the slab near the former degreaser sump (RISG-103), and one outside the building, in an upwind location (AA-C19). Samples were collected in accordance with the SAP and submitted to Analytical Laboratory Services (ALS) in Simi Valley, California for analysis for VOCs. The samples were analyzed for VOCs using the TO-15 method with selected ion monitoring to allow for lower reporting limits that could be compared to the screening levels proposed in the SAP. The soil vapor grab sample was collected immediately following completion of the indoor air sampling, and VOCs were analyzed for using the TO-15 scan method to account for the elevated VOC concentrations anticipated below the slab, in the former degreaser sump area. All air samples were collected using 6-liter Summa canisters that were individually cleaned and certified by the laboratory.

One indoor air sample (IA01-C19) was collected from inside a breakroom in Bay #2 and the other two indoor air samples (IA02-C19 and IA03-C19) were collected in Bay #3 (Figure 3). The ambient air sample (AA-C19) was collected approximately 75 feet (ft) south of Building C-19, and the wind was coming from the south-southeast during sampling activities. The sub-slab soil vapor sample (RISG-103) was collected within 5 ft of the former degreaser sump immediately after collecting the indoor air samples. The air sampling locations are shown on Figure 3.

## Indoor Air Evaluation Results

Differential pressure and analytical results are discussed in detail below and summarized on Figure 4, and Tables 1 and 2.

### Differential Pressure Evaluation

Differential pressure data were evaluated on October 20, 2021, after about 48 hours of continuous data logging to determine if significant positive differential pressures (i.e., pressures that would produce a driving force from inside the building toward the subsurface) develop inside Building C-19 as a result of building operations (i.e., doorways being open or heating, ventilation, and air-conditioning system use in Bay #2), and, if present, to identify the hours in which these positive differential pressures would be greatest. Sample collection times would then be selected to avoid these hours of the day. This evaluation indicated relatively neutral (i.e., minimal) pressure differentials over the 48-hour period as shown by the solid green line along the zero axis on Figure 4 and that pressure differentials were not influenced by building operations. Where pressure differential fluctuations were observed during this period, they tended to be equally positive and negative resulting in an overall neutral pressure differential. Observations during this period also indicated that sub-slab/indoor air differential pressure was not significantly impacted by changes in barometric pressure. These observations suggested that sample collection did not need to be planned around any particular building operations or barometric pressure conditions, though common practice calls for avoiding indoor air sampling during rising barometric pressure conditions.

Much of the fluctuations in pressure differentials observed beginning on October 20 (Figure 4) can be attributed to a significant increase in wind speeds at that time that were maintained throughout most of the remaining differential pressure monitoring period. Wind loads on buildings are known to cause fluctuations in indoor air pressure measurements (EPA 2015), especially leaky buildings or metal buildings with somewhat flexible wall structures. This phenomenon is especially evident when looking at differential pressures measured over the last 5 hours of October 20, as shown on Figure 4. During this period, wind speeds were generally calm relative to wind speeds before and after this period with no recorded wind gusts (NWS; accessed October 23, 2021). As shown on Figure 4, these calm conditions again produced minimal differential pressures, similar to the differential pressures measured during the first 48 hours of pressure monitoring.

The indoor air samples were collected over an approximate 9-hour period beginning at 10:00 a.m. on October 22, 2021 during a period when barometric pressure was stable to slightly decreasing (Figure 4). Though differential pressures were slightly positive during this period ranging from 0 to 0.0015 inches of water due to the influence of strong winds, these minimal differential pressures are not expected to have a significant effect on the assessment of the soil vapor to indoor air pathway and measured indoor air VOC concentrations.

## Analytical Results

Indoor air, ambient air, and soil vapor samples were analyzed according to the SAP/QAPP for the following VOCs:

- Benzene
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- cis-1,2-dichloroethene (cDCE)
- Vinyl chloride (VC)
- 1,1,1-trichloroethane (1,1,1-TCA)
- 1,1-dichloroethane (1,1-DCA)
- 1,2-dichloroethane (1,2-DCA)
- 1,4-dioxane

Upon receipt of the laboratory analytical report, the analytical data were reviewed to determine if the data are acceptable and meet the quality objectives listed in the project QAPP. A US Environmental Protection Agency Level IIA verification and validation was performed with guidance from applicable portions of the National Functional Guidelines for Organic Data Review (EPA 2016). All data were determined to be acceptable for use without further qualification.

The analytical data were compared to the screening criteria presented in the SAP. Screening criteria for evaluating indoor air analytical data include a short-term action screening level value of 7.5 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) for TCE, and values for Model Toxics Control Act (MTCA) Methods B (residential) and C (industrial). The short-term TCE value is based on protection of a fetus and therefore is a concern for women who are pregnant. Because women, particularly early in pregnancy, may not know that they are pregnant, all women of child-bearing age are considered to be the population at risk if concentrations of TCE exceed short-term screening levels. This screening level was important in this evaluation because there are women of child-bearing age working in Building C-19. Residential MTCA Method B values for VOCs were included because they are comparable to the screening levels that have been used during the RI and will support the ongoing RI and pending FS. Other than the short-term action screening level for TCE, all other VOC concentration results should be below the MTCA Method C values for industrial properties since this is the current building use condition. Indoor air MTCA Method B and C screening levels are summarized in Table 1.

None of the indoor air samples contained concentrations of VOCs that exceeded the short-term screening level for TCE ( $7.5 \mu\text{g}/\text{m}^3$ ) or the MTCA Method C (industrial) indoor air cleanup levels.

Therefore, consideration or discussion of the potential mitigation response actions described in the SAP are not warranted. VOCs were detected in all samples as described below.

- **Indoor Air:**
  - Bay #2 (IA01-C19): Benzene and TCE were detected in the Bay #2 sample at concentrations above the laboratory reporting limit and the benzene concentration ( $0.57 \mu\text{g}/\text{m}^3$ ) exceeded the MTCA Method B indoor air residential screening level of  $0.321 \mu\text{g}/\text{m}^3$ . TCE was detected (estimated at  $0.060 \mu\text{g}/\text{m}^3$ ) but at a level below the MTCA Method B indoor air screening level ( $0.334 \mu\text{g}/\text{m}^3$ ).
  - Bay #3 (IA02-C19 and IA03-C19): 1,1,1-TCA, 1,2-DCA, benzene, PCE and TCE were detected at concentrations above the laboratory reporting limits in both Bay #3 samples. Benzene concentrations exceeded the indoor air residential screening level in both samples and concentrations ranged from  $0.69 \mu\text{g}/\text{m}^3$  (IA03-C-19) to  $1.3 \mu\text{g}/\text{m}^3$  (IA02-C19). The IA02-C19 1,2-DCA concentration of  $0.12 \mu\text{g}/\text{m}^3$  exceeded the MTCA Method B residential indoor air screening level of  $0.096 \mu\text{g}/\text{m}^3$ .
- **Ambient Air (AA-C19):** VOCs detected above the laboratory reporting limit consist of 1,2-DCA, 1,4-dioxane, benzene, and PCE. The benzene concentration of  $0.39 \mu\text{g}/\text{m}^3$  exceeded the MTCA Method B indoor air residential screening level of  $0.321 \mu\text{g}/\text{m}^3$ .
- **Soil Vapor (RISG-103):** 1,1,1-TCA, 1,1-DCA, 1,4-dioxane, benzene, cDCE, PCE, and TCE were detected below the slab and near the former degreaser sump in Bay #3. The TCE result of  $530 \mu\text{g}/\text{m}^3$  exceeded both the residential (MTCA Method B) and industrial (MTCA Method C) sub-slab soil vapor screening levels of  $11 \mu\text{g}/\text{m}^3$  and  $67 \mu\text{g}/\text{m}^3$ , respectively.

Indoor and ambient air analytical results are presented on Table 1, along with the residential and industrial screening levels for indoor air. Table 2 presents the soil vapor results, along with the residential and industrial sub-slab screening levels. A copy of the laboratory analytical report is provided in Attachment 3.

## Discussion and Recommendations

None of the data indicate an exceedance of indoor air screening criteria applicable to an industrial setting. Sampling results show that two VOCs (1,2-DCA and benzene) were present in the Building-C-19 indoor air at concentrations above the residential screening criteria but below the MTCA Method C industrial criteria for indoor air. 1,2-DCA was detected in the ambient air sample but not the soil vapor sample, and the laboratory reporting limit ( $0.085 \mu\text{g}/\text{m}^3$ ) for the soil vapor sample was below the residential screening level ( $0.096 \mu\text{g}/\text{m}^3$ ) for indoor air. This suggests that the source of the 1,2-DCA inside Bay #3 could be coming from ambient conditions outside the building.

Benzene was found in both Bays #2 and #3, below the slab, and in ambient air. Potential sources of indoor air concentrations could include ambient air, sub-slab vapor, and current fuel storage activities. Sample IA02-C-19 had the highest benzene concentration at  $1.3 \mu\text{g}/\text{m}^3$  and is the only location where benzene would remain above the residential screening level ( $0.321 \mu\text{g}/\text{m}^3$ ) if the ambient air concentration ( $0.39 \mu\text{g}/\text{m}^3$ ) were subtracted from the laboratory result. Household-sized

fuel containers with up to about 3 gallons of gasoline were present in Bay #3 during the building survey and sampling activities. There was also a gas-powered boat and vehicle being stored in Bay #3 at the time of sampling that weren't present during the building survey.

### **Task 3: Groundwater Monitoring Well Installation**

Two shallow groundwater monitoring wells (RIGW-1 and RIGW-2) were installed near former Building C-27 to support the ongoing RI activities and development of a conceptual site model. Public and private utility locates were conducted prior to commencement of drilling activities. Both wells were drilled and installed on August 17, 2021 using hollow-stem auger drilling techniques.

Each of the wells was installed in accordance with the 2018 work plan using 10-ft screen lengths and flush-mounted surface monuments. Well casing materials and total depths differed slightly due to refusal encountered at one of the locations. RIGW-1 was installed to a depth of 20 ft below ground surface (bgs) using a 2-inch, Schedule 40 polyvinyl chloride (PVC) well casing and RIGW-2 was installed to a depth of 13 ft bgs using a 1-inch, Schedule 80 PVC well casing. No groundwater was encountered at RIGW-1. A small amount of water seeped into RIGW-2 immediately following installation but it wasn't measurable. RIGW-2 was developed on December 7, 2021 using a surge block and an electric submersible pump. Approximately 5 times the casing volume was removed from RIGW-2; RIGW-1 was still dry and was therefore not developed. The coordinates and top of casing elevations were surveyed on December 7, 2021 by an Airport preferred land surveyor. The survey data are provided in Attachment 4. An additional 14 location coordinates and ground surface elevations were surveyed during the same mobilization. The 14 locations are previous RI locations and the survey data results will be incorporated into the final RI report and subsequent FS.

While drilling the borehole for RIGW-2, the auger encountered refusal at a depth of 15 ft bgs. A permeable sand layer was present at this location between 5 and 12.5 ft bgs, and a less permeable, glacial till layer was encountered at 12.5 ft bgs. The less permeable layer continued until the refusal depth of 15 ft bgs, and the well was installed to a depth of 13 ft bgs to allow the well screen to be positioned within the more permeable sand. The locations of the two new wells are shown on Figure 2 and copies of well completion logs are provided in Attachment 5.

The absence of significant groundwater within the shallow perched zone at RIGW-1 and RIGW-2 was not completely unexpected given that the wells were installed during the dry summer months. In addition, lack of water is consistent with the current Site conceptual model, which hypothesizes that perched groundwater is lacking in areas where the glacial till surface is within 10 to 15 ft of ground surface and instead tends to collect within deeper portions of the irregular till surface (e.g., near the former East Fuel Farm). RIGW-1 and RIGW-2 provide important data points that strengthen the validity and refinement of this conceptual model.

## Use of This Report

This report has been prepared for the exclusive use of Snohomish County and Ecology for specific application to the Site. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. LAI makes no other warranty, either express or implied.

LANDAU ASSOCIATES, INC.



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December 15, 2021

## References

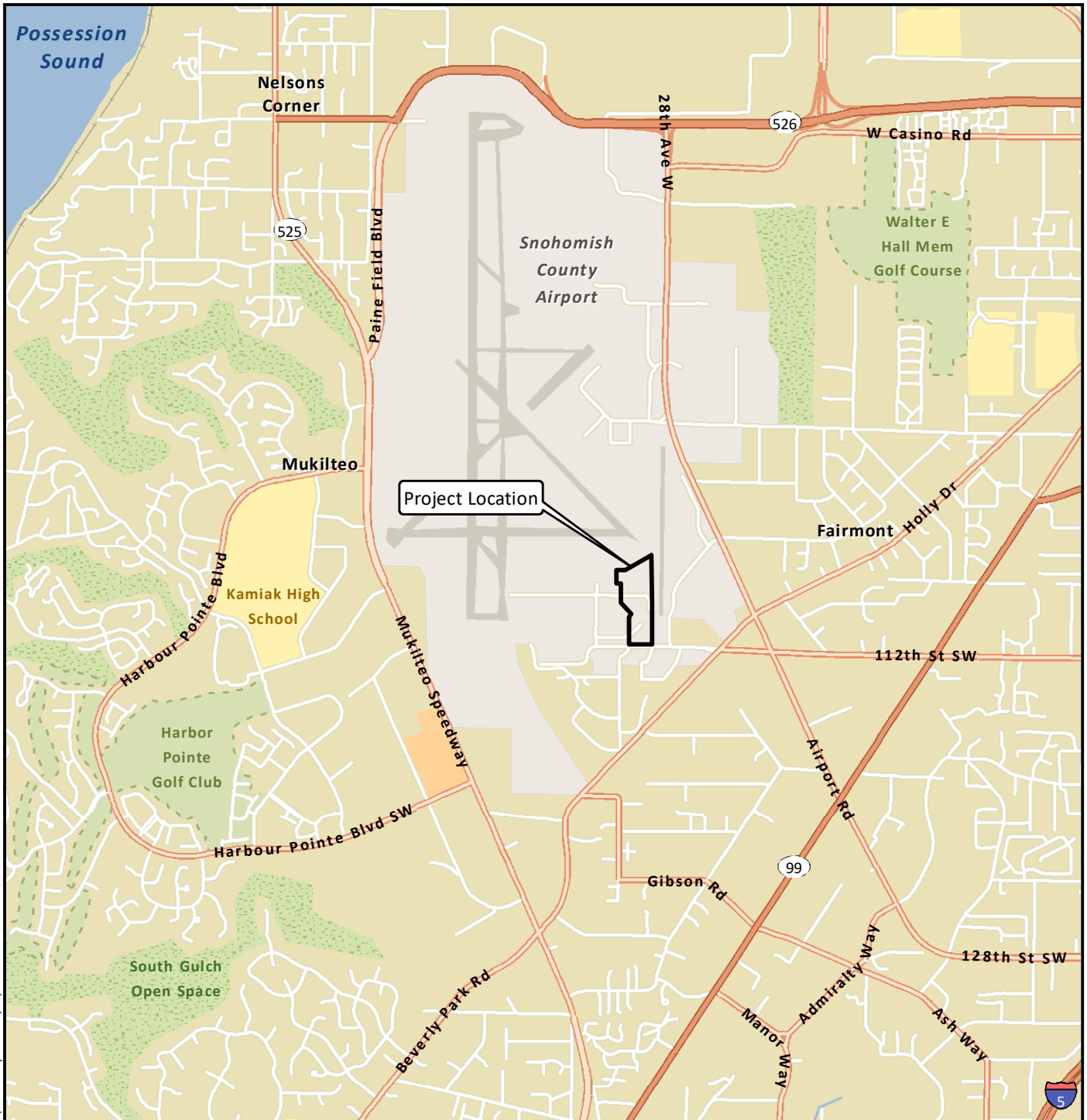
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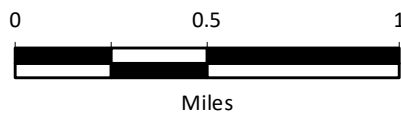
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## Attachments

- Figure 1: Vicinity Map
- Figure 2: Site Plan and New Groundwater Well Locations
- Figure 3: Building C-19 Features and Sampling Locations
- Figure 4: Building C-19 Pressure Data Plot
- Table 1: Indoor and Ambient Air Analytical Results
- Table 2: Soil Vapor Analytical Results
- Attachment 1: Inadvertent Discovery Plan
- Attachment 2: Indoor Air Sampling and Analysis Plan
- Attachment 3: Laboratory Analytical Report
- Attachment 4: Survey Data Results
- Attachment 5: Well Completion Logs



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Data Source: Esri.



TECT Aerospace Leasehold  
Everett, Washington

Vicinity Map

Figure  
**1**

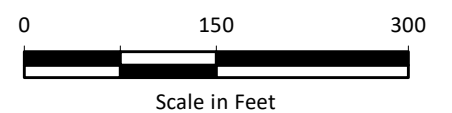


**Legend**

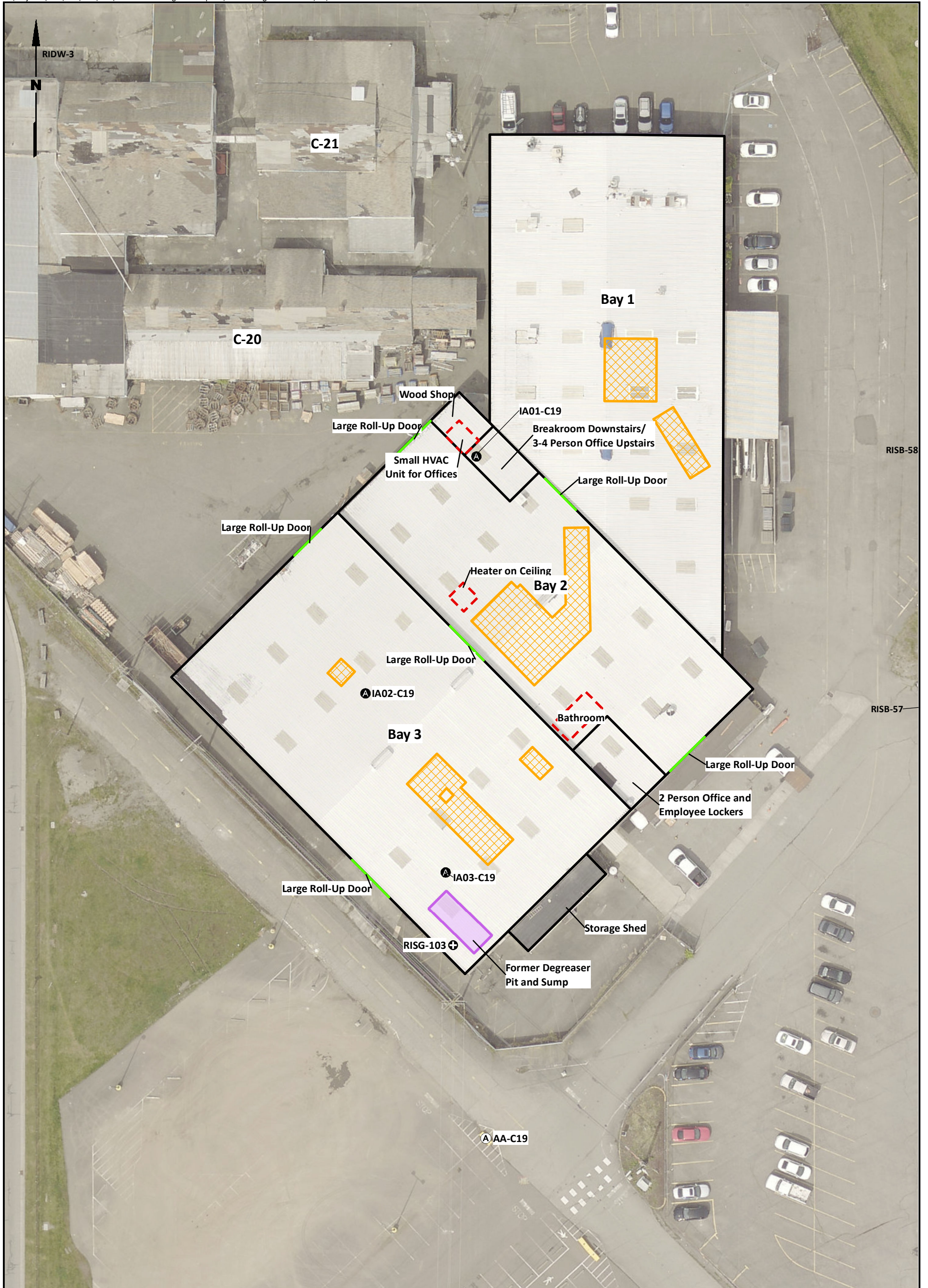
- Monitoring Well
- Approximate Site Boundary
- ▭ Building C-19

**Note**

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

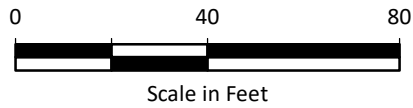


Data Sources: AGI 1999; Landau Associates 2006; King County GIS.



**Legend**

- Ⓐ Ambient Air Sampling Location (Upwind During Sampling)
- Ⓐ Indoor Air Sampling Location
- ⊕ Sub-Slab Sampling Location
- ⊠ Previous Remedial Excavation Areas



**Note**

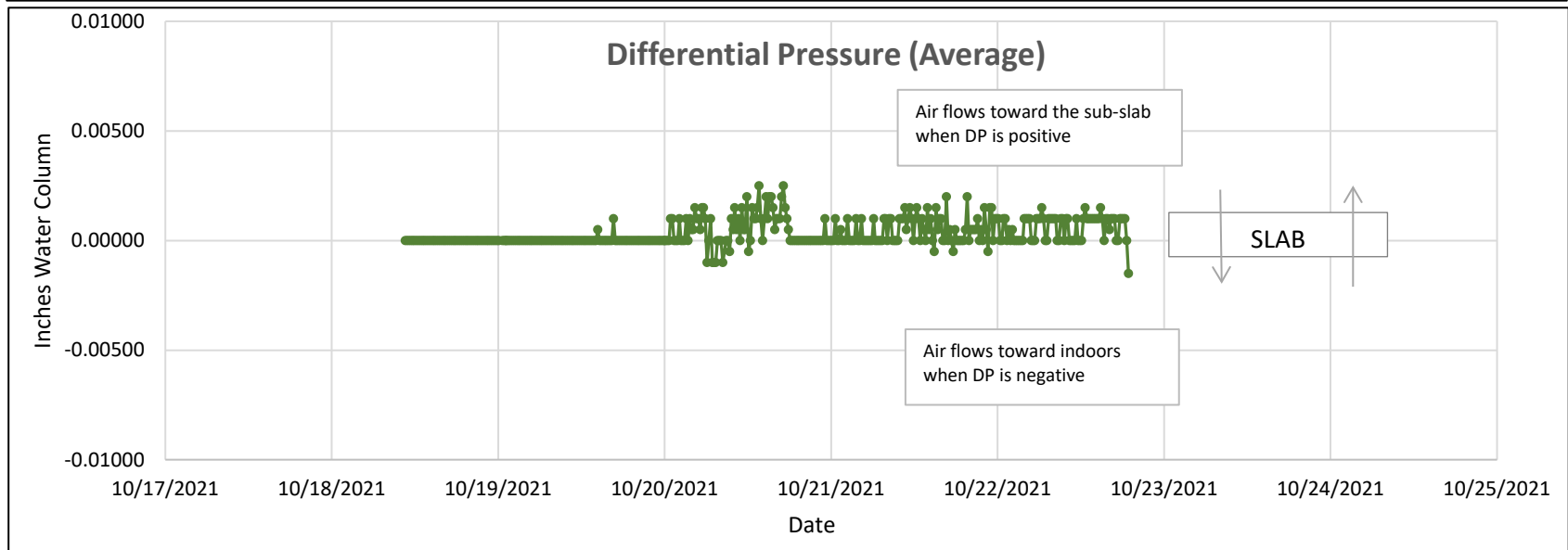
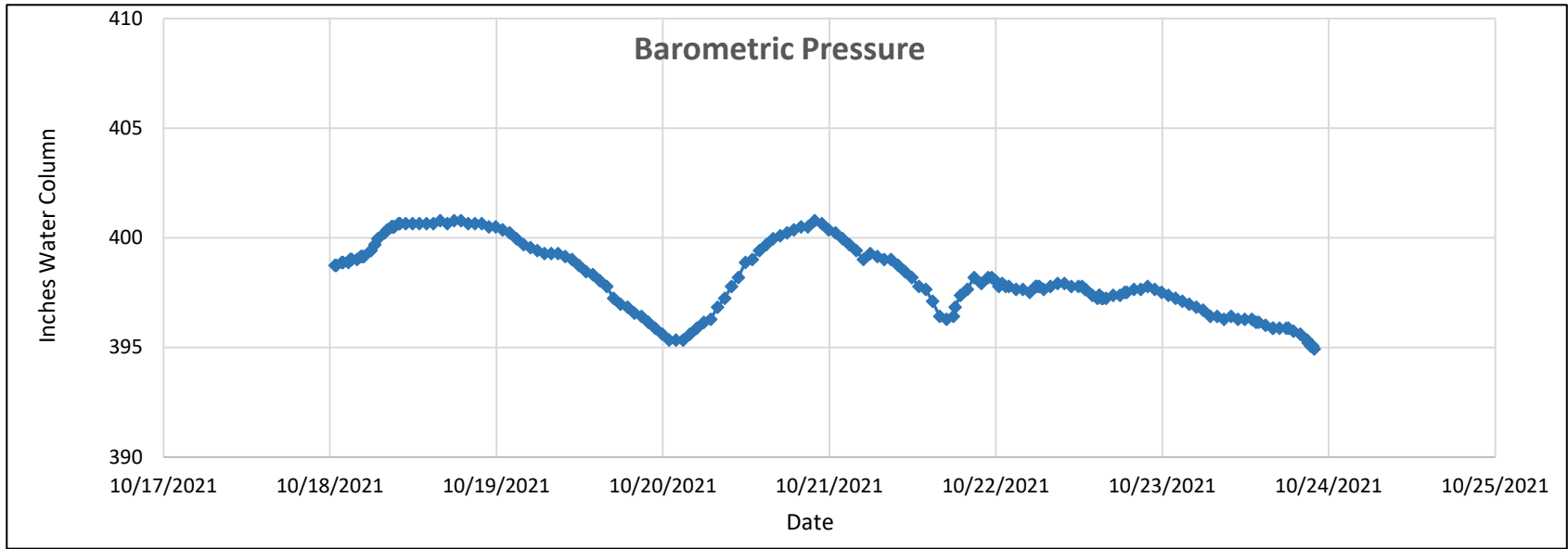
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: AGI 1999; Landau Associates 2006; King County GIS.

TECT Aerospace Leasehold  
Everett, Washington

**Building C-19 Features and  
Sampling Locations**

Figure  
**3**



**Table 1**  
**Indoor and Ambient Air Analytical Results**  
**C-19 Indoor Air Evaluation**  
**Snohomish County Airport – Everett, Washington**

Analyte	MTCA Method B Indoor Air Screening Level <sup>a</sup>	MTCA Method C Indoor Air Screening Level	Sampling Location, Sampling Date, Sample Type, Lab SDG			
			IA01-C19	IA02-C19	IA03-C19	AA-C19
			10/22/2021 N P2105652	10/22/2021 N P2105652	10/22/2021 N P2105652	10/22/2021 N P2105652
<b>Volatile Organic Compounds (<math>\mu\text{g}/\text{m}^3</math>; TO-15 SIM)</b>						
1,1,1-Trichloroethane	2285 <sup>b</sup>	5,000 <sup>b</sup>	0.061 U	<b>0.019 J</b>	<b>0.024 J</b>	0.013 U
1,1-Dichloroethane	1.56	15.6	0.056 U	0.011 U	0.012 U	0.011 U
1,2-Dichloroethane	0.096	0.96	0.056 U	<b>0.12</b>	<b>0.069</b>	<b>0.042</b>
1,4-Dioxane	0.5	5	0.059 U	0.012 U	0.012 U	<b>0.014 J</b>
Benzene	0.321	3.210	<b>0.57</b>	<b>1.3</b>	<b>0.69</b>	<b>0.39</b>
cis-1,2-Dichloroethene	<sup>c</sup>	<sup>c</sup>	0.049 U	0.0098 U	0.010 U	0.010 U
Tetrachloroethene	9.62	40.00	0.11 U	<b>0.073</b>	<b>0.049</b>	<b>0.045</b>
Trichloroethene	0.334	2	<b>0.060 J</b>	<b>0.038</b>	<b>0.043</b>	0.011 U
Vinyl Chloride	0.284	2.84	0.082 U	0.016 U	0.017 U	0.017 U

**Notes:**

U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

**Bold** = detected compound

**Green Box** = detected concentration is greater than MTCA Method B indoor air screening level

(a) Preliminary screening levels based on Ecology CLARC Method B, indoor air cancer cleanup levels (Ecology 2021a).

(b) Value is based on non-cancer because there is no MTCA Method B or Method C cancer cleanup level available in CLARC.

(c) Indoor air and soil gas screening levels not established in CLARC for this chemical.

**Abbreviations and Acronyms:**

$\mu\text{g}/\text{m}^3$  = micrograms per cubic meter

CLARC = cleanup levels and risk calculations

Ecology = Washington State Department of Ecology

MTCA = Model Toxics Control Act

SDG = sample delivery group

SIM = selected ion monitoring

**Table 2**  
**Soil Vapor Analytical Results**  
**C-19 Indoor Air Evaluation**  
**Snohomish County Airport – Everett, Washington**

Analyte	MTCA Method B Sub-Slab Soil Vapor Screening Level <sup>a</sup>	MTCA Method C Sub-Slab Soil Vapor Screening Level	Sampling Location, Date, and Type; Lab SDG
			RISG-103 10/22/2021 N P2105652
<b>Volatile Organic Compounds (<math>\mu\text{g}/\text{m}^3</math>; TO-15)</b>			
1,1,1-Trichloroethane	76,000 <sup>b</sup>	170,000 <sup>b</sup>	<b>150</b>
1,1-Dichloroethane	52	520	<b>3.9</b>
1,2-Dichloroethane	3.2	32	0.085 U
1,4-Dioxane	17	170	<b>0.96</b>
Benzene	10.7	110	<b>0.47 J</b>
cis-1,2-Dichloroethene	<sup>c</sup>	<sup>c</sup>	<b>0.71 J</b>
Tetrachloroethene	320	1,300	<b>3.1</b>
Trichloroethene	11	67	<b>530</b>
Vinyl Chloride	9.5	95	0.082 U

**Notes:**

U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

**Bold** = detected compound

**Green Box** = detected concentration is greater than MTCA Method B sub-slab soil vapor screening level

(a) Preliminary screening levels based on Ecology CLARC Method B, sub-slab soil cancer cleanup levels (Ecology 2021).

(b) Value is based on non-cancer because there is no MTCA Method B or Method C cancer cleanup level available in CLARC.

(c) Indoor air and soil vapor screening levels not established in CLARC for this chemical.

**Abbreviations and Acronyms:**

$\mu\text{g}/\text{m}^3$  = micrograms per cubic meter

CLARC = Cleanup Levels and Risk Calculations

Ecology = Washington State Department of Ecology

MTCA = Model Toxics Control Act

SDG = Sample Delivery Group

# Inadvertent Discovery Plan





# INADVERTENT DISCOVERY PLAN PLAN AND PROCEDURES FOR THE DISCOVERY OF CULTURAL RESOURCES AND HUMAN SKELETAL REMAINS

To request ADA accommodation, including materials in a format for the visually impaired, call Ecology at 360-407-6000 or visit <https://ecology.wa.gov/accessibility>. People with impaired hearing may call Washington Relay Service at 711. People with a speech disability may call TTY at 877-833-6341.

Site Name(s):

Location:

Project Lead/Organization:

County:

*If this Inadvertent Discovery Plan (IDP) is for multiple (batched) projects, ensure the location information covers all project areas.*

## 1. INTRODUCTION

The IDP outlines procedures to perform in the event of a discovery of archaeological materials or human remains, in accordance with applicable state and federal laws. An IDP is required, as part of Agency Terms and Conditions for all grants and loans, for any project that creates disturbance above or below the ground. An IDP is not a substitute for a formal cultural resource review (Executive 21-02 or Section 106).

Once completed, **the IDP should always be kept at the project site** during all project activities. All staff, contractors, and volunteers should be familiar with its contents and know where to find it.

## 2. CULTURAL RESOURCE DISCOVERIES

A cultural resource discovery could be prehistoric or historic. Examples include (see images for further examples):

- An accumulation of shell, burned rocks, or other food related materials.
- Bones, intact or in small pieces.
- An area of charcoal or very dark stained soil with artifacts.
- Stone tools or waste flakes (for example, an arrowhead or stone chips).
- Modified or stripped trees, often cedar or aspen, or other modified natural features, such as rock drawings.
- Agricultural or logging materials that appear older than 50 years. These could include equipment, fencing, canals, spillways, chutes, derelict sawmills, tools, and many other items.
- Clusters of tin cans or bottles, or other debris that appear older than 50 years.
- Old munitions casings. **Always assume these are live and never touch or move.**
- Buried railroad tracks, decking, foundations, or other industrial materials.
- Remnants of homesteading. These could include bricks, nails, household items, toys, food containers, and other items associated with homes or farming sites.

The above list does not cover every possible cultural resource. When in doubt, assume the material is a cultural resource.

### 3. ON-SITE RESPONSIBILITIES

If any employee, contractor, or subcontractor believes that they have uncovered cultural resources or human remains at any point in the project, take the following steps to **Stop-Protect-Notify**. **If you suspect that the discovery includes human remains, also follow Sections 5 and 6.**

#### **STEP A: Stop Work.**

All work must stop immediately in the vicinity of the discovery.

#### **STEP B: Protect the Discovery.**

Leave the discovery and the surrounding area untouched and create a clear, identifiable, and wide boundary (30 feet or larger) with temporary fencing, flagging, stakes, or other clear markings. Provide protection and ensure integrity of the discovery until cleared by the Department of Archaeological and Historical Preservation (DAHP) or a licensed, professional archaeologist.

Do not permit vehicles, equipment, or unauthorized personnel to traverse the discovery site. Do not allow work to resume within the boundary until the requirements of this IDP are met.

#### **STEP C: Notify Project Archaeologist (if applicable).**

If the project has an archaeologist, notify that person. If there is a monitoring plan in place, the archaeologist will follow the outlined procedure.

#### **STEP D: Notify Project and Washington Department of Ecology (Ecology) contacts.**

##### **Project Lead Contacts**

###### Primary Contact

Name:

Organization:

Phone:

Email:

###### Alternate Contact

Name:

Organization:

Phone:

Email:

##### **Ecology Contacts (completed by Ecology Project Manager)**

###### Ecology Project Manager

Name:

Program:

Phone:

Email:

###### Alternate or Cultural Resource Contact

Name:

Program:

Phone:

Email:

**STEP E: Ecology will notify DAHP.**

Once notified, the Ecology Cultural Resource Contact or the Ecology Project Manager will contact DAHP to report and confirm the discovery. To avoid delay, the Project Lead/Organization will contact DAHP if they are not able to reach Ecology.

DAHP will provide the steps to assist with identification. DAHP, Ecology, and Tribal representatives may coordinate a site visit following any necessary safety protocols. DAHP may also inform the Project Lead/Organization and Ecology of additional steps to further protect the site.

**Do not continue work until DAHP has issued an approval for work to proceed in the area of, or near, the discovery.**

DAHP Contacts:

Name: Rob Whitlam, PhD  
Title: State Archaeologist  
Cell: 360-890-2615  
Email: [Rob.Whitlam@dahp.wa.gov](mailto:Rob.Whitlam@dahp.wa.gov)  
Main Office: 360-586-3065

**Human Remains/Bones:**

Name: Guy Tasa, PhD  
Title: State Anthropologist  
Cell: 360-790-1633 (24/7)  
Email: [Guy.Tasa@dahp.wa.gov](mailto:Guy.Tasa@dahp.wa.gov)

**4. TRIBAL CONTACTS**

In the event cultural resources are discovered, the following tribes will be contacted. See Section 10 for Additional Resources.

Tribe:	Tribe:
Name:	Name:
Title:	Title:
Phone:	Phone:
Email:	Email:
Tribe:	Tribe:
Name:	Name:
Title:	Title:
Phone:	Phone:
Email:	Email:

Please provide contact information for additional tribes within your project area, if needed, in Section 11.

**5. FURTHER CONTACTS (if applicable)**

If the discovery is confirmed by DAHP as a cultural or archaeological resource, or as human remains, and there is a partnering federal or state agency, Ecology or the Project Lead/Organization will ensure the partnering agency is immediately notified.

Federal Agency:

Agency:

Name:

Title:

Phone:

Email:

State Agency:

Agency:

Name:

Title:

Phone:

Email:

## 6. SPECIAL PROCEDURES FOR THE DISCOVERY OF HUMAN SKELETAL MATERIAL

Any human skeletal remains, regardless of antiquity or ethnic origin, will at all times be treated with dignity and respect. Follow the steps under **Stop-Protect-Notify**. For specific instructions on how to handle a human remains discovery, see: [RCW 68.50.645: Skeletal human remains—Duty to notify—Ground disturbing activities—Coroner determination—Definitions](#).

**Suggestion:** If you are unsure whether the discovery is human bone or not, contact Guy Tasa with DAHP, for identification and next steps. Do not pick up the discovery.

Guy Tasa, PhD State Physical Anthropologist

[Guy.Tasa@dahp.wa.gov](mailto:Guy.Tasa@dahp.wa.gov)

(360) 790-1633 (Cell/Office)

For discoveries that are confirmed or suspected human remains, follow these steps:

1. Notify law enforcement and the Medical Examiner/Coroner using the contacts below. **Do not call 911** unless it is the only number available to you.

Enter contact information below (required):

- Local Medical Examiner or Coroner name and phone:
  
  - Local Law Enforcement main name and phone:
  
  - Local Non-Emergency phone number (911 if without a non-emergency number):
2. The Medical Examiner/Coroner (with assistance of law enforcement personnel) will determine if the remains are human or if the discovery site constitutes a crime scene and will notify DAHP.
  3. **DO NOT speak with the media, allow photography or disturbance of the remains, or release any information about the discovery on social media.**
  4. If the remains are determined to be non-forensic, Cover the remains with a tarp or other materials (not soil or rocks) for temporary protection and to shield them from being photographed by others or disturbed.

Further activities:

- Per [RCW 27.44.055](#), [RCW 68.50](#), and [RCW 68.60](#), DAHP will have jurisdiction over non-forensic human remains. Ecology staff will participate in consultation. Organizations may also participate in consultation.
- Documentation of human skeletal remains and funerary objects will be agreed upon through the consultation process described in [RCW 27.44.055](#), [RCW 68.50](#), and [RCW 68.60](#).
- When consultation and documentation activities are complete, work in the discovery area may resume as described in Section 8.

If the project occurs on federal lands (such as a national forest or park or a military reservation) the provisions of the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) apply and the responsible federal agency will follow its provisions. Note that state highways that cross federal lands are on an easement and are not owned by the state.

If the project occurs on non-federal lands, the Project Lead/Organization will comply with applicable state and federal laws, and the above protocol.

## **7. DOCUMENTATION OF ARCHAEOLOGICAL MATERIALS**

Archaeological resources discovered during construction are protected by state law [RCW 27.53](#) and assumed eligible for inclusion in the National Register of Historic Places under Criterion D until a formal Determination of Eligibility is made.

The Project Lead/Organization must ensure that proper documentation and field assessment are made of all discovered cultural resources in cooperation with all parties: the federal agencies (if any), DAHP, Ecology, affected tribes, and the archaeologist.

The archaeologist will record all prehistoric and historic cultural material discovered during project construction on a standard DAHP archaeological site or isolate inventory form. They will photograph site overviews, features, and artifacts and prepare stratigraphic profiles and soil/sediment descriptions for minimal subsurface exposures. They will document discovery locations on scaled site plans and site location maps.

Cultural features, horizons, and artifacts detected in buried sediments may require the archaeologist to conduct further evaluation using hand-dug test units. They will excavate units in a controlled fashion to expose features, collect samples from undisturbed contexts, or to interpret complex stratigraphy. They may also use a test unit or trench excavation to determine if an intact occupation surface is present. They will only use test units when necessary to gather information on the nature, extent, and integrity of subsurface cultural deposits to evaluate the site's significance. They will conduct excavations using standard archaeological techniques to precisely document the location of cultural deposits, artifacts, and features.

The archaeologist will record spatial information, depth of excavation levels, natural and cultural stratigraphy, presence or absence of cultural material, and depth to sterile soil, regolith, or bedrock for each unit on a standard form. They will complete test excavation unit level forms, which will include plan maps for each excavation level and artifact counts and material types, number, and vertical provenience (depth below

surface and stratum association where applicable) for all recovered artifacts. They will draw a stratigraphic profile for at least one wall of each test excavation unit.

The archaeologist will screen sediments excavated for purposes of cultural resources investigation through 1/8-inch mesh, unless soil conditions warrant 1/4-inch mesh.

The archaeologist will analyze, catalogue, and temporarily curate all prehistoric and historic artifacts collected from the surface and from probes and excavation units. The ultimate disposition of cultural materials will be determined in consultation with the federal agencies (if any), DAHP, Ecology, and the affected tribe(s).

Within 90 days of concluding fieldwork, the archaeologist will provide a technical report describing any and all monitoring and resultant archaeological excavations to the Project Lead/Organization, who will forward the report to Ecology, the federal agencies (if any), DAHP, and the affected tribe(s) for review and comment.

If assessment activities expose human remains (burials, isolated teeth, or bones), the archaeologist and Project Lead/Organization will follow the process described in **Section 6**.

## **8. PROCEEDING WITH WORK**

The Project Lead/Organization shall work with the archaeologist, DAHP, and affected tribe(s) to determine the appropriate discovery boundary and where work can continue.

Work may continue at the discovery location only after the process outlined in this plan is followed and the Project Lead/Organization, DAHP, any affected tribe(s), Ecology, and the federal agencies (if any) determine that compliance with state and federal laws is complete.

## **9. ORGANIZATION RESPONSIBILITY**

The Project Lead/Organization is responsible for ensuring:

- This IDP has complete and accurate information.
- This IDP is immediately available to all field staff at the sites and available by request to any party.
- This IDP is implemented to address any discovery at the site.
- That all field staff, contractors, and volunteers are instructed on how to implement this IDP.

## **10. ADDITIONAL RESOURCES**

### **Informative Video**

Ecology recommends that all project staff, contractors, and volunteers view this informative video explaining the value of IDP protocol and what to do in the event of a discovery. The target audience is anyone working on the project who could unexpectedly find cultural resources or human remains while excavating or digging. The video is also posted on DAHP's inadvertent discovery language website.

[Ecology's IDP Video](https://www.youtube.com/watch?v=ioX-4cXfbDY) (<https://www.youtube.com/watch?v=ioX-4cXfbDY>)

## **Informational Resources**

[DAH P \(https://dahp.wa.gov\)](https://dahp.wa.gov)

[Washington State Archeology \(DAH P 2003\)](https://dahp.wa.gov/sites/default/files/Field%20Guide%20to%20WA%20Arch_0.pdf)

[\(https://dahp.wa.gov/sites/default/files/Field%20Guide%20to%20WA%20Arch\\_0.pdf\)](https://dahp.wa.gov/sites/default/files/Field%20Guide%20to%20WA%20Arch_0.pdf)

[Association of Washington Archaeologists \(https://www.archaeologyinwashington.com\)](https://www.archaeologyinwashington.com)

## **Potentially Interested Tribes**

[Interactive Map of Tribes by Area](https://dahp.wa.gov/archaeology/tribal-consultation-information)

[\(https://dahp.wa.gov/archaeology/tribal-consultation-information\)](https://dahp.wa.gov/archaeology/tribal-consultation-information)

[WSDOT Tribal Contact Website](https://wsdot.wa.gov/tribal/TribalContacts.htm)

[\(https://wsdot.wa.gov/tribal/TribalContacts.htm\)](https://wsdot.wa.gov/tribal/TribalContacts.htm)

## **11. ADDITIONAL INFORMATION**

Please add any additional contact information or other information needed within this IDP.

**Implement the IDP if you see...**

**Chipped stone artifacts.**

Examples are:

- Glass-like material.
- Angular material.
- “Unusual” material or shape for the area.
- Regularity of flaking.
- Variability of size.



*Stone artifacts from Oregon.*



*Stone artifacts from Washington.*



*Biface-knife, scraper, or pre-form found in NE Washington. Thought to be a well knapped object of great antiquity. Courtesy of Methow Salmon Rec. Foundation.*



## Implement the IDP if you see...

### Ground stone artifacts.

Examples are:

- Unusual or unnatural shapes or unusual stone.
- Striations or scratching.
- Etching, perforations, or pecking.
- Regularity in modifications.
- Variability of size, function, or complexity.



Above: Fishing Weight - credit [CRITFC Treaty Fishing Rights website](#).



Artifacts from unknown locations (left and right images).

**Implement the IDP if you see...**

**Bone or shell artifacts, tools, or beads.**

Examples are:

- Smooth or carved materials.
- Unusual shape.
- Pointed as if used as a tool.
- Wedge shaped like a “shoehorn”.
- Variability of size.
- Beads from shell (‘dentalium’) or tusk.



Upper Left: Bone Awls from Oregon.

Upper Center: Bone Wedge from California.

Upper Right: Plateau dentalium choker and bracelet, from Nez Perce National Historical Park, 19th century, made using Antalis pretiosa shells Credit: Nez Perce - Nez Perce National Historical Park, NEPE 8762, [Public Domain](#).

Above: Tooth Pendants. Right: Bone Pendants. Both from Oregon and Washington.



## Implement the IDP if you see...

### Culturally modified trees, fiber, or wood artifacts.

Examples are:

- Trees with bark stripped or peeled, carvings, axe cuts, de-limbing, wood removal, and other human modifications.
- Fiber or wood artifacts in a wet environment.
- Variability of size, function, and complexity.



Left and Below: *Culturally modified tree and an old carving on an aspen (Courtesy of DAHP).*

Right, Top to Bottom: *Artifacts from Mud Bay, Olympia: Toy war club, two strand cedar rope, wet basketry.*



## Implement the IDP if you see...

### Strange, different, or interesting looking dirt, rocks, or shells.

Human activities leave traces in the ground that may or may not have artifacts associated with them. Examples are:

- “Unusual” accumulations of rock (especially fire-cracked rock).
- “Unusual” shaped accumulations of rock (such as a shape similar to a fire ring).
- Charcoal or charcoal-stained soils, burnt-looking soils, or soil that has a “layer cake” appearance.
- Accumulations of shell, bones, or artifacts. Shells may be crushed.
- Look for the “unusual” or out of place (for example, rock piles in areas with otherwise few rocks).



*Shell Midden pocket in modern fill discovered in sewer trench.*



*Underground oven. Courtesy of DAHP.*

*Shell midden with fire cracked rock.*



*Hearth excavated near Hamilton, WA.*

**Implement the IDP if you see...**

**Historic period artifacts (historic archaeology considered older than 50 years).**

Examples are:

- Agricultural or logging equipment. May include equipment, fencing, canals, spillways, chutes, derelict sawmills, tools, etc.
- Domestic items including square or wire nails, amethyst colored glass, or painted stoneware.



Left: Top to Bottom: *Willow pattern serving bowl and slip joint pocket knife discovered during Seattle Smith Cove shantytown (45-KI-1200) excavation.*



Right: *Collections of historic artifacts discovered during excavations in eastern Washington cities.*



**Implement the IDP if you see...**

**Historic period artifacts (historic archaeology considered older than 50 years).**

Examples are:

- Railway tokens, coins, and buttons.
- Spectacles, toys, clothing, and personal items.
- Items helping to understand a culture or identity.
- Food containers and dishware.



Main Image: *Dishes, bottles, workboot found at the North Shore Japanese bath house (ofuro) site, Courtesy Bob Muckle, Archaeologist, Capilano University, B.C. This is an example of an above ground resource.*



Right, from Top to Bottom: *Coins, token, spectacles and Montgomery Ward pitchfork toy discovered during Seattle Smith Cove shantytown (45-KI-1200) excavation.*



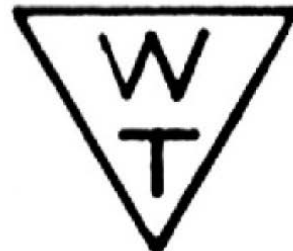
**Implement the IDP if you see...**

- Old munition casings – if you see ammunition of any type – ***always assume they are live and never touch or move!***
- Tin cans or glass bottles with an older manufacturer's technique – maker's mark, distinct colors such as turquoise, or an older method of opening the container.



Far Left: .303 British cartridge found by a WCC planting crew on Skagit River. Don't ever touch something like this!  
Left: Maker's mark on bottom of old bottle.

Right: Old beer can found in Oregon. ACME was owned by Olympia Brewery. Courtesy of Heather Simmons.



Logo employed by Whithall Tatum & Co. between 1924 to 1938 (Lockhart et al. 2016).



Can opening dates, courtesy of W.M. Schroeder.

Implement the IDP if you see...

You see historic foundations or buried structures.

Examples are:

- Foundations.
- Railroad and trolley tracks.
- Remnants of structures.



Counter Clockwise, Left to Right: *Historic structure 45KI924, in WSDOT right of way for SR99 tunnel. Remnants of Smith Cove shantytown (45-KI-1200) discovered during Ecology CSO excavation, City of Spokane historic trolley tracks uncovered during stormwater project, intact foundation of historic home that survived the Great Ellensburg Fire of July 4, 1889, uncovered beneath parking lot in Ellensburg.*



**Implement the IDP if you see...**

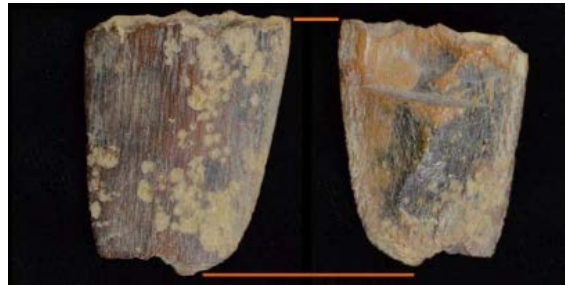
**Potential human remains.**

Examples are:

- Grave headstones that appear to be older than 50 years.
- Bones or bone tools--intact or in small pieces. It can be difficult to differentiate animal from human so they must be identified by an expert.
- These are all examples of animal bones and are not human.

Center: *Bone wedge tool, courtesy of Smith Cove Shantytown excavation (45KI1200).*

*Other images (Top Right, Bottom Left, and Bottom) Center: Courtesy of DAHP.*



Directly Above: This is a real discovery at an Ecology sewer project site.

*What would you do if you found these items at a site? Who would be the first person you would call?*

*Hint: Read the plan!*

# **Indoor Air Sampling and Analysis Plan**

# Technical Memorandum

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**TO:** Andrew Rardin, Paine Field / Snohomish County Airport  
**FROM:** Stephanie Renando and Jerry Ninteman, PE  
**DATE:** October 8, 2021  
**RE:** **Indoor Air Sampling and Analysis Plan**  
**Former TECT Aerospace Lease Area**  
**Building C-19**  
**Snohomish County Airport**  
**Everett, Washington**  
**LAI Project No. 0222057.030**

## Introduction

At the request of Snohomish County Airport (Airport), Landau Associates, Inc. (LAI) has prepared this Indoor Air Sampling and Analysis Plan (SAP) detailing the proposed Building C-19 indoor air evaluation activities. Building C-19 is located within the boundaries of the former TECT Aerospace (TECT) site at Paine Field / Snohomish County Airport in Everett, Washington (Figures 1 and 2). LAI has been conducting a remedial investigation (RI) at the TECT site on behalf of Snohomish County since November 2018 in accordance with the Remedial Investigation/Feasibility Study Work Plan (LAI 2018) and subsequent RI work plan addendum (LAI 2019a). RI activities continued through December 2019 and are documented in a data report (LAI 2019b).

On June 17, 2021, the Airport entered into an Interagency Agreement (IAA; Ecology 2021b) with the Washington State Department of Ecology (Ecology) that would allow the Airport to use agency grant funds to support the ongoing RI and inform the subsequent feasibility study (FS). The Building C-19 indoor air evaluation is the primary task to be conducted under the IAA grant and preparation of this SAP is a required deliverable under the IAA. This SAP includes a Quality Assurance Project Plan (QAPP) to identify the data objectives, along with a description of how the data will be validated and reported (Attachment 1). An Inadvertent Discovery Plan (IDP) was prepared separately and will be used to respond in the unlikely event that cultural resources are encountered during ground-disturbing activities.

During the RI, soil gas samples were collected in and around the southeast corner of Building C-19 in the vicinity of a former sump used for degreasing operations. Soil gas samples were analyzed for volatile organic compounds (VOCs), and results showed concentrations of trichloroethene (TCE) above Ecology Model Toxics Control Act (MTCA) Method B sub-slab soil gas screening criteria. Elevated TCE concentrations from samples collected within 30 feet of the former degreaser sump (Figure 3) below the concrete slab ranged from 310 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) to 1,400  $\mu\text{g}/\text{m}^3$ . Based on the detected concentrations of VOCs in soil gas, there is potential for vapor intrusion to result in concentrations of VOCs in indoor air that are greater than screening criteria for indoor air and therefore present a potential health concern for building occupants.

In response, indoor air samples will be collected to determine if chemicals detected in soil gas are present in indoor air at concentrations that exceed applicable screening criteria. The indoor air evaluation will focus on the southern half of Building C-19 where elevated VOC concentrations in soil gas were detected below the building slab (Bay #3), plus the adjacent Bay #2 because of its proximity to Bay #3 (Figure 3). In preparation for indoor air sampling, a survey of Building C-19 was conducted on September 1, 2021. This technical memorandum presents the results of the building survey, an indoor air sampling plan, and a summary of potential mitigation measures that may be considered in the event that chemical concentrations in indoor air are found to exceed applicable screening levels.

## Building Survey

Building C-19 is located in an industrial manufacturing complex in the southeastern portion of Paine Field. The building is surrounded by paved roads and parking areas, and unpaved grassy areas to the east and southwest.

The building survey consisted of observing relevant features of the building construction (e.g., foundation type and condition); documenting building heating, cooling, and ventilation systems; documenting building operations; and conducting a chemical inventory. During the building survey, LAI personnel were escorted by Jafet Rivera Laboy, Operations Manager for Brand Safway, and Thomas Giddens, the primary leaseholder for Building C-19. Mr. Laboy and Mr. Giddens provided information regarding the building and operations. A diagram of the building and key features are provided on Figure 3.

## Building Construction

Building C-19 is a one-story building that is a combination of concrete and metal frame construction with slab-on-grade foundations. Building C-19 is divided into three bays (Bay #1, Bay #2, and Bay #3) by two masonry interior walls; one separates Bay #1 and Bay #2, and the other separates Bay #2 and Bay #3. There are multiple roll-up doors and single person doors located along the interior and exterior walls, but the interior wall doors are no longer in use and remain closed. The following key features of the building construction were observed in Bays #2 and #3 (Bay references are shown on Figure 3):

- Bay #2 is primarily used to store metal scaffolding, which is used for building construction and maintenance. The building slab is in fair condition but has cracks throughout and the joints are not sealed. Multiple steel beams embedded into the concrete were observed and likely functioned as foundations for heavy machinery at these locations during previous tenant operations. Oil staining was observed in the northeast corner of the bay.
- Bay #3 was vacant during the September 1, 2021 survey; the previous tenant, Vector Aerospace, vacated Bay #3 in June 2021. A former degreaser pit and sump are located in the southern corner. The former degreaser and sump have been decommissioned and paved over but subsurface contamination associated with a release from this area is still being

investigated as part of the RI. The building slab is in fair condition but has cracks throughout and the joints are not sealed. Multiple steel beams embedded into the concrete were observed and likely functioned as foundations for heavy machinery at these locations during previous tenant operations. A machine pit that had been recently backfilled and covered with four sections of concrete was observed in the northeast area of Bay #3. The joints had not been sealed and there were cracks throughout.

- Underground utilities are generally present under the slab, mostly near and running parallel to the southernmost interior wall. Electrical power lines are located overhead in breakroom and restroom facilities. Underground sewer connections associated with the restrooms are located in the southeastern portion of the building. No floor drains were noted in the building.
- Stormwater runoff is discharged from the roof to the ground where it either infiltrates or enters catch basins.

## Heating and Cooling

Heating and cooling methods can have a significant impact on building pressure, air flow, and air flux, which are important in evaluating the potential for vapor intrusion and interpreting analytical results. Building C-19 uses a combination of heating and cooling methods throughout the building. The following bullets describe key features of the heating and cooling system:

- Heat throughout the building is primarily from electric wall or ceiling-mounted heating units. None of the heating units rely on internal combustion of fuel and subsequent venting to the outdoors that can have a significant impact on indoor air-pressure conditions.
- Ventilation in the building is provided by manually opening exterior roll-up or single person doors. Louvered roof vents were observed but they are not currently used for ventilation. During hot weather, pedestal-mounted floor fans are used to blow warm air outside from inside the building.

These heating and cooling operations suggest that differential pressure monitoring should focus on changes in building ventilation and outdoor ambient barometric pressure conditions when evaluating optimum conditions for detecting soil vapor intrusion and that it is not necessary to focus on changes in building heating conditions. Differential pressure monitoring (described below) will be conducted prior to and during indoor air sampling to understand the air flux at the time of sampling.

## Building Operations

The occupied Bay #2 operates 24 hours per day, 7 days per week, with employees spending most of their time out of the building on project sites. Bay #2 is occupied by adult employees. At least one female employee between the ages of 20 and 60 was noted to be working in the building. The presence of female employees potentially of child-bearing age is noted because TCE has a short-term action level related to fetal health. Additional information on screening criteria is provided later in this document.

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## Chemical Inventory

A chemical inventory was conducted to determine what chemicals are in use inside the building. The primary chemicals observed were household cleansers, sanitizers, paints and primers, and home maintenance products, such as concrete patching muds, powders, and lawn care products, as described below. Large volumes of products containing VOCs are not currently used or stored at the facility.

- Bay #2 chemicals are stored in a small janitorial closet below the lofted offices in the northwest corner of the bay. The closet was clean, organized, and no odors or stains were observed indicating potential leaks. Containers were labeled and had secure lids in place.
- Bay #3 chemicals are stored in two places, in the southeastern storage shed addition and in a closet just north of the storage shed along the eastern exterior wall. The chemicals in the storage shed were a combination of the building owners' personal items (such as paints, primers, weed and feed, furniture polishes, and concrete patching compounds) and chemicals that were currently in use to prepare the space for future occupancy. Two plastic gasoline containers with less than 3 gallons total were being temporarily stored in the main open area and in the northeastern closet that were being used for a gasoline-powered pressure washer.

Chemicals listed in the inventory will be further evaluated in the event that indoor air monitoring detects constituents of concern and it becomes necessary to evaluate the potential that the results may have been impacted by the presence of chemicals listed in the inventory.

## Indoor Air Sampling Program

TCE was detected in soil gas samples collected during the RI from below the Building C-19 slab at concentrations that exceeded the MTCA Method B sub-slab soil gas screening levels. Other VOC compounds such as 1,1,1-trichloroethane, 1,1-dichloroethane, and benzene were detected above their respective laboratory reporting limits but at concentrations below the sub-slab soil gas screening levels.

Shallow soil and groundwater samples collected from within or near Building C-19 during RI activities had VOCs detected above the laboratory reporting limits, and some of those detections were above the applicable MTCA Method B screening levels for soil and groundwater. VOCs that have been detected in the soil and groundwater in or near Building C-19 include tetrachloroethene, vinyl chloride, cis-1,2-dichloroethene, 1,2-dichloroethane, and 1,4-dioxane. These VOCs will be incorporated into the analytical program for the Building C-19 indoor air evaluation.

Based on the locations where the samples with the elevated VOC concentrations were collected, the indoor air investigation will focus on the southern portion of the building, where the former degreaser and sump are located. Proposed indoor air sampling locations are shown on Figure 3.

---

## Sampling Activities

Prior to sampling, differential pressure monitoring (between sub-slab and indoor air using a differential pressure datalogger) will be conducted to gain an understanding of whether a negative or positive relative pressure (between sub-slab and indoor air) condition develops under differing building ventilation and atmospheric pressure conditions. Pressure conditions will be measured with the Bay #2 office furnace on and off and under other conditions (e.g., bay doors open vs. closed, heating vs. non-heating). Differential pressure monitoring activities are outlined below.

- A soil gas probe will be installed near the former degreaser pit and sump. A semi-permanent vapor pin will be installed using a hand-operated rotohammer tool and specialized vapor pin installation kit. The pin will be installed to a depth that is adequate to penetrate below the bottom of the slab and slightly into the fill material beneath it.
- Sub-slab and indoor air pressures will be logged over a 2- to 3-day period when the building is occupied and during the indoor air sampling period.
- The logged data will be evaluated to develop conclusions on whether certain conditions (e.g., bay doors open vs. closed, rising or falling barometer) are more conducive than others in developing conditions most favorable to soil vapor intrusion. An attempt will then be made to conduct the indoor air sampling during periods when these conditions exist.
- The vapor pin and differential pressure monitoring equipment will remain in place until the indoor air sampling is complete, at which point a sub-slab soil gas grab sample will be collected from the same vapor pin.

Based on the results of the RI soil gas sampling and the building survey, three indoor air samples from three separate sampling locations will be collected (two locations in Bay #3 and one location in Bay #2). The location in Bay #2 was selected to be within a separate break room where indoor air conditions are less influenced by proximity to bay doors that are normally open. Short-term (8-hour) indoor air samples will be collected, plus one sub-slab soil gas grab sample. An ambient air sample will also be collected from an upwind direction outside the building during the 8-hour sampling period. The 8-hour samples will be collected in Summa canisters and collection will occur during working hours representative of potential worker exposure. Since most of the workers are present during the day, it is anticipated that sampling will also occur during the day, but the precise timing of sampling will be determined after differential pressure data have been evaluated. The 8-hour samples will be designated with a code beginning with IA followed by the sample number and the building number (e.g., IA01-C19). The sub-slab and ambient air sample codes will follow the RI/FS Work Plan (LAI 2018) sample nomenclature. Additional details on sample collection, handling, and management are provided in the QAPP (Attachment 1).

After collection, samples will be packaged and shipped to Analytical Laboratory Services (ALS) in Simi Valley, California for analysis. The sample analytical results will be requested with a standard turnaround time. Indoor and ambient air samples will be analyzed by US Environmental Protection

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Agency (EPA) Air Method TO-15 with selected ion monitoring (SIM), and sub-slab soil gas samples will be analyzed using the EPA Method TO-15 Scan for low-level concentration reporting. Additional details on methods, containers and sample holding times are provided in the QAPP (Attachment 1). Per the IAA, a shortened VOC reporting list will be requested as follows:

- Benzene
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- cis-1,2-dichloroethene (cDCE)
- Vinyl chloride (VC)
- 1,1,1-trichloroethane (1,1,1-TCA)
- 1,1-dichloroethane (1,1-DCA)
- 1,2-dichloroethane (1,2-DCA)
- 1,4-dioxane.

## Screening Criteria

Indoor air sampling results will be compared to screening levels, which are concentrations above which the chemical may pose a health concern based on the individual exposed and the time period over which the exposure occurred. Screening levels are concentrations that have been established by Ecology or the EPA and are based on available scientific research on how the chemical may affect certain human populations over specific time periods.

There are two types of indoor air screening levels, screening levels based on short-term exposure, and screening levels based on long-term exposure (also called chronic exposure). Most VOCs have only chronic exposure screening levels. MTCA Method B chronic exposure screening levels are based on a risk model that assumes an adult person is exposed to the chemical at the screening-level concentration 24 hours a day, 365 days per year, for 30 years; at this rate of exposure there is a slight increase in risk of certain health conditions. TCE is a chemical that, in addition to a chronic exposure screening level, also has a short-term screening level based on a 21-day exposure period. The short-term TCE screening level ( $7.5 \mu\text{g}/\text{m}^3$ ) is based on potential harm to a fetus and therefore is a concern for women who are pregnant. Because women, particularly early in pregnancy, may not know that they are pregnant, all women of child-bearing age are considered to be the population at risk if concentrations of TCE exceed short-term screening levels.

Ecology has developed chronic screening levels for both unrestricted use (based on exposure in a place of residence) and industrial use (based on exposure in an industrial work setting). TCE also has short-term screening levels for unrestricted (residential) use and workplace scenario (commercial or industrial). The TECT RI soil gas results reported thus far have been compared to screening levels



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based on MTCA Method B (residential) air cleanup levels but the Building C-19 indoor air evaluation is being conducted in an industrial building where occupants are present during work hours only. For this reason, screening levels developed from both the residential (MTCA Method B) and industrial (MTCA Method C) air cleanup levels will be compared to the C-19 Building results. The most conservative Method B values are presented in the QAPP as target laboratory reporting limits to ensure the results are low enough to be comparable to all screening level criteria. Both MTCA Method B and C air cleanup levels for soil gas and indoor air are summarized in Table 1.

## **Mitigation Planning**

In the event that target VOCs are detected in indoor air samples at concentrations that exceed the industrial screening criteria, mitigation and additional sampling may be warranted. Because a portion of the facility is actively operating and short-term screening levels for TCE are applicable (because the worker population includes women of child-bearing age), planning for potential mitigation prior to the receipt of sample results is warranted.

## **Decision Criteria**

Indoor air sample results will be compared to both the short-term and chronic industrial screening levels. If concentrations of TCE in indoor air exceed the short-term screening level, the property owner (Snohomish County) and Ecology will be notified within 24 hours, and building occupants will be notified immediately or following thorough review and evaluation of the results in accordance with guidelines in Section 7.2 of Ecology's Implementation Memorandum No. 22 (Ecology 2019). Implementation Memorandum No. 22 states that if initial laboratory results indicate that indoor air TCE concentrations are high enough to indicate a short-term risk of TCE exposure to women of childbearing age, then the building occupants will be notified prior to thoroughly evaluating the data results. If initial analytical results indicate results are close to the short-term TCE screening level and that further review of the data is warranted, then building occupants will be notified of any short-term exposure risks after the data have been evaluated. If the concentrations of target VOCs in indoor air exceed the chronic screening level, the property owner will be notified within 5 days.

## **Mitigation Selection**

In the event that mitigation is deemed necessary, the timeframe for implementation may range from days to months or longer. Short-term actions that can be implemented in a matter of days may be effective at temporarily reducing indoor air TCE concentrations, but may not be practicable long-term solutions. Information gathered during the building survey has been used to evaluate potential mitigation measures that could be implemented at Building C-19.

Vapor intrusion mitigation can be accomplished via several mechanisms that include the following:

- The potential for vapor intrusion can be reduced by adjusting the pressure differential between the interior of the building and the subsurface. Vapors will migrate from areas of high pressure to areas of low pressure. Therefore, if the interior of the building is negatively pressurized compared to the subsurface, vapors can flow into the building through cracks or openings in the slab. Adjusting the pressure differential can be accomplished by either increasing the pressure inside the building (typically using heating, ventilation, and air-conditioning systems) or by reducing the pressure below the building (sub-slab depressurization).
- Concentrations of chemicals in indoor air can often be reduced either via air-cleaning units or by increasing ventilation from outside the building to dilute chemical concentrations in indoor air.
- Vapor intrusion can also be addressed by sealing vapor entry points. Sealing can be accomplished in a variety of ways, but is often challenging in existing buildings.
- Occupants, or populations of occupants, such as women of child-bearing age, may be advised to temporarily refrain from working in the building if chemical concentrations in air pose a significant risk. Appropriately communicating potential risks to individuals under the advisory will assist in the decision-making process.

## Use of This Technical Memorandum

This technical memorandum has been prepared for the exclusive use of Snohomish County and Ecology for specific application to the TECT site. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. LAI makes no other warranty, either express or implied.

\* \* \* \* \*

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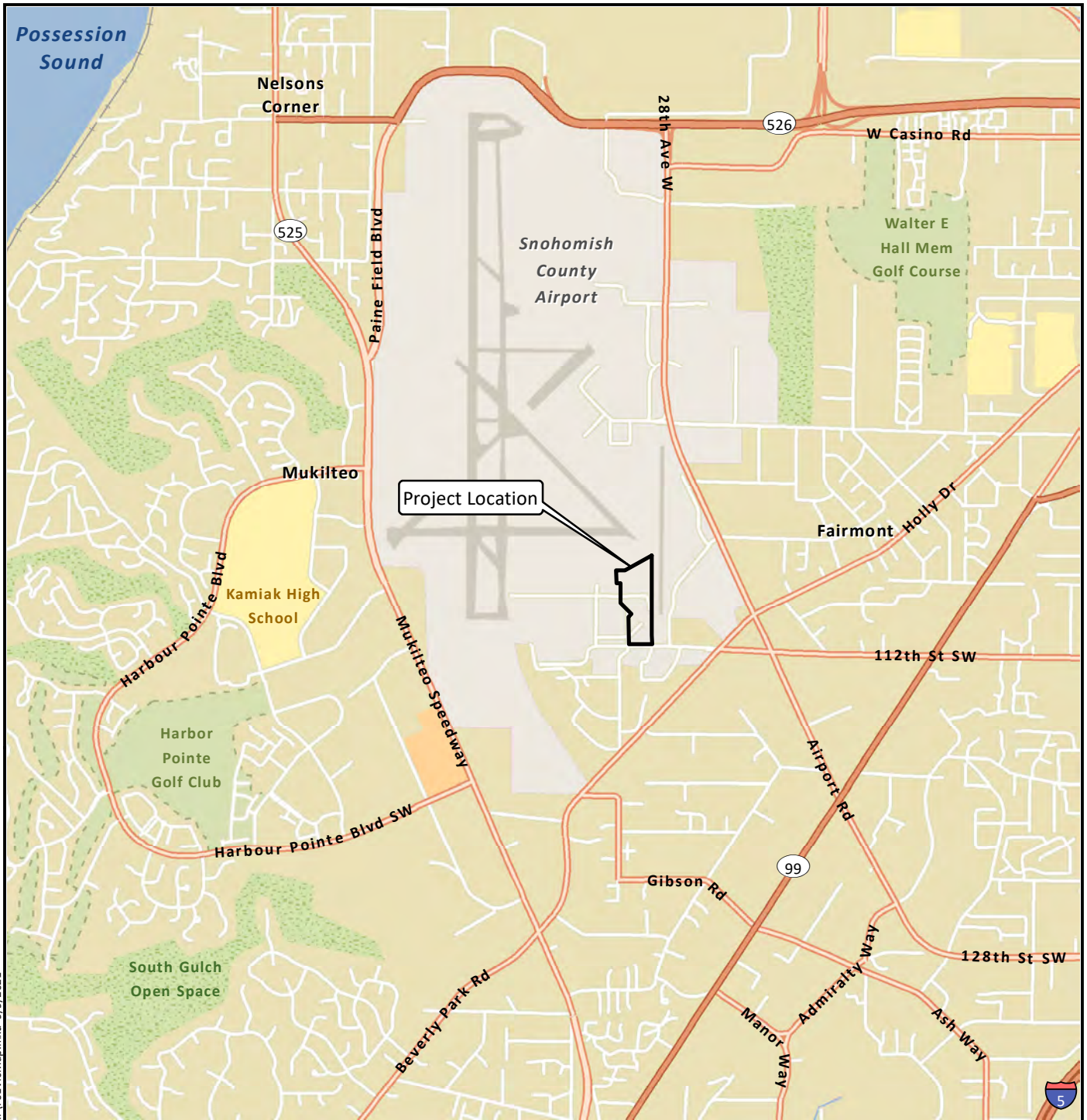
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## References

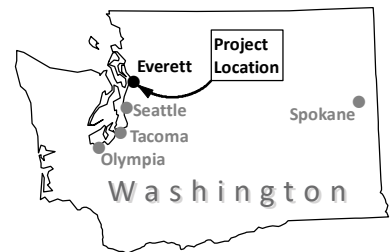
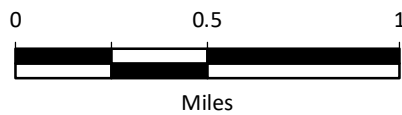
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## Attachments

- Figure 1: Vicinity Map  
Figure 2: Site Plan  
Figure 3: C-19 Building Features and Proposed Sampling Locations  
Table 1: Summary of Screening Levels  
Attachment 1: Quality Assurance Project Plan



G:\Projects\222\057\030\032\C-19 Indoor Air Evaluation SA\F01VicMap.mxd 9/9/2021





Data Source: Esri.

<p>TECT Aerospace Leasehold Everett, Washington</p>	<p>Vicinity Map</p>	<p>Figure <b>1</b></p>
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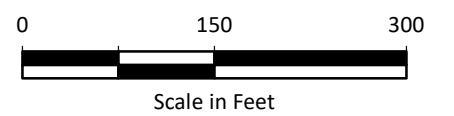


**Legend**

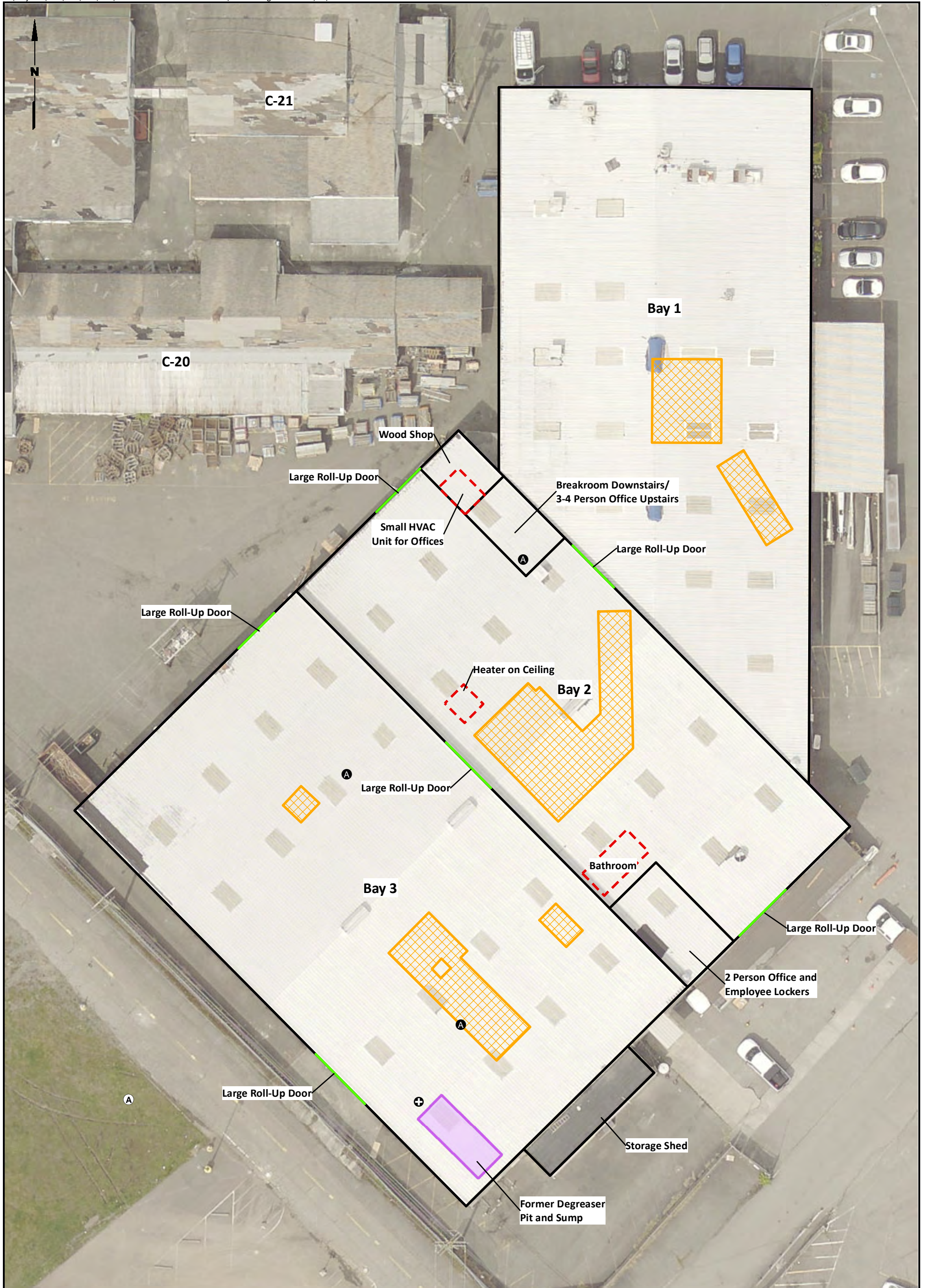
-  Approximate Site Boundary
-  Building C-19

**Note**

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

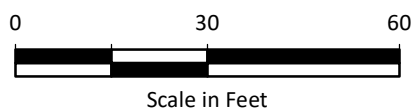


Data Sources: AGI 1999; Landau Associates 2006; King County GIS.



**Legend**

- Ⓐ Proposed Ambient Air Sampling Location (Upwind During Sampling)
- Ⓐ Proposed Indoor Air Sampling Location
- ⊕ Proposed Sub-Slab Sampling Location
- ⊠ Previous Remedial Excavation Areas



Data Sources: AGI 1999; Landau Associates 2006; King County GIS.

**Note**

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

**Table 1**  
**Summary of Screening Levels**  
**Sampling and Analysis Plan**  
**Building C-19 – TECT Aerospace Leasehold**  
**Snohomish County Airport – Everett, Washington**

Analyte	CAS No.	Preliminary Indoor Air Screening Level <sup>a</sup>	MTCA Method B		MTCA Method C		Units
			Indoor Air	Sub-Slab Soil Gas	Indoor Air	Sub-Slab Soil Gas	
1,1,1-Trichloroethane	71-55-6	2,285	2,285 <sup>b</sup>	76,000 <sup>b</sup>	5,000 <sup>b</sup>	170,000 <sup>b</sup>	µg/m <sup>3</sup>
1,1-Dichloroethane	75-34-3	1.56	1.56	52	15.6	520	µg/m <sup>3</sup>
1,2-Dichloroethane	107-06-2	0.096	0.096	3.2	0.96	32	µg/m <sup>3</sup>
1,4-Dioxane	123-91-1	0.5	0.5	17	5	170	µg/m <sup>3</sup>
Benzene	71-43-2	0.321	0.321	10.7	3.21	110	µg/m <sup>3</sup>
cis-1,2-Dichloroethene	156-59-2	c	c	c	c	c	µg/m <sup>3</sup>
Tetrachloroethene	127-18-4	9.62	9.62	320	40	1,300	µg/m <sup>3</sup>
Trichloroethene	79-01-6	0.334	0.334	11	2	67	µg/m <sup>3</sup>
Vinyl Chloride	75-01-4	0.284	0.284	9.5	2.84	95	µg/m <sup>3</sup>

**Notes:**

Analyte list was determined based on soil gas, soil, and groundwater analytical results from the ongoing remediation investigation being conducted by LAI.

(a) Preliminary screening levels based on Ecology CLARC Method B, indoor air cancer cleanup levels.

(b) Value is based on non-cancer because there is no MTCA Method B cancer cleanup level available in CLARC.

(c) Indoor air and soil gas screening levels not established in CLARC for this chemical.

**Abbreviations and Acronyms:**

µg/m<sup>3</sup> = micrograms per cubic meter

CAS = Chemical Abstracts Service

CLARC = Cleanup Levels and Risk Calculations

Ecology = Washington State Department of Ecology

MTCA = Model Toxics Control Act

# Quality Assurance Project Plan



**Quality Assurance Project Plan  
Building C-19 – TECT Aerospace Leasehold  
Snohomish County Airport  
Everett, Washington**

October 8, 2021

Prepared for

Snohomish County Airport  
Everett, Washington



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**Quality Assurance Project Plan  
Building C-19 – TECT Aerospace Leasehold  
Snohomish County Airport  
Everett, Washington**

This document was prepared by, or under the direct supervision of, the technical professionals noted below.

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Document reviewed by:  Stephanie Renando  
Quality Reviewer

Date: October 8, 2021  
Project No.: 0222057.030  
File path: P:\222\057 (TECT RI\_FS)\R\Building C 19 Indoor Air Sampling Work Plan\QAPP  
Project Coordinator: Christopher C. Young

**Quality Assurance Project Plan  
Building C-19 – TECT Aerospace Leasehold  
Snohomish County Airport  
Everett, Washington**

This document was approved by the Washington State Department of Ecology regulatory professionals noted below.

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3	Building C-19 Building Features and Proposed Sampling Locations

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2	Data Quality Indicators
3	Indoor Air, Ambient Air, and Sub-Slab Vapor Targeted Reporting Limits
4	Sample Containers, Preservatives, and Holding Times
5	Data Validation Elements

## APPENDICES

<u>Appendix</u>	<u>Title</u>
A	Laboratory Standard Operating Procedures
B	Example Field Forms

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## LIST OF ABBREVIATIONS AND ACRONYMS

CLP .....	Contract Laboratory Program
COC .....	chain-of-custody
DQI .....	data quality indicator
DQO .....	data quality objective
EDD .....	electronic data deliverable
EPA.....	US Environmental Protection Agency
EQuIS.....	Environmental Quality Information Systems
eV.....	electron volt
HASP.....	health and safety plan
HAZWOPER.....	Hazardous Waste Operations and Emergency Response
LAI .....	Landau Associates, Inc.
LCS.....	laboratory control sample
LCSD .....	laboratory control sample duplicate
MDL.....	method detection limit
MQO.....	measurement quality objective
MS.....	matrix spike
MSD.....	matrix spike duplicate
PID.....	photoionization detector
QA .....	quality assurance
QAPP .....	quality assurance project plan
QC .....	quality control
RI.....	remedial investigation
RL .....	reporting limit
RPD.....	relative percent difference
SAP .....	sampling and analysis plan
Site .....	TECT Aerospace Leasehold
SL.....	screening level
SOPs .....	Standard Operating Procedures
TECT .....	TECT Aerospace
VOC .....	volatile organic compound

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## 1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) establishes the quality assurance (QA) objectives for the Building C-19 indoor air evaluation being conducted at the TECT Aerospace (TECT) Leasehold (Site) located in the southeastern portion of Sector 5 at Paine Field in Everett, Washington (Figures 1 and 2). This plan presents the quality control (QC) procedures developed to meet project QA objectives to support implementation of the Building C-19 Indoor Air Sampling and Analysis Plan (SAP).

### 1.1 Distribution List

The following list identifies those individuals to receive an electronic copy of the approved QAPP, as well as any subsequent revised versions of the documentation:

- Andrew Rardin – Project Manager for Snohomish County Airport (andrew.rardin@co.snohomish.wa.us)
- Gerald Ninteman – Consultant (Landau Associates, Inc. [LAI]) Project Manager (jninteman@landauinc.com)
- Danille Jorgensen – Consultant (LAI) Quality Assurance Officer (djorgensen@landauinc.com)
- Sue Anderson – Project Coordinator for ALS Global Laboratory Simi Valley (sue.anderson@alsglobal.com)
- Stephanie Renando – Consultant (LAI) Field Lead (srenando@landauinc.com).

### 1.2 Project Organization

The proposed Site SAP activities will be implemented by Snohomish County Airport; Andrew Rardin is the project manager. LAI is responsible for preparing documents associated with the SAP activities, implementing the activities, and reporting the SAP results to Snohomish County Airport. Gerald Ninteman is the LAI project manager and will communicate directly with Andrew Rardin, as necessary, throughout all SAP activities. Mr. Ninteman will be responsible for implementing and executing the technical, QA, and administrative aspects of the SAP and will manage LAI staff working on this project. Danille Jorgensen, the designated LAI QA officer, is responsible for the overall management of the project-specific QA and QC requirements, including field and laboratory QC. LAI's staff managing field operations will report field progress and problems to Mr. Ninteman on a daily basis and will be responsible for managing subcontractors, as necessary, that support remedial investigation (RI) activities at the Site. Christine Kimmel is LAI's designated health and safety manager for field activities.

Specific QA responsibilities for this project are listed in Table 1. The QA officer will be responsible for QA oversight during investigation activities including sampling events, analytical laboratory coordination, and direct implementation of this QAPP. The QA officer will be responsible for overseeing data validation and for confirming that the QA objectives of the project are met.



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## 2.0 PROJECT BACKGROUND/DESCRIPTION

The Site is approximately 10 acres in size and is located in the southeastern portion of the Snohomish County Airport. The Site is generally bounded by Runway 34-16 and associated taxiways on the east, a paved surface parking lot followed by Paine Field Road to the south, 109<sup>th</sup> Street and 30<sup>th</sup> Avenue South to the west, and the former TECT Aerospace lease area to the north.

The Site is currently zoned for light industrial use (Snohomish County; accessed September 22, 2021). Currently, the Site land is leased by Snohomish County to tenants for aerospace manufacturing and other light industrial operations.

Various environmental investigations and remedial actions have been conducted at the Site to characterize and evaluate the chemical quality and physical condition of soil, groundwater, and soil gas, or to address documented releases. LAI has been conducting an RI at the Site on behalf of Snohomish County Airport since November 2018. The RI is ongoing, and results to date were presented in an Interim Remedial Investigation Data Report (LAI 2019).

### 2.1 Project Goals and Objectives

This QAPP has been prepared to cover work related to the indoor air SAP. The specifics of the investigation are detailed in the SAP; this QAPP is Attachment 1 of the SAP.

The purpose of this QAPP is to provide specific QA and QC procedures that will be used to support the evaluation and interpretation of data determined to be of acceptable quality and completeness. This QAPP has been prepared based on the requirements outlined in the US Environmental Protection Agency's (EPA's) Guidance for Quality Assurance Project Plans (EPA 2002) and the EPA's Requirements for Quality Assurance Project Plans (EPA 2001).

To the extent possible, the procedures described in this QAPP have been standardized to support effective evaluation of data resulting from sampling of the various media that have the potential to be evaluated at the Site. In the event that additional investigation activities are performed following the publication of this QAPP (i.e., additional activities not addressed in the SAP), work plan addenda will be prepared to document data quality objectives and sampling, and will include any revisions to screening levels (SLs), reporting limits (RLs), sampling procedures, and laboratories, as needed.

ALS Global Laboratories in Simi Valley, California is the laboratory to be used for planned SAP activities. Analytical testing will be in accordance with the methodologies established by the EPA. Laboratory standard operating procedures (SOPs) are provided in Appendix A.

## 3.0 QUALITY ASSURANCE OBJECTIVES

This section presents the QA and QC objectives and processes including data quality objectives (DQOs), data quality indicators (DQIs), measurement quality objectives (MQOs), and QC procedures for field and laboratory work.

### 3.1 Data Quality Objectives

DQOs specify the environmental decisions that the data will support and the corresponding level of data quality required to ensure decisions are based on sound scientific data. The DQOs for this project are determined by the area of investigation:

- Building C-19
  - Obtain data that are representative of Site conditions
  - Characterize concentrations of volatile organic compounds (VOCs) in indoor air, ambient air, and below the concrete building slab
  - Obtain data that are comparable to applicable screening criteria
  - Obtain data that will inform evaluation of worker health related to chronic and/or short-term VOC exposure
  - Obtain data that will inform evaluation of mitigation actions to decrease exposure risks, if present.

### 3.2 Data Quality Indicators

DQIs are used to establish DQOs and are discussed in detail below. A summary of DQIs and their associated MQOs are presented by sample matrix in Table 2.

#### 3.2.1 Precision

Precision is a measure of variability in the results of replicate measurements due to random error (Ecology 2016). Precision is best expressed in terms of the standard deviation or relative percent difference (RPD). QC sample types that can be used to evaluate precision include field and laboratory duplicates, matrix spike duplicates (MSDs), and laboratory control sample duplicates (LCSDs). The precision of duplicate measurements will be expressed as an RPD, which is calculated by dividing the absolute value of the difference of the two measurements by the average of the two measurements, and expressing it as a percentage. The formula for RPD calculation is shown below.

$$RPD = \left[ \frac{|D1 - D2|}{[(D1 + D2) \div 2]} \right] \times 100\%$$

Where:

D1 = first measurement value

D2 = second measurement value (duplicate).

MS/MSDs are not performed on air samples.

### 3.2.2 Accuracy

Accuracy is a combination of precision and bias (described in Section 3.2.7), in that it represents the degree to which a measured value represents the known value (Ecology 2016). Accuracy is expressed as the percent recovery of spiked samples (matrix spike [MS], laboratory control sample [LCS], and surrogate spike). The general formula used to calculate percent recovery is shown below.

$$\%R = \left[ \frac{SSR}{C_s} \right] \times 100\%$$

Where:

%R = percent recovery

SSR = spiked sample result

C<sub>s</sub> = concentration of the spike added.

### 3.2.3 Representativeness

Representativeness is an indicator of how accurately a result reflects the desired characteristic(s) of a defined population, accounting for both temporal and spatial variability (Ecology 2016).

Representativeness qualitatively describes how well the analytical data characterize an area of concern. Representativeness is largely determined by the sampling design; analytical parameters for use in its evaluation include method-specified holding times and preservation requirements, and matrix heterogeneity.

### 3.2.4 Comparability

Comparability is the “degree of confidence with which one data set can be compared to another” (Ecology 2016). QC procedures and MQOs, as stated in this QAPP, will provide for measurements that are consistent and representative of the media and conditions measured.

### 3.2.5 Completeness

Completeness is a measure of “the amount of valid data obtained from a measurement system compared to the amount that could be expected to be obtained under normal conditions” (EPA 2009). Field completeness is calculated as the number of actual samples collected divided by the number of planned samples. Analytical completeness is calculated as the number of valid data points divided by the total number of data points requested. Data points are considered invalid if they are rejected during data validation. The data validation approach for this project is provided in Section 8.0. The requirements for field sampling and analytical completeness are 95 and 90 percent, respectively.

### **3.2.6 Sensitivity**

Sensitivity is the capability of a method or an instrument to discern the difference between very small amounts of a substance. For the purposes of this project, sensitivity is the lowest concentration that can be accurately detected by the analytical method. The analytical method will be considered sufficiently sensitive if the RLs are below the specific SLs for the area under investigation. Proposed method and target RLs are presented in Table 3. As necessary to meet project-specified SLs, sample results will be reported to the method detection limit (MDL). Results that are detected at concentrations between the MDL and the RL will be J-qualified as estimated.

### **3.2.7 Bias**

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Bias of the laboratory results will be evaluated based on analysis of reference materials and method blanks, as described in Section 6.5.

## **4.0 SPECIAL TRAINING/CERTIFICATION**

Personnel performing onsite investigation tasks will have completed formal 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) health and safety training, in compliance with 29 Code of Federal Regulations 1910.120 and Chapter 296 of the Washington Administrative Code. Certificates of successful completion of training, which will be maintained in personnel health and safety files, will verify on-the-job training for those tasks staff are assigned to perform. At least one member of each field team and the designated site safety officer will be trained in cardiopulmonary resuscitation and first aid.

As indicated in Section 2.1, ALS in Simi Valley, California is the laboratory to be used for planned SAP activities. ALS is accredited through the Washington State Department of Ecology for the applicable methods and target analytes listed in this QAPP and shall maintain current accreditation while performing analyses for the project. Laboratories used for this project have a documented QA program that complies with standards promulgated by the International Organization for Standardization/International Electrotechnical Commission(ISO/IEC 17025:2017); The NELAC Institute 2016 Standard (TNI 2016); and the US Department of Defense Quality Systems Manual for Environmental Laboratories Version 5.3 (DoD QSM 5.3 2019).

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## 5.0 DOCUMENTS AND RECORDS

This section describes the management requirements for production, distribution, and storage of documents and records associated with planned activities at the Site.

### 5.1 Document Distribution

Prior to beginning field activities, field staff will receive and have an opportunity to review project-related documents pertinent to the field activities, including work plans, SAPs, and health and safety plans (HASPs), as appropriate to the planned activities. Project managers will meet with field staff prior to field activities to review the relevant plans accordingly. The HASP will be reviewed in the field on the first day of activities, with each field person documenting their attendance to the HASP review on a sign-in sheet. The HASP will be reviewed again every few days or when a new field person begins working on field activities. The SAP, HASP, and work plans for each phase of the project will be finalized prior to commencement of field activities, and only the finalized versions will be distributed to field staff. Changes to procedures and plans after finalization will be documented as addenda and distributed along with the original finalized versions.

### 5.2 Field Documentation

Reference and related manuals will be stored with field equipment. In addition, equipment that requires calibration will be accompanied by a calibration logbook. Field staff will record the calibration process in the logbook every time a calibration is performed.

A complete record of field activities will be maintained for the duration of the field phase of the work. Documentation will include the following:

- Daily recordkeeping by field personnel of field activities
- Recordkeeping of samples collected for analysis (field sampling forms)
- Use of sample labels and tracking forms for samples collected for analysis.

The field logs will provide a description of sampling activities completed, sampling personnel, daily weather conditions, and a record of modifications to the procedures and plans identified in the work plan or related documentation. The field logs are intended to provide sufficient data and observations to enable project staff to reconstruct events that occurred during the sampling period.

Field logs will be supplemented by sample collection forms, boring logs, and groundwater well logs completed by field staff, as applicable. The information that will be recorded in these forms is specified in the SAP.

Sample possession and handling will also be documented with chain-of-custody (COC) forms so that it is traceable from the time of sample processing in the field to delivery to the laboratory, and to the ultimate data analysis. Sample handling and COC procedures are described in Section 6.3.

The following example field forms are provided in Appendix B:

- Chain-of-Custody Form
- Air Sample Collection Form
- Sub-slab Vapor Sample Collection Form
- Field Report.

### **5.3 Analytical Data Records**

Laboratory analytical data reports will be provided in electronic format by the laboratory. These reports will be included as appendices in documents where data are reported, and will be kept along with all other documents in the project files. Data will be provided in a Level II laboratory report format. Data package elements are listed in Section 6.7.

### **5.4 Storage**

Documents and records associated with the project (i.e., final documents, billing and invoice records) and the documents described in Sections 5.2 and 5.3 will be stored in electronic form in project files on LAI's servers for the duration of the project.

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## 6.0 DATA GENERATION AND ACQUISITION

This section provides an overview of the data collecting and handling processes that will ensure data quality that meets project standards. More details about the sampling approach are included in the SAP.

### 6.1 Sampling Process Design

A sampling design that achieves the DQOs described in Section 3.0 has been prepared and is detailed in the SAP.

### 6.2 Sampling Methods and Containers

Samples will be collected using methods that are standard in environmental remediation. A detailed description of the sampling methods is provided in the SAP. Methods for sampling and decontamination will be conducted in accordance with the RI/FS Work Plan (LAI 2018).

Sampling containers will be provided by the laboratory. Extra containers will be requested to ensure that clean containers are available to replace any broken or misused containers during sampling events.

### 6.3 Sample Handling and Custody

Indoor air, ambient air, and sub-slab vapor samples submitted to the analytical laboratory will be collected in the appropriate sample containers and preserved as specified in Table 4. The maximum holding times for physical/chemical analyses are also provided in Table 4.

The transportation and handling of samples will be accomplished in a manner that not only protects the integrity of the samples, but also prevents any detrimental effects due to release of samples. Samples will be logged on a COC form (Appendix B) that will be provided by the laboratory, and accompany each shipment of samples to the laboratory. A sample is in custody if at least one of the following is true:

- It is in someone's physical possession
- It is in someone's view
- It is secured in a locked container or otherwise sealed so that tampering will be evident
- It is kept in a secured area, restricted to authorized personnel only.

Sample control and COC protocols in the field and during transport to the laboratory will be conducted in general conformance with the procedures described below.

- As few persons as possible will handle samples.
- Sample containers will be obtained new or pre-cleaned from the laboratory performing the analyses.



- The sample collector will be personally responsible for the completion of the COC record and the care and custody of samples collected until they are transferred to another person or dispatched properly under COC protocols.
- The onsite team leader will oversee implementation of the field custody procedures during the field work and, in the event of non-compliance, will determine if corrective action is required.
- The sample shipping containers will be accompanied by the COC record identifying their contents. The original record and laboratory copy will accompany the shipment (sealed inside the shipping container). The other copy will be distributed as appropriate to LAI's QA officer or designee. The QA officer for this project is Danille Jorgensen.
- Shipping containers will be sealed with custody seals for shipment to the laboratory. The method of shipment, name of courier, and other pertinent information will be entered in the "remarks" section of the COC record.
- If sent by mail, the package will be registered with return receipt requested. If sent by common carrier, a bill of lading will be used. Freight bills, postal services receipts, and bills of lading will be retained as part of the permanent documentation.

When samples are transferred, the individuals relinquishing and receiving the samples will sign the COC form and record the date and time of transfer. The sample collector will sign the form in the first signature space. The only exception to this is the shipment of samples via commercial carriers. Because sample containers are sealed with the COC record inside prior to delivery to the carrier, the custody signature will be that of the individual taking possession of the samples from the carrier at its final destination. Each person taking custody will observe whether the shipping container is correctly sealed and in the same condition as noted by the previous custodian; deviations will be noted on the appropriate section of the COC record.

A designated sample custodian at the laboratory will accept custody of the shipped samples, verify the integrity of the custody seals, and certify that the sample identification numbers match those on the COC record. The custodian will then enter sample identification number data into a bound logbook, which is arranged by a project code and station number. If containers arrive with broken custody seals, the laboratory will note this on the COC record and immediately notify the sampler who will, in turn, notify the QA officer and the LAI project manager.

## 6.4 Analytical Methods

Laboratory methods and target RLs for all potential analyses of indoor and ambient air, and sub-slab vapor are summarized in Table 3. Samples collected and analyzed as part of the SAP will be reported to the MDL.

Sample containers, preservation, and holding times are provided in Table 4.

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## 6.5 Quality Control

Field and analytical laboratory control samples will be collected to evaluate data precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity of the analytical results for this investigation. The quality control samples and the frequency at which they will be collected and/or analyzed by matrix and analysis is summarized in Table 2. The evaluation of these quality control samples is discussed further in Section 8.

## 6.6 Instrument/Equipment/Consumables

To ensure that field measurement is accomplished accurately, field equipment undergoes routine maintenance and calibration as described below.

### 6.6.1 Testing, Inspection, and Maintenance

LAI performs routine inspections and preventive maintenance (parts replacement and cleaning) for all pieces of field equipment in our supply and equipment room. Maintenance activities are conducted by LAI field technicians, who are specifically trained in the use, operation, and maintenance of the equipment. All field equipment used during this project—which may include photoionization detectors (PIDs) and differential pressure and helium detection meters—will be cleaned and decontaminated prior to use. Each piece of equipment will be inspected and tested to ensure proper working function and facilitate replacement or repair of broken or non-operational components. Extra batteries will be included in the equipment cases or in field vehicles for replacing dead batteries during field work. Extra disposables will be packed for equipment requiring disposables for use, such as sample collection tubing.

Field equipment is maintained by the field equipment manager. Field staff continually notify the field equipment manager when equipment maintenance is needed. This system ensures that the equipment is maintained and working for the next field project. Equipment will be repaired or replaced, as needed.

Meters used to make field measurements will be further inspected and tested during calibration, as described in the next section.

### 6.6.2 Calibration and Frequency

All field equipment are calibrated according to the manufacturers' guidelines and recommendations. If a PID is used during this project, it will be calibrated on a daily basis according to the manufacturer's specifications. The PID preferred by LAI field personnel uses a 10.6-eV (electron volt) probe and is calibrated using a manufacturer-supplied standard gas (isobutylene, equivalent to 34 parts per million benzene). Similarly, helium detection and differential pressure meters will be calibrated at the start of each sampling day with laboratory-prepared calibration standards within the range of the anticipated

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measurement. An instrument will also be recalibrated at any time an anomalous reading suggests instrument imprecision or inaccuracy.

### **6.6.3 Inspection/Acceptance of Supplies and Consumables**

Supplies are ordered and maintained by the field equipment manager. Disposables and consumables include nitrile gloves, Ziploc® bags for sample ice, field test kits, and polyethylene tubing.

## **6.7 Data Management**

All laboratory analytical results, including QC data, will be submitted electronically. Electronic formats will include a PDF file of the laboratory report, and electronic data deliverable (EDD) files that will be uploaded directly to an Environmental Quality Information Systems (EQUS) database; the data management team will supply the required format for the EDDs. EQUS EDDs will be provided by the laboratory in the EFWEDD format (also known as EQUS 4-File), using LAI valid values. After validation of the data, any applicable qualifiers will be added to the database.

Differential pressure data will be uploaded from a datalogger and entered into cumulative Excel® spreadsheets and/or the EQUS database. Data will be verified to determine all entered data are correct and without omissions and errors.

Field notes, including field reports, sampling forms, and survey forms, will be maintained in the project files. Survey notes will be condensed and/or abbreviated to provide coordinates and elevations with correct character formatting that can be uploaded to the database.

Level II laboratory reports will include the following:

- Case narrative, including adherence to prescribed protocols, non-conformity events, corrective measures, and/or data deficiencies (including initial and continuing instrument calibrations, and explanations for any missed target RLs)
- Sample analytical results
- Surrogate recoveries
- Matrix spike/matrix spike duplicate results
- Blank spike/blank spike duplicate results
- Laboratory duplicates
- Blank results
- Sample custody (including signed COC records, and laboratory sample receipt forms)
- Analytical responsibility.

## **7.0 ASSESSMENT AND OVERSIGHT**

This section describes assessment and oversight.

### **7.1 Assessment and Response Actions**

Assessments during implementation of the project will include daily communication and updates during field work and data quality review by the LAI project manager and field staff. Response actions to assess issues will be coordinated between the LAI project manager, field staff, the project manager for Snohomish County Airport, and involved subcontractors, as appropriate.

If any project non-conformance is considered significant or requires special expertise, corrective action(s) may include the following:

- Reanalyzing the samples, if holding times can be met
- Resampling and analyzing
- Evaluating and amending sampling and analytical procedures
- Accepting data and acknowledging the level of uncertainty or inaccuracy by flagging the data.

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## 8.0 DATA VALIDATION AND USABILITY

This section describes data validation and usability.

### 8.1 Data Review, Verification, and Validation

All SAP data will be verified and validated to determine that the results are acceptable and meet the quality objectives described in Section 3.

Validation of the data will be performed by a data validator with guidance from applicable portions of the National Functional Guidelines for Organic Data Review (EPA 2016).

All data generated as part of the SAP will undergo an EPA Level IIA verification and validation.

EPA Level IIA-equivalent verification and validation elements are presented in Table 5 and will include the following:

- Verification that the laboratory data package contains all necessary documentation (including COC records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related QC data, and QC acceptance criteria)
- Verification that all requested analyses, special cleanups, and special handling methods were conducted
- Verification that QC samples were analyzed per the method and frequency specified in the QAPP
- Evaluation of sample holding times
- Evaluation of QC data compared to acceptance criteria, including laboratory QC samples (method blanks, surrogate recoveries, laboratory duplicate and/or replicate results, and LCS results)
- Verification that RLs for target analytes are at or below the target RLs specified in the QAPP.

In the event that a portion of the data is outside the DQO limits or the EPA guidance (EPA 2016), or sample collection and/or documentation practices are deficient, corrective action(s) will be initiated. Corrective action, as described in Section 7.1, may include any of the following:

- Rejection of the data and resampling
- Qualification of the data
- Modified field and/or laboratory procedures.

### 8.2 Verification and Validation Methods

The processes that will be used to verify and validate data are described in the sections below.

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## **8.2.1 Data Verification Methods**

This section describes data verification methods.

### **8.2.1.1 Chain of Custody**

COC forms will be reviewed by field personnel upon completion of sampling, who will verify information against the packed sample coolers they represent. A copy of the COC form will be retained in the electronic project files, and the original and remaining copies will be taped inside the cooler for delivery to the analytical laboratory.

### **8.2.1.2 Corrective Actions**

The corrective action process may be initiated by any project team member. The process consists of identifying a problem, acting to eliminate the problem, documenting the corrective action, monitoring the effectiveness of the corrective action, and verifying that the problem has been sufficiently addressed. The LAI field lead will be responsible for correcting and resolving situations in the field that may result in non-compliance with the QAPP. Corrective measures identified by the field lead will be immediately documented in the field notes. Examples of corrective actions for field measurements may include: repetition of a measurement to check the error, check for proper adjustments for ambient conditions, check of batteries, recalibration, replacement of instruments, revisions to COC forms, and (if necessary) stop work. Laboratory project managers are responsible for ensuring that corrective action processes as identified in their quality systems manuals, SOPs, and this QAPP are followed. The laboratory project manager is responsible for notifying the LAI QA officer of any non-conformance. If a corrective action is initiated at the laboratory, it shall be narrated in the laboratory data package. Technical staff will be responsible for reporting any QA non-conformance or suspected deficiencies they identify to the LAI project manager, who will in turn notify the LAI QA officer. The LAI QA officer is responsible for assessing the suspected deficiency or non-conformance and its potential to impact data quality.

If corrective actions are required, a copy of the documented corrective action taken will be maintained in the electronic project files. At the completion of the sampling event, the LAI QA officer and the LAI project manager will ensure all appropriate corrective actions have been taken and that the corrective action reports have been included in the electronic project files; if corrective actions have not been taken, the project manager will ensure action is taken.

### **8.2.1.3 Field Notes**

Field notes will be reviewed by the LAI field lead and placed in the electronic project files.

### **8.2.1.4 Analytical Data Packages**

All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.

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All laboratory data packages, with the exception of waste characterization samples, will be verified by an LAI data validator who is not associated with the collection or analysis of samples, interpretation of sample data, or with any decision-making process within the scope of the investigation.

The data validator will conduct an EPA Level IIA-equivalent validation and verification, which will be performed with guidance from applicable portions of the National Functional Guidelines for Organic Data Review (EPA 2016). Additional information regarding the data validation process is provided in the following sections.

### **8.2.2 Data Validation Methods**

Validation of the analytical data will include the criteria listed below. Validation procedures will be followed to ensure data are evaluated properly, completely, and consistently for use in meeting DQOs.

The data validator (unless noted otherwise) will complete the following:

- **Data deliverables:** Ensure that all required verified information on sampling and analysis has been made available as part of data validation (see Section 8.2.1; this also includes associated planning documents [i.e., work plan, SAP, or QAPP]).
- **Analytes:** Ensure that the required list of analytes was reported as specified in the planning documents.
- **COC:** Review the COC form for traceability of the data from sample collection through to data reporting.
- **Holding times:** Verify that samples were analyzed within specified holding times (i.e., method, procedure, or planning document). If holding times were not met, confirm that the laboratory has documented any deviations and made appropriate notifications to the project team, and that approval to proceed was received prior to analysis.
- **Sample handling:** Verify that sample handling, receipt, and storage procedures were followed, with any deviations documented.
- **Sampling methods and procedures:** Verify that required sampling methods were used and any deviations documented. Ensure that the sampling procedures and field measurements met performance criteria and any deviations were documented.
- **Field transcription:** Authenticate transcription accuracy of field data (i.e., from field forms to report tables).
- **Analytical methods and procedures:** Verify that required analytical methods were used, with any deviations documented. Ensure that QC samples met performance criteria, with any deviations documented.
- **Data qualifiers:** Verify that laboratory data qualifiers were defined and applied as specified (i.e., method, procedure, or planning document).

- Laboratory transcription: Authenticate the accuracy of transcription of analytical data (i.e., instrument to the Laboratory Information Management System, or laboratory notebook to reporting form).
- Standards: Verify that standards are traceable and meet requirements (method, procedure, or planning document).
- Communication: Confirm that required communication procedures were followed by field and/or laboratory personnel.
- Audits: Review laboratory audit reports, accreditation, and certification records for the laboratory's performance on specific methods; review field forms to verify compliance with work plan and QAPP procedures.

### 8.2.3 Data Validation Review and Data Qualification

For Level IIA data validation, data quality will be assessed by comparing QC parameters to the appropriate criteria (i.e., limits) as specified in the planning documents (i.e., work plan, SAP, QAPP).

Analytical data may be qualified based on the data validation review. Qualifiers will be consistent with applicable EPA national functional guidelines and will be used to provide data users with an estimate of the level of uncertainty associated with the qualified result.

Data validation results will be evaluated with respect to assigned qualifiers to determine any data usability issues. The following qualifiers may be assigned during the data validation process:

- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The result is an estimated quantity, but the result may be biased high.
- J- The result is an estimated quantity, but the result may be biased low.
- NJ The analyte has been "tentatively identified" or "presumptively identified" as present and the associated numerical value is the estimated concentration in the sample.
- R The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
- U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
- UJ The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

The objectives, evaluations, and actions employed during the data validation process will be guided by EPA national functional guidelines. Laboratories will be permitted to provide Contract Laboratory Program (CLP)-like forms in lieu of original CLP forms. The data validation criteria will not strictly adhere to national functional guidelines, but will also take into consideration method criteria for preservation and holding times; laboratory-specified criteria for surrogate, laboratory control samples, laboratory duplicates, and matrix spikes; and the data validator's professional judgment.



## **9.0 PROJECTS USING EXISTING DATA**

Since the TECT Aerospace remedial investigation is ongoing, secondary data may be collected and analyzed as directed under this QAPP, and used to evaluate performance and concentration trends. Historical data will be considered usable for the decisions being made on this project, especially in light of the effort to identify and resolve data gaps.

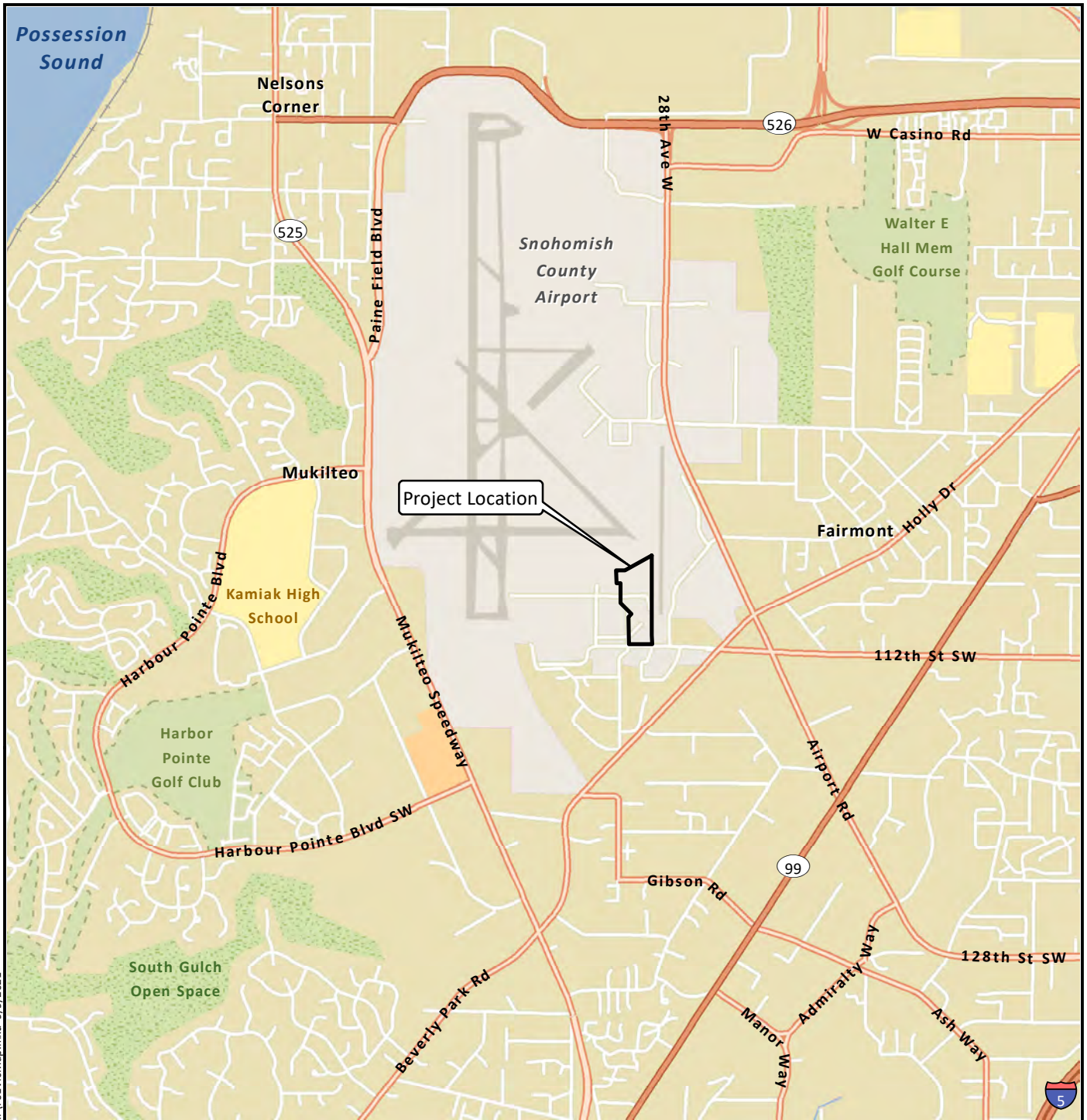
## **10.0 USE OF THIS QUALITY ASSURANCE PROJECT PLAN**

This Quality Assurance Project Plan has been prepared for the exclusive use of Snohomish County Airport and applicable regulatory agencies for specific application to the former Paine Field TECT Aerospace Leasehold. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. LAI makes no other warranty, either express or implied.

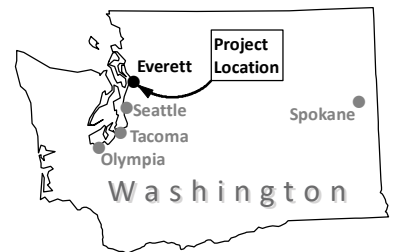
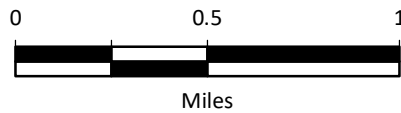
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## 11.0 REFERENCES

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Data Source: Esri.

<p>TECT Aerospace Leasehold Everett, Washington</p>	<p>Vicinity Map</p>	<p>Figure <b>1</b></p>
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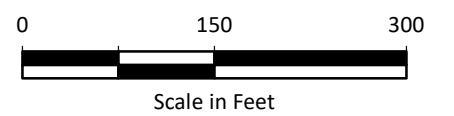


**Legend**

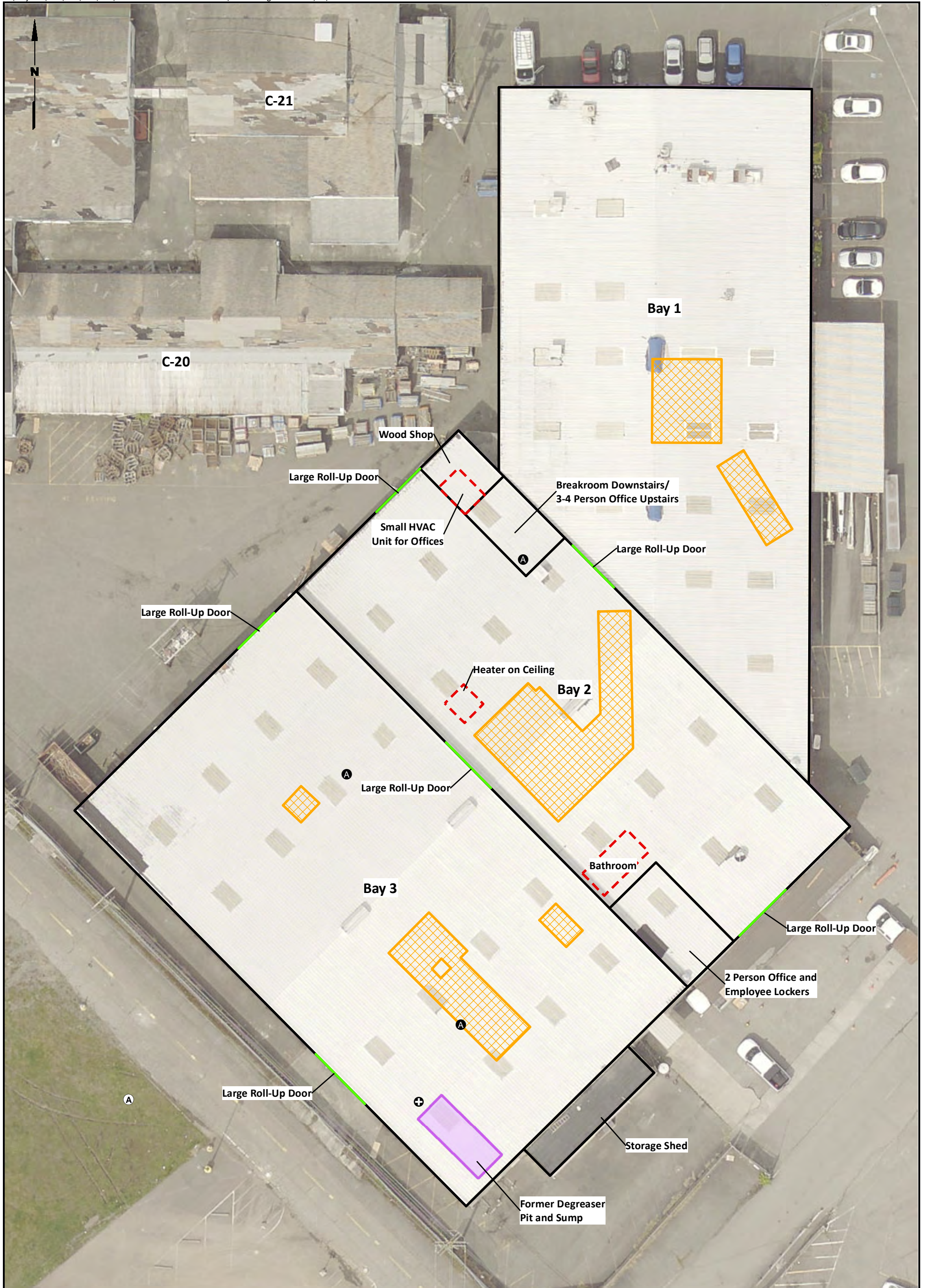
- Approximate Site Boundary
- Building C-19

**Note**

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

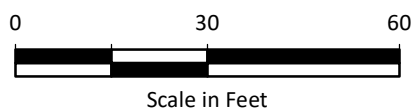


Data Sources: AGI 1999; Landau Associates 2006; King County GIS.



**Legend**

- Ⓐ Proposed Ambient Air Sampling Location (Upwind During Sampling)
- Ⓐ Proposed Indoor Air Sampling Location
- ⊕ Proposed Sub-Slab Sampling Location
- ⊠ Previous Remedial Excavation Areas



Data Sources: AGI 1999; Landau Associates 2006; King County GIS.

**Note**

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

**Table 1**  
**Key Personnel Project Responsibilities**  
**Quality Assurance Project Plan**  
**Building C-19 – TECT Aerospace Leasehold**  
**Snohomish County Airport – Everett, Washington**

Name	Title/Role	Organization Affiliation	Responsibilities
Andrew Rardin	Project Manager	Snohomish County Public Works	Manages the project for Snohomish County.
Kim Wooten	Ecology Project Manager	Washington State Department of Ecology, Toxics Cleanup Program/Northwest Regional Office	Oversees the project on behalf of the Washington State Department of Ecology.
Gerald Ninteman	Consultant Project Manager	Landau Associates	Supervises and coordinates all work for the project. These responsibilities include project planning and execution, scheduling, staffing, data evaluation, report preparation, subcontracts, and managing deliverables.
Danille Jorgensen	Quality Assurance Officer	Landau Associates	Oversees and directs quality assurance (QA) reviews for the project, including periodic reports, analytical program requirements, and schedules before submittal to the Washington State Department of Ecology for review and comment. Responsible for inputting all field data and the maintenance of the database.
Kristi Schultz	Data Specialist	Landau Associates	Reviews laboratory analytical data and provides data validation. Has oversight responsibility for management and integrity of the data.
Chris Kimmel	Site Health & Safety Manager	Landau Associates	Responsible for review and implementation of the Health and Safety Plan (HASP).
Sue Anderson	Project Manager/ Project Coordinator	ALS Global Laboratories Simi Valley	Manages laboratory analysis and reporting.
Stephanie Renando	Field Lead/Coordinator	Landau Associates	Leads and coordinates field activities including documentation, sampling, and sample handling. Reports directly to the LAI project manager.

**Table 2**  
**Data Quality Indicators**  
**Quality Assurance Project Plan**  
**Building C-19 – TECT Aerospace Leasehold**  
**Snohomish County Airport – Everett, Washington**

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
<b>Indoor Air and Ambient Air Samples Analyzed for Volatile Organic Compounds by EPA Method TO-15 SIM</b>				
Representativeness	Preservation	Pressure < 5 psi	All project samples	S
Accuracy	BFB Tune	Criteria per EPA Method TO-15, Section 10.4.	Criteria per EPA Method TO-15, Section 10.4.	A
Accuracy	ICAL	Criteria per EPA Method TO-15, Section 10.5.	Criteria per EPA Method TO-15, Section 10.5.	A
Accuracy	CCV	Criteria per EPA Method TO-15, Section 10.6.	Criteria per EPA Method TO-15, Section 10.6.	A
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations >1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Bias/Contamination	Canister Cleaning	All canisters used to collect project samples certified as individually cleaned to the method detection limit.	All canisters certified as clean prior to sample collection.	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	95%	N/A	S
<b>Sub-Slab Vapor Samples Analyzed for Volatile Organic Compounds by EPA Method TO-15 scan</b>				
Representativeness	Preservation	Pressure < 5 psi	All project samples	S
Accuracy	BFB Tune	Criteria per EPA Method TO-15, Section 10.4.	Criteria per EPA Method TO-15, Section 10.4.	A
Accuracy	ICAL	Criteria per EPA Method TO-15, Section 10.5.	Criteria per EPA Method TO-15, Section 10.5.	A
Accuracy	CCV	Criteria per EPA Method TO-15, Section 10.6.	Criteria per EPA Method TO-15, Section 10.6.	A
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations >1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Bias/Contamination	Canister Cleaning	All canisters used to collect project samples certified as batch cleaned	All canisters certified as clean prior to sample collection.	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	95%	N/A	S

**Abbreviations/Acronyms:**

- |   |                                     |
|---|-------------------------------------|
| % = percent                               | MQO = measurement quality objective |
| A = analytical                            | N/A = not applicable                |
| BFB = bromofluorobenzene                  | psi = pounds per square inch        |
| CCV = continuing calibration verification | QA = quality assurance              |
| DQI = data quality indicator              | QC = quality control                |
| EPA = US Environmental Protection Agency  | RL = reporting limit                |
| ICAL = initial calibration                | RPD = relative percent difference   |
| LCS = laboratory control spike            | S = sampling                        |
| LCSD = laboratory control spike duplicate | SIM = selected ion monitoring       |



**Table 3**  
**Indoor Air, Ambient Air, and Sub-Slab Vapor Targeted Reporting Limits**  
**Quality Assurance Project Plan**  
**Building C-19 – TECT Aerospace Leasehold**  
**Snohomish County Airport – Everett, Washington**

Matrix	Method	Analyte	CAS No.	Preliminary Indoor Air Screening Level	MDL	RL	Units
Indoor Air	TO-15 SIM	1,1,1-Trichloroethane	71-55-6	2,285 (a)	0.009	0.025	µg/m <sup>3</sup>
Indoor Air	TO-15 SIM	1,1-Dichloroethane	75-34-3	1.56	0.0082	0.025	µg/m <sup>3</sup>
Indoor Air	TO-15 SIM	1,2-Dichloroethane	107-06-2	0.096	0.0083	0.025	µg/m <sup>3</sup>
Indoor Air	TO-15 SIM	1,4-Dioxane	123-91-1	0.5	0.0087	0.1	µg/m <sup>3</sup>
Indoor Air	TO-15 SIM	Benzene	71-43-2	0.321	0.015	0.075	µg/m <sup>3</sup>
Indoor Air	TO-15 SIM	cis-1,2-Dichloroethene	156-59-2	(b)	0.0072	0.025	µg/m <sup>3</sup>
Indoor Air	TO-15 SIM	Tetrachloroethene	127-18-4	9.62	0.016	0.025	µg/m <sup>3</sup>
Indoor Air	TO-15 SIM	Trichloroethene	79-01-6	0.334	0.0077	0.025	µg/m <sup>3</sup>
Indoor Air	TO-15 SIM	Vinyl Chloride	75-01-4	0.284	0.012	0.05	µg/m <sup>3</sup>
Ambient Air	TO-15 SIM	1,1,1-Trichloroethane	71-55-6	N/A	0.009	0.025	µg/m <sup>3</sup>
Ambient Air	TO-15 SIM	1,1-Dichloroethane	75-34-3	N/A	0.0082	0.025	µg/m <sup>3</sup>
Ambient Air	TO-15 SIM	1,2-Dichloroethane	107-06-2	N/A	0.0083	0.025	µg/m <sup>3</sup>
Ambient Air	TO-15 SIM	1,4-Dioxane	123-91-1	N/A	0.0087	0.1	µg/m <sup>3</sup>
Ambient Air	TO-15 SIM	Benzene	71-43-2	N/A	0.015	0.075	µg/m <sup>3</sup>
Ambient Air	TO-15 SIM	cis-1,2-Dichloroethene	156-59-2	N/A	0.0072	0.025	µg/m <sup>3</sup>
Ambient Air	TO-15 SIM	Tetrachloroethene	127-18-4	N/A	0.016	0.025	µg/m <sup>3</sup>
Ambient Air	TO-15 SIM	Trichloroethene	79-01-6	N/A	0.0077	0.025	µg/m <sup>3</sup>
Ambient Air	TO-15 SIM	Vinyl Chloride	75-01-4	N/A	0.012	0.05	µg/m <sup>3</sup>
Sub- Slab Vapor	TO-15 Scan	1,1,1-Trichloroethane	71-55-6	N/A	0.066	0.52	µg/m <sup>3</sup>
Sub- Slab Vapor	TO-15 Scan	1,1-Dichloroethane	75-34-3	N/A	0.078	0.54	µg/m <sup>3</sup>
Sub- Slab Vapor	TO-15 Scan	1,2-Dichloroethane	107-06-2	N/A	0.059	0.52	µg/m <sup>3</sup>
Sub- Slab Vapor	TO-15 Scan	1,4-Dioxane	123-91-1	N/A	0.063	0.52	µg/m <sup>3</sup>
Sub- Slab Vapor	TO-15 Scan	Benzene	71-43-2	N/A	0.077	0.52	µg/m <sup>3</sup>
Sub- Slab Vapor	TO-15 Scan	cis-1,2-Dichloroethene	156-59-2	N/A	0.075	0.52	µg/m <sup>3</sup>
Sub- Slab Vapor	TO-15 Scan	Tetrachloroethene	127-18-4	N/A	0.069	0.52	µg/m <sup>3</sup>
Sub- Slab Vapor	TO-15 Scan	Trichloroethene	79-01-6	N/A	0.072	0.51	µg/m <sup>3</sup>
Sub- Slab Vapor	TO-15 Scan	Vinyl Chloride	75-01-4	N/A	0.057	0.53	µg/m <sup>3</sup>

**Notes:**

Results will be reported to the MDL.

Analyte list was determined based on results from soil and groundwater results from the ongoing remedial investigation being conducted by LAI.

Preliminary screening levels based on Washington State Department of Ecology CLARC Method B, indoor air, cancer for vapor intrusion from February 2021.

(a) Value is based on non-cancer because there is no MTCA Method B cancer value available in CLARC.

(b) Indoor air and soil gas screening levels not established in CLARC for this chemical.

**Abbreviations and Acronyms:**

µg/m<sup>3</sup> = micrograms per cubic meter

CAS = Chemical Abstracts Service

CLARC = Cleanup Levels and Risk Calculations database

LAI = Landau Associates, Inc.

MDL = method detection limit

N/A = not applicable

RL = reporting limit

SIM = selected ion monitoring

**Table 4**  
**Sample Containers, Preservatives, and Holding Times**  
**Quality Assurance Project Plan**  
**Building C-19 – TECT Aerospace Leasehold**  
**Snohomish County Airport – Everett, Washington**

<b>Matrix</b>	<b>Method</b>	<b>Container</b>	<b>Preservative</b>	<b>Holding Time</b>	<b>Laboratory Performing Analyses</b>
Indoor Air, Ambient Air	TO-15 SIM	6-L Summa Canister	Pressure inside the canister maintained within+/- 5 psi from sampling to analysis, individually cleaned	30 days	ALS - Simi Valley
Sub-Slab Vapor	TO-15 scan	6-L Summa Canister	Pressure inside the canister maintained within+/- 5 psi from sampling to analysis, batch cleaned	30 days	ALS - Simi Valley

**Acronyms/Abbreviations:**

ALS = ALS Global Laboratories

L = liter

psi = pound force per square inch

SIM = selected ion monitoring

**Table 5**  
**Data Validation Elements**  
**Quality Assurance Project Plan**  
**Building C-19 – TECT Aerospace Leasehold**  
**Snohomish County Airport – Everett, Washington**

QC Element	Evaluation Criteria	Qualification
Case Narrative	A case narrative shall be included with all laboratory packages.	Depending on issues presented in case narrative, additional qualification to the data may be warranted.
Chain of Custody	A COC form shall be included with all laboratory packages.	If discrepancies are noted on the COC, then the laboratory report may be revised to correct any issues.
Preservation	Preservation conditions as noted in laboratory report are compared to method-specified requirements.	Depending on the preservation issue, data may be qualified as estimated (J/UJ) or rejected.
Holding Times	Holding times are compared to method-specified hold times.	If hold times are exceeded, then all results for the method are qualified as estimated (J/UJ). If hold times are grossly exceeded, then detected results are qualified as estimated (J) and non-detected results are rejected (R).
Method Blanks	Detections of target analytes in the method blank should be < RL for the analyte or < level of acceptable blank contamination specified in the QAPP.	If an analyte is detected in the method blank outside the evaluation criteria, and the project sample result is <5x blank concentration (10x for common laboratory contaminants) and the project sample result is between MDL and RL, raise result to RL and flag "U." If the project sample result is <5x blank concentration (10x for common laboratory contaminants) and >RL, flag "U."  Apply method blank results to all samples in the same analytical batch.
LCS	Recoveries are compared to laboratory-specified QC limits.	If %R is <10%, qualify detected results as estimated (J) and reject non-detected results. If %R is <laboratory-specified QC limits, qualify results as estimated (J/UJ). If %R is >laboratory-specified QC limits, qualify detected results as estimated (J).
Surrogates	Recoveries are compared to laboratory-specified QC limits.	If %R is <10%, qualify detected results as estimated (J) and reject non-detected results. If %R is <laboratory-specified QC limits, qualify results as estimated (J/UJ). If %R is >laboratory-specified QC limits, qualify detected results as estimated (J).

**Table 5  
Data Validation Elements  
Quality Assurance Project Plan  
Building C-19 – TECT Aerospace Leasehold  
Snohomish County Airport – Everett, Washington**

QC Element	Evaluation Criteria	Qualification
Laboratory Duplicate or LCSD	RPDs are compared to laboratory-specified QC limits.	If RPDs exceed laboratory-specified QC limits, then results for the sample that was analyzed in duplicate will be qualified as estimated (J/UJ).
Dilutions	Results shall be reported within the calibration range of the instrument.	Results reported by the laboratory that are outside the calibration range of the instrument (E-qualified) will be marked as not reportable during data validation. The detected result that is within the calibration range is the reportable result. Non-detected results will be reported from the lowest dilution run.

**Abbreviations and Acronyms:**

- |   |                                       |
|---|---------------------------------------|
| % = percent                               | MDL = method detection limit          |
| %R = percent recovery                     | QAPP = Quality Assurance Project Plan |
| COC = chain of custody                    | QC = quality control                  |
| LCS = laboratory control sample           | RL = reporting limit                  |
| LCSD = laboratory control spike duplicate | RPD = relative percent difference     |

**Notes:**

- J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample
- U = The analyte was analyzed for but was not detected above the level of the reported sample quantitation limit.
- UJ = The analyte was analyzed for but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

# Laboratory Standard Operating Procedures



## Determination of Volatile Organic Compounds in Air Samples Collected in Specially Prepared Canisters and Gas Collection Bags by Gas Chromatography/Mass Spectrometry (GC/MS)

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## 1) Scope and Applicability

- 1.1 This procedure is based on and incorporates the requirements detailed in EPA Compendium Methods TO-15 and TO-14A and is used to quantify a wide range of volatile organic compounds (VOCs) in gaseous matrices collected in gas collection bags (method modification) and specially prepared stainless steel canisters or glass bottles. This method typically applies to ambient concentrations of VOCs 0.50ug/m<sup>3</sup> (down to 0.10ug/m<sup>3</sup> for low level ambient analyses) and above for the SCAN mode and 0.010ug/m<sup>3</sup> and above for the SIM mode; however, refer to Tables 3 and 3A for the specific laboratory initial calibration ranges for each target compound. The method requires VOC enrichment by concentrating up to one liter of a sample volume, with a virtually unlimited upper concentration range using dilutions from source level samples.

In this document, Tables 2 and 2A (see Note 1 below) list compounds that can be determined by this procedure along with their corresponding laboratory method reporting limits (MRLs) and method detection limits (MDLs). The reported MRL may be adjusted higher; however, the capability of achieving lower MRLs for specific project requirements must be thoroughly demonstrated (by an acceptable initial calibration and method reporting limit check standard) and documented as long as the MRL is higher than the current method detection limit for each compound. Additional compounds may be analyzed according to this procedure as described in the referenced methods as long as the requirements of this document are adhered to. The number of samples that may be analyzed in a 24-hour period is about twenty. The number of sample results that may be reduced in an eight-hour day is approximately twenty.


## 2) Summary of Procedure

- 2.1 The analytical method involves using a high-resolution gas chromatograph (GC) coupled to a mass spectrometer (MS). The GC/MS utilizes a linear quadrupole system, which allows for it to be operated by either continuously scanning a wide range of mass to charge ratios (SCAN mode) or by Select Ion Monitoring mode (SIM), which consists of monitoring a small number of ions from a specified compound list.

An aliquot of an air sample is concentrated on a solid adsorbent trap (either cryogenically or fan cooled glass beads or stronger adsorbents at higher temperatures) to collect the analytes of interest. To remove co-collected water vapor, the concentrated sample then goes through a water removal (dry purge) step. After the sample is pre-concentrated on a trap, the trap is heated and the VOCs are thermally desorbed onto a refocusing cold trap. The VOCs are then thermally desorbed onto the head of a capillary column once the cold trap is heated. The oven temperature (programmed) increases and the VOCs elute and are detected by the mass spectrometer.


Mass spectra for individual peaks in the total ion chromatogram are examined with respect to the fragmentation pattern of ions corresponding to various VOCs including the intensity of primary and secondary ions. The fragmentation pattern is compared with stored spectra taken under similar conditions, in order to identify the compound. For any given compound, the intensity of the primary fragment is compared with the system response to the primary fragment for known amounts of the compound. This method utilizes the internal standard calibration technique; refer to Section 3.16 for a complete definition.



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### 3) Definitions


- 3.1 Cryogen A refrigerant used to obtain sub-ambient temperatures in the VOC concentrator and/or on front of the analytical column. Liquid nitrogen (cryogen) is used for this purpose and it has a boiling point of  $-195.8^{\circ}\text{C}$ .
- 3.2 Gauge Pressure Pressure measure with reference to the surrounding atmospheric (barometric) pressure, usually expressed in units of psig. Zero gauge pressure is equal to atmospheric pressure.
- 3.3 MS-SCAN Mass spectrometric mode of operation in which the gas chromatograph (GC) is coupled to a mass spectrometer (MS) programmed to SCAN all ions repeatedly over a specified mass range.
- 3.4 MS-SIM Mass spectrometric mode of operation in which the GC is coupled to a MS that is programmed to scan a selected number of ions repeatedly [i.e., selected ion monitoring (SIM) mode].
- 3.5 Analytical Sequence The analytical sequence describes exactly how the field and QC samples in an analytical batch are to be analyzed.
- 3.6 Neat Stock Standard A purchased, single component assayed reference material having a stated purity used to prepare working calibration standards.
- 3.7 Stock Standards Solution A concentrated solution of one or more target analytes at a known concentration purchased from a reputable commercial vendor. Stock standard solutions are used to prepare working calibration standards.
- 3.8 Intermediate Calibration Standard A solution of one or more target analytes at a known concentration prepared either from one or more neat stock standards or from one or more stock standards solutions.
- 3.9 Working Calibration Standard A solution of all the target analytes at a known concentration prepared either from one or more intermediate calibration standards and/or from one or more stock standard solutions.
- 3.10 Calibration or Standard Curve A calibration or standard curve is a graph which plots the concentration of a compound (or an analyte) versus the instrument response to the compound.
- 3.11 Initial Calibration Verification (ICV) Standard A solution prepared in the laboratory containing known concentration(s) of analytes of interest. The solution is prepared from neat stock standards and/or stock standards solutions which are from a different source than the standards used to prepare the working calibration standards.
- 3.12 Continuing Calibration Verification (CCV) Standard A working calibration standard which is analyzed at specific intervals in order to verify that the instrument continues to meet the calibration criteria.
- 3.13 Field Sample A sample collected and delivered to the laboratory for analysis.
- 3.14 Manual Integration This term applies to a data file in which setpoints have been changed and reintegration has occurred under the changed setpoints; baselines have been adjusted; peak integration start and stop "ticks" have been changed; peak area, or peak height, are changed after the time of data collection and data file generation.
- 3.15 Batch Quality Control (QC) Batch QC refers to the QC samples that are analyzed in an analytical batch of field samples and includes the Method Blank (MB), Laboratory Control Sample (LCS) and Laboratory Duplicate (LD).

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- 3.16 Internal Standard Calibration Compares the instrument responses from the target compound in the sample to the responses of specific standards (called internal standards), which are added to the sample or sample preparation prior to analysis. The ratio of the peak area (or height) of the target compound in the sample or sample preparation is compared to a similar ratio derived for each calibration standard.
- 3.17 May This action, activity, or procedural step is neither required nor prohibited.
- 3.18 Must This action, activity, or procedural step is required.
- 3.19 Shall This action, activity, or procedural step is required.
- 3.20 Should This action, activity, or procedural step is suggested, but not required.
- 3.21 SOP Standard Operating Procedure
- 3.22 Service Request A form generated, at the time of sample receipt, which details pertinent information such as client name, address, contact, client and laboratory sample identifications, sampling and receipt dates and times, requested analyses, sample type, canister pressures (initial and final), and the service request number (unique number for each submitted job) and serves as an inter-laboratory “custody” form which accompanies all samples throughout the laboratory.
- 3.23 Selectivity Selectivity of a method refers to the extent to which it can determine particular analyte(s) in a complex mixture without interference from other components in a mixture. Another definition is the extent to which a particular method can be used to determine analytes under given conditions in the presence of other components of similar behavior.
- 3.24 Limit of Detection (LOD) The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the LOD, the false negative rate (Type II error) is 1%. (DoD Clarification). For consistency purposes, the LOD may be referred to as the MDL once it is reported; however, full verification will be on file in the laboratory per the procedures detailed in this document.
- 3.25 Limit of Quantitation (LOQ) The lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard. (DoD Clarification). For consistency purposes and since the LOQ and MRL are equivalent with regards to laboratory procedure, the LOQ will be referred to as the MRL in this document and once it is reported. Full verification will be on file in the laboratory per the procedures detailed in the document.
- 3.26 Detection Limit (DL) / Method Detection Limit (MDL) The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the DL, the false positive rate (Type I error) is 1%. (DoD Clarification). For consistency purposes, the DL may be referred to as MDL. Also, as far as reporting is concerned the MDL will be raised up (where necessary) to the verified LOD per the procedures defined in this document and reported accordingly.

#### 4) Responsibilities

- 4.1 It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for data review. Personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP may perform analysis, interpretation and peer review of the results. Data reduction and/or peer review may be performed by another qualified employee. This employee must be

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familiar with the analytical technique and have completed a data review training plan to ensure familiarity with specific analysis and requirements.

- 4.2 The supervisor/manager must ensure that method proficiency is documented initially and whenever significant changes in the instrument type, personnel, and matrix or test method are made.
- 4.3 The department supervisor/manager or designee shall perform final review and sign-off of the data.

## 5) Interferences

### 5.1 Canisters

Canisters shall be stored in a contaminant free location and shall be capped tightly during shipment to prevent leakage and minimize any compromise of the sample. The pressure/vacuum is checked prior to shipment and upon receipt from the field. Any problems with the sample from the field are noted and the Project Manager contacted.

Also, canisters must be cleaned and certified to be free from target analytes before being shipped to the field for sample collection. The procedure is described in detail in the *SOP for Cleaning and Certification of Summa Canisters and Other Specially Prepared Containers* (refer to this procedure as well as Section 12.7 for the acceptance criteria).

Current laboratory practice entails the segregation of 6L canisters into ambient (low) level and source levels. All the ambient canisters are used for low level (indoor air, ambient air) projects and not intentionally for soil gas, SVE monitoring, or other higher level applications. It may be necessary to “retire” an ambient canister and re-assign for source level use if high concentrations are encountered. This decision will be made by management based on analytical concentrations and what compounds were encountered at these levels. If the level of any analyte is detected above 5,000ug/m<sup>3</sup> in the ambient can, then the supervisor/team leader must be contacted to determine if the canister(s) is to be retired. If retirement is decided upon, make a notation on the sample tag (or other color coded tag) of each canister in question. The notation must contain the analyte, threshold levels and retirement from ambient use (initial and date notation) so that the canister conditioning/management department may properly execute the retirement.

### 5.2 Analytical System


The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running humidified zero air blanks. The use of non-chromatographic grade stainless steel tubing, non-PTFE thread sealants, or flow controllers with buna-N rubber components must be avoided.

### 5.3 Carbon Dioxide

Excessive levels of carbon dioxide present in a sample may interfere with analysis by freezing up the cryogenic trap. A smaller aliquot must be analyzed to eliminate this problem, or the sample should be analyzed using the higher temperature multi-adsorbent trapping technique which allows carbon dioxide to pass.

### 5.4 Gas Collection Bags

This procedure covers the use of gas collection vessels such as Tedlar® or Mylar® bags. However, due to the nature of these types of bags it is not recommended that clients use this option for ambient air samples. Sample collection bags made out of Tedlar®

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have contaminants that are inherent to the manufacturing process. The two main contaminants are phenol and N,N-Dimethylacetamide. However, this only becomes a problem when the concentration levels in the sample are low ppbv such as ambient air monitoring samples where more of the sample usually has to be concentrated and analyzed. To minimize the loss of sample integrity, a 72-hour hold time has been incorporated into the procedure.

#### 5.5 Glassware

Interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware results in discrete artifacts and/or elevated baselines in the detector profiles should be minimized. All glassware associated with this method must be scrupulously cleaned to avoid possible contamination. The cleaning shall be performed in accordance with the procedure outlined in the *SOP for Glassware Cleaning*. The use of high purity water, reagents, and solvents helps to minimize these problems.

### 6) Safety

6.1 Each compound, mixture of compounds, standards, and surrogates, as well as samples, should be treated as a potential health hazard. Exposure to these chemicals should be reduced to the lowest level possible through the use of gloves (to minimize absorption through the skin) and hoods (to minimize inhalation). Refer to the laboratory's Safety Manual as it makes reference to the safe handling of chemicals and SDS location. Refer to the laboratory waste management plan for the safe disposal of chemicals and samples.

#### 6.2 Safety Data Sheets (SDS)

The analyst should consult SDS for compounds being handled in the course of this procedure, and be familiar with proper safety precautions to be followed when handling hazardous chemicals. Care should be taken when handling standard material in a neat or highly concentrated form.

#### 6.3 Liquid Nitrogen

Liquid nitrogen can cause serious tissue damage (frostbite) with only a few seconds of contact. The valves on the cryogen dewars should be opened slowly so leaky fittings can be identified. Neoprene or leather gloves should be worn when turning valves and handling tubing and fittings that have been in contact with the cryogen.

#### 6.4 Protective Clothing


Personal protective clothing (safety glasses, gloves and lab coat) are required when preparing standards and handling standard material in neat form.

#### 6.5 Pressurized Gases

The use of pressurized gases is required for this procedure. Care should be taken when moving cylinders. All gas cylinders must be secured to a wall or an immovable counter with a chain or a cylinder clamp when not in use. The regulator should never remain on small "D" size cylinders following use. Sources of flammable gases (i.e. pressurized hydrogen) should be clearly labeled.

#### 6.6 Syringes

The proper use of syringes should be part of employee training for this SOP. Care should be taken to avoid personal injury as a result of improper handling techniques.

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## 7) Sample Collection, Containers, Preservation, and Storage

- 7.1 Air samples are collected in the field and delivered to the laboratory and shall be collected in either a specially prepared, leak-free, passivated stainless steel canister (with valve) of desired volume (e.g., 6L), a glass sampling bottle (Bottle Vac, Entech Instruments) or a sample collection bag (Tedlar). Canister samples may either be grab or time integrated (using a variable flow controller, refer to the *SOP for Flow Controllers and Critical Orifices*) utilizing the canister vacuum to draw the sample. Bags require the use of an upstream pump or a “lung machine.”
- 7.2 There are no special preservation requirements for either canisters, Bottle Vacs or bags. However, bags should be stored in an environment free from puncture or deterioration sources (by hanging them from clips), labeled with the specific service request number, in accordance with the *SOP for Laboratory Storage, Analysis and Tracking*. Canisters and bottles should be stored on the appropriate shelves until they are to be analyzed.
- 7.3 Sample collection bags must be analyzed within 72 hours from the confirmed time of sampling. Samples received by the laboratory shall be analyzed within 30 days of sampling or sooner if project specific requirements dictate.

Program(s), which have shorter recommended or required hold times include:

- The Minnesota Pollutions Control Agency (MPCA) requires a 14 days hold time. Additionally, the MPCA does not allow the use of Tedlar bags for sampling or sample dilution.

## 8) Apparatus and Equipment

8.1 Additional instruments and/or differing models may be utilized as long as they are equivalent and meet the minimum requirements of this document.


### 8.2 Gas Chromatograph (GC)

An instrument capable of temperature programming, with a column oven that may be cooled to sub-ambient temperature at the start of the gas chromatographic run to result in the resolution of the VOCs.

- Hewlett Packard 6890 Series
- Hewlett Packard 6890A Series
- Agilent 6890N Series
- Agilent 7890A Series
- Agilent 7890B Series

### 8.3 Autosampler

- Tekmar-Dohrmann AUTOCAN Autosampler: 14-ACAN-074
- Entech 7200 Preconcentrator
- Entech 7200 CTS Preconcentrator
- Markes UNITY 2/CIA Advantage/Satellite

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#### 8.4 Mass Spectrometer (MS)

A MS capable of scanning from 34 to 350 amu every second or less, using 70 volts (nominal) electron energy in the electron impact ionization mode. The mass spectrometer must be capable of producing a mass spectrum for Bromofluorobenzene (BFB) which meets all of the criteria when 50ng or less of BFB is injected onto the GC/MS system.

- Hewlett Packard 5973 Series
- Agilent 5973N
- Agilent 5973 inert
- Agilent 5975B inert
- Agilent 5975C inert
- Agilent 5977A

##### 8.4.1 Ionization Gauge Controller

- Agilent: 59864B
- Granville-Phillips 330 Ionization Gauge Controller: 330001/2/3
- Hewlett Packard Ionization Gauge Controller: 59864B

#### 8.5 Analytical Column

Any analytical column capable of separating the compounds of interest may be used. The capillary column should be directly coupled to the source of the mass spectrometer. The following are suggested columns; an alternative column may be used as long as sufficient peak resolution and separation is achieved.

- Restek Rxi-1ms Fused Silica Capillary Column; 60m x 0.32mm ID  
1.0µm film thickness

OR

- Restek Rxi-1ms Fused Silica Capillary Column; 60m x 0.25mm ID  
1.0µm film thickness

#### 8.6 Data Systems

IBM-compatible PC with Windows XP/7/10 (Microsoft Office EXCEL version 2003 or newer) and Hewlett Packard Chemstation software including EnviroQuant with Extracted Ion Current Profile (EICP), National Institute of Standards and Technology (NIST) library (2011 version or newer) or equivalent.


#### 8.7 Canister Pressurization Station

Vacuum/Pressure Gauge [0 to -30 inHg; 0-90 or 100 psig]

#### 8.8 Canister Sampling Devices

Refer to the *SOP for Flow Controllers and Critical Orifices* for specific calibration and other pertinent information.

- VICI Condyne Model 300 Flow Controller
- Entech CS1200E Flow Controller
- Veriflow Flow Controllers
- Critical Orifices (Laboratory produced)

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### 8.9 Gas Collection Devices

- Lab Commerce, Aerosphere Model S6L, 6.0L Passivated Canisters or equivalent
- Lab Commerce, Stabilizer Model 22.4L, 2.4L Canisters or equivalent
- Restek Corporation, #24203, 3.0L Silco Canisters or equivalent
- Tedlar bags – 0.5L, 1L, 3L, 5L, 10L, 25L, and 40L (other sizes are available; however, the volumes that are listed encompass the majority of the bags supplied and the samples submitted to the laboratory).
- Entech Instrument, Silonite™ Canisters or equivalent
- Entech Instruments, Bottle Vacs or equivalent

### 8.10 Static Dilution System

- Entech Precision Static Diluter Model 4700
- Toshiba laptop computer Model 2210CDT/6.0 and Entech 4700 Version 2.1.2.9 Software

## 9) Standards, Reagents, and Consumable Materials

### 9.1 Reagents and Equipment

- 9.1.1 UHP Grade Helium (99.999%) (GC carrier gas, preconcentrator purge/sweep gas, pressurization gas)
- 9.1.2 Cryogen - Liquid nitrogen from bulk tank or 50 psig dewars (used to cool preconcentrator traps)
- 9.1.3 UHP/Zero Grade Air (canister pressurization)
- 9.1.4 ASTM Type II Water, DI water or equivalent
- 9.1.5 UHP Grade Nitrogen (99.999%)

Additional pressurization gases, based on other methods requested – modification to method.

### 9.2 Standards

Standards are prepared for both SCAN and Selective Ion Monitoring (SIM) modes according to the procedures detailed in this section. The preparation of standards for the analysis of air samples is carried out by following the procedure, "Preparation of Gas Phase Standards for Ambient Air Analysis", Application Note, Spring 96, Vol. 6.5, *Tekmar-DOHRMANN AutoCan User's Manual*. Neat standards that are used for making trace gas standards must be of high purity; generally a purity of 98 percent or better is commercially available.

9.2.1 Instrument Performance Check, Internal Standard and Surrogate Spiking Mixture  
 Prepare a standard solution of p-Bromofluorobenzene (BFB-used as both a tune check and surrogate compound), bromochloromethane, chlorobenzene-d5, and 1,4-difluorobenzene, 1,2-dichloroethane-d4(surrogate), and toluene-d8(surrogate) at 500µg/m<sup>3</sup> each in humidified zero air (Section 9.2.1.2). Prepare this standard according to the procedure outlined in Volume 6.5 of the *Tekmar-DOHRMANN Application Note*. This standard may also be prepared from a neat cocktail as in Section 9.2.2.2.1 or as stated in Section 9.2.1.3.

9.2.1.1 An intermediate standard is prepared from neat compounds in a glass static dilution bottle (SDB). After the volume of the SDB is determined, calculate the mass of each compound to be spiked to achieve a final

concentration of 5.0µg/ml. Then use the density of each neat compound to calculate the microliter amount to be spiked into the SDB. The SDB is then heated for a minimum of one hour at ~60°C to completely volatilize all components.

Concentration of the intermediate standard prepared in a SDB is 5.0µg/mL. The amount required to achieve this concentration is determined through the use of the following equation.

$$A = \frac{(C)(V)}{D} \quad \text{(Equation 1)}$$

Where:

- A Amount of each compound required to achieve the desired concentration of the standard in the SDB (µL)
- C Desired concentration of SDB (µg/mL)
- V Actual volume of the SDB (mL)
- D Density of the compound in question (µg/µL)

Example:

Calculate the amount of neat bromochloromethane needed to achieve the final concentration of 5.0µg/mL of that compound in the SDB.


- V = 2010mL
- D = 1934.4µg/µL
- C = 5.0µg/mL

$$A = \frac{\left(5.0 \frac{\mu\text{g}}{\text{mL}}\right) 2010 \text{ mL}}{1934.4 \frac{\mu\text{g}}{\mu\text{L}}} = 5.2 \mu\text{L}$$

Density (µg/µL)	Compound
1934.4	Bromochloromethane
1170.1	1,4-Difluorobenzene
1157	Chlorobenzene-d5
1307	1,2-Dichloroethane-d4
943	Toluene-d8
1593	BFB

9.2.1.2 The Working standard is prepared in a canister by spiking an aliquot of the stock SDB standard (Section 9.2.1.1) using a heated gastight syringe. Connect a cleaned, evacuated canister to a source of pure diluent gas (humidified zero air) using a Teflon line with a stainless steel tee directly above the canister valve. One port of the tee is fitted with a septum. Spike the SDB stock and following removal of syringe a small flow of diluent gas to flush the spike into the can. Pressurize the can to positive



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83.3 psig with humid zero air, and allow the contents to equilibrate for approximately 24 hours before using.

Concentration of the working standard prepared in a canister is 500ng/L. The final pressure of the canister is 83.3psig; therefore, the pressurized volume is 40L, which is obtained through the use of the following equation.

$$PV = PDF(V) \quad (\text{Equation 2})$$

Where:

PV Pressurized canister volume (L)

PDF Pressure Dilution Factor, where  $PF = \frac{P_{atm} + P_f}{P_{atm} + P_i}$

$P_f$  Final Canister Pressure

$P_i$  Initial Canister Pressure

V Volume of canister at 1 atm

$P_{atm}$  Atmospheric Pressure = 14.7psig

Example:

$$\frac{14.7 + 83.3}{14.7 + 0} (6L) = 40L$$

In order to prepare the canister with a concentration of 500ng/L, it must be determined how much of the intermediate standard is required. This is achieved through the use of the following equation.

$$A = \frac{(F)(V)}{(C) \left( 1000 \frac{ng}{\mu g} \right)} \quad (\text{Equation 3})$$

Where:

F Desired concentration of working standard (ng/L)


V Pressurized Volume of Canister (L)

C Concentration of prepared SDB ( $\mu\text{g}/\text{mL}$ )

A Amount of standard (mL) of the SDB required to obtain the desired working standard concentration

Example:

$$A = \frac{500 \frac{ng}{L} (40L)}{\left( 5.0 \frac{\mu g}{mL} \right) \left( 1000 \frac{ng}{\mu g} \right)} = 4mL$$

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9.2.1.3 Currently the working standard is purchased in a cylinder at a certified concentration of 500ng/L (prepared by Linde SPECTRA Environmental Gases, Alpha, NJ).

The internal standard (IS) cylinder comes from the vendor with a one year expiration date. These compounds should be stable in the high-pressure cylinder for five years or longer so the laboratory will extend the expiration date to two years from the date of preparation. The working standards are canisters filled directly from the main cylinder and are assigned:

- Two month expiration when prepared in a 6L canister
- Three month expiration when prepared in a 15L canister
- Six month expiration when prepared in a 30L or greater canister.

The method utilized relative response factors for target analyte quantitation so the IS concentrations are factored out since they appear in the numerator and denominator of the final calculation.

A quantitation report with chromatogram of a TO-15 blank run will be printed as soon as a new IS cylinder is put into use and again after one year. The latter will be checked for any unexpected peaks to look for possible degradation of the IS compounds in the cylinder. These shall be kept on file with the original certificate of analysis.


9.2.1.3.1 For **SCAN analyses**, the working standard is filled directly into a canister to a pressure of 70 to 80 psig.

9.2.1.3.2 For **SIM analyses**, the working standard is diluted and pressurized with humid zero air to the desired concentration using Equation 2 in Section 9.2.1.2. Typical concentrations will be 20ng/L, 40ng/L or 50ng/L.

9.2.2 Initial Calibration (ICAL) Standard Prepare the primary source calibration standards in canisters with nominal concentrations of 1ng/L (optional), 20ng/L and 200ng/L for analyses in SCAN mode and 0.1ng/L, 5.0ng/L, and 200ng/L for analyses in Selective Ion Monitoring (SIM) mode for each of the target analytes. Differing injection volumes will create the standard concentrations listed in Tables 3 (SCAN) and 3A (SIM) of this document. The full list of analytes which are analyzed according to this method can also be found in Tables 2 (SCAN) and 2A (SIM).

Standards are prepared by diluting the stock standard with humid zero air into a canister. The stock standard is a certified custom-blended cylinder (prepared by Linde SPECTRA Environmental Gases, Alpha, NJ). Refer to Tables 3 and 3A for the list of analytes and certified concentrations in the purchased cylinder.

9.2.2.1 Working standards are prepared into canisters using the Entech 4700 Precision Static Diluter. Turn on the power to the diluter ten minutes prior to using to allow for the components to come to thermal equilibrium. Connect the computer and start the software. Connect a Zero Air source to the Diluent port on the back of the diluter and adjust the cylinder regulator to 50 psig. The ports for the stock standards are color-coded and use quick-connect fittings. Connect up to four stock standard cylinders to the inlet ports on the right side of the diluter using

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the Silonite-coated 1/8" stainless steel tubing and quick connects provided. Open the cylinder valve. Adjust the inlet pressures to 10psig.

*Purge Diluter Lines:* Click on Manual Control (left side of window), click Enable and choose channel for the desired standard. Move the slider bar to around 20% for a few seconds to purge the lines with the standard, then move back to 0%. Click Disable.

*Set Configuration:* Click the Settings button on top of window then click the Configuration tab. Enter the standard concentrations for each cylinder channel used. Save the file using the File tab. A previously saved configuration file can be loaded here also.

*Dilution Settings:* Click the Dilution button at top of window. Load a method or create a new method with the desired dilution parameters. Select the channel of the stock cylinder to be used for the dilution (check box in Use column). Multiple channels can be diluted into the same canister. Enter the target final concentration, final canister pressure (psia), canister volume and barcode ID, standards log ID, preparer's initials, and a brief description of the dilution. Save the file if desired.

*Connect Canister:* Spike 50µl clean DI water into the valve of a clean, evacuated canister and connect to the outlet port. Open the valve for a few seconds and then close it and watch the pressure reading in the software window. It should stabilize quickly and stop drifting. If there is a leak check the connection and the canister valve.


*Start Dilution:* Open the canister valve and start the dilution program. It will partially fill the canister with diluent air, then add the required amount of stock standard, and then fill to the final pressure. Remove the canister when finished.

*Redilution:* A serial dilution may be made from a standard canister. Create a configuration file as above with the first canister on channel 6 and then create a method using channel 6 as the stock. Connect the standard canister to position 6 Input (front of diluter) then continue as above with the evacuated canister.

9.2.2.2 When analysis of additional (extra) compounds are requested which are not in the purchased stock cylinders, the following preparation instructions should be used. In addition, the internal standard / surrogate standard may also be prepared in this manner (Sections 9.2.2.2.1 – 9.2.2.2.2) as mentioned in Section 9.2.1.

9.2.2.2.1 *Equi-mass "soup"* (contains compounds in equal mass amounts) or *cocktail* prepared from the neat compounds for a large number of components. If additional SIM compounds are requested, the same cocktail may be used.

*Cocktail Preparation:*

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Step 1: This cocktail is prepared by combining 25mg of each neat compound into a small glass vial. Use a microliter syringe to transfer each compound, cleaning with solvents in between. Put the vial in the freezer between aliquots to minimize volatilization. Take the density of each compound into account to determine the actual amount of each compound to spike into the cocktail by using the following equation.

$$S = \frac{A}{D} \quad (\text{Equation 4})$$

Where:

- S Actual spike amount ( $\mu\text{L}$ )
- A Desired amount for each compound (mg)
- D Density ( $\text{mg}/\mu\text{L}$ ); refer to Table 2 for the density

Example: The actual volume of acrolein to add to the cocktail is calculated by the following.

$$S(\text{Acrolein}) = \frac{25\text{mg}}{\left(0.840 \frac{\text{mg}}{\mu\text{l}}\right)} = 29.8\mu\text{L}$$

Step 2: The concentration of each compound in the cocktail is determined by the following equation.

$$C = \frac{A}{V} \left(1000 \frac{\mu\text{g}}{\text{mg}}\right) \quad (\text{Equation 5})$$


Where:

- C Concentration of cocktail ( $\mu\text{g}/\mu\text{L}$ )
- A Amount of each compound (mg)
- V Final volume of cocktail (total spike volumes of each compound) ( $\mu\text{L}$ )

Example:

$$C = \frac{25\text{mg}}{631.8\mu\text{L}} \left(1000 \frac{\mu\text{g}}{\text{mg}}\right) = 39.569\mu\text{g}/\mu\text{L}$$

9.2.2.2.2 An intermediate standard is prepared from neat compounds by spiking individual compounds into a glass static dilution bottle (SDB) as described in Section 9.2.1.1 or spiking an aliquot of a cocktail into the SDB. The spike amount of a cocktail is determined by using the following equation.

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$$S = \frac{C_1 V}{C_2} \quad (\text{Equation 6})$$

Where:

S Spike amount required in order to obtain the desired concentration ( $\mu\text{L}$ )

$C_1$  Desired concentration of SDB ( $\mu\text{g}/\text{mL}$ )

$C_2$  Concentration of cocktail ( $\mu\text{g}/\mu\text{L}$ )

V Volume of SDB (L)

**Example:** Determine the spike amount of the cocktail required to achieve the desired intermediate standard concentration.

$$S = \frac{\left(1 \frac{\mu\text{g}}{\text{ml}}\right)(2010\text{ml})}{27.81 \frac{\mu\text{g}}{\mu\text{L}}} = 72.28\mu\text{L}$$

9.2.2.2.3 **Intermediate Standard Preparation (Gaseous Compounds)** As an alternative to the glass SDB method, if the extra compounds needed to be analyzed are gases at room temperature, use a gastight syringe to prepare an intermediate standard in a 1L Tedlar bag filled with humidified zero-grade air. Use the molecular weight of the compound to calculate the microliter amount to be spiked into the bag to achieve desired concentration. The spike amount is determined by using the following equation.

$$S = \frac{C * V * 24.46}{M * \left(1000 \frac{\text{ng}}{\mu\text{l}}\right)}$$

S Spike amount required in order to obtain the desired concentration ( $\mu\text{l}$ )

C Desired concentration (ng/L)


V Volume of the Tedlar Bag (1L)

M Molecular Weight of the compound

24.46 Molar Volume of gas at 25°C, 1atm

**Example:**

Make a 100,000ng/L intermediate standard of Chloro-difluoromethane (Freon22) in a Tedlar Bag, where M=86

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$$S = \frac{100,000 \frac{ng}{L} * 1L * 24.46}{86 * \left(1000 \frac{ng}{\mu l}\right)} = 28.44 \mu l$$

9.2.2.2.4 The Working standard for extra compounds is prepared in a canister by spiking an aliquot of the intermediate standard (glass SDB or Tedlar bag) using a heated gastight syringe. The preparation of these standards shall follow the instructions detailed in Section 9.2.1.2. The concentrations for working standards are usually 20 and 200ng/L, however different concentrations can be chosen which work best for a particular project.

9.2.3 Initial Calibration Verification (ICV) - (Laboratory Control Sample - LCS) Prepare a secondary source standard (either a different manufacturer or different lot from the same manufacturer as the initial calibration standard) using the same procedures as the primary source. The ICV/LCS working standard should contain each target analyte present in the calibration working standard. Prepare the ICV/LCS working standard at a concentration of 200ng/L. Differing injection volumes account for the allowed concentrations listed in Table 4 for SCAN and 4A for SIM. The preparation of this standard shall follow the instructions detailed in Section 9.2.2, using the certified second-source standard cylinder.


9.2.4 Continuing Calibration Verification (CCV) Standard The CCV is the same as the initial calibration working standards detailed in Section 9.2.2.

9.2.5 Screening Standards Recommended procedure: Prepare a 0.5ug/mL and/or a 3.0ug/mL concentration standard so that the GC may be calibrated utilizing a few levels (may include approximately 0.5ng, 150ng and 600ng). However, other concentrations can be prepared depending on the desired range.

Any of the desired standard concentrations (primary and secondary) may change as long as the equations and the appropriate densities remain the same.

### 9.3 Storage and Expiration Dates

- All standards that are to be stored in a freezer shall be stored at  $\leq -10^{\circ}\text{C}$  for DoD projects.
- Neat Stock Liquids are stored at  $< -10^{\circ}\text{C}$  ( $-10^{\circ}\text{C}$  to  $-20^{\circ}\text{C}$ ) as specified by the manufacturer or for a period of five years.
- Equi-Mass Primary Stock Standard is a cocktail or soup of neat compounds (containing compounds in equal mass amounts) used to in preparing intermediate gas phase standards and shall be stored in the freezer at  $< -10^{\circ}\text{C}$  ( $-10^{\circ}\text{C}$  to  $-20^{\circ}\text{C}$ ) for up to six months. This is assuming that the soup is sealed with a septum-containing screw cap or Mininert™ valve. The selection of the compounds for the soup should be performed in accordance with the guidelines in Volume 6.5 of the *Tekmar-DOHRMANN* Application Note.
- Purchased Stock Standards Cylinders must be stored at laboratory temperature for a period of 2 years or as specified by the manufacturer before vendor re-certification or purchase of new standards. Expiration dates of the cylinders must be entered into the yearly wall calendar located next to the cylinders. Analysts must verify that the

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assigned expiration dates of prepared standard canisters do not exceed the parent standard expiration date.

- Intermediate Calibration Standards prepared by static dilution must be stored in an oven at a temperature of approximately 60°C to ensure analyte vaporization. Every time a standard is prepared from the static dilution bottle (SDB), the concentration changes. To increase the useful lifetime of an SDB standard, remove volumes of 25mL or less. The volume removed can be manipulated by increasing the SDB concentration or by adjusting the canister final volume/pressure. Depending upon the volume removed, an SDB intermediate standard is stable for approximately two months as long as new working standards made from this standard continue to meet acceptance criteria. These bottles must be in the oven for a minimum of one hour prior to use in preparing working standards. The guidelines for the storage and expiration date for the intermediate calibration standards are stated in Volume 6.5 of the *Tekmar-DOHRMANN* Application Note.
- Prepared Stock / Intermediate Calibration Standards prepared in canisters (1000ng/L) may be stored at laboratory conditions for up to three months in an atmosphere free of potential contaminants. Upon preparation, canister standards should be allowed to sit for approximately 24 hours prior to use in order for equilibration to take place. Shorter equilibration periods may be necessary and acceptable as long as performance criteria are met.
- Calibration or Working Calibration Standards prepared in canisters may be stored at laboratory conditions for one month in an atmosphere free of potential contaminants. Upon preparation, canister standards should be allowed to sit for approximately 24 hours prior to use in order for equilibration to take place. Shorter equilibration periods may be necessary and acceptable as long as performance criteria are met.

## 10) Preventive Maintenance


- 10.1 A maintenance log will be kept documenting maintenance performed on each analytical system. The serial numbers of each instrument shall be recorded, and each log entry must include a description of the maintenance performed and be initialed by the analyst performing or observing/authorizing maintenance by an outside contractor.

The instrument maintenance log must be kept current. An entry shall be made in the appropriate log every time maintenance is performed (no matter the extent). The entry in the log must include.

- The date of maintenance
- Who did the maintenance
- Description of the maintenance
- Proof that the maintenance activity was successful

A notation of a successful tune and continuing calibration or initial calibration and the file number that accompanies the data will serve as proof that the maintenance is complete and the instrument is in working order.

The extent of the maintenance is not important, however, it is important that a notation be included for each maintenance activity such as changing a column, tuning the instrument, changing the pump oil, cleaning the source, ordering a part. In addition, a notation should be made in the logbook stating that no samples were analyzed during the days that the instrument was down and no active maintenance was being conducted (i.e., where no other notation was made in the logbook for those days).

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## 10.2 Concentrating Trap

Routine maintenance includes periodic solvent cleaning of the Silco steel lines in the valve oven if contamination is suspected. Also, periodic replacement of the multi-sorbent or partial replacement of the trap if analyte specific deterioration is detected is required. See Attachment 5 for trap packing instructions. For specific trap information refer to the instrument maintenance logbook.

After repacking, the trap should be baked at 265°C for a minimum of three hours (or until a clean blank is generated) and a partial repacking requires baking (at 265°C) the trap for a minimum of 20 minutes (or until a clean blank is generated).

## 10.3 GC System

Column performance is monitored by observing both peak shapes and column bleed. Over time, the column will exhibit a poor overall performance, as contaminated sample matrices are analyzed. The length of time for this to occur will depend on the samples analyzed. When a noticeable decrease in column performance is evident and other maintenance options do not result in improvement, the column should be replaced (see Section 8.5). Whenever GC maintenance is performed, care should be taken to minimize the introduction of air or oxygen into the column.

Clipping off a small portion of the head of the column often improves chromatographic performance. When cutting off any portion of the column, make sure the cut is straight and “clean” (uniform, without fragmentation) by using the proper column-cutting tool. When removing any major portion of the column, which will affect the retention times and elution characteristics, a change in instrument conditions may be required to facilitate nominal analytical activity.

Declining performance can also be due to ineffective column ferrules, which should be replaced when a tight seal around the column is no longer possible. This can be detected with the use of a leak detector.

## 10.4 Mass Spectrometer

The Mass Selective Detector (MSD) ion source requires periodic cleaning to maintain proper performance. Symptoms of a dirty ion source include difficulty keeping the MSD in tune and fluctuating internal standard areas. The vacuum system should be serviced every six months, including changing the pump oil and checking the molecular sieve in the back-streaming trap.

## 10.5 Instrument Tuning


The instrument is tuned with guidance from the procedure described in the HP Operations Manual, when necessary.

## 10.6 Computer Troubleshooting

Computer care and troubleshooting is conducted by the IT department. Refer to Section 8.6 for the computer hardware and software requirements.

Computers are selected to meet or exceed operating system and or acquisition software requirements. Periodic upgrades of memory are performed to maintain or improve system performance and reliability. Upgrades may be performed on systems until instrument hardware configurations become the limiting factor.



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Basic Troubleshooting Outline:

- 1) Document occurrence and severity in IT Log
- 2) Interview user(s)
- 3) Investigate any available logs (Event Logs, Acquisition Logs, etc.)
- 4) Determine if problem is isolated (single user or acquisition) or widespread (multi user or network).
- 5) If multiple possibilities exist for cause, then eliminate in systematic manner.
- 6) Hardware issues are addressed with component replacement (beginning with most suspect portion).
- 7) Software issues are addressed first with internet investigation (user blogs, software source updates/findings).
- 8) Network issues are investigated from the Server, to Switch, to Network Card; utilizing all available managed devices to help discover possible failure points.
- 9) In some cases, system corruption may require reload or complete system replacement.
- 10) Finalize documentation in IT Log with actions taken
- 11) Perform periodic follow-up with User and review any log found to have suspect events that suggested source of issue.


## 11) Procedure

### 11.1 Initial Calibration

The initial calibration is performed to determine instrument sensitivity and the linearity of the GC/MS response for the target compounds.

Initial calibration requirements are as follows:

1. A minimum of 5 concentrations must be used to calculate the calibration curve.
2. An initial calibration must be performed at a minimum initially per instrument, annually thereafter or whenever the continuing calibration verification standard does not meet the acceptance criteria.
3. Highest concentration, together with the lowest concentration, defines the calibration range.
4. The method reporting limit for any reported analyte must be at  $\geq$  the lowest calibration point.
5. The initial calibration event may not be interrupted by maintenance.
6. Only one value per concentration may be used.
7. Analyze calibration standards from lowest to highest concentration.
8. All CAL analyses must be completed within the 24-hour tune window.
9. Only one calibration standard concentration may be replaced.
10. One of the calibration points from the initial calibration curve must be at the same concentration as the continuing calibration verification standard.
11. The upper end of the calibration range must not exhibit any peak saturation for any analyte or the range must be lowered accordingly.
12. The initial calibration model must be linear calibration using average of response factors and cannot be changed for any reason.
13. Point dropping policy
  - Minimum of 5 consecutive concentrations must be used to calculate the calibration curve.
  - Lowest concentration must be at or below the MRL (LOQ) and may not be dropped unless the MRL is changed to the concentration of the remaining lowest standard.

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- Points at the high end may be dropped, but doing so lowers the calibration range.
- Points may not be dropped from the interior of the curve unless an assignable cause (i.e., gross dilution error, missing internal standards, purge malfunction, standard preparation error, or instrument malfunction) is accounted for and documented. In these instances, all the analytes in that calibration standard must be dropped from the calibration curve as the corrective action (the reason must be documented and the results maintained with the documentation for the final ICAL).
- Dropping individual compound points from the upper or lower end of the calibration range to improve linearity is not considered an error correction. The reason for dropping these points does not need to be documented but the ICAL documentation must state the revised calibration range if the MRL must be adjusted or the calibration range is lowered for a particular compound. This must be documented on the ICAL Review Checklist.


When an individual compound point is dropped from an ICAL both the response and concentration fields in the compound database of the method must be cleared. This ensures the average ICAL RRF calculates correctly when executing the CCV check routine.

- One calibration standard may be re-analyzed if the first analysis of the standard has been dropped and other requirements in this policy are met (i.e., still within 24 hours).
- Once the ICAL has been used to calculate and report sample results it MUST not to be changed for any reason.
- It is recommended that if an analyte has a higher MRL than the lowest concentration analyzed that the low standard be automatically dropped from the curve (i.e., acetone MRL is 5, drop at least the 0.5ng point).

11.1.1 Calibration Points Analyze the calibration standards (analyze low to high) that span the monitoring range of interest of the samples. For SCAN, the range is typically 0.5ng-100ng on column; however, 0.1ng on column may be added if low level analyses are requested. For SIM, the range is 20pg on column to 50,000pg on column. The dynamic range is dependent on the sensitivity of a particular instrument as well as the required reporting limit for a given project and may be adjusted accordingly. Refer to Table 3 (SCAN) and Table 3A (SIM) for the concentrations of the compounds of interest in the initial calibration at each particular calibration concentration level.

Note: Refer to the EXCEL TO-15 Standard Concentration templates, located on the network at Q:\\TO15 Std. Concentrations\\Std. Conc. Templates for both the SIM and SCAN templates. These templates must be utilized for the documentation of the standard canister concentration selection, final ICAL level concentrations and the determination of the correct injection volumes for the selected standard canister concentrations. **If the primary or secondary stock standard cylinder concentrations are revised (upon re-certification or new purchases), the EXCEL spreadsheet templates, injection amounts and the ICAL concentrations in each instrument method must be adjusted accordingly.** Other templates may be employed as long as they are validated and provide at least the same information.

SCAN


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1. Determine if the lower end of the calibration range is to be 0.1ng or 0.5ng on column. If the low end is 0.1ng, then the 1ng/L standard must be utilized.
2. Determine if the 1ng/L or 20ng/L standard canister is to be used for the 0.5ng on column point.
3. Follow the instructions in the spreadsheet and save the file under the correct instrument folder and the initial calibration method identification.
4. Print the final ICAL concentration sheets and place into the corresponding ICAL folder

11.1.2 Recalibration Each GC/MS system must be recalibrated following any instrument maintenance which may change or effect the sensitivity or linearity of the instrument, if the continuing calibration verification acceptance criteria are not met and at least annually. The following procedure must be followed when updating an initial calibration method.

1. Open the most recent method.
2. Save the method with the new ICAL method ID using the "Save Method As" option. Date used in the method ID must be the date files were analyzed.
3. Quantitate midpoint standard and check retention times and integrations. Update retention times if necessary using QEdit or Easy ID (Tools → Easy ID). Requant if any changes are made and verify all peaks are identified correctly. Print.
  - a. While midpoint standard is loaded update reference spectra (Continuing Calibration → Update Reference Spectra).
  - b. With midpoint standard loaded update qualifier ion ratios and retention times (Initial Calibration → Update Levels → Select Update Level and then select Retention Times (Replace) and Replace Qualifier Ion Relative Responses).
  - c. If necessary adjust integration parameters prior to processing remaining ICAL points.
4. Quantitate remaining ICAL standards. Review each peak for retention time, integration, and print. Review low level standards for acceptable signal to noise ratios and high level standards for saturation.
5. All responses must be cleared from ICAL before updating (Initial Calibration → Clear All Calibration Responses).
6. Update responses for each standard level (Initial Calibration → Update Levels) or (Initial Calibration → Quick Levels Update). If Quick Levels Update is used do not requant datafiles.
7. Save method.
8. Check Response Factor Report and evaluate whether any points should be dropped following the criteria outlined in this SOP.
9. Save method if any changes are made.
10. Verify calibration files listed on Response Factor Report are correct.
11. Verify file ID, acquisition time, quant time, update time, and last update information is correct on the Calibration Status Report.

11.1.3 Analytical Window If time remains in the tune window after meeting the acceptance criteria for the initial calibration, samples may be analyzed according to the procedure described in this document (see Section 11.5.2). If time does not remain in the analytical window, a new sequence shall commence with the analysis of the instrument performance check compound (BFB) and the continuing calibration verification standard.

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11.1.4 Procedure The system should be operated using temperature and flow rate parameters equivalent to those in Section 11.6. Use the standard prepared in accordance with Section 9.2.2 of this SOP. Attach the calibration standard and internal standard/surrogate canisters to the designated inlets on the preconcentrator and open the canister valves. Analyzing different volume aliquots of the calibration standards produces differing concentrations.


Analyte responses (target ion areas) are tabulated and recorded using the Enviroquant program. Quantitation ions for the target compounds are shown in Table 2 and 2A and the primary ion should be used unless interferences are present, in which case the secondary ion may be used, but the reason documented in the initial calibration file and all subsequent quantitations utilizing that ICAL must be performed using the same ion selections. Refer to Section 13.2 for the required calculations and Section 12.4 for the acceptance criteria.

11.1.4.1 Additional Requirements The procedure for performing and generating a new initial calibration method must follow a few additional requirements.

1. If any analyte lacks the appropriate sensitivity (3 to 1 signal to noise ratio) at the low end of the calibration range, this point must be dropped from the curve and the MRL/LOQ raised accordingly.
2. No detector saturation may occur for any compound; the upper calibration level must produce no saturated peaks. Exhibited by:
  - The flattening of the response for the higher concentration standards as shown on the plot;
  - The presence of a reverse tail or rise on the front part of the peak;
  - The observed actual percent ratio of the secondary ion presence is lower than the expected percent ratio; or
  - The presence of a flat topped peak and again by the decline or saturation of the secondary ion compared with the expected % recovery.

11.1.4.2 LOQ Establishment, Verification and Acceptance Criteria

1. The LOQ must be set within the calibration range ( $\geq$  low std. of the current passing ICAL) prior to sample analysis.
2. The LOQ is verified by analyzing an LOQ verification QC sample containing the analyte at the claimed LOQ.
2. The LOQ for each analyte must be  $>$  the analyte's LOD.
3. The verification is acceptable if:
  - a. The S/N ratio is at least 3:1 for each analyte.
  - b. All ion abundances are acceptable per the requirements in this document.
  - c. The % recovery for each analyte is within the laboratory generated control limits or 70-130% recovery for the annual Navy LOQ verification.
4. Using from 2 to 4 LOQ verification points, calculate the ongoing %RSD to demonstrate precision at the LOQ.
5. If the LOQ verification check fails, determine and document the cause. Additional LOQ verification checks must be performed at a higher level to set a higher LOQ.

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6. Turn in all LOQ verification data (quantitation reports and software reports/checks) to QA regardless of pass or fail.
7. Verify the LOQ on each instrument quarterly. Navy accreditation requires an annual LOQ verification.
8. Annually, all results of the ongoing verification sample testing must be tabulated. All data representative of current operations must be used, if generated within the last two years. A minimum of seven points must be used. Refer to the *SOP for Method Detection Limit Studies and Establishing Limits of Detection and Quantitation* for additional requirements.

11.1.5 Initial Calibration Review Analyst's calculation and assessment along with a peer review of all ICAL data and documentation as stated in Attachment 2 is required before the ICAL may be used to analyze samples. In the case where samples are placed on the autosampler and allowed to run overnight, the sample results may only be reported if the ICAL is reviewed and found to be acceptable. The ICAL checklist in Attachment 2 must be used to document the review and approval process.

Perform a review of specific aspects of the calibration which might compromise data quality such as inappropriate extension of the calibration range with detector saturation and/or a lack of sensitivity for any analyte. Analyte concentrations which do not meet the signal to noise ratio or exhibit saturation are not to be reported and must be eliminated from the initial calibration. These instances should be followed by a short explanation regarding the reason for the omission.

11.1.6 Initial Calibration File An ICAL file is to be created for each initial calibration performed per instrument into which is placed the following ICAL documents. The file shall remain in the laboratory and be filed by instrument and date.


- ICAL Checklist filled out, reviewed and approved
- BFB tune analysis report
- Calibration status report (aka Calibration History)
- Relative Response Factor Report / Percent Relative Standard Deviation
- Quantitation report for each calibration standard (including manual integration documentation – before and after manual integration)
- ICV quantitation report and % recovery report.
- TO-15 Standard Concentration Spreadsheet (exact ICAL level concentrations and ICV concentrations)
- Any manual integration documentation

### 11.2 Initial Calibration Verification Standard

Verify the initial calibration by analyzing an initial calibration verification standard (ICV). This standard shall be obtained or prepared from materials acquired from a different manufacturer or lot from that of the initial calibration and prepared according to Section 9.2.3.

Analyze 50ng or less (refer to Table 4 for the secondary source standard concentrations) of the ICV standard depending on the dynamic range of a given instrument and refer to Section 13.4 for the required calculations.

### 11.3 Sample Preparation

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The pressure/vacuum is checked and the canister pressurized upon receipt by the laboratory, as needed. When necessary, canisters shall be pressurized with humidified zero grade air. However, if the samples are to be analyzed in accordance with EPA Method 3C then the samples must be pressurized with UHP Helium (refer to Section 11.11 for additional information). The client must be made aware of this in advance and given the option of either submitting two canisters for analysis or receiving a report with qualified results (TO-15 Modified).

Depending on the size of the canister and location of sampling and as specified in the SOP below, samples may be pressurized to approximately 1.0psig to 3.5psig. Additional information may be found in the *SOP for Evaluation and Pressurization of Specially Prepared Stainless Steel Canisters*. Initial and final pressures are recorded in LIMS and should be repeated on the back of the sample tag. The dilution factor created by filling the sample canister is calculated using equation number 12 in Section 13.7.

#### 11.4 Screening

The analyst must screen a sample or subset of samples if the source is of unknown origin. Typically, if the source is known to be indoor or ambient outdoor air, no screening is necessary. However, if screening is required make sure that the instrument is calibrated. A single point calibration is sufficient; however, the instrument may be calibrated utilizing a two point calibration. The ICAL points are recommended to be at approximately 0.5ng, 150ng and/or 600ng spanning the desired dynamic range. Refer to Section 9.2.5 for additional information.

Inject a 1mL or smaller aliquot of each sample into a GC/flame ionization detector (FID) system that has been calibrated with a standard containing a subset of the target analytes. This subset represents the most commonly found compounds in air samples, such as acetone, trichloroethylene, and toluene. Use the results to determine the maximum volume of sample to be analyzed by TO-15 by utilizing the following equation. Dilutions may be prepared as necessary according to Section 11.11.1.

$$I = \frac{C}{H}$$

Where:

- I Injection volume (mL)
- C Maximum calibration level (ng on column)
- H Compound screening concentration (ng/mL)

Example: Select the compound with the highest concentration (toluene = 1.0ng/mL). If the upper calibration level is 100ng on column, then the following calculation determines the maximum injection volume to analyze.

$$\frac{100ng}{1.0ng / mL} = 100mL \text{ maximum injection volume}$$

#### 11.5 Analytical Sequence and Data System Setup

11.5.1 Data System For the Tekmar AUTOCAN, fill in the sequence log of the Teklink program with the appropriate information. Refer to the Section 11.6.1 for the operating parameters.

For HP Chemstation, load the appropriate acquisition method for the GC/MS in the top window of the Chemstation program. Suggested GC/MS operating parameters are given in Section 11.6.2.

11.5.2 Analytical Sequence The analytical sequence must be completed for the analysis of  $\leq 20$  field samples. Re-runs, dilutions, and sample duplicates are not counted as separate samples. A method blank (MB) shall be run to monitor for laboratory introduced contamination. There must be at a minimum a laboratory duplicate (LD) analyzed in each batch to assess batch precision. The following generalized analytical sequence is to be followed:

Analytical Sequence Guideline

With Calibration

- Tune Check<sup>1</sup>
- Calibration Standards (5 Standards Minimum)
- ICV Standard<sup>2</sup> (Acts as the ICV and LCS)
- QC Canister Checks<sup>6</sup>
- MB<sup>7</sup>
- Sample(s) - 1-20
- Laboratory Duplicate<sup>4</sup>

With Continuing

- Tune Check<sup>1</sup>
- CCV Standard<sup>5</sup>
- QC Canister Checks<sup>6</sup>
- MB<sup>7</sup>
- LCS<sup>3</sup>
- MRL Check Standard<sup>8</sup>
- Sample(s) - 1-20
- Laboratory Duplicate<sup>4</sup>

<sup>1</sup> The instrument performance check solution must be analyzed initially and once per 24 hour (or as specified by the project) time period (sequence / tune window) of operation. All analyses for a sequence must be initiated (injected) prior to the expiration of the tune window.

<sup>2</sup> In this scenario, the ICV may also be evaluated as the LCS (differing acceptance criteria).

<sup>3</sup> An LCS shall be analyzed at a rate of 1 in 20 or fewer samples. The LCS is the second source calibration check standard analyzed at the lower end of the calibration curve (below the midpoint).

<sup>4</sup> A laboratory duplicate must be analyzed at a rate of 1 per 20 or fewer samples. The duplicate must be rotated among clients, whenever possible. Also, a duplicate laboratory control sample may be analyzed to assess precision to meet project requirements or due to sample matrix effects.

<sup>5</sup> A CCV must be analyzed at the beginning of every analytical sequence.

<sup>6</sup> Any number of QC check canisters may be analyzed in the sequence to determine a canister cleaning batch or batches acceptability.

<sup>7</sup> Any of the QC Check Canisters may serve as the method blank as long as the minimum requirements detailed in this document are met. A method blank shall be analyzed at a rate of 1 in 20 or fewer samples.

<sup>8</sup> A MRL check standard may be analyzed with each batch of 20 or fewer samples (when an initial calibration is not analyzed within the same batch). Additional information is included in Section 11.17.

**Note:** Client project batch specifications may require certain modifications to the analytical sequence; however, a batch may not be more lenient than that which is specified in this document.

## 11.6 Conditions

11.6.1 Sample Collection Conditions The suggested settings and system parameters are as follows:

### Adsorbent Trap

*Set Point:* 35°  
*Sample Volume:* up to 1L  
*Dry Purge:* 300mL  
*Sampling Rate:* 100mL/min (utilize for a sample injection volume of >100mL); 40mL/min (utilize for a sample injection volume of 25-100mL)  
*Desorb Temp.:* 200°C to 230°C  
*Desorb Flow Rate:* 8-10mL/min He, measured at refocuser split vent  
*Desorb Time:* 3.0 minutes

### Refocusing Trap

*Temperature:* -180°C  
*Injection Temp.:* 160°C  
*Injection Time:* 1.0 min

### Adsorbent Trap Reconditioning Conditions

*Temperature:* 265°C  
*Initial Bakeout:* 3 hours or until clean blank is obtained  
*After each run:* 5-8 minutes

### Sample Run Time


Each analytical run is approximately 20 minutes long; the total cycle time is about 30 minutes between injections.

## 11.6.2 GC/MS System

Optimize GC conditions for compound separation and sensitivity.

<u>Item</u>	<u>Condition</u>
<i>Carrier Gas</i>	Helium
<i>Flow Rate</i>	1.0-1.6mL/minute
<i>Temperature Program</i>	Initial Temperature: ~20°C Initial Hold Temperature: 3 minutes Ramp Rate: 5°C/min to 80°C 2 <sup>nd</sup> Ramp: 10°C/min to 160°C 3 <sup>rd</sup> Ramp: 20°C/min to 240°C for 5 min hold



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<i>Detector B</i>	
(MSD Interface)	260°C
<i>Electron Energy</i>	70 Volts (nominal)
<i>Mass Range (Scan mode)</i>	34 to 280 amu
<i>Mass Range (SIM mode)</i>	Scan masses corresponding to the target analytes
<i>Scan Time</i>	To give at least 10 scans per peak, not to exceed 1 second per scan.

*Note: The instrument may be operated in Selective Ion Monitoring (SIM) mode if requested by the client.*

#### 11.7 Instrument Performance Check

Since the BFB tuning compound is included in the internal standard and surrogate standard canister and an autosampler is used, it is necessary to establish that a given GC/MS meets tuning and standard mass spectral abundance criteria prior to the reduction and approval of any data collection. The 24-hour time period for GC/MS instrument performance check and standards calibration (initial calibration or continuing calibration verification criteria) begins at the injection of the BFB, which shall be documented in laboratory records. Upon completion of the successful BFB tune, the tune report must be printed and retained on file for future reference.

The mass spectrum of BFB must be acquired in the following manner.

- Inject 50ng or less (on column)
- Three scans (peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged.
- Background subtraction is conducted using a single scan prior to the elution of BFB.
- All ion abundances must be normalized to m/z 95, the nominal base peak, even though the ion abundance of m/z 174 may be up to 120 percent that of m/z 95.
- The ion abundance criteria must not be changed from the requirement stated in this document (TO-15 or TO-14A, as requested).

All subsequent standards, samples and QC samples associated with a BFB analysis must use identical instrument conditions.


#### 11.8 Continuing Calibration Verification Standard

Verify the calibration each working day, where necessary (e.g., an ICAL was not analyzed or the tune window has closed) by analyzing a continuing calibration verification (CCV) standard from the initial calibration standard canister. The concentration of the calibration verification may be varied between the low calibration standard and the midpoint of the calibration range; however, the concentration must be at one of the levels analyzed in the initial calibration. Refer to Table 3 for the standard concentrations. Refer to Section 13.3 for the required calculations.

DoD QSM Requirement: A CCV standard must be analyzed daily before sample analysis; after every 24 hours of analysis time; and at the end of the analytical batch run.

#### 11.9 Canister Quality Control Check and Method Blank

The method blank must be a sample of a matrix similar to the batch of associated samples 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 procedure, and in which no target or interferences are present at concentrations that impact the analytical results for sample analyses. Prepare a canister that has not left the building by pressuring with humidified zero air. Analyze an aliquot of one liter along with the

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same volume of internal standard and surrogate as standards and samples. Additionally, a blank must be analyzed whenever a high concentration sample is encountered and carryover is suspected. For all method blanks the unique laboratory barcode for the canister must be included in the sample analysis identification.

A Quality Control (QC) check canister pressurized with humidified zero air may serve as a method blank as long as the analyte concentration requirements stated in the canister quality control check section (Sections 12.7 and 12.8) and other requirements (refer to Section 12.12 for internal standard requirements) are met. Assuming continuing failure, another QC canister or a new canister must be prepared and analyzed in order to verify that no system contamination exists. For tracking purposes the unique laboratory barcode given to a canister shall be the information included in the sample analysis identification.

11.9.1 Sampling Systems Section 7.1 and 8.4 of Method TO-15 describe the setup and certification procedure for a specific sampling apparatus that has been used by the EPA for several of its large air monitoring programs. These systems are rarely used for the types of projects that make up the bulk of the laboratory's work. The vast majority of samples analyzed by the laboratory are taken into canisters either as grab samples or using a simple time integrated sampling device (flow controller), as in Section 8.2.1 of the method, so these procedures are not part of the typical protocol for providing sampling materials to clients. The laboratory has developed an SOP for the cleaning and certification of the materials it provides its clients for obtaining air samples to be analyzed by method TO-15. Refer to the *SOP for Cleaning and Certification of Summa Canisters and Other Specially Prepared Containers* for additional information.

It is this laboratory's interpretation that the sampler system certification procedure described in Section 8.4.4 of the TO-15 method applies to the specific sampling apparatus described in the method and not to the sampling procedures used by our clients. The laboratory does not maintain a dynamic calibration manifold or canister sampler apparatus as described in the method and thus performance of the relative accuracy certification procedure described in section 8.4.4 is not possible.


#### 11.10 Laboratory Control Sample

The laboratory control sample is a sample matrix, which is free from the analytes of interest and spiked with a standard containing known amounts of analytes. The laboratory control sample is an injection of the initial calibration verification standard. Inject the LCS (ICV) at concentrations below the midpoint of the calibration curve. Make sure that all of the pertinent information is included on the quantitation report including the sample identification (LCS), concentration, standard used, and analyst.

#### 11.11 Sample Analysis

Prior to analysis, all sample containers (canisters and bags) should be at temperature equilibrium with the laboratory.

- Attach sample canisters to Tekmar AUTOCAN using a 9/16" wrench. Bottle Vacs use a proprietary quick connect fitting (Micro-QT, Entech Instruments). Tedlar bags can be connected using soft silicone tubing or a 3/16" fitting with a reusable ferrule.
- Before opening the valve, check for leaking fittings by running the leak check program in the Teklink software. Quick connect fittings must be leak checked before connecting the sample container.

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- If system is leak tight, open the canister valves and start the automated preconcentration procedure. Make sure the Chemstation data acquisition software has been readied.
- Maintain the trap at an elevated temperature until the beginning of the next analysis.

Check all target compounds using the QEdit routine in Enviroquant, making sure all extracted ion chromatogram peaks are integrated properly (see Section 11.15).

*Note 1: The secondary ion quantitation is only allowed if there is sample matrix interference with the primary ion. If the secondary ion quantitation is performed, document the reasons in the instrument run logbook and/or on the quantitation report (initial and date any notation).*

*Note 2: Each female Micro-QT fitting must be purged after use to remove any remaining sample residue and prevent contamination from subsequent usage. Connect a male Micro-QT fitting to a source of ultrapure or carbon-filtered gas. Adjust the pressure to about 10 psig using an inline regulator. Connect the female fitting for several seconds, then remove and place in an oven kept at 60°C until the next use. Do not heat the fitting higher than 80°C.*

**SCAN Mode** - The instrument is normally operated in the SCAN mode, where the following procedure may be followed.

- Upon sample injection onto the column, the GC/MS system is operated so that the MS scans the atomic range from 34 to 270 amu. At least ten scans per eluting chromatographic peak should be acquired. Scanning allows identification of unknown compounds in the sample through searching of library spectra. See operating conditions in Section 11.6.
- Generate a quantitation report for each run.
- If reporting Tentatively Identified Compounds (TICs), refer to Section 11.11.2 for identification criteria.

**SIM Mode** - When the client requests SIM mode, select SIM instead of SCAN mode and identify a minimum of two ions per analyte of interest. Also, a minimum of two ions for each internal standard and surrogate compound should be selected.

**Helium Pressurization** - If a canister is pressurized with helium, a correction factor is applied to sample volumes extracted from the canister via auto sampler. This is due to the difference in thermal properties between helium and air. A correction factor worksheet has been generated to determine the exact volume taken from a canister and may be found at J:\A-GCMS\Helium Pressurization. Save file, print the sheet and include with the data. Refer to the instruction page in the template for all of the instructions and calculations including backfilled canisters.

**AutoCAN Leak Checks** - Canisters should be put on at least two different AutoCAN positions to confirm a “leak”. In addition, the valve threads should be inspected for defects which may prevent a good seal with the AutoCAN. Once a canister has “failed” the leak check it must be tagged, an NCAR initiated, and the PM notified. Regardless of what the client or PM specifies as the fate of the sample, the canister must be put on maintenance hold to complete a full 24-hour leak check. The leaking canister must be documented on the Sample Review Checklist (or yellow sheet). This is a fixed QA procedure with no allowance for deviation.

11.11.1 Sample Dilution If any target analyte results are above the highest level of the initial calibration, a smaller sample aliquot should be analyzed. The dynamic range of volume aliquots for the automatic cryogenic concentrator is 15ml to 1L. If a volume smaller than 15ml is to be analyzed, a dilution should be made in a Tedlar bag, or the sample directly injected using a gastight syringe. Guidance in performing dilutions and exceptions to this requirement are given below.

- Refer to Section 11.6.1 (Adsorbent Trap Sampling Rate) for the required sampling rate if less than 100mL is to be analyzed.
- Use results of the original analysis to determine the approximate dilution factor required and get the largest analyte peak within the initial calibration range.
- The dilution factor must be documented (and included in the final report) and chosen in such a way as to keep the response of the analyte peak for a reported target compound in the upper half of the initial calibration range of the instrument.

Tedlar bag dilution:

- Make a dilution by filling a Tedlar bag with 1.0 liter of humidified zero air using a one-liter gas syringe.
- Calculate the volume of balance gas needed to obtain the required dilution.
- Remove the difference in the balance gas using a syringe.
- Add the calculated sample amount using a gastight syringe.

Direct injection:

- Make a direct injection by attaching a clean, humidified zero air filled canister to the preconcentrator autosampler using 1/4" stainless steel or teflon tubing with a "tee" septum port. This canister should be the same canister that may be used as the method blank.
- Inject the sample through the septum while the preconcentrator withdraws a 200cc aliquot from the canister.

11.11.2 Tentatively Identified Compounds When requested, a mass spectral library search may be made for the purpose of tentatively identifying sample components not associated with the calibration standards. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data system mass spectral library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Certain programs may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification. The following guidelines are used for making tentative identifications.

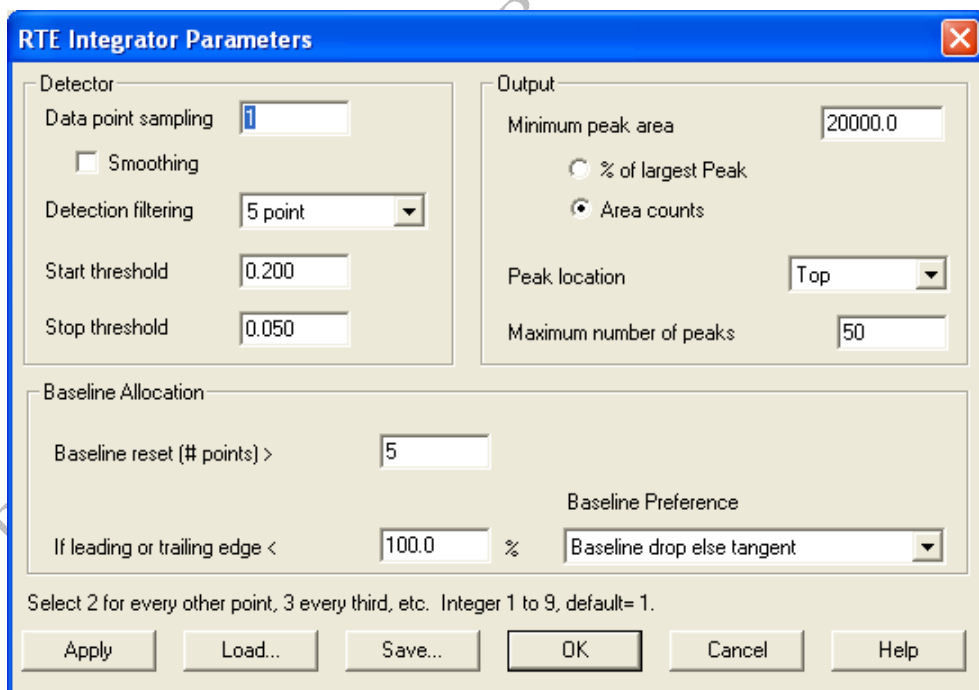
- Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.
- The relative intensities of the major ions should agree within  $\pm 20\%$ . For example, for an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance should be between 30 and 70%.
- Molecular ions present in the reference spectrum should be present in the sample spectrum.



- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.
- Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting peaks. Data system library reduction programs can sometimes create these discrepancies.
- The concentration of the tentatively identified compound is estimated by assuming a response factor of 1.0 and comparing the response of the tentatively identified compound to the response of the nearest internal standard.
- If non-target analytes are not Q-deleted from the quant report, the analyst must evaluate whether these compounds should be reported as TICs.

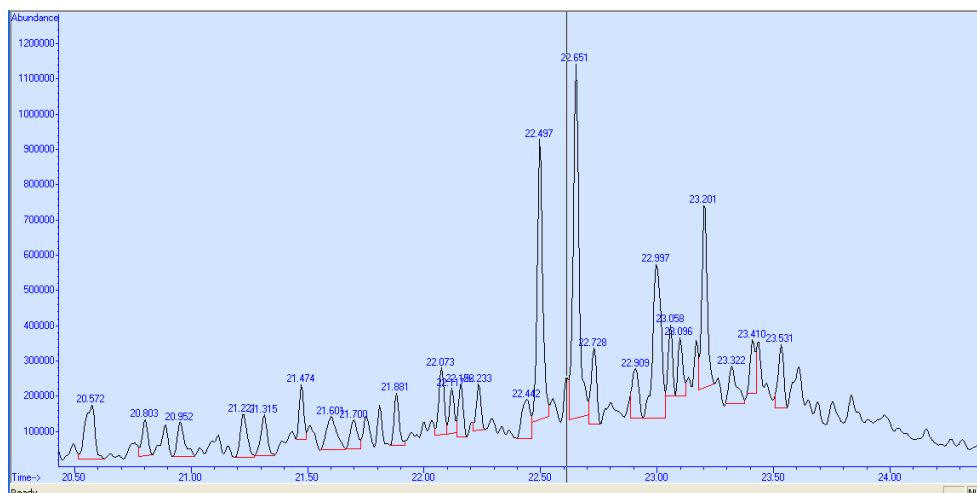
Procedure for Reporting Tentatively Identified Compounds (TICs) for samples and associated Method Blanks

1. Load the datafile in the main Enviroquant window.
2. Load the TIC integration parameters (LSCINT.p). Typical setpoints are as shown below.

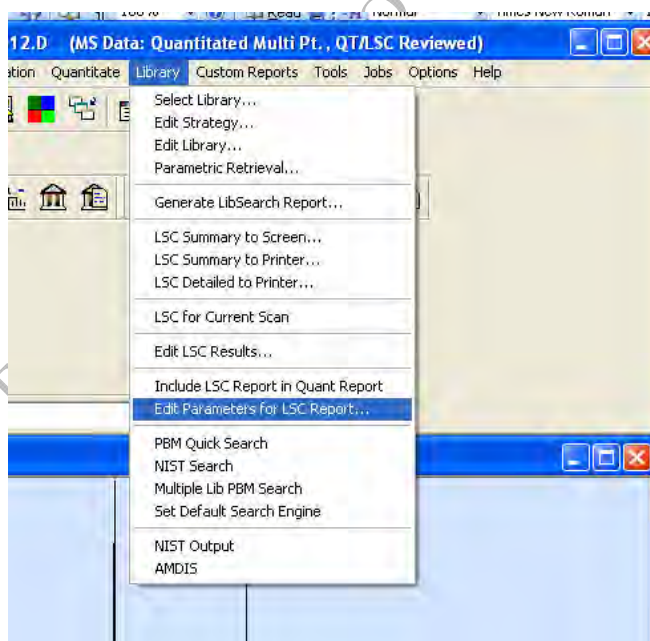


3. Integrate the chromatogram and inspect the peak integrations. Adjust the parameters as needed to achieve integration that will:
  - Resolve closely-eluting peaks that only have a small valley separating them.
  - Not include excess area below the peak in a complex matrix with an elevated baseline.
  - Include peak tailing when necessary.

- Yield a sufficient number of peaks that will ensure that the internal standards are included.



4. Edit the parameters to be used in generation the library search report:



Select the most current mass spectral library database available, the correct integration parameters file, the area threshold (as a percent of IS area), number of peaks to report, and a time range of the chromatogram to search (set to start after the CO2 peak).



Library Search Compounds (LSC)

Mass Spectral Data Base: NIST11.L

RTEINT Parameter File: LSCINT.P

Peak Percent of Closest ISTD: 15

Maximum # of LSCs to Report: 15

External Standard Response Factor: 1

Exclude Identified Alkanes

Use Peak Purity


Use Library Search Time Range

Library Search From: 3.8 to 11.5 Minutes

Select Library Select RTEINT Report OK Cancel Help

Enter the name of the mass spectral library

5. Run the LSC routine from the Library menu. You may choose 'LSC Summary to Screen' (Calculate/Generate Report) to get a quick view of the results and then proceed if they seem acceptable. Set the default printer to 'Adobe PDF' and then choose 'LSC Detailed to Printer'.
6. Open the pdf file and inspect the LSC summary (last page). Check the internal standard areas and confirm that they are correct. If any IS area is biased high due to a coeluting peak use the 'Edit LSC Results' routine to switch all associated TICs to use a different IS. If all three IS peaks have coelutions substitute the areas from the daily method blank in the calculations.
7. Use the LSC Summary as a guide and inspect the chromatogram in the data analysis window. Integrate the chromatogram from the Integrate menu and look for peaks that may have been missed by the LSC routine. Possible reasons for missed peaks are excessive tailing (organic acids), RT close to a target compound, coeluting peaks with no valley between them. These will need to be added manually.
8. Use the DOSCAN routine from the Tools menu to search individual missed peaks one by one. This will add them to the LSC list.
9. Go back into the Edit LSC Results routine and make any necessary changes to compound names and/or the internal standard used for quantitation.
10. Run the macro "QT '0,0,C'" by clicking the Custom Tool 1 button. This will update the LSC list to the quant.csv file.
11. Run the LSC Detailed to Printer routine from the Library menu (Generate Report *only*). This will print the file to pdf.
12. Excel Reporting
  1. In Excel, open the TIC reporting template (I:\A-GCMS\TICS\System\StarLIMS\_TICQ).
  2. Enter the service request number and click ok.
  3. Click the Get Samples button. Select the samples to be reported. Delete any samples that are not to be reported (right click/delete row).

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4. Click the Update PEF button.
5. Click the Get TICs from CSV button. Enter the date analyzed and select the instrument ID.
6. Click the Apply to all Samples button. Change the date for any sample that was analyzed on a different date.
7. Click the Apply Instrument to all Samples button.
8. Enter file number in column E (i.e. enter 07 for file 12301507.d).
9. Click the Copy Data button. This copies the TIC info to the report sheets.

#### 11.12 Duplicate

A duplicate must be analyzed to assess laboratory precision and samples selected for duplicate analysis shall be rotated among client samples, where applicable. Some projects or sample matrix issues may require the analysis of a duplicate laboratory control sample (DLCS).

#### 11.13 Internal Standard (IS)

The concentration of internal standard added to each standard, field sample and QC sample must be consistent from that of each current ICAL standard.

#### 11.14 Surrogates

Internal standards/surrogates must be added at the same volume for every standard, sample and QC sample. Surrogate compound recoveries are requested by a number of clients, but are more appropriately used as system monitoring compounds. This is due to the fact that the compounds are introduced directly into the analytical system and not into the canisters or bags. It is for this reason that they are not considered to be true surrogates and a fixed window is applied. Additionally, surrogates are not included in the ICAL because they are not required by the method and are only system monitoring compounds.


#### 11.15 Manual Integration and Q Deletion

A list of abbreviations (codes) that may be used to give a reason for performing either of these procedures are listed in the *SOP for Data Review and Reporting*.

11.15.1 Manual Integration The integration for each peak must be legally defensible and shall be checked to ensure that it has been integrated properly and consistently between samples, standards and QC samples. All peak reviews and manual integrations must follow the requirements specified in the *SOP for Manual Integration* and the *SOP for Laboratory Ethics and Data Integrity*. The requirements in the above stated procedure include when manual integrations are performed, raw data records shall include a complete audit trail for those manipulations (i.e., chromatograms showing both the integration prior to any manual integrations and those depicting the corresponding manually integrated peaks), and notation of rationale, date, and initials of person performing the manual integration operation. In addition, manual integrations must be reviewed and approved by a second reviewer and the manual integrations maintained in the appropriate job file.

Reporting Requirements Certain project requirements including samples which are submitted under the Department of Defense (DoD) QSM require that the case narrative include an identification of samples and analytes for which manual integration is required. Refer to project requirements to determine if this is necessary.



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11.15.2 Q Deletion Q deleting may be performed to either delete a false positive or delete non-target compounds.

#### 11.16 Detection Limits and Limits of Detection

The MDL shall be performed in accordance with the procedure outlined in the *SOP for Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation*. The detection limit shall be used to determine the LOD for each analyte.

##### 11.16.1 Performance and Acceptance Criteria

1. The MDL must be <0.5ppbV for each analyte (Method 11.11.1).
2. Following the MDL study perform a Limit of Detection (LOD) verification on all instruments (performing this method). Spike the LOD at 2-4x the MDL; the spike level establishes the LOD.
3. LOD Acceptance
  - Analyte must be detected reliably and identified by the method-specific criteria (i.e, ion confirmation) and produce a signal that is at least 3 times the instrument's noise level (3:1 signal to noise ratio).
  - It is specific to each combination of analyte, matrix, method and instrument configuration.
  - The LOD must be verified quarterly on each instrument (spiked at LOD) using the criteria listed above.
4. If the LOD verification fails (per #3), repeat the detection limit determination and LOD verification at a higher concentration or perform and pass two consecutive LOD verifications at a higher concentration and set the LOD at the higher concentration.
5. The laboratory shall maintain documentation for all detection limit determinations and and LOD verifications (regardless of pass or fail).

#### 11.17 Method Reporting Limit Check Standard


It is recommended to analyze a MRL check standard at the current MRL or required MRL for the batch (per client requirements) of twenty or fewer samples if the CCV fails low for any target compound. A MRL check standard may also be required per client specifications.

This check standard can also serve as the LOQ verification if it meets the specific requirements listed in Section 11.1.4.2. Apply the requirements and retain all documentation accordingly. Refer to Attachment 4 for Minnesota specified MRL check standard criteria.

#### 11.18 Method Modifications

Method modifications are not allowed under TNI standards; therefore, a statement, however worded, must be included in the final report indicating that data reported does not fall under the laboratory's NELAP certificate of approval. In addition, the following items are considered to be method modifications and must be reported accordingly.

- Sample collection in gas collection bags
- The pressurization of canisters with nitrogen or helium (if EPA Method 3C is requested) refer to Section 11.11.

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## 12) Quality Control Requirements and Corrective Action

12.1 To the extent possible, samples shall be reported only if all of the quality control measures are acceptable. If a quality control measure is found to be out of control, and the data must be reported, all samples associated with the out of control quality control measure shall be reported with the appropriate data qualifier(s).

12.2 Corrective actions shall follow the procedures outlined in the *SOP for Nonconformance and Corrective Action*, where appropriate. Any maintenance which may alter instrument sensitivity or linearity must result in the re-analysis of the entire sequence including the tune compound, ICAL or CCV or any batch QC.

### 12.3 Instrument Performance Check

#### 12.3.1 Acceptance Criteria

Refer to Tables 1 and 1A for the required ion abundance criteria.

12.3.2 Corrective Action Perform auto tune or manual tune and then re-analyze BFB. If the BFB acceptance criteria are still not met, the MS must be retuned according to the procedure outlined in the instrument user's manual. Perform necessary maintenance and make notations in the instrument maintenance logbook. It may be necessary to clean the ion source, or quadrupole, or take other necessary actions to achieve the acceptance criteria. An acceptable tune is required for sample results to be calculated and reported.

### 12.4 Initial Calibration

12.4.1 Acceptance Criteria Refer to the following acceptance criteria for the initial calibration.


- The RRT for each target compound at each calibration level must be within 0.06RRT units of the mean RRT for the compound.
- The calculated %RSD for the RRF for each compound in the calibration standard must be less than 30% with at most two exceptions up to a limit of 40% (this may not be true for all projects).

DoD QSM/Navy Requirement: The two exceptions of %RSD up to 40%, allowed by the method, are not allowed.

- For each Internal Standard the area response (Y) at each calibration level must be within 40% of the mean area response  $\bar{Y}$  over the initial calibration range.
- The retention time shift for each of the internal standards at each calibration level must be within 20s of the mean retention time over the initial calibration range for each internal standard.

Navy Requirement: The absolute retention time for each of the internal standard and calibrated analytes must be within  $\pm 0.20$  minutes (12 seconds) of the mean retention time for the corresponding internal standard or analyte over the initial calibration range.

- All of the following information must be retained to permit reconstruction of the initial instrument calibration: calibration date, test method, instrument, analysis date, analyte identification, analyst's initials, concentration and responses, and response factors.
- All initial instrument calibrations must be verified with an acceptable ICV.

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12.4.2 Corrective Action Follow the initial calibration requirements detailed in Section 11.1 for information on re-analyzing or dropping points and the restriction of maintenance performed during the analysis of the initial calibration standards.

If the initial calibration results are outside the established acceptance criteria, corrective actions must be performed and all associated samples reanalyzed, if reanalysis of the samples is not possible, data associated with an unacceptable initial calibration shall be reported as estimated with the appropriate data qualifiers.

12.5 Initial Calibration Verification Standard (ICV)

12.5.1 Acceptance Criteria The percent recovery for each compound in the ICV must be between 70%-130% for all analytes except vinyl acetate, which must be within 50-150%. Exceptions to this allowance for the vinyl acetate recovery are project specific requirements and any DoD type project, which shall adhere to the 70-130% requirement for all target compounds.

12.5.2 Corrective Action If the initial calibration verification technical acceptance criteria are not met, reanalyze and if it fails again, prepare a new canister and analyze. If the criteria are still not met inspect the system for possible sources and perform any necessary maintenance and make a notation in the maintenance logbook of any steps taken. It may be necessary to clean the ion source or change the column. Perform a new initial calibration if any performed maintenance has altered instrument linearity and/or sensitivity. Perform another initial calibration or if reanalysis is not possible, data associated with an unacceptable ICAL/ICV shall be reported as estimated with the appropriate data qualifiers.

12.6 Continuing Calibration Verification (CCV)

12.6.1 Acceptance Criteria All compounds must be evaluated prior to rounding. The percent difference for each target analyte must be within plus or minus 30% of the initial calibration average RRFs.

12.6.2 Corrective Action If the continuing calibration verification technical acceptance criteria are not met, reanalyze and if it fails again, prepare a new canister and analyze. If the criteria are still not met inspect the system for possible sources of the problem and perform any necessary maintenance and make a notation in the maintenance logbook of any steps taken. It may be necessary to clean the ion source or change the column.

If any corrective action and/or reanalysis fails to produce continuing calibration verification within acceptance criteria (analyzed immediately following the initial failure), then either two consecutive successful verifications must be performed following corrective action or a new initial calibration must be performed; however, refer to 16.6.2.1 below.

DOD Requirement: If a CCV fails, the laboratory must immediately analyze two additional consecutive CCVs (The two consecutive CCVs must be analyzed within one hour).

- Both of these CCVs must meet acceptance criteria in order for samples to be reported without reanalysis.
- If either of these two CCVs fail or if the laboratory cannot immediately analyze two CCVs, the associated samples cannot be reported and must be reanalyzed.

- Corrective action(s) and recalibration must occur if the above scenario fails.
- Flagging data for a failed CCV is only appropriate when the affected samples cannot be reanalyzed. The laboratory must notify the client prior to reporting data associated with a failed CCV.

12.6.2.1 Method Reporting Limit Check Standard

If a per batch MRL check standard is analyzed due to a failing CCV or client requirement and is unacceptable for any compound (sensitivity; ratio or %D), reanalyze at the same or higher level within the same batch and report data with the CCV flag and case narrative notes accordingly. Reporting data with these conditions must be acceptable per project and client requirements otherwise corrective action must be initiated and samples reanalyzed.

Refer to Section 11.1.4.2 for annual (NELAP and Navy) and quarterly (DoD) LOQ verification requirements.

12.7 Canister Quality Control Check

The actual cleaning procedure, number of cans to select for analysis (to release a cleaning batch) and corrective actions are covered in the *SOP for Cleaning and Certification of Summa Canisters and Other Specially Prepared Canisters* and are not covered in this section. However, the procedure for analyzing and certifying a cleaning batch is included. If a canister passes as a QC canister it meets all of the requirements for a method blank (Method, TNI Standards, and Department of Defense Quality Systems Manual - DoD QSM, etc.).


12.7.1 Scan Analyses A canister is considered “clean” for normal SCAN analyses if the analysis shows <0.2ppbv of any target analyte (analyte exceptions listed in table below). If a canister passes as a QC canister it meets all of the requirements for a method blank (Method, TNI Standards, and Department of Defense Quality Systems Manual - DoD QSM, etc.).

Low Level SCAN Analyses For those analytes with a MRL of 0.1ug/m3, the QC criteria of <MRL is acceptable; otherwise, <0.2ppbv is required (analyte exceptions listed in table below).

SIM Analyses Results <MRL will be acceptable as this complies with the <0.2ppbv method requirement.

DoD QSM Requirement Each canister must be individually certified. A canister is considered clean if no reported analytes are detected at >1/2 the LOQ.

ANALYTE EXCEPTION LIST					
Compounds	ppbV	On Column (ng)	Compounds	ppbV	On Column (ng)
Target Analytes	0.2	0.50	Acrylonitrile	0.2	0.43
Chloromethane	0.2	0.41	Acetone	1.5	3.5
1,3-Butadiene	0.2	0.44	Ethanol	1.9	3.5
Acetonitrile	0.2	0.33	Vinyl acetate	0.99	3.5
Acrolein	0.31	0.70	1-Butanol	0.23	0.70
Isopropanol	0.57	1.4	Carbon Disulfide	0.22	0.70
2-Butanone	0.24	0.70			

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Document the status of the check in LIMS and return the canister to the canister conditioning room. Additionally, if the check was found to be acceptable, the quantitation report must be kept on file for future reference.

12.7.2 Tentatively Identified Compounds (TIC) If the batch of canisters are to be used for tentatively identified compounds (TIC) analysis, any non-target peaks present in the QC check canister analysis must be evaluated and determined to be less than the TIC reporting limit (10% of the internal standard). The concentration is estimated by assuming a RRF of 1.0 and comparing the response of the TIC to the response of the nearest internal standard.


## 12.8 Method Blank

### 12.8.1 Acceptance Criteria

- The concentration of a targeted analyte in the blank cannot be at or above the MRL, AND be greater than 1/10 of the amount measured in any associated sample. For any project that requires reported results less than the MRL, all associated measurements found in the MB should result in a qualifier; however, project requirements may differ and must be followed. Refer to DoD requirements listed below.
- The method blank should not contain additional compounds with elution characteristics and mass spectral features that would interfere with identification and measurement of a method analyte.
- For DoD samples, the method blank will be considered to be contaminated if:
  1. The concentration of any target analyte in the blank exceeds 1/2 the reporting limit or is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater);
  2. The concentration of any common laboratory contaminant (acetone, ethanol, carbon disulfide, and methylene chloride) in the blank exceeds the reporting limit and is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater); or
  3. The blank result otherwise affects the samples results as per the test method requirements or the project-specific objectives.

The laboratory shall evaluate whether reprocessing of the samples is necessary based on the above criteria.

12.8.2 Corrective Action If the analyte concentration results in the blank do not meet the acceptance criteria repeat analysis with remaining QC canisters until results are acceptable or prepare a canister per Section 11.9. If the analyte results in the blank still do not meet the acceptance criteria the source of the problem must be investigated and measures taken to eliminate the source. Each method blank must be critically evaluated as to the nature of the interference and the effect on the analysis of each sample within the batch. Determine whether the contamination is from the instrument or due to contamination in the blank container (if results from the new can are not acceptable then the system is probably contaminated). In all cases, the corrective action (reprocessing or data qualifying codes) must be documented. However, the specific corrective action depends on the type of project the blank is utilized for; therefore, refer (below) to the reporting/reprocessing requirements.

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**DEPARTMENT OF DEFENSE (DoD) QSM PROJECT:** Any sample associated with a blank that fails the criteria shall be reprocessed in the same or subsequent analytical batch, except when the sample analysis resulted in a non-detect. If reanalysis is not performed, the results shall be reported with appropriate data qualifier.

**OTHER PROJECT TYPE:** Appropriate corrective measures must be taken and documented before sample analysis proceeds. However, if this is not a possibility and the results must be reported follow the reporting requirements stated in Section 16.4.

## 12.9 Laboratory Control Sample (LCS)

12.9.1 Acceptance Criteria Round all results to the nearest whole number prior to determining if the acceptance criteria have been met. The percent recoveries must be within the laboratory-generated limits and are referenced in the electronic TO-15 Method Manual. However, Arizona requires the percent recovery for each compound in the LCS to be 70%-130% (to match the ICV requirement). Therefore, the ICV exception for vinyl acetate stated in Section 12.5 requires the percent recovery for AZ samples to be 50-150%.

**Note:** Client project requirements and DoD requirements shall take precedence over the AZ requirement for AZ samples. Meaning if a sample is collected for a DoD project in AZ, DoD requirements specified in this document and the project specific QAPP (if supplied) are to be followed.

**DoD Requirement:** In the absence of client specified LCS reporting criteria, the LCS control limits outlined in the DoD QSM Appendix C tables shall be used when reporting data for DoD projects.

12.9.2 Corrective Action If the LCS criteria are not met, determine whether the cause is instrumentation or the result of a poor injection. If the problem is instrumentation, perform maintenance and if the problem is with the injection re-analyze the LCS. DoD considers the same analyte exceeding the LCS control limits two out of three consecutive LCS to be indicative of non-random behavior; therefore, this trend should be monitored and the appropriate corrective action taken when it occurs.


## 12.10 Sample Results

### 12.10.1 Acceptance Criteria

- Sample results must be quantitated from the initial instrument calibration and may not be quantitated from any continuing instrument calibration verification.
- The field sample must be analyzed on a GC/MS system meeting the BFB tuning, initial calibration, initial calibration verification technical acceptance criteria described in this document.
- All target analyte peaks must be within the initial calibration range, diluted or reported with the appropriate data qualifier.

### 12.10.2 Corrective Action

- If the retention time for any internal standard within the sample changes by more than 20 sec from the latest daily calibration or initial calibration mid-point standard, the GC/MS system must be inspected for malfunctions, and maintenance performed as required. Repeat sample analysis as needed.

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Navy Requirement: The absolute retention time for each of the internal standard and calibration analytes must be within  $\pm 0.20$  minutes (12 seconds) of the mean retention time for the corresponding internal standard or analyte over the initial calibration range.

- If the area for any internal standard changes by more than  $\pm 40$  percent between the sample and the most recent calibration, check for possible matrix interferences and re-analyze at a greater dilution. If the requirement is still not met and matrix interference is not detected the GC/MS system must be inspected for malfunction and maintenance made where necessary.
- When corrective actions are made, samples analyzed while the instrument was not functioning properly must be re-analyzed or the appropriate data qualifiers must be attached to the results.

To the extent possible, samples shall be reported only if all of the quality control measures are acceptable. If a quality control measure is found to be out of control, and the data must be reported, all samples associated with the out of control quality control measure shall be reported with the appropriate data qualifier(s).

#### 12.11 Laboratory Duplicate

12.11.1 Acceptance Criteria The relative percent difference must fall within  $\pm 25\%$ . This RPD criterion also applies to duplicate laboratory control samples (DLCS).

12.11.2 Corrective Action If the duplicate results do not meet the technical acceptance criteria, perform another duplicate analysis. If the results are still unacceptable and the associated samples are not reanalyzed then all of the sample results in the associated batch must be flagged accordingly.

#### 12.12 Internal Standards


12.12.1 Acceptance Criteria The following acceptance criteria must be applied to each run (except the ICAL - see Section 12.4).

- The area response for each internal standard in the blank must be within  $\pm 40$  percent of the area response for each internal standard in the most recent valid calibration. (CCV or mid-point from the initial calibration, whichever is most current).
- The retention time for each internal standard must be within  $\pm 0.33$  minutes of the retention time for each internal standard in the most recent valid calibration. (CCV or mid-point from the initial calibration, whichever is most current).

Navy Requirement: The absolute retention time for each of the internal standard and calibration analytes must be within  $\pm 0.20$  minutes (12 seconds) of the mean retention time for the corresponding internal standard or analyte over the initial calibration range.

#### 12.12.2 Corrective Action

- Internal Standard Responses If the problem is with the instrument, perform maintenance. If the problem is with a sample, check for interferences. If the response is high, it is likely that interference is present. In this case, lower the volume or aliquot of the sample and re-analyze. If the problem persists, report the results with the best quality and qualify the results. If the problem is corrected with the lower volume analysis, report those results.

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- Internal Standard Retention Times If the retention time for any internal standard within the sample changes by more than 20 sec from the latest daily calibration or initial calibration mid-point standard, the GC/MS system must be inspected for malfunctions, and maintenance performed as required. Repeat sample analysis where required.

### 12.13 Surrogates

12.13.1 Acceptance Criteria Since the matrix precludes the use of true surrogates and there is no established method criterion, acceptable surrogate recoveries are based on a fixed window of 70 - 130%. This is the typical requirement from clients. Additionally, these limits are referenced in SW-846 for use as guidance in evaluating recoveries. These limits are sufficient for evaluating the effect indicated for the individual sample results.

12.13.2 Corrective Action Poor surrogate recovery should be followed by re-analyzing a smaller aliquot to mitigate any matrix interferences. Evaluate the out of control surrogate for the effect on individual sample results.

### 12.14 Method Reporting Limit Check Standard

12.14.1 Acceptance Criteria Per client requirements or if the CCV is biased low for any compound, then evaluate the MRL check standard. Analyte must be detected reliably and identified by the method-specific criteria (i.e, ion confirmation) and produce a signal that is at least 3 times the instrument's noise level (3:1 signal to noise ratio). A percent difference +/-50% is recommended but program and client specific requirements must be followed if applicable.

### 12.15 Sample Holding Time Expired

The customer is to be notified that the sample's holding time was missed and the customer is to decide if the sample analysis is to continue. The documentation of missed holding time and the client's decision to proceed must be included in the corresponding job file. A statement dictating all holding time occurrences must accompany the sample results in the final report.

## 13) **Data Reduction and Reporting**

13.1 This method has specific requirements including the use of canisters; any modification must be reported accordingly. All reports that fall under the laboratory's certificate of approval (in accordance with TNI standards) must include a statement(s) clarifying any deviations from the scope of this certification. Refer to Section 13.10 for additional information and specific items, which require this clarification.

### 13.2 Initial Calibration


Tabulate each of the following:

#### 13.2.1 Equation Number 1 - Relative Response Factor (RRF):

$$RRF = \frac{A_x C_{is}}{A_{is} C_x} \quad \text{where:}$$

$A_x$  is the area response of the analyte quantitation ion.



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$A_{is}$  is the area response of the corresponding internal standard quantitation ion.

$C_{is}$  Internal standard concentration, ng.

$C_x$  Analyte concentration, ng.

*Note: The equation above is valid under the condition that the volume of internal standard spiking mixture added in all field and QC samples is the same from run to run.*

### 13.2.2 Equation Number 2 - Average (or Mean) RRF:

$$\overline{RRF} = \frac{\sum_{i=1}^N RRF_i}{N} \quad \text{where:}$$

$RRF_i$  are the individual RRFs from each concentration level in the initial calibration curve.

N is the number of calibration concentration levels.

### 13.2.3 Equation Number 3 - Standard Deviation, SD:

$$SD = \sqrt{\frac{\sum_{i=1}^N (RRF_i - \overline{RRF})^2}{N - 1}} \quad \text{where:}$$

$RRF_i$  are the individual RRFs from each concentration level in the initial calibration curve.

$\overline{RRF}$  Average (or Mean) RRF of all concentration levels in the initial calibration curve.

N total number of calibration concentration levels

### 13.2.4 Equation Number 4 - Percent Relative Standard Deviation, %RSD:

$$\%RSD = \frac{SD}{\overline{RRF}}(100) \quad \text{where:}$$

SD Standard Deviation calculated in equation number 3

$\overline{RRF}$  Average or Mean RRF

### 13.2.5 Equation Number 5 - Relative Retention Time (RRT):

$$RRT = \frac{RT_c}{RT_{is}} \quad \text{where:}$$

$RT_c$  Retention time of the target compound, seconds.

$RT_{is}$  Retention time of the internal standard, seconds.

### 13.2.6 Equation Number 6 - Mean Relative Retention Time ( $\overline{RRT}$ ):

$$\overline{RRT} = \sum_{i=1}^n \frac{RRT_i}{n} \quad \text{where:}$$

$\overline{RRT}$  Mean relative retention time (seconds) for the target compound for all initial calibration levels.

$RRT_i$  Relative retention time for the target compound in level i.

$n$  Number of calibration levels

### 13.2.7 Equation Number 7 - Mean Area Response ( $\overline{Y}$ ):

$$\overline{Y} = \sum_{i=1}^n \frac{Y_i}{n} \quad \text{where:}$$

$Y_i$  Area response for the primary quantitation ion for the internal standard for each initial calibration standard.

$n$  number of calibration concentration levels

### 13.2.8 Equation Number 8 - Mean Retention Times ( $\overline{RT}$ ):

$$\overline{RT} = \sum_{i=1}^n \frac{RT_i}{n} \quad \text{where:}$$

$\overline{RT}$  Mean retention time, seconds

$RT_i$  Retention time for the internal standard for each initial calibration standard, seconds.

$n$  number of initial calibration levels

## 13.3 Continuing Calibration Verification

- Calculate the (RRF) of each target compound using equation number 1.

### 13.3.1 Equation Number 9 - Percent Difference, %D:


$$\%D = \frac{RRF_x - \overline{RRF}}{\overline{RRF}} (100) \quad \text{where, for any given analyte:}$$

$RRF_x$  is the RRF from the CCV being evaluated.

$\overline{RRF}$  is the mean RRF from the current calibration curve.

## 13.4 Percent Recovery - ICV, LCS, Surrogates, MRL Check Standard

### 13.4.1 Equation Number 10 - Percent Recovery (%R):

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$$\%R = X/TV \times 100$$

where

X = Concentration of the analyte recovered

TV = True value of amount spiked

### 13.5 Duplicate Analysis

#### 13.5.1 Equation Number 11 - Relative Percent Difference (RPD):

$$\frac{x_1 - x_2}{\bar{x}} (100) \quad \text{where:}$$

$x_1$  First measurement value  
 $x_2$  Second measurement value  
 $\bar{x}$  Average of the two values

### 13.6 Internal Standards (IS)

- Calculate the mean area response  $\bar{Y}$  for each internal standard using equation number 7.
- Calculate the mean of the retention times for each internal standard using equation number 8.

### 13.7 Pressure Dilution Factor (PDF)

#### 13.7.1 Equation Number 12 - PDF, for samples collected in canisters:

$$PDF = \frac{P_{am} + P_f}{P_{am} + P_i} \quad \text{where:}$$

$P_{am}$  is the ambient atmospheric pressure, 14.7 psi at sea level.

$P_f$  is the final sample canister pressure, in psig.

$P_i$  is the initial sample canister pressure, in psig. This will most often be a negative value (sub-ambient initial pressure).

### 13.8 Results


If a canister has been pressurized with Helium and the Tekmar AutoCan was utilized, refer to Section 11.11.

#### 13.8.1 Equation Number 13 - For calculating analyte concentrations in a sample, the starting point is the nanogram amount generated by the HP Enviroquant software, which appears on the quantitation report.

$$ng_x = \frac{A_x ng_{is}}{A_{is} RRF} \quad \text{where:}$$

$ng_x$  is the nanogram amount of analyte x.

$A_x$  is the area response of the analyte's quantitation ion.

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$A_{is}$  is the area response of the corresponding internal standard's quantitation ion.

$ng_{is}$  is the internal standard amount, in nanograms.

$RRF$  is the average or mean RRFs

13.8.2 Equation Number 14 - The final analyte concentration,  $C_x$ , in units of micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ), is then calculated from the following:

$$C_x = \left( \frac{ng_x PDF}{V} \right) \left( \frac{1\mu\text{g}}{1000ng} \right) \left( \frac{1000\text{l}}{1\text{m}^3} \right) \quad \text{where:}$$

$V$  is the sample volume analyzed, in liters.

$PDF$  is the sample canister pressure dilution factor.

13.8.3 Equation Number 15 - To convert to units of parts per billion volume (ppbv):

$$ppbv = \frac{\mu\text{g}/\text{m}^3}{MW} \times 24.46 \quad \mu\text{g}/\text{m}^3 = \frac{ppbv}{24.46} \times MW \quad \text{where:}$$

$MW$  is the molecular weight (Table 2) of the analyte, in g/mole.

24.46 is the molar volume of an ideal gas at 298 K (25 °C) and 760 mmHg (1 atm), in liters per mole (l/mol).

$C_x$  the final analyte concentration in micrograms per cubic meter.

13.8.4 Equation Number 16 - Helium Pressurization (Injection Amount)

Applicable to canisters pressurized with helium and injected utilizing the mass flow controller of the AutoCAN. For full instructions and calculations, refer to the 1<sup>st</sup> tab of the template located at: J:\A-GCMS\Helium Pressurization\System\HE Pressurization Template.


### 13.9 Data Review

The analyst must review data on a real time basis for all calibration and QC data. The QC data must be evaluated by analytical sequence following the Daily QC review checklist (Attachment 3). The data shall be reviewed and the sample results calculated and assessed by one analyst and reviewed by a second qualified analyst. The Sample Review checklist (Attachment 3) is used to document sample review per service request and once completed, initialed and dated must be filed with each job file.

Initial calibrations must be reviewed in the same manner as QC data with all ICAL documentation retained in a separate file organized by instrument and date. Refer to the initial calibration checklist in Attachment 2 for the review guideline. The ICAL file must contain all the pertinent information stated in Section 11.1.6.

### 13.10 Reporting

The results of each test shall be reported clearly, unambiguously and objectively, and shall include all the information necessary for the interpretation of the test results and

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information required by this laboratory's policy, TNI standards, DoD Manual (applicable version, see reference section), client projects, and the TO-15 method including modifications, observances, data qualifiers, and certification information.

If the project requires that results be reported below the MRL (LOQ), but above the LOD all of the requirements specified for normal reporting apply (3:1 S/N ratio and ion abundance). This is regardless of the fact that the results will be qualified as estimated.

#### 13.10.1 Analysis Observations / Case Narrative Summary Form

This form, which is included in the *SOP for Laboratory Storage, Analysis and Tracking*, may be generated when there are specific sample composition information or analysis issues and/or observations. In addition, during the analysis, specific identification information or problems, interferences, calibration issues, flags, and additional/expanded explanation of flags should be added to the form. This form may be modified as long as the sections and basic concepts are reserved. All data qualifiers and flags should follow those listed in the most recent Quality Assurance Manual or as defined in any client requirements.

This form may be used as a means for documentation. This form, among other information, will be reviewed when compiling the final report and case narrative. Alternatively, information may be included on the Daily QC and Sample Review Checklists (Attachment 3). All information regarding the job shall remain in the file, in order that sufficient documentation is available to recreate the job from sample receipt through analysis, data reduction, and reporting.

#### 13.10.2 NELAP\TNI Requirements

The following items do not comply with TNI standard requirements and must be reported accordingly. A statement, however worded, must be included in the final report indicating that data reported does not fall under the laboratory's NELAP certificate of approval.

- Reporting any compound which is not included in the second source standard (ICV or LCS) does not meet NELAP requirements.
- In addition, a report that contains a compound not included on the NELAP certificate of approval must also include the statement listed above.


##### 13.10.2.1 Modifications

Method modifications are also not allowed under TNI standards; therefore, a statement, however worded, must be included in the final report indicating that data reported does not fall under the laboratory's NELAP certificate of approval. In addition, the following items are considered to be method modifications and must be reported accordingly.

- Sample collection in gas collection bags
- The pressurization of canisters with nitrogen or helium (if EPA Method 3C is requested) refer to Section 11.11.

#### 13.10.3 Surrogates

Only report surrogates at the request of the client. If any surrogate is out of control, all samples results (with surrogates requested) associated with the surrogate must be reported with the appropriate data qualifier.

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#### 13.10.4 DoD Requirements

Report results with the appropriate data qualifiers, if samples cannot be reanalyzed for any reason. In addition and at a minimum, the following situations are to be noted in the case narrative: manual integrations, CCV out of control, and results exceeding the calibration range.

#### 13.11 Storing Electronic Data

The initial calibration data must be stored in a quantitation method (on the server) using a unique filename and may not be overwritten at any time in order to maintain an accurate audit trail. There are multiple quantitation methods, which are subsets of the compound list in Table 2. Therefore, files will be named with a notation indicating the compound list and the date of the corresponding initial calibration. In addition, all data files including method blanks, continuing calibration verification, laboratory control samples and client submitted samples files are saved in a unique sub-directory on the server.

- 13.12 Sufficient raw data records must be retained on file of all laboratory analyses described in this document including passing QC canister checks, tune checks, instrument calibrations, verifications, sample analyses and dilutions, QC checks, and method detection limit studies. The information that is required includes: analysis/calibration date and time, test method, instrument, sample identification, analyte identification, analyst's initials, concentrations and responses, as well as standards used for the analysis and calibrations, all manual calculations including sample dilutions and manual integrations to permit reconstruction of analyses. Information entered and reported on the quantitation report and instrument run log must be complete and accurate. All data shall be obtained following defensible and ethical practices in accordance with the most recent Quality Assurance Manual and the *SOP for Laboratory Ethics and Data Integrity*.

Note: All data records must explicitly connect data to the initial instrument calibration. This includes all samples, continuing calibrations and QC samples.


- 13.13 The essential information to be associated with analysis, such as computer data files, run logs, etc. shall include: Sample ID code, date and time (if the holding time is 72 hours) of analysis, instrument operating conditions/parameters (or reference to such data), analysis type, all manual calculations including dilutions and manual integrations, analyst's initials, sample preparation (pressure readings and balance gas if pressurized with helium), standard and reagent origin, receipt, preparation, and use, as well as calibration criteria, frequency and acceptance criteria, data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions.

### 14) **Method Performance**

- 14.1 An on-going assessment of method performance is conducted in order to ensure that the laboratory is capable of reporting results which are acceptable for its intended use. Validation of the method is confirmed by the examination and provision of objective evidence that these requirements are met.

#### 14.2 Method Detection Limit (MDL)

The procedure used to determine the method detection limits are as stated in the *Code of Federal Regulations* (40 CFR 136 Appendix B) as defined in the *SOP for Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation*. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is distinguishable from method blank results. The MDL

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concentrations are listed in Tables 2 and 2A for both SCAN and SIM modes and were obtained using spiked canisters prepared with humidified zero air, making at least seven replicate measurements of the compounds of interest, computing the standard deviation, and multiplying this value by the appropriate Student's t value for 99 percent confidence. Additionally, at least seven method blank results were processed according to the procedure described in this document. Refer to the *SOP for Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation* for the method blank MDL calculation and additional requirements for establishing the MDL. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects. All MDLs, regardless of the mode of operation, meet the method performance criteria of <0.5ppbV.

#### 14.3 Accuracy and Precision

Refer to Section 11.4 in the referenced method for information on replicate precision criteria for method performance. Single laboratory accuracy is presented as the second source initial calibration verification standard, which meets the method performance criteria of 30%. Additionally, laboratory generated control limit data for LCSs are presented for the analytes of interest and may be referenced in the electronic TO-15 Method Manual. Refer to Section 11.1.4.2 for the accuracy and precision requirements for concentrations at the LOQ/MRL.

#### 14.4 Selectivity


Mass spectrometry is considered a more definitive identification technique than single specific detectors such as flame ionization detector (FID), electron capture detector (ECD), photoionization detector (PID), or a multidetector arrangement of these (see discussion in Compendium Method TO-14A). The use of both gas chromatographic retention time and the generally unique mass fragmentation patterns reduce the chances for misidentification.

It is necessary to establish that a given GC/MS meets tuning and standard mass spectral abundance criteria prior to initiating any data collection. Upon sample injection onto the column, the GC/MS system is operated so that the MS scans the atomic mass range from 35 to 300 amu. At least ten scans per eluting chromatographic peak must be acquired. Scanning also allows identification of unknown compounds in the sample by searching through library spectra.

The sample analysis using the GC/MS is based in part on a combination of retention times and relative abundances of selected ions. The retention time of each chromatographic peak should be  $\pm 0.10$  minutes of the library/reference retention time of the compound. The acceptance level for relative abundance should be set at  $\pm 20\%$  of the expected abundance. The data should be manually examined by the analyst to determine the reason for the # flag [(#) = qualifier out of range], if present and whether the compound should be reported as found or if there is matrix interference. A background subtraction may aid in this determination. Manual inspection of the qualitative results should also be performed to verify concentrations outside the expected range.

Specific selectivity information is provided in this section and document (such as relative retention time) as well as in the referenced method. Refer to the method for additional information on selectivity.

- Use NIST Library 2011 or newer version

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- The *reference spectra updates* must be performed with every new ICAL utilizing the mid-level standard (minimum). If needed, the reference spectra may be updated sooner with the continuing calibration standard.
- *Retention time updates* must be performed using EasyID and not by updating to the method (InitCal \ Update Calibration). Refer to the Help selection of the software.

#### 14.5 Demonstration of Capability

This laboratory has continuously performed this method since before July 1999. Therefore, ongoing demonstration of capable shall be performed and documented; however, the initial demonstration of method capability is not required.

#### 14.6 Proficiency Testing (PT) Program

The laboratory shall participate in an air and emissions PT study for TO-15. The testing shall be performed in accordance with this document and meet the frequency and proficiency requirements detailed in the DoD QSM.

Proficiency testing samples including all accredited compounds are not available. Therefore, in addition to third party PT samples, intra laboratory comparisons (repeatability studies) must be performed biannually to meet the DoD QSM proficiency testing requirements. Eight QC analyses from various analysts and instruments shall be compiled and the statistical validity evaluated using a Z-score.

### 15) **Pollution Prevention and Waste Management**

- 15.1 All waste disposals shall be carried out in accordance with the requirements detailed in the *Simi Valley Lab Waste Management Plan*. In addition, canisters must be cleaned in accordance with the requirements detailed in the *SOP for Cleaning and Certification of Summa Canisters and Other Specially Prepared Containers*.

### 16) **Contingencies for Handling Out-of-Control or Unacceptable Data**

- 16.1 The following is specific information on how to report unacceptable data. If the data requires a data qualifier flag, as specified in this SOP, refer to Appendix D of the most recent version of the Quality Assurance Manual for the appropriate data qualifier.

#### 16.2 Initial Calibration and/or Initial Calibration Verification


All results reported with an unacceptable ICAL must be reported as estimated and all data shall be reported using defined qualifiers or flags or explained in the case narrative accordingly.

#### 16.3 Continuing Calibration Verification

All results associated with an unacceptable CCV must be reported with the appropriate data qualifier or flag and explained in the case narrative.

1. When the acceptance criteria for the continuing calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported with a qualifier or flag and explained in the case narrative. The case narrative may include information stating the data quality is not affected.
2. When the acceptance criteria for the continuing calibration verification are exceeded high, i.e., high bias, and there are associated samples with detects, then those detects must be reported with a qualifier or flag and explained in the case narrative.



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3. If however, the acceptance criteria for the continuing calibration verification are exceeded low, i.e., low bias, and there are associated samples that are non-detects, then those non-detects must be reported with qualifiers or flags and explained in the case narrative as having less certainty. However, along with the data qualifiers, the case narrative may include information stating the fact that the results were not significantly affected if:
  - a. *An MRL check standard was analyzed and found to be acceptable. The MRL must be the same as that analyzed in the MRL check standard for those analytes that were biased low in the CCV. Adjust MRLs (if required), flag data and state the certainty in the case narrative where the sensitivity of the instrument was demonstrated at the MRL; therefore, results were not significantly affected.*
  - b. *With the reporting limit adjusted to the next level in the calibration curve (typically 5 times higher) to prove the nonexistence of a false negative and note procedure in case narrative.*
4. If the acceptance criteria was exceeded (biased high) for the CCV and there were detectable results in a sample, the results may be “qualified” if the results exceeded the regulatory/decision limit (this is to be stated in the case narrative along with the data qualifiers or flags).
5. Data associated with a biased low CCV may be fully useable if the results reported exceed a maximum regulatory limit/decision level.

#### 16.4 Method Blank

- If an analyte in the blank is found to be out of control and the analyte is also found in associated samples, those sample results shall be “flagged” in the report and the method blank results reported.
- If the analyte is found in the blank but not in the sample then the results for the sample may be reported without a qualifier.

#### 16.5 Laboratory Control Sample

All results associated with an out of control laboratory control sample must be reported with the appropriate data qualifier. An indication of whether the LCS was out high or low should also be included.

#### 16.6 Surrogate

Report sample results with the appropriate data qualifier.

#### 16.7 Laboratory Duplicate

All batch sample results associated with an out of control laboratory duplicate must be flagged with the appropriate data qualifier.

#### 16.8 Internal Standard

All target analytes associated with an out of control internal standard must be flagged with the appropriate data qualifier.

#### 16.9 Estimated Sample Results

16.9.1 Sample Hold Time All occurrences of missed holding times must be included on the final report including those samples received and/or analyzed outside of the specified hold times detailed in this SOP.

16.9.2 Matrix Interference Sample data associated with matrix interference must be flagged with the appropriate data qualifier.

16.9.3 Results Outside Initial Calibration Range All sample results not bracketed by initial calibration standards (within calibration range) must be reported as having less certainty by reporting with the appropriate data qualifier.

## 17) Training

### 17.1 Demonstration of Capability

All analysts must be trained in accordance with the guidelines detailed in the *SOP for Training Policy*. Demonstrations shall also be performed in accordance with the TNI Standards and DoD Quality Systems Manual. Attachment 1 shall be used to document the training plan for new analysts' initial demonstration. Additionally, these demonstrations are performed anytime there is a change in instrument type, personnel or method.

Once performance is found to be acceptable, a required certification statement must be completed by the QA Manager and either the immediate supervisor or Laboratory Manager and retained on file as a demonstration of compliance.

17.1.1 Quarterly Demonstration A demonstration of method sensitivity must be performed *quarterly on each instrument* performing this method.

- 1) A spike at the current LOD must be analyzed.
- 2) Verification of precision and bias at the LOQ must be performed.

Refer to Section 11.1.4.2 (LOQ) and 11.16.1 (LOD) for additional information on how these demonstrations are to be performed as well as the acceptance criteria.

17.1.2 Annual Demonstration Each analyst must perform a demonstration of capability initially and annually. For the initial demonstration analyze four LCS standards at 1-4x the MRL (LOQ) either concurrently or over a period of days as a verification of precision and bias of the quantitation range. The standard deviation (n-1) and average percent recovery of the four replicates are compared against the method requirement for precision ( $\pm 25\%$ ) and current laboratory control limits for bias/LCS.

17.1.3 Change in Personnel, Instruments, Method and/or Matrix The requirements in Sections 17.1.1 and 17.1.2 must be performed per the schedule noted and when there is a change in personnel, instruments, method or matrix. "Change" refers to any change in personnel, instrument, test method, or sample matrix that potentially affects the precision and bias, sensitivity, or selectivity of the output (e.g., a change in the detector, column type, matrix, or other components of the sample analytical system, or a method revision).

All completed attempts at this demonstration must be turned into the QA department for retention.

## 18) Summary of Changes

Revision Number	Effective Date	Document Editor	Description of Changes
27.0	12/14/2020	N. Nash	7.3 - Reformatted and revised section
		C. Parnell	8.2 - Updated
			8.3 - Updated

		8.4 - Updated
		8.5 - Updated
		8.8 - Updated
	N. Nash	9.2.1.3 - Added 15L canister size
		19.11 New reference
		Tables 2, 3, 3A, 4, 4A - updated values
		Attachment 4, updated DTSC holding time

## 19) References and Related Documents

- 19.1 EPA Method TO-14A, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA/625/R-96/010b, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1997.
- 19.2 EPA Method TO-15, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA/625/R-96/010b, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1997.
- 19.3 Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, January 1999.
- 19.4 Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Addendum, January 17, 2002.
- 19.5 TNI Standard 2009 and 2016, Volume 1, *Management and Technical Requirements for Laboratories Performing Environmental Analysis*.
- 19.6 *Preparation of Gas Phase Standards for Ambient Air Analysis*, Tekmar-DOHRMANN Application Note, Spring 96, Vol. 6.5.
- 19.7 DoD/DoE QSM, *Department of Defense (DoD), Department of Energy (DoE) Quality Systems Manual (QSM) for Environmental Laboratories*, Current Version.
- 19.8 Arizona Administrative Code, Title 9. Health Services, Chapter 14. Department of Health Services Laboratories, October 1, 2016.
- 19.9 Florida Department of Environmental Protection, Chapter 62-160.
- 19.10 Minnesota Department of Health, 4740.2065, *Standard Operating Procedures*, Statutory Authority: MS s 144.97; 144.98; History: 31 SR 446, Posted: October 09, 2006, Revised April 16, 2010.
- 19.11 California Environmental Protection Agency Department of Toxic Substances Control, *ADVISORY ACTIVE SOIL GAS INVESTIGATIONS*, July 2015.

## 20) Attachments

### 20.1 Tables

Table 1: Instrument Tune Check Ion Abundance Criteria (TO-15)

Table 1A: Instrument Tune Check Ion Abundance Criteria (TO-14A)

Table 2: Volatile Organic Compounds, EPA Compendium Method TO-15 (SCAN)

Table 2A: Volatile Organic Compounds, EPA Compendium Method TO-15 (SIM)

Table 3: Standard Concentrations (SCAN) (Primary Sources)

Table 3A: Standard Concentrations (SIM) (Primary Sources)


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Table 4: Standard Concentrations (SCAN) (Secondary Sources)

Table 4A: Standard Concentrations (SIM) (Secondary Sources)

20.2 Attachments

Attachment 1 - Training Plan

Attachment 2 - Initial Calibration Checklist

Attachment 3 - Daily QC and Sample Review Checklists

Attachment 4 - State and Project Specific Requirements

Attachment 5 - Tekmar AutoCan Trap Packing Instructions

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**TABLE 1**

Required BFB Key Ions and Ion Abundance Criteria for Method TO-15

Mass	Ion Abundance Criteria <sup>1</sup>
50	8.0 to 40.0 percent of m/e 95
75	30.0 to 66.0 percent of m/e 95
95	Base Peak, 100 Percent Relative Abundance
96	5.0 to 9.0 Percent of m/e 95
173	Less than 2.0 Percent of m/e 174
174	50.0 to 120.0 Percent of m/e 95
175	4.0 to 9.0 Percent of m/e 174
176	93.0 to 101.0 Percent of m/e 174
177	5.0 to 9.0 Percent of m/e 176

<sup>1</sup> All ion abundances must be normalized to m/z 95, the nominal base peak, even though the ion abundance of m/z 174 may be up to 120 percent that of m/z 95.

**TABLE 1A**

Required BFB Key Ions and Ion Abundance Criteria for Method TO-14A

Mass	Ion Abundance Criteria
50	15 to 40 percent of m/e 95
75	30 to 60 percent of m/e 95
95	Base Peak, 100 Percent Relative Abundance
96	5 to 9 Percent of m/e 95
173	Less than 2 Percent of m/e 174
174	>50 Percent of m/e 95
175	5 to 9 Percent of m/e 174
176	>95 and <101 Percent of m/e 174
177	5 to 9 Percent of m/e 176

**Note:** The criteria listed in Tables 1 and 1A shall be met or exceeded in order for EPA Compendium Methods TO-15 or TO-14A to be referenced.



TABLE 2 - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)

Compound <sup>1</sup>	CAS Number	Molecular Weight	Density	Primary Ion <sup>2</sup>	Secondary Ion(s) <sup>2</sup>	MRL <sup>3</sup> (µg/m <sup>3</sup> )	MDL <sup>3</sup> (µg/m <sup>3</sup> )	IS <sup>4</sup>
Bromochloromethane (IS1)	74-97-5	-	-	130	128, 132	-	-	-
Propene	115-07-1	42.08	NA	42	39,41	0.53	0.13	IS1
Dichlorodifluoromethane (CFC 12)	75-71-8	120.9	1.329	85	87, 101, 103	0.53	0.087	IS1
Chloromethane	74-87-3	50.49	0.911	50	52	0.53	0.086	IS1
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	76-14-2	170.9	1.455	135	137	0.53	0.084	IS1
Vinyl Chloride	75-01-4	62.50	0.9106	62	64	0.54	0.057	IS1
1,3-Butadiene	106-99-0	54.09	0.6149	54	39, 53	0.53	0.088	IS1
Bromomethane	74-83-9	94.94	1.6755	94	96	0.54	0.074	IS1
Chloroethane	75-00-3	64.52	0.8902	64	66	0.54	0.066	IS1
Ethanol	64-17-5	46.07	0.7893	45	46	5.2	0.37	IS1
Acetonitrile	75-05-8	41.05	0.7857	41	40	0.53	0.13	IS1
Acrolein	107-02-8	56.06	0.840	56	55	1.0	0.15	IS1
Acetone	67-64-1	58.08	0.7845	58	43	5.3	1.2	IS1
Trichlorofluoromethane	75-69-4	137.4	NA	101	103	0.53	0.081	IS1
Isopropyl Alcohol	67-63-0	60.10	0.7809	45	43	2.1	0.22	IS1
Acrylonitrile	107-13-1	53.06	0.8060	53	52	0.53	0.11	IS1
1,1-Dichloroethene	75-35-4	96.94	1.213	96	61	0.54	0.074	IS1
tert-Butanol	75-65-0	74.12	0.7887	59	57,41,43	1.1	0.16	IS1
Methylene Chloride	75-09-2	84.94	1.3266	84	49	0.53	0.15	IS1
Allyl Chloride	107-05-1	76.53	0.9376	41	76	0.54	0.072	IS1
Trichlorotrifluoroethane	76-13-1	187.38	1.5635	151	101	0.54	0.076	IS1



TABLE 2 (Continued) - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)

Compound <sup>1</sup>	CAS Number	Molecular Weight	Density	Primary Ion <sup>2</sup>	Secondary Ion(s) <sup>2</sup>	MRL <sup>3</sup> (µg/m <sup>3</sup> )	MDL <sup>3</sup> (µg/m <sup>3</sup> )	IS <sup>4</sup>
Carbon Disulfide	75-15-0	76.14	1.2632	76	78	1.1	0.16	IS1
trans-1,2-Dichloroethene	156-60-5	96.94	1.2565	61	96	0.54	0.074	IS1
1,1-Dichloroethane	75-34-3	98.96	1.1757	63	65	0.55	0.078	IS1
Methyl tert-Butyl Ether	1634-04-4	88.15	0.7402	73	57	0.54	0.063	IS1
Vinyl Acetate	108-05-4	86.09	0.9317	86	43	5.4	1.2	IS1
2-Butanone (MEK)	78-93-3	72.11	0.7999	72	43	1.1	0.11	IS1
cis-1,2-Dichloroethene	156-59-2	96.94	1.2837	61	96	0.53	0.075	IS1
Diisopropyl Ether	108-20-3	102.18	0.7241	87	45,59,43	0.54	0.070	IS1
Ethyl Acetate	141-78-6	88.106	0.9003	61	70	1.1	0.28	IS1
n-Hexane	110-54-3	86.18	0.6548	57	86	0.54	0.11	IS1
Chloroform	67-66-3	119.4	1.4832	83	85	0.54	0.071	IS1
<b>1,2-Dichloroethane-d4(S)</b>	17060-07-0	-	-	65	67	-	-	IS1
Tetrahydrofuran	109-99-9	72.11	0.8892	72	71,42	0.55	0.067	IS1
Ethyl tert-Butyl Ether	637-92-3	102.176	0.7519	87	59,57	0.54	0.064	IS1
1,2-Dichloroethane	107-06-2	98.96	1.2351	62	64	0.54	0.059	IS1
<b>1,4-Difluorobenzene(IS2)</b>	540-36-3	-	-	114	88	-	-	-
1,1,1-Trichloroethane	71-55-6	133.4	1.3390	97	99, 61	0.54	0.066	IS2
Isopropyl acetate *Removed	108-21-4	102.13	0.8718	61	87,43	1.1	0.17	NA
1-Butanol *Removed	71-36-3	74.1224	0.8098	56	41	1.0	0.14	NA
Benzene	71-43-2	78.11	0.8765	78	77	0.53	0.077	IS2
Carbon Tetrachloride	56-23-5	153.8	1.5940	117	119	0.53	0.074	IS2



TABLE 2 (Continued) - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)

Compound <sup>1</sup>	CAS Number	Molecular Weight	Density	Primary Ion <sup>2</sup>	Secondary Ion(s) <sup>2</sup>	MRL <sup>3</sup> (µg/m <sup>3</sup> )	MDL <sup>3</sup> (µg/m <sup>3</sup> )	IS <sup>4</sup>
Cyclohexane	110-82-7	84.16	0.7739	84	69,56	1.1	0.15	IS2
tert-Amyl Methyl Ether	994-05-8	102.176	0.7703	73	87,55,43	0.54	0.065	IS2
1,2-Dichloropropane	78-87-5	113	1.1560	63	62	0.54	0.066	IS2
Bromodichloromethane	75-27-4	163.8	1.980	83	85	0.54	0.077	IS2
Trichloroethene	79-01-6	131.4	1.4642	130	132	0.54	0.072	IS2
1,4-Dioxane	123-91-1	88.11	1.0337	88	58	0.54	0.063	IS2
Isooctane	540-84-1	114.23	0.6877	57	41	0.54	0.080	IS2
Methyl Methacrylate	80-62-6	100.12	0.944	100	69	1.1	0.19	IS2
n-Heptane	142-82-5	100.2	0.6837	71	57,100	0.54	0.085	IS2
cis-1,3-Dichloropropene	10061-01-5	111	1.224	75	77	0.52	0.083	IS2
4-Methyl-2-Pentanone	108-10-1	100.2	0.7965	58	85	0.53	0.073	IS2
trans-1,3-Dichloropropene	10061-02-6	111	1.217	75	77	0.53	0.11	IS2
1,1,2-Trichloroethane	79-00-5	133.4	1.4397	97	83	0.54	0.054	IS2
<b>Chlorobenzene-d5(IS3)</b>	3114-55-4	-	-	82	117	-	-	-
<b>Toluene-d8(S)</b>	2037-26-5	-	-	98	100	-	-	IS3
Toluene	108-88-3	92.14	0.8669	91	92	0.54	0.065	IS3
2-Hexanone	591-78-6	100.16	0.8113	43	58	0.54	0.066	IS3
Dibromochloromethane	124-48-1	208.3	2.451	129	127	0.54	0.070	IS3
1,2-Dibromoethane	106-93-4	187.9	2.1791	107	109	0.54	0.062	IS3
n-Butyl Acetate	123-86-4	116.16	0.8825	43	56, 73	0.55	0.073	IS3
n-Octane	111-65-9	114.23	0.6986	57	114	0.54	0.12	IS3





TABLE 2 (Continued) - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)

Compound <sup>1</sup>	CAS Number	Molecular Weight	Density	Primary Ion <sup>2</sup>	Secondary Ion(s) <sup>2</sup>	MRL <sup>3</sup> (µg/m <sup>3</sup> )	MDL <sup>3</sup> (µg/m <sup>3</sup> )	IS <sup>4</sup>
Tetrachloroethene	127-18-4	165.8	1.6227	166	164	0.52	0.069	IS3
Chlorobenzene	108-90-7	112.6	1.1058	112	114	0.54	0.071	IS3
Ethylbenzene	100-41-4	106.2	0.8670	91	106	0.54	0.075	IS3
m-, p-Xylenes	179601-23-1	106.2	0.8642, 0.8611	91	106	1.1	0.14	IS3
Bromoform	75-25-2	252.8	2.899	173	175	0.54	0.11	IS3
Styrene	100-42-5	104.1	0.9060	104	78, 103	0.53	0.086	IS3
o-Xylene	95-47-6	106.2	0.8802	91	106	0.54	0.077	IS3
n-Nonane	111-84-2	128.26	0.7176	43	57, 85	0.54	0.089	IS3
1,1,2,2-Tetrachloroethane	79-34-5	167.9	1.5953	83	85	0.54	0.074	IS3
<b>4-Bromofluorobenzene(S)</b>	460-00-4	-	-	174	176	-	-	IS3
Cumene	98-82-8	120.2	0.8618	105	120	0.54	0.077	IS3
alpha-Pinene	80-56-8	136.24	0.8582	93	77	0.54	0.082	IS3
n-Propylbenzene	103-65-1	120.1938	0.8670	91	120,65	0.54	0.077	IS3
<b>3-Ethyltoluene *Removed</b>	620-14-4	120.2	0.8645	105	120	0.53	0.072	NA
4-Ethyltoluene	622-96-8	120.2	0.8614	105	120	0.54	0.085	IS3
1,3,5-Trimethylbenzene	108-67-8	120.2	0.8652	105	120	0.53	0.077	IS3
<b>alpha-Methylstyrene *Removed</b>	98-83-9	118.19	0.9106	118	103,117	0.54	0.085	NA
<b>2-Ethyltoluene *Removed</b>	611-14-3	120.2	0.8807	105	120	0.54	0.068	NA
1,2,4-Trimethylbenzene	95-63-6	120.2	0.8758	105	120	0.54	0.074	IS3
<b>n-Decane *Removed</b>	124-18-5	142.28	0.7300	57	71,85	0.54	0.072	NA
Benzyl Chloride	100-44-7	126.59	1.1004	91	126	1.1	0.12	IS3




TABLE 2 (Continued) - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)

Compound <sup>1</sup>	CAS Number	Molecular Weight	Density	Primary Ion <sup>2</sup>	Secondary Ion(s) <sup>2</sup>	MRL <sup>3</sup> (µg/m <sup>3</sup> )	MDL <sup>3</sup> (µg/m <sup>3</sup> )	IS <sup>4</sup>
1,3-Dichlorobenzene	541-73-1	147	1.2884	146	148	0.54	0.080	IS3
1,4-Dichlorobenzene	106-46-7	147	1.2475	146	148	0.54	0.082	IS3
sec-Butylbenzene	135-98-8	134.2206	0.8601	105	134,91	0.54	0.073	IS3
p-Isopropyltoluene	99-87-6	134.2206	0.8573	119	134,91	0.55	0.081	IS3
1,2,3-Trimethylbenzene *Removed	526-73-8	120.1938	0.8944	105	120	0.55	0.073	NA
1,2-Dichlorobenzene	95-50-1	147	1.3059	146	148	0.54	0.079	IS3
d-Limonene	5989-27-5	136.24	0.8402	68	93	0.54	0.11	IS3
1,2-Dibromo-3-Chloropropane	96-12-8	236.33	2.093	157	75, 39	0.53	0.10	IS3
n-Undecane *Removed	1120-21-4	156.31	0.7402	57	71, 85	0.54	0.14	NA
1,2,4-Trichlorobenzene	120-82-1	181.5	1.459	180	182, 184	0.54	0.13	IS3
Naphthalene	91-20-3	128.17	1.0253	128	129	0.52	0.13	IS3
n-Dodecane *Removed	112-40-3	170.34	0.7487	57	71,85	0.52	0.15	NA
Hexachlorobutadiene	87-68-3	260.8	1.556	225	227	0.53	0.11	IS3
Cyclohexanone *Removed	108-94-1	98.14	0.9478	55	42, 98	0.50	0.083	NA
tert-Butylbenzene	98-06-6	134.22	0.867	119	134	0.54	0.080	IS3
n-Butylbenzene	104-51-8	134.22	0.867	91	134	0.54	0.077	IS3
1,1,1,2-Tetrachloroethane	630-20-6	167.85	1.553	131	133	.52	.23	IS3

(S) = Surrogate (IS1) = Internal Standard 1 (IS2) = Internal Standard 2 (IS3) = Internal Standard 3  
NA = Not Available / Not Applicable

**Note 1:** Additional compounds may be reported as long as the minimum requirements of this document are met. The compounds listed in this table are reported using TO-15 SCAN. The Selected Ion Monitoring (SIM) compounds are a subset of this list and are included in Table 2A.

**Note 2:** These are suggested primary and secondary ions. However, any ions in the analyte spectra that are sufficient enough in response to reach the desired reporting limit and having a limited amount of interference, is acceptable for both the primary and secondary ion selection. Analyst experience should be utilized in determining appropriate ions.

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Note 3: The laboratory performs three concentration level analyses (SIM, SCAN and Low Level SCAN). The method reporting limit listed is the standard SCAN limit (at or above lowest concentration in the initial calibration curve), but may change with each new initial calibration performed. Therefore, current reporting limits for the three analysis levels, MRLs in ppbv, and those from the Low Level SCAN should be reviewed in the electronic TO-15 Method Manual.

Note 4: The listing of the internal standard by which the compounds are quantitated is for TO-15 SCAN only. SIM compounds (SCAN subset) and their corresponding ions and internal standards are listed in Table 2A.

Note 5: m/e 101 is ~10% or less of m/e 85 (the base peak) and may not be present for low level results. Retention times must be carefully verified.

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Table 2A - Volatile Organic Compounds, EPA Compendium Method TO-15 (SIM)

Compound	Primary Ion <sup>1</sup>	Secondary Ion <sup>1</sup>	MRL <sup>2</sup> (ug/m3 )	MDL <sup>2</sup> (ug/m3)	IS
Dichlorodifluoromethane	85	87	0.050	0.017	IS1
Chloromethane	52	50	0.050	0.019	IS1
Vinyl Chloride	62	64	0.025	0.0076	IS1
1,3-Butadiene	54	39	0.050	0.014	IS1
Bromomethane	94	96	0.025	0.0093	IS1
Chloroethane	64	66	0.025	0.0085	IS1
Acrolein	56	55	0.20	0.039	IS1
Acetone	58	43	2.5	0.056	IS1
Freon 11	101	103	0.050	0.015	IS1
1,1-Dichloroethene	96	98,61	0.025	0.0086	IS1
Methylene Chloride	84	49	0.10	0.013	IS1
Trichlorotrifluoroethane	151	153	0.025	0.0089	IS1
trans-1,2-Dichloroethene	96	98,61	0.025	0.0073	IS1
1,1-Dichloroethane	63	65	0.025	0.0061	IS1
Methyl tert-Butyl Ether	73	57	0.025	0.0093	IS1
cis-1,2-Dichloroethene	96	98,61	0.025	0.0092	IS1
Chloroform	83	85	0.10	0.018	IS1
1,2-Dichloroethane	62	64	0.025	0.0084	IS1
1,1,1-Trichloroethane	97	99	0.025	0.0059	IS1
Benzene	78	77	0.075	0.020	IS1
Carbon Tetrachloride	117	119	0.025	0.012	IS1
1,2-Dichloropropane	63	62,76	0.025	0.0073	IS2
Bromodichloromethane	83	85	0.025	0.0069	IS2
Trichloroethene	130	132	0.025	0.0085	IS2
1,4-Dioxane	88	58	0.10	0.0085	IS2
cis-1,3-Dichloropropene	75	77,39	0.025	0.0062	IS2
trans-1,3-Dichloropropene	75	77,39	0.025	0.0055	IS2
1,1,2-Trichloroethane	83	97,61	0.10	0.0079	IS2
Toluene	91	92	0.10	0.011	IS2
Dibromochloromethane	129	127	0.025	0.0088	IS3
1,2-Dibromoethane	107	109	0.025	0.0079	IS2
Tetrachloroethene	166	164	0.025	0.0082	IS2
Chlorobenzene	112	114	0.10	0.0092	IS3
Ethylbenzene	91	106	0.10	0.0097	IS3
m-&p-Xylene	91	106	0.10	0.019	IS3
Styrene	104	103	0.10	0.0074	IS3
o-Xylene	91	106	0.10	0.0089	IS3
1,1,2,2-Tetrachloroethane	83	85	0.025	0.0072	IS3
1,3,5-Trimethylbenzene	105	120	0.10	0.0073	IS3
1,2,4-Trimethylbenzene	105	120	0.10	0.0083	IS3
1,3-Dichlorobenzene	146	148	0.025	0.0085	IS3
1,4-Dichlorobenzene	146	148	0.025	0.0081	IS3
1,2-Dichlorobenzene	146	148	0.025	0.0083	IS3
1,2-Dibromo-3-chloropropane	157	75	0.10	0.0095	IS3
1,2,4-Trichlorobenzene	182	184	0.050	0.013	IS3
Naphthalene	128	129	0.10	0.016	IS3
Hexachlorobutadiene	225	227	0.10	0.0092	IS3
Bromobenzene	77	156, 158	0.10	0.0042	IS3

NA = Not Available (IS1) = Internal Standard 1 (IS2) = Internal Standard 2 (IS3) = Internal Standard 3

Note 1: These are suggested primary and secondary ions. However, any ions in the analyte spectra that is sufficient enough in response to reach the desired reporting limit and having a limited amount of interference, is acceptable



for both the primary and secondary ion selection. Analyst experience should be utilized in determining appropriate ions.

Note 2: The method reporting limit listed is the standard SIM limit (lowest concentration in the initial calibration curve; must be higher than MDL), but may change with each new initial calibration performed. Therefore, current reporting limits should be reviewed. MDLs in ppbV may be reviewed in the electronic TO-15 Method Manual.

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**Table 3**  
**Standard Concentrations (SCAN) (Primary Sources)<sup>1</sup>**

Compound Name	0.1ng	0.2ng	0.5ng	1.0ng	5.0ng	25ng	50ng	100ng
<b>Bromochloromethane (IS1)</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>
Propene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Dichlorodifluoromethane (CFC 12)	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Chloromethane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Vinyl Chloride	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
1,3-Butadiene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Bromomethane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Chloroethane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Ethanol	0.528	1.056	2.640	5.28	26.40	132.00	264.0	528
Acetonitrile	0.106	0.212	0.530	1.06	5.30	26.50	53.0	106
Acrolein	0.218	0.436	1.090	2.18	10.90	54.50	109.0	218
Acetone	0.516	1.032	2.580	5.16	25.80	129.00	258.0	516
Trichlorofluoromethane	0.102	0.204	0.510	1.02	5.10	25.50	51.0	102
Isopropyl Alcohol	0.205	0.410	1.025	2.05	10.25	51.25	102.5	205
Acrylonitrile	0.205	0.410	1.025	2.05	10.25	51.25	102.5	205
1,1-Dichloroethene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
tert-Butanol	0.207	0.414	1.035	2.07	10.35	51.75	103.5	207
Methylene Chloride	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Allyl Chloride	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Trichlorotrifluoroethane	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
Carbon Disulfide	0.208	0.416	1.040	2.08	10.40	52.00	104.0	208
trans-1,2-Dichloroethene	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
1,1-Dichloroethane	0.107	0.214	0.535	1.07	5.35	26.75	53.5	107
Methyl tert-Butyl Ether	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
Vinyl Acetate	0.549	1.098	2.745	5.49	27.45	137.25	274.5	549
2-Butanone (MEK)	0.206	0.412	1.030	2.06	10.30	51.50	103.0	206
cis-1,2-Dichloroethene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Diisopropyl Ether	0.209	0.418	1.045	2.09	10.45	52.25	104.5	209
Ethyl Acetate	0.208	0.416	1.040	2.08	10.40	52.00	104.0	208
n-Hexane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Chloroform	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
<b>1,2-Dichloroethane-d4 (S)</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>
Tetrahydrofuran	0.204	0.408	1.020	2.04	10.20	51.00	102.0	204
Ethyl tert-Butyl Ether	0.208	0.416	1.040	2.08	10.40	52.00	104.0	208
1,2-Dichloroethane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
<b>1,4-Difluorobenzene (IS2)</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>
1,1,1-Trichloroethane	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103



**Table 3 - Continued  
Standard Concentrations (SCAN) (Primary Sources)<sup>1</sup>**

Compound Name	0.1ng	0.2ng	0.5ng	1.0ng	5.0ng	25ng	50ng	100ng
Benzene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Carbon Tetrachloride	0.102	0.204	0.510	1.02	5.10	25.50	51.0	102
Cyclohexane	0.207	0.414	1.035	2.07	10.35	51.75	103.5	207
tert-Amyl Methyl Ether	0.207	0.414	1.035	2.07	10.35	51.75	103.5	207
1,2-Dichloropropane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Bromodichloromethane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Trichloroethene	0.102	0.204	0.510	1.02	5.10	25.50	51.0	102
1,4-Dioxane	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
Isooctane	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
Methyl Methacrylate	0.208	0.416	1.040	2.08	10.40	52.00	104.0	208
n-Heptane	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
cis-1,3-Dichloropropene	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
4-Methyl-2-Pentanone	0.208	0.416	1.040	2.08	10.40	52.00	104.0	208
trans-1,3-Dichloropropene	0.102	0.204	0.510	1.02	5.10	25.50	51.0	102
1,1,2-Trichloroethane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
<b>Chlorobenzene-d5 (IS3)</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>
<b>Toluene-d8 (S)</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>
Toluene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
2-Hexanone	0.206	0.412	1.030	2.06	10.30	51.50	103.0	206
Dibromochloromethane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
1,2-Dibromoethane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
n-Butyl Acetate	0.207	0.414	1.035	2.07	10.35	51.75	103.5	207
n-Octane	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Tetrachloroethene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
Chlorobenzene	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
Ethylbenzene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
m- & p-Xylene	0.209	0.418	1.045	2.09	10.45	52.25	104.5	209
Bromoform	0.106	0.212	0.530	1.06	5.30	26.50	53.0	106
Styrene	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
o-Xylene	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
n-Nonane	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
1,1,2,2-Tetrachloroethane	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
<b>4-Bromofluorobenzene (S)</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>	<b>12.5</b>
Cumene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
alpha-Pinene	0.106	0.212	0.530	1.06	5.30	26.50	53.0	106
n-Propylbenzene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
4-Ethyltoluene	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
1,3,5-Trimethylbenzene	0.105	0.210	0.525	1.05	5.25	26.25	52.50	105
1,2,4-Trimethylbenzene	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
Benzyl Chloride	0.210	0.420	1.050	2.10	10.50	52.50	105.0	210
1,3-Dichlorobenzene	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105



**Table 3 - Continued**  
**Standard Concentrations (SCAN) (Primary Sources)<sup>1</sup>**

Compound Name	0.1ng	0.2ng	0.5ng	1.0ng	5.0ng	25ng	50ng	100ng
1,4-Dichlorobenzene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
sec-Butylbenzene	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
p-Isopropyltoluene	0.102	0.204	0.510	1.02	5.10	25.50	51.0	102
1,2-Dichlorobenzene	0.105	0.210	0.525	1.05	5.25	26.25	52.5	105
d-Limonene	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
1,2-Dibromo-3-Chloropropane	0.200	0.400	1.000	2.00	10.00	50.00	100.0	200
1,2,4-Trichlorobenzene	0.200	0.400	1.000	2.00	10.00	50.00	100.0	200
Naphthalene	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
Hexachlorobutadiene	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
tert-Butylbenzene	0.104	0.208	0.520	1.04	5.20	26.00	52.0	104
n-Butylbenzene	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103
1,1,1,2-Tetrachloroethane	0.103	0.206	0.515	1.03	5.15	25.75	51.5	103

**Note 1:** The concentrations detailed in this table may change with each standard purchased or internally prepared. Refer to the appropriate initial calibration file, where necessary for the corresponding concentrations.





**Table 3A - Standard Concentrations (SIM) (Primary Sources)<sup>1</sup>**

Compound Name	20pg	50pg	100pg	500pg	1000pg	5000pg	10,000pg	25,000pg	50,000pg
Freon-12	20.8	52.0	104	520	1040	5200	10400	26000	52000
Chloromethane	20.8	52.0	104	520	1040	5200	10400	26000	52000
Vinyl Chloride	21.0	52.5	105	525	1050	5250	10500	26250	52500
1,3-Butadiene	20.8	52.0	104	520	1040	5200	10400	26000	52000
Bromomethane	20.8	52.0	104	520	1040	5200	10400	26000	52000
Chloroethane	20.8	52.0	104	520	1040	5200	10400	26000	52000
Acrolein	43.6	109.0	218	1090	2180	10900	21800	54500	109000
Acetone	103.2	258.0	516	2580	5160	25800	51600	129000	258000
Freon-11	20.4	51.0	102	510	1020	5100	10200	25500	51000
1,1-Dichloroethene	20.8	52.0	104	520	1040	5200	10400	26000	52000
Methylene Chloride	20.8	52.0	104	520	1040	5200	10400	26000	52000
Freon-113	21.0	52.5	105	525	1050	5250	10500	26250	52500
trans-1,2-Dichloroethene	21.0	52.5	105	525	1050	5250	10500	26250	52500
1,1-Dichloroethane	21.4	53.5	107	535	1070	5350	10700	26750	53500
Methyl tert-Butyl Ether	20.6	51.5	103	515	1030	5150	10300	25750	51500
cis-1,2-Dichloroethene	20.8	52.0	104	520	1040	5200	10400	26000	52000
Chloroform	21.0	52.5	105	525	1050	5250	10500	26250	52500
1,2-Dichloroethane	20.8	52.0	104	520	1040	5200	10400	26000	52000
1,1,1-Trichloroethane	20.6	51.5	103	515	1030	5150	10300	25750	51500
Benzene	20.8	52.0	104	520	1040	5200	10400	26000	52000
Carbon Tetrachloride	20.4	51.0	102	510	1020	5100	10200	25500	51000
1,2-Dichloropropane	20.8	52.0	104	520	1040	5200	10400	26000	52000
Bromodichloromethane	20.8	52.0	104	520	1040	5200	10400	26000	52000
Trichloroethene	20.4	51.0	102	510	1020	5100	10200	25500	51000
1,4-Dioxane	20.6	51.5	103	515	1030	5150	10300	25750	51500
cis-1,3-Dichloropropene	21.0	52.5	105	525	1050	5250	10500	26250	52500
trans-1,3-Dichloropropene	20.4	51.0	102	510	1020	5100	10200	25500	51000
1,1,2-Trichloroethane	20.8	52.0	104	520	1040	5200	10400	26000	52000
Toluene	20.8	52.0	104	520	1040	5200	10400	26000	52000
Dibromochloromethane	20.8	52.0	104	520	1040	5200	10400	26000	52000
1,2-Dibromoethane	20.8	52.0	104	520	1040	5200	10400	26000	52000
Tetrachloroethene	20.8	52.0	104	520	1040	5200	10400	26000	52000
Chlorobenzene	20.6	51.5	103	515	1030	5150	10300	25750	51500
Ethylbenzene	20.8	52.0	104	520	1040	5200	10400	26000	52000
m,p-Xylenes	41.8	104.5	209	1045	2090	10450	20900	52250	104500
Styrene	20.6	51.5	103	515	1030	5150	10300	25750	51500
o-Xylene	21.0	52.5	105	525	1050	5250	10500	26250	52500
1,1,2,2-Tetrachloroethane	21.0	52.5	105	525	1050	5250	10500	26250	52500
1,3,5-Trimethylbenzene	21.0	52.5	105	525	1050	5250	10500	26250	52500
1,2,4-Trimethylbenzene	20.6	51.5	103	515	1030	5150	10300	25750	51500
1,3-Dichlorobenzene	21.0	52.5	105	525	1050	5250	10500	26250	52500
1,4-Dichlorobenzene	20.8	52.0	104	520	1040	5200	10400	26000	52000
1,2-Dichlorobenzene	21.0	52.5	105	525	1050	5250	10500	26250	52500
1,2-Dibromo-3-chloropropane	40.0	100.0	200	1000	2000	10000	20000	50000	100000
1,2,4-Trichlorobenzene	40.0	100.0	200	1000	2000	10000	20000	50000	100000
Naphthalene	20.6	51.5	103	515	1030	5150	10300	25750	51500
Hexachloro-1,3-butadiene	20.6	51.5	103	515	1030	5150	10300	25750	51500

**Table 3A - Standard Concentrations (SIM) (Primary Sources)<sup>1</sup> - Continued**

Compound Name	20pg	50pg	100pg	500pg	1000pg	2000pg	5000pg	10,000pg
Bromobenzene	21.0	52.5	105	525	1050	2100	5250	10500

Note 1: The concentrations detailed in Table 3A may change with each standard purchased or internally prepared. Refer to the appropriate initial calibration file, where necessary for the corresponding concentrations.

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Table 4 - Standard Concentrations (SCAN) (Secondary Sources)<sup>1</sup>

Compound Name	25ng	Compound Name	25ng	Compound Name	25ng
Bromochloromethane (IS1)	12.5	1,1,1-Trichloroethane	25.75	4-Ethyltoluene	26.25
Propene	26.25	Benzene	25.50	1,3,5-Trimethylbenzene	25.75
Dichlorodifluoromethane (CFC 12)	26.25	Carbon Tetrachloride	26.25	1,2,4-Trimethylbenzene	25.50
Chloromethane	25.75	Cyclohexane	52.00	Benzyl Chloride	50.25
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	27.00	tert-Amyl Methyl Ether	52.25	1,3-Dichlorobenzene	25.75
Vinyl Chloride	26.00	1,2-Dichloropropane	25.75	1,4-Dichlorobenzene	25.50
1,3-Butadiene	26.25	Bromodichloromethane	26.25	sec-Butylbenzene	25.75
Bromomethane	25.50	Trichloroethene	25.75	p-Isopropyltoluene	25.75
Chloroethane	25.50	1,4-Dioxane	26.00	1,2-Dichlorobenzene	25.75
Ethanol	124.75	Isooctane	26.50	d-Limonene	26.00
Acetonitrile	25.25	Methyl Methacrylate	52.00	1,2-Dibromo-3-Chloropropane	48.25
Acrolein	54.50	n-Heptane	26.25	1,2,4-Trichlorobenzene	48.50
Acetone	129.00	cis-1,3-Dichloropropene	26.25	Naphthalene	24.75
Trichlorofluoromethane	25.50	4-Methyl-2-Pentanone	52.00	Hexachlorobutadiene	26.25
Isopropyl Alcohol	51.00	trans-1,3-Dichloropropene	25.25	tert-Butylbenzene	25.75
Acrylonitrile	51.25	1,1,2-Trichloroethane	25.75	n-Butylbenzene	25.75
1,1-Dichloroethene	26.50	<b>Chlorobenzene-d5 (IS3)</b>	<b>12.5</b>	1,1,1,2-Tetrachloroethane	25.75
tert-Butanol	52.25	<b>Toluene-d8 (S)</b>	<b>12.5</b>		
Methylene Chloride	26.00	Toluene	25.75		
Allyl Chloride	26.25	2-Hexanone	50.50		
Trichlorotrifluoroethane	26.75	Dibromochloromethane	26.25		
Carbon Disulfide	53.50	1,2-Dibromoethane	26.00		
trans-1,2-Dichloroethene	26.50	Butyl Acetate	50.75		
1,1-Dichloroethane	26.50	n-Octane	26.25		
Methyl tert-Butyl Ether	26.50	Tetrachloroethene	25.75		
Vinyl Acetate	137.50	Chlorobenzene	25.75		
2-Butanone (MEK)	51.50	Ethylbenzene	25.75		
cis-1,2-Dichloroethene	26.00	m- & p-Xylene	51.50		
Diisopropyl Ether	53.00	Bromoform	26.00		
Ethyl Acetate	52.75	Styrene	25.75		
n-Hexane	26.50	o-Xylene	25.75		
Chloroform	26.75	n-Nonane	26.00		
<b>1,2-Dichloroethane-d4 (S)</b>	<b>12.5</b>	1,1,2,2-Tetrachloroethane	25.75		
Tetrahydrofuran	50	<b>4-Bromofluorobenzene (S)</b>	<b>12.5</b>		
Ethyl tert-Butyl Ether	52.50	Cumene	26.00		
1,2-Dichloroethane	26.00	alpha-Pinene	26.75		
<b>1,4-Difluorobenzene(IS2)</b>	<b>12.5</b>	n-Propylbenzene	26.00		


**Note 1:** The concentrations detailed in this table may change with each standard purchased or internally prepared. Refer to the appropriate initial calibration file, where necessary for the corresponding concentrations.



**Table 4A - ICV/LCS Standard Concentrations (SIM) (Secondary Sources)<sup>1</sup>**

Compound Name	1000pg
Freon-12	1050
Chloromethane	1030
Vinyl Chloride	1040
1,3-Butadiene	1050
Bromomethane	1020
Chloroethane	1020
Acrolein	2180
Acetone	5160
Freon-11	1020
1,1-Dichloroethene	1060
Methylene Chloride	1040
Freon-113	1070
trans-1,2-Dichloroethene	1060
1,1-Dichloroethane	1060
Methyl tert-Butyl Ether	1060
cis-1,2-Dichloroethene	1040
Chloroform	1070
1,2-Dichloroethane	1040
1,1,1-Trichloroethane	1030
Benzene	1020
Carbon Tetrachloride	1050
1,2-Dichloropropane	1030
Bromodichloromethane	1050
Trichloroethene	1030
1,4-Dioxane	1040
cis-1,3-Dichloropropene	1050
trans-1,3-Dichloropropene	1010
1,1,2-Trichloroethane	1030
Toluene	1030
Dibromochloromethane	1050
1,2-Dibromoethane	1040
Tetrachloroethene	1030
Chlorobenzene	1030
Ethylbenzene	1030
m,p-Xylenes	2060
Styrene	1030
o-Xylene	1030
1,1,2,2-Tetrachloroethane	1030
1,3,5-Trimethylbenzene	1030
1,2,4-Trimethylbenzene	1020
1,3-Dichlorobenzene	1030
1,4-Dichlorobenzene	1020
1,2-Dichlorobenzene	1030
1,2-Dibromo-3-chloropropane	1930
1,2,4-Trichlorobenzene	1940
Naphthalene	990
Hexachloro-1,3-butadiene	1050
Bromobenzene	1040

**Note 1:** The concentrations detailed in this table may change with each standard purchased or internally prepared. Refer to the appropriate initial calibration file, where necessary for the corresponding concentrations.

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Attachment 1  
Training Plan

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### Training Plan for Analysis of VOCs by GC/MS

Trainee \_\_\_\_\_ Trainer \_\_\_\_\_ Instrument \_\_\_\_\_ Training Completion Date \_\_\_\_\_

1. Read SOP *Training Duration* \_\_\_\_\_ Trainer \_\_\_\_ Trainee \_\_\_\_ Date \_\_\_\_\_
2. Read Methods TO-14A & TO-15 *Training Duration* \_\_\_\_\_ Trainer \_\_\_\_ Trainee \_\_\_\_ Date \_\_\_\_\_
3. Demonstrated understanding of the scientific basis of the analysis  
 Whole air sample preconcentration techniques  
 Gas chromatography *Training Duration* \_\_\_\_\_  
 Mass spectrometry
4. Demonstrated familiarity with related SOPs  
 SOP for Batches and Sequences; Rev. \_\_\_\_  
 SOP for Making Entries onto Analytical Records; Rev. \_\_\_\_ *Training Duration* \_\_\_\_\_  
 SOP for Manual Integration; Rev. \_\_\_\_\_  
 SOP for Significant Figures; Rev. \_\_\_\_  
 SOP for Nonconformance and Corrective Action; Rev. \_\_\_\_  
 SOP for Performing MDL Studies and Establishing Limits of Detection and Quantitation; Rev. \_\_\_\_  
 SOP for Cleaning and Certification of Summa Canisters; Rev. \_\_\_\_
5. Observe performance of SOP *Training Duration* \_\_\_\_\_ Trainer \_\_\_\_ Trainee \_\_\_\_ Date \_\_\_\_\_  
 \_\_\_ sample preparation/dilution and sample loading and analysis  
 \_\_\_ analytical sequence setup  
 \_\_\_ standard preparation  
 \_\_\_ BFB tuning evaluation  
 \_\_\_ initial calibration (model, calculations, manual integrations)/initial calibration verification  
 \_\_\_ manual integrations  
 \_\_\_ continuing calibration verification  
 \_\_\_ EnviroQuant introduction (recognizing saturation and sensitivity issues)  
 \_\_\_ data reduction and reporting including reporting req. for various agencies, autotexts, documentation  
 \_\_\_ canister and bag handling (including leakers)
6. Perform SOP with supervision *Training Duration* \_\_\_\_\_ Trainer \_\_\_\_ Trainee \_\_\_\_ Date \_\_\_\_\_  
 \_\_\_ sample preparation/dilution and sample loading and analysis  
 \_\_\_ analytical sequence setup  
 \_\_\_ standard preparation  
 \_\_\_ BFB tuning evaluation  
 \_\_\_ initial calibration (model, calculations, manual integrations)/initial calibration verification  
 \_\_\_ manual integrations  
 \_\_\_ continuing calibration verification  
 \_\_\_ EnviroQuant use (recognizing saturation and sensitivity issues)  
 \_\_\_ data reduction and reporting including reporting req. for various agencies, autotexts, documentation  
 \_\_\_ canister and bag handling (including leakers)
7. Independent performance of the SOP *Training Duration* \_\_\_\_\_ Trainer \_\_\_\_ Trainee \_\_\_\_ Date \_\_\_\_\_  
 \_\_\_ sample preparation/dilution and sample loading and analysis  
 \_\_\_ analytical sequence setup  
 \_\_\_ standard preparation  
 \_\_\_ BFB tuning evaluation  
 \_\_\_ initial calibration (model, calculations, manual integrations)/initial calibration verification  
 \_\_\_ manual integrations  
 \_\_\_ continuing calibration verification  
 \_\_\_ EnviroQuant proficiency (recognizing saturation and sensitivity issues)  
 \_\_\_ data reduction and reporting including reporting req. for various agencies, autotexts, documentation  
 \_\_\_ canister and bag handling (including leakers)  
 \_\_\_ initial demonstration of competency (4 Laboratory Control Samples)
8. Instrument operation and maintenance  
 \_\_\_ autosampler Trainer \_\_\_\_ Trainee \_\_\_\_ Date \_\_\_\_\_  
 \_\_\_ GC and capillary column installation *Training Duration* \_\_\_\_\_  
 \_\_\_ mass spectrometer *Training Duration* \_\_\_\_\_  
 \_\_\_ data system *Training Duration* \_\_\_\_\_

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Attachment 2  
Initial Calibration Checklist

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**Initial Calibration Review Checklist - EPA Compendium Method TO-15**

ICAL Date: \_\_\_\_\_ ICAL ID: \_\_\_\_\_ LIMS ICAL ID: \_\_\_\_\_

Instrument: MS9 MS13 MS16 MS19 MS21 MS22 MS25

Mode: SIM Scan Scan Low Level (0.1ng): Yes No

Analyst


Reviewer

1. Is the required documentation in the ICAL file? .....  
 BFB Tune analysis Report .....  
 Calibration Status Report (aka Calibration History) .....  
 Response Factor Report/Percent RSD .....  
 Quant Report for each calibration std (including manual integration documentation) .....  
 ICV Quantitation Report .....  
 TO-15 Standard Calculation Spreadsheet .....
2. Was the ICAL performed continuously (not interrupted for maintenance or sample analysis)? .....
3. Have all the calibration standards been analyzed within 24 hours of each other? .....
4. Does the BFB tune check standard analysis at the start meet the tune criteria? .....
5. Are all the analytes in the blank analysis <MRL? .....
6. Does each analyte's ICAL include a minimum of 5 concentrations at 5 consecutive levels? .....
7. Were the standards analyzed from low concentration to high concentration? .....
8. For each analyte, are there no levels skipped? .....
9. For each analyte, is there only one value used for each calibration level? .....
10. For each analyte, is the lowest standard's concentration at or below the analyte's MRL? .....
11. For each analyte, is the corresponding signal to noise ratio at least 3:1 at the lowest point on the curve? .....
12. For each analyte, are the corresponding upper levels free from saturation? .....
13. If a calibration level is dropped, are all the responses for each target analyte dropped and is the information noted in the ICAL explaining the reason? .....
14. Is the average RSD ≤30% for all analytes, with no more than two exceptions ≤40%? .....
15. DoD/Navy: Is the average RSD ≤30% for all analytes? .....
16. Is the response Y at each calibration level within 40% of the mean area response over the initial calibration range for each internal standard? .....
17. Percent recovery for each analyte in the ICV 70%-130% (AZ: 50-150% for VA)? .....
18. Was the RRT for each target compound at each calibration level within 0.06RRT units of the mean RRT for the compound? .....
19. Is the retention time shift for each of the internal standards at each calibration level within 20s of the mean retention time over the initial calibration range for each standard? .....
20. If there are any manual integrations, are they performed correctly according to the corresponding SOP? If so, initial and date the appropriate pages. ....
21. Is the ICAL good at 0.5ng (or 0.1ng)-100ng (Scan) or 10-20000pg (SIM) for all compounds?  
 Yes No Note exceptions and corresponding MRLs below - *Specify applicable range* .....
22. Are ALL of the peak selections for each analyte correct according to retention time (all RTs must be checked by both the initial and peer reviewer)? .....

COMMENTS:

Analyst: \_\_\_\_\_ Secondary Reviewer: \_\_\_\_\_



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Attachment 3  
Daily QC and Sample Review Checklists

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**EPA Compendium Method TO-15 - Sample Review Checklist**

(Note exceptions in Comments and include Analysis Observations/Case Narrative Summary Form as appropriate)

**Method:** EPA TO-15    EPA TO-14A    **Analysis Date:** \_\_\_\_\_    **Project #:** \_\_\_\_\_

**Instrument:**    MS9    MS13    MS16    MS19    MS21    MS22    MS25

**Mode:**    SIM    Scan    **Scan Low Level (0.1ng):**    Yes    No    **DOD:**    Yes    No

**Analyst**

**Reviewer**

1. All analyte hits in the samples within the **calibration range** and/or noted? .....
2. All **peak integrations** acceptable? .....
3. All **manual integrations** flagged and documented? .....
4. Have **Q values** been verified for each peak? .....
5. All **calculations** correct? .....
6. Has the analyst initialed and dated each **quantitation report**? .....
7. For **TICs** are the relative intensity and other requirements met (associated MB reported)? .....
8. **Auto report** correct? .....
9. **MRL** = \_\_\_\_\_ ng    pg (ethanol, acetone, vinyl acetate = 5.0ng) .....
10. Pressurized with **Helium**? Is the worksheet completed for all samples? .....
11. Report to **MDL**?    Yes    No .....
12. **Global Minimum Detection Limit** = \_\_\_\_\_ ng    pg .....
13. **DOD:** Are **manual integrations** notated in the **case narrative**? .....

**Air-Phase Petroleum Hydrocarbons**


1. Are all manual **integrations** flagged and documented (except for HC ranges)? .....
2. Are the associated ICAL responses correct? .....
3. Does the lab **duplicate** meet RPD  $\leq 30\%$  for results  $> 5x$  the MRL? Otherwise, repeat analyses if: .....

RPD $> 30$ (where both analyses are $> 5x$ RL	1 <sup>st</sup> analysis detect @ $> 5x$ MRL, Dup=ND
1 <sup>st</sup> analysis $\leq 5x$ RL; Dup=ND (RPD not calculable)	

**COMMENTS:**

1. **CASE NARRATIVE COMPLETED?** .....

Analyst/LIMS Run Approval: \_\_\_\_\_ Secondary/LIMS Supervisor Approval: \_\_\_\_\_

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Attachment 4

State and Project Specific Requirements


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Minnesota Requirements	
Item	Criteria
Holding Time (HT)	14 days
Tedlar bags	Not allowed for sampling or sample dilution
Canisters and flow controllers	Individually certified Individually leak checked before shipment
	<p>Samples with concentrations outside of the calibration curve will have a zero canister analysis performed to check for carryover. If carryover is detected, system bake out shall be performed and documented.</p> <p>Additionally, in instances where the laboratory has evidence on file that a particular compound when present at a high concentration does not exhibit carry-over, the samples will not be reanalyzed.</p> <p>When samples are analyzed that have a higher concentration than the evidence on file, the above requirements must be followed.</p> <p>Also, samples that have hits below the MRL will not be reanalyzed when analyzed after a sample with concentrations over the calibration range.</p>
Method Reporting Verification Check	Analyze a Method Reporting Verification at the beginning of the sequence prior to analyzing samples. Acceptance criteria $\pm 40\%$ .
Duplicates	10 percent laboratory duplicates
Record retention	MN/NELAP 5 years MPCA (Minnesota Pollution Control Agency) compliant samples 10 years
Tier level	TIII

Arizona Requirements	
Item	Criteria
LCS	70-130% (vinyl acetate 50-150%)

Department of Toxic Substances Control (DTSC) Requirements	
Item	Criteria
Holding Time (HT)	30 day hold time for canisters

	STANDARD OPERATING PROCEDURE	VOCs in Air by GC/MS
	ALS   Environmental - Simi Valley	VOA-TO15, Rev. 27.0
		Effective 12/14/2020
		Page 81 of 83

Attachment 5

Tekmar AutoCan Trap Packing Instructions

PROPRIETARY - UNCONTROLLED COPY

### Tekmar AutoCan Trap Packing Instructions

The internal sample trap on the AutoCan is a 1/8" x 12" thin-walled stainless steel tube, usually coated with fused silica (Silcosteel). It is packed with a combination of graphitized carbon black and carbon molecular sieve adsorbents, with the weakest adsorbent at the top (inlet) and the strongest at the bottom (outlet). Each bed is separated by a small plug of untreated glass wool. Untreated is used because DCMS-treated wool will release siloxanes when heated to the temperatures used for TO-15 analysis.

The adsorbents listed below are further refined at the lab by sifting in an 80-mesh sieve. This removes the smaller particles and leaves a very uniform product of about 60-mesh size. Getting rid of the "fines" helps ensure good flow through the trap during sampling and reduces the pressure drop across the trap. A tightly-packed trap can lead to problems such as poor reproducibility, slowed flow rates, and channeling (small spaces in the beds that let analytes pass through).

Adsorbent	Mesh	Supplier	Catalog #	Packing Amount (mg)
Carbosieve SIII	60/80	Supelco	10184	40
Carbosieve G	60/80	Supelco	10198	30
Carbopack Z	60/80	Supelco	20273	30
Tenax TA	20/30 or 45/60	Supelco	10257	rest of trap

Old traps can be reused if unpacked carefully and cleaned and baked out properly. Use a glass wool puller to remove the wool plugs, and gently tap the sorbent out onto a piece of paper. If necessary, use the other end of the puller to loosen the sorbent bed, being careful not to scratch the inside of the trap. Discard the old sorbent. Rinse the empty trap with methanol, then bake in a GC oven for 30 minutes at 150°C.

The total length of the adsorbent bed is 12 to 13cm. You want to leave 2 to 3cm of space above the top of the last glass wool layer to ensure that all of the material is within the heated zone of the AutoCan trap heater.


With clean hands (no lotion!) place a small amount of glass wool, about 10-15mg, into the top of the trap and work it in with a piece of wire or tubing. Then use the trap packing tool (the larger steel rod that just barely fits inside the trap) to hold the plug in the trap while you pull away any loose strands of wool. Then use the long steel tube to push the plug down about 15cm. The idea is to keep the plug very compact, so it is a good idea to use the trap packing tool to push up from the bottom while pushing the wool in from the top, meeting 15cm down. The plug should not move too easily when pushed.

Weigh out the first sorbent (Carbosieve SIII) on weighing paper using the analytical balance. Using the glass funnel and a short piece of silicone tubing, pour the sorbent into the top of the trap. Tap on counter to get it all out of the funnel, then remove the funnel and tap some more to settle the sorbent into a compact bed. It is very important that there are no air spaces in the bed. However, it is also very important not to compress the sorbents too much, so be very careful when placing the glass wool plugs.

Place a glass wool plug on top of the first bed, starting as described above for the first plug. Push it gently onto the top of the sorbent with very little pressure.

Proceed with the other three packings in the table above (Carbosieve G, Carbopack Z, and Tenax TA).

After placing the last glass wool plug on top, turn the trap over and gently tap it on a piece of white paper to see if any sorbent comes out. If it does, you need to add more glass wool.

	STANDARD OPERATING PROCEDURE	VOCs in Air by GC/MS
	ALS   Environmental - Simi Valley	VOA-TO15, Rev. 27.0
		Effective 12/14/2020
		Page 83 of 83

Now the trap needs to be conditioned in the trap heater. The sorbent manufacturers recommend that they be conditioned at succeeding higher temperatures, with the final temperature being about 20-30°C higher than the desorb temperature. The reason is that the sieves hold a lot of air and moisture and it is better to drive these off at lower temperatures to avoid damage to the material, such as cracking and oxidation which creates active sites. The temperatures and times are:

- 80°C for 30 minutes, 50 to 100 ml/min nitrogen flow
- 200°C for 30 minutes
- 265°C for at least 3 hours

These temperatures are set using the variable power controller and thermocouple meter. Repeat for the other temperatures (low to high). Make sure the gas toggle valve in back is open, and measure flow at the top of the trap.

PROPRIETARY - UNCONTROLLED COPY



## **Example Field Forms**

## Sub Slab Vapor / Soil Gas Sample Collection Form

Project Name: \_\_\_\_\_ Project Number: \_\_\_\_\_  
 Client: \_\_\_\_\_ Sample Number: \_\_\_\_\_  
 Landau Rep: \_\_\_\_\_ Date/Time Collected: \_\_\_\_\_  
 Location Information: \_\_\_\_\_

**SAMPLE TYPE**

Sub Slab Vapor   
  Soil Gas   
  Other: \_\_\_\_\_

**WEATHER DATA**

Rainfall < 1" in 24 hrs.? (YES or NO)   
 Irrigation not w/in 5 hrs.? (YES or NO)   
 Standing water near sampling location? (YES or NO)  
 Air Temperature \_\_\_\_\_ °F or °C   
 Wind Direction \_\_\_\_\_   
 Wind Speed \_\_\_\_\_ mph   
 Humidity \_\_\_\_\_ %  
 Barometric Pressure \_\_\_\_\_ in HG or mBar   
 Is sampling occurring after frontal system during stable pressure? (YES or NO)

**SOIL GAS AND SUB SLAB INFORMATION AND AND PURGE DATA**

Nature of Location: PERMENANT or TEMPORARY (circle one)   
 Post-Run Tubing (PRT)   
 Soil Gas Monitoring Well   
 Other: \_\_\_\_\_  
 Installation Method :  Direct Push Drill Rig   
 Hollow Stem Auger   
 Rotasonic   
 Other: \_\_\_\_\_  
 Hand Driven   
 Rotohammer   
 Vapor Pin   
 Manufacturer: \_\_\_\_\_

If Permanent, Is Well Secure? (YES or NO or NA)   
 Damaged (YES or NO)   
 YES-Describe: \_\_\_\_\_

Materials:  PVC Pipe   
 Stainless Steel   
 Teflon   
 Nylon or Polyethylene Tubing   
 Other: \_\_\_\_\_

Well/Hole Diameter: \_\_\_\_\_ inches   
 Total Depth of Well: \_\_\_\_\_ ft   
 Depth to Groundwater: \_\_\_\_\_ ft

Vacuum/Pressure of source (in. H<sub>2</sub>O): \_\_\_\_\_   
 Time: \_\_\_\_\_

Purge Volume Calculation: \_\_\_\_\_

Purge: Begin Time \_\_\_\_\_ End Time \_\_\_\_\_ Casing Volume (ft<sup>3</sup>): \_\_\_\_\_

Flow Rate (liter or ml/min): \_\_\_\_\_ Volume Purged (ft<sup>3</sup>): \_\_\_\_\_

Vol. Purged (ft<sup>3</sup>)   
 Temp. (°F/°C)   
 PID (ppm)   
 Other   
 Comments/Observations

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

VOLUME EXAMPLES			
Diameter (in)	OD (in)	ID (in)	Vol (ft <sup>3</sup> /ln ft)
0.25 (tubing)	0.250	0.170	0.00016
1 (sch. 40)	1.315	1.029	0.006
1.25 (sch. 40)	1.660	1.380	0.010
2 (sch. 40)	2.375	2.067	0.020

**LEAK TEST OPTIONS**

Shut-in Test   
 Starting Vacuum: \_\_\_\_\_ in H<sub>2</sub>O (target 100 inches H<sub>2</sub>O)   
 Test Duration: \_\_\_\_\_ minutes (target > 1 min)  
 Ending Vacuum: \_\_\_\_\_ in H<sub>2</sub>O (target no noticable vacuum decrease)   
 Result: PASS FAIL (circle one)  
 Helium   
 Shroud Design: \_\_\_\_\_   
 Helium Source Concentration: \_\_\_\_\_  
 Shroud Tracer Concentration Fluctuation: \_\_\_\_\_ % (target ± 10%)   
 Tracer Equilibration Time: \_\_\_\_\_ (target min. 5 min)  
 Sample Air Tracer Concentration: \_\_\_\_\_ % of Shroud Conc. (target <5%)  
 Water Bath (vapor pins only)

**SAMPLE COLLECTION DATA**

Sample Container:  Summa Canister, Size (liters) \_\_\_\_\_ Canister #: \_\_\_\_\_   
 Tedlar Bag, Size (liters): \_\_\_\_\_  
 Passive / Diffusive   
 Manufacturer: \_\_\_\_\_   
 Other: \_\_\_\_\_  
 Sample Type:  Grab   
 Integrated (composite sample over time)

Sample Collection/Purge Pump (if used): \_\_\_\_\_

Summa Canister, Pre-Sampling and Post-Sampling:   
 Initial Vacuum: \_\_\_\_\_ in Hg   
 Vacuum After Sample Collection: \_\_\_\_\_ in Hg

LABORATORY ANALYSES: \_\_\_\_\_

Duplicate Sample Number(s) and Comments: \_\_\_\_\_

\_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_







# Air - Chain of Custody Record & Analytical Service Request

2655 Park Center Drive, Suite A  
 Simi Valley, California 93065  
 Phone (805) 526-7161  
 Fax (805) 526-7270

<b>Requested Turnaround Time in Business Days (Surcharges) please circle</b> 1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard	ALS Project No.
--	-----------------

Company Name & Address (Reporting Information)				Project Name					ALS Contact:		<b>Comments</b> e.g. Actual Preservative or specific instructions
				Project Number					<b>Analysis Method</b>		
Project Manager				P.O. # / Billing Information							
Phone		Fax									
Email Address for Result Reporting				Sampler (Print & Sign)							

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code #- FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume			

<b>Report Tier Levels - please select</b>						Project Requirements (MRLs, QAPP)		
Tier I - Results (Default if not specified) _____		Tier III (Results + QC & Calibration Summaries) _____		EDD required Yes / No			Chain of Custody Seal: (Circle) INTACT    BROKEN    ABSENT	
Tier II (Results + QC Summaries) _____		Tier IV (Data Validation Package) 10% Surcharge _____		Type: _____ Units: _____				
Relinquished by: (Signature)			Date:	Time:	Received by: (Signature)		Date:	Time:
Relinquished by: (Signature)			Date:	Time:	Received by: (Signature)		Date:	Time:
Cooler / Blank Temperature _____ °C								

# Laboratory Analytical Report



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2655 Park Center Dr., Suite A  
Simi Valley, CA 93065  
T: +1 805 526 7161  
[www.alsglobal.com](http://www.alsglobal.com)

## LABORATORY REPORT

November 8, 2021

Stephanie Renando  
Landau Associates, Inc.  
130 2nd Ave. South  
Edmonds, WA 98020

**RE: C-19 Indoor Air Evaluation / 0222027.030.032**

Dear Stephanie:

Your report P2105652 has been amended for the samples submitted to our laboratory on October 26, 2021. Both methods were reprocessed to report down to the Method Detection Limit (MDL) and the scan method was corrected to report the same list as for the SIM method. The changes have been indicated by the "Revised Report" footer located at the bottom right corner of each page.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at [www.alsglobal.com](http://www.alsglobal.com). Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

**ALS | Environmental**

*By Sue Anderson at 4:58 pm, Nov 08, 2021*

Sue Anderson  
Project Manager



2655 Park Center Dr., Suite A  
Simi Valley, CA 93065  
T: +1 805 526 7161  
[www.alsglobal.com](http://www.alsglobal.com)

Client: Landau Associates, Inc.  
Project: C-19 Indoor Air Evaluation / 0222027.030.032

Service Request No: P2105652

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## CASE NARRATIVE

The samples were received intact under chain of custody on October 26, 2021 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

### Volatile Organic Compound Analysis

One sample was analyzed in scan mode and four samples were analyzed in SIM mode for volatile organic compounds in accordance with EPA Method TO-15 from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition (EPA/625/R-96/010b), January, 1999. This procedure is described in laboratory SOP VOA-TO15. The analytical system was comprised of a gas chromatograph / mass spectrometer (GC/MS) interfaced to a whole-air preconcentrator. This method is included on the laboratory's NELAP and DoD-ELAP scope of accreditation. Any analytes flagged with an X are not included on the NELAP or DoD-ELAP accreditation.

The response for the #3 internal standard in sample IA01-C19-211022 (P2105652-001) was outside control criteria because of suspected matrix interference. The sample was diluted in an attempt to eliminate the effects of the matrix interference. The results were reported from the dilution; therefore, the associated method reporting limits have been elevated accordingly.

The containers were cleaned, prior to sampling, down to the method reporting limit (MRL) reported for this project. For projects requiring DoD QSM 5.3 compliance canisters were cleaned to <1/2 the MRL. Please note, projects which require reporting below the MRL could have results between the MRL and method detection limit (MDL) that are biased high.

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*The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.*

*Use of ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.*





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ALS Environmental – Simi Valley

CERTIFICATIONS, ACCREDITATIONS, AND REGISTRATIONS

Agency	Web Site	Number
Alaska DEC	<a href="http://dec.alaska.gov/eh/lab.aspx">http://dec.alaska.gov/eh/lab.aspx</a>	17-019
Arizona DHS	<a href="http://www.azdhs.gov/preparedness/state-laboratory/lab-licensure-certification/index.php#laboratory-licensure-home">http://www.azdhs.gov/preparedness/state-laboratory/lab-licensure-certification/index.php#laboratory-licensure-home</a>	AZ0694
Florida DOH (NELAP)	<a href="http://www.floridahealth.gov/licensing-and-regulation/environmental-laboratories/index.html">http://www.floridahealth.gov/licensing-and-regulation/environmental-laboratories/index.html</a>	E871020
Louisiana DEQ (NELAP)	<a href="http://www.deq.louisiana.gov/page/la-lab-accreditation">http://www.deq.louisiana.gov/page/la-lab-accreditation</a>	05071
Maine DHHS	<a href="http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/labCert.shtml">http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/labCert.shtml</a>	2018027
Minnesota DOH (NELAP)	<a href="http://www.health.state.mn.us/accreditation">http://www.health.state.mn.us/accreditation</a>	1776326
New Jersey DEP (NELAP)	<a href="http://www.nj.gov/dep/enforcement/oqa.html">http://www.nj.gov/dep/enforcement/oqa.html</a>	CA009
New York DOH (NELAP)	<a href="http://www.wadsworth.org/labcert/elap/elap.html">http://www.wadsworth.org/labcert/elap/elap.html</a>	11221
Oregon PHD (NELAP)	<a href="http://www.oregon.gov/oha/ph/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx">http://www.oregon.gov/oha/ph/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx</a>	4068-008
Pennsylvania DEP	<a href="http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx">http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx</a>	68-03307 (Registration)
PJLA (DoD ELAP)	<a href="http://www.pjlabs.com/search-accredited-labs">http://www.pjlabs.com/search-accredited-labs</a>	65818 (Testing)
Texas CEQ (NELAP)	<a href="http://www.tceq.texas.gov/agency/qa/env_lab_accreditation.html">http://www.tceq.texas.gov/agency/qa/env_lab_accreditation.html</a>	T104704413- 19-10
Utah DOH (NELAP)	<a href="http://health.utah.gov/lab/lab_cert_env">http://health.utah.gov/lab/lab_cert_env</a>	CA01627201 9-10
Washington DOE	<a href="http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html">http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html</a>	C946

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at [www.alsglobal.com](http://www.alsglobal.com), or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

# ALS ENVIRONMENTAL

## DETAIL SUMMARY REPORT

Client: Landau Associates, Inc.  
 Project ID: C-19 Indoor Air Evaluation / 0222027.030.032

Service Request: P2105652

Date Received: 10/26/2021  
 Time Received: 09:40

TO-15 - VOC SIM	TO-15 - VOC Cans
-----------------	------------------

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	Container ID	Pi1 (psig)	Pf1 (psig)	TO-15 - VOC SIM	TO-15 - VOC Cans
IA01-C19-211022	P2105652-001	Air	10/22/2021	19:24	AC01910	-1.04	3.85	X	
IA02-C19-211022	P2105652-002	Air	10/22/2021	19:26	AC02357	-1.02	3.92	X	
IA03-C19-211022	P2105652-003	Air	10/22/2021	19:30	AC02512	-1.60	3.83	X	
RISG-103-211022	P2105652-004	Air	10/22/2021	19:45	AC02162	-1.80	3.89		X
AA-C19-211022	P2105652-005	Air	10/22/2021	20:08	AC01466	-1.52	3.81	X	



# Air - Chain of Custody Record & Analytical Service Request

2655 Park Center Drive, Suite A  
 Simi Valley, California 93065  
 Phone (805) 526-7161

Requested Turnaround Time in Business Days (Surcharges) please circle  
 1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

ALS Project No. 2105652

Company Name & Address (Reporting Information) <u>Landau Associates, Inc.</u> <u>155 NW 100th St, Suite 302</u> <u>Seattle, WA 98125</u>		Project Name <u>E-19 Indoor Air Evaluation</u>			ALS Contact: <u>Sue Anderson</u>	
Project Manager <u>Jerry Ninteman/Stephanie Renando</u>		Project Number <u>0222057.030.032</u>			Analysis Method <u>TO-15 SIM</u>	
Phone <u>(509) 863-3900</u>		P.O. # / Billing Information <u>0222057.030.032</u>			Comments e.g. Actual Preservative or specific instructions  <u>TO-15 Scan</u>	
Fax _____		Send to <u>srenando@landauinc.com</u>				
Email Address for Result Reporting <u>srenando@landauinc.com, djorgensen@landauinc.com</u>		Sampler (Print & Sign) <u>Stephanie Renando</u>				

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code # - FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume		
<u>IA01-C19-211022</u>	<u>1</u>	<u>10/22/21</u>	<u>1924</u>	<u>AC01910</u>	<u>SFC00255</u>	<u>-30</u>	<u>-5</u>	<u>6L</u>	<u>X</u>	
<u>IA02-C19-211022</u>	<u>2</u>	<u>10/22/21</u>	<u>1926</u>	<u>AC02357</u>	<u>SFC00079</u>	<u>-30</u>	<u>-5</u>	<u>6L</u>	<u>X</u>	
<u>IA03-C19-211022</u>	<u>3</u>	<u>10/22/21</u>	<u>1930</u>	<u>AC02512</u>	<u>SFC00078</u>	<u>-27</u>	<u>-5</u>	<u>6L</u>	<u>X</u>	
<u>RISG-103-211022</u>	<u>7</u>	<u>10/22/21</u>	<u>1945</u>	<u>AC02162</u>	<u>0401451</u>	<u>-30</u>	<u>-5</u>	<u>6L</u>		<u>X</u>
<u>AA-C19-211022</u>	<u>7</u>	<u>10/22/21</u>	<u>2008</u>	<u>AC01466</u>	<u>SFC00486</u>	<u>-30</u>	<u>-5</u>	<u>6L</u>	<u>X</u>	

Report Tier Levels - please select				Chain of Custody Seal: (Circle)		Project Requirements (MRLs, QAPP)	
Tier I - Results (Default if not specified) _____		Tier III (Results + QC & Calibration Summaries) <u>X</u>		INTACT <u>X</u> BROKEN _____ ABSENT _____		MRL'S Sent via email by S. Renando	
Tier II (Results + QC Summaries) _____		Tier IV (Data Validation Package) 10% Surcharge _____		Type: <u>EQUS</u> Units: _____			
Relinquished by: (Signature) <u>[Signature]</u>		Date: <u>10/25/21</u>	Time: <u>1430</u>	Received by: (Signature) <u>[Signature]</u>		Date: <u>10/26/21</u>	Time: <u>0910</u>
Relinquished by: (Signature)		Date:	Time:	Received by: (Signature)		Date:	Temperature _____ °C

5 of 35

**ALS Environmental  
Sample Acceptance Check Form**

Client: Landau Associates, Inc. Work order: P2105652  
 Project: C-19 Indoor Air Evaluation / 0222027.030.032  
 Sample(s) received on: 10/26/21 Date opened: 10/26/21 by: ADAVID

*Note:* This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

- |   | Yes                                 | No                       | N/A                                 |
|---|-------------------------------------|--------------------------|-------------------------------------|
| 1 Were <b>sample containers</b> properly marked with client sample ID?  | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 2 Did <b>sample containers</b> arrive in good condition?  | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 3 Were <b>chain-of-custody</b> papers used and filled out?  | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 4 Did <b>sample container labels</b> and/or tags agree with custody papers?                                     | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 5 Was <b>sample volume</b> received adequate for analysis?  | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 6 Are samples within specified holding times?   | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 7 Was proper <b>temperature</b> (thermal preservation) of cooler at receipt adhered to?                         | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 8 Were <b>custody seals</b> on outside of cooler/Box/Container?   | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| Location of seal(s)? <u>Box sealing.</u> Sealing Lid?   | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| Were signature and date included?   | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| Were seals intact?  | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 9 Do containers have appropriate <b>preservation</b> , according to method/SOP or Client specified information? | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Is there a client indication that the submitted samples are <b>pH</b> preserved?                                | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Were <b>VOA vials</b> checked for presence/absence of air bubbles?  | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Does the client/method/SOP require that the analyst check the sample pH and <u>if necessary</u> alter it?       | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 10 <b>Tubes:</b> Are the tubes capped and intact?   | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 11 <b>Badges:</b> Are the badges properly capped and intact?  | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Are dual bed badges separated and individually capped and intact?   | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P2105652-001.01	6.0 L Ambient Can					
P2105652-002.01	6.0 L Ambient Can					
P2105652-003.01	6.0 L Ambient Can					
P2105652-004.01	6.0 L Ambient Can					
P2105652-005.01	6.0 L Ambient Can					

Explain any discrepancies: (include lab sample ID numbers): \_\_\_\_\_

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Sample ID:** RISG-103-211022

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

ALS Sample ID: P2105652-004

Test Code: EPA TO-15

Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13

Analyst: Jessie Macaluso

Sample Type: 6.0 L Summa Canister

Test Notes:

Container ID: AC02162

Date Collected: 10/22/21

Date Received: 10/26/21

Date Analyzed: 11/2/21

Volume(s) Analyzed: 1.00 Liter(s)

0.25 Liter(s)

Initial Pressure (psig): -1.80      Final Pressure (psig): 3.89

Canister Dilution Factor: 1.44

CAS #	Compound	Result	MRL	MDL	Result	MRL	MDL	Data
		µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	ppbV	ppbV	ppbV	Qualifier
75-01-4	Vinyl Chloride	ND	0.75	0.082	ND	0.29	0.032	
75-34-3	1,1-Dichloroethane	<b>3.9</b>	0.76	0.11	<b>0.96</b>	0.19	0.028	
156-59-2	cis-1,2-Dichloroethene	<b>0.71</b>	0.75	0.11	<b>0.18</b>	0.19	0.027	<b>J</b>
107-06-2	1,2-Dichloroethane	ND	0.76	0.085	ND	0.19	0.021	
71-55-6	1,1,1-Trichloroethane	<b>150</b>	0.75	0.095	<b>27</b>	0.14	0.017	
71-43-2	Benzene	<b>0.47</b>	0.72	0.11	<b>0.15</b>	0.23	0.035	<b>J</b>
79-01-6	Trichloroethene	<b>530</b>	3.0	0.41	<b>98</b>	0.56	0.077	<b>D</b>
123-91-1	1,4-Dioxane	<b>0.96</b>	0.75	0.091	<b>0.27</b>	0.21	0.025	
127-18-4	Tetrachloroethene	<b>3.1</b>	0.75	0.099	<b>0.46</b>	0.11	0.015	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

D = The reported result is from a dilution.

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Sample ID:** Method Blank

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

ALS Sample ID: P211102-MB

Test Code: EPA TO-15

Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13

Analyst: Jessie Macaluso

Sample Type: 6.0 L Summa Canister

Test Notes:

Date Collected: NA

Date Received: NA

Date Analyzed: 11/2/21

Volume(s) Analyzed: 1.00 Liter(s)

Canister Dilution Factor: 1.00

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	MDL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.52	0.057	ND	0.20	0.022	
75-34-3	1,1-Dichloroethane	ND	0.53	0.078	ND	0.13	0.019	
156-59-2	cis-1,2-Dichloroethene	ND	0.52	0.075	ND	0.13	0.019	
107-06-2	1,2-Dichloroethane	ND	0.53	0.059	ND	0.13	0.015	
71-55-6	1,1,1-Trichloroethane	ND	0.52	0.066	ND	0.095	0.012	
71-43-2	Benzene	ND	0.50	0.077	ND	0.16	0.024	
79-01-6	Trichloroethene	ND	0.52	0.072	ND	0.097	0.013	
123-91-1	1,4-Dioxane	ND	0.52	0.063	ND	0.14	0.017	
127-18-4	Tetrachloroethene	ND	0.52	0.069	ND	0.077	0.010	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

## SURROGATE SPIKE RECOVERY RESULTS

Page 1 of 1

**Client:** Landau Associates, Inc.  
**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

Test Code: EPA TO-15  
 Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13  
 Analyst: Jessie Macaluso  
 Sample Type: 6.0 L Summa Canister(s)  
 Test Notes:

Date(s) Collected: 10/22/21  
 Date(s) Received: 10/26/21  
 Date(s) Analyzed: 11/2/21

Client Sample ID	ALS Sample ID	1,2-Dichloroethane-d4	Toluene-d8	Bromofluorobenzene	Acceptance Limits	Data Qualifier
		Percent Recovered	Percent Recovered	Percent Recovered		
Method Blank	P211102-MB	<b>88</b>	<b>95</b>	<b>92</b>	70-130	
Lab Control Sample	P211102-LCS	<b>92</b>	<b>94</b>	<b>98</b>	70-130	
Duplicate Lab Control Sample	P211102-DLCS	<b>91</b>	<b>94</b>	<b>97</b>	70-130	
RISG-103-211022	P2105652-004	<b>83</b>	<b>98</b>	<b>100</b>	70-130	

Surrogate percent recovery is verified and accepted based on the on-column result.

Reported results are shown in concentration units and as a result of the calculation, may vary slightly from the on-column percent recovery.

# ALS ENVIRONMENTAL

## LABORATORY CONTROL SAMPLE / DUPLICATE LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

**Client:** Landau Associates, Inc.  
**Client Sample ID:** Duplicate Lab Control Sample  
**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652  
 ALS Sample ID: P211102-DLCS

Test Code: EPA TO-15  
 Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13  
 Analyst: Jessie Macaluso  
 Sample Type: 6.0 L Summa Canister  
 Test Notes:

Date Collected: NA  
 Date Received: NA  
 Date Analyzed: 11/2/21  
 Volume(s) Analyzed: 0.125 Liter(s)

CAS #	Compound	Spike Amount		Result		% Recovery		ALS		Data Qualifier
		LCS / DLCS µg/m <sup>3</sup>	LCS µg/m <sup>3</sup>	DLCS µg/m <sup>3</sup>	LCS	DLCS	Acceptance Limits	RPD	RPD Limit	
75-01-4	Vinyl Chloride	208	240	244	<b>115</b>	<b>117</b>	63-123	2	25	
75-34-3	1,1-Dichloroethane	214	193	197	<b>90</b>	<b>92</b>	70-114	2	25	
156-59-2	cis-1,2-Dichloroethene	206	195	200	<b>95</b>	<b>97</b>	73-117	2	25	
107-06-2	1,2-Dichloroethane	210	192	194	<b>91</b>	<b>92</b>	71-119	1	25	
71-55-6	1,1,1-Trichloroethane	208	188	195	<b>90</b>	<b>94</b>	73-119	4	25	
71-43-2	Benzene	208	204	210	<b>98</b>	<b>101</b>	72-113	3	25	
79-01-6	Trichloroethene	204	208	214	<b>102</b>	<b>105</b>	74-115	3	25	
123-91-1	1,4-Dioxane	206	203	209	<b>99</b>	<b>101</b>	77-124	2	25	
127-18-4	Tetrachloroethene	212	194	198	<b>92</b>	<b>93</b>	63-130	1	25	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.  
 Reported results are shown in concentration units and as a result of the calculation, may vary slightly.



**ALS ENVIRONMENTAL**

RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.  
**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

**Method Blank Summary**

Test Code: EPA TO-15  
Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13  
Analyst: Jessie Macaluso  
Sample Type: 6.0 L Summa Canister(s)  
Test Notes:

Lab File ID: 11022102.D  
Date Analyzed: 11/2/21  
Time Analyzed: 03:04

<b>Client Sample ID</b>	<b>ALS Sample ID</b>	<b>Lab File ID</b>	<b>Time Analyzed</b>
Lab Control Sample	P211102-LCS	11022108.D	06:30
Duplicate Lab Control Sample	P211102-DLCS	11022109.D	07:04
RISG-103-211022 (Dilution)	P2105652-004	11022115.D	13:24
RISG-103-211022	P2105652-004	11022120.D	16:15

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.  
**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

### Internal Standard Area and RT Summary

Test Code: EPA TO-15  
 Instrument ID: Tekmar AUTOCAN/Agilent 5975Binert/6890N/MS13  
 Analyst: Jessie Macaluso  
 Sample Type: 6.0 L Summa Canister(s)  
 Test Notes:

Lab File ID: 11022101.D  
 Date Analyzed: 11/2/21  
 Time Analyzed: 02:30

	IS1 (BCM)		IS2 (DFB)		IS3 (CBZ)	
	AREA #	RT #	AREA #	RT #	AREA #	RT #
<b>24 Hour Standard</b>	138376	11.34	659634	13.46	194213	17.76
<b>Upper Limit</b>	193726	11.67	923488	13.79	271898	18.09
<b>Lower Limit</b>	83026	11.01	395780	13.13	116528	17.43

Client Sample ID		IS1 (BCM)		IS2 (DFB)		IS3 (CBZ)	
		AREA #	RT #	AREA #	RT #	AREA #	RT #
01	Method Blank	138479	11.32	657557	13.45	181263	17.76
02	Lab Control Sample	167301	11.35	780426	13.46	217698	17.76
03	Duplicate Lab Control Sample	171207	11.34	789555	13.46	218636	17.76
04	RISG-103-211022 (Dilution)	170789	11.33	799598	13.45	220439	17.76
05	RISG-103-211022	170266	11.33	813699	13.45	216585	17.76
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

IS1 (BCM) = Bromochloromethane

IS2 (DFB) = 1,4-Difluorobenzene

IS3 (CBZ) = Chlorobenzene-d5

AREA UPPER LIMIT = 140% of internal standard area

AREA LOWER LIMIT = 60% of internal standard area

RT UPPER LIMIT = 0.33 minutes of internal standard RT

RT LOWER LIMIT = 0.33 minutes of internal standard RT

# Column used to flag values outside QC limits with an I.

I = Internal standard not within the specified limits.

Method Path : I:\MS13\METHODS\

JMM 10/26/21

Method File : R13102521.M

Title : EPA TO-15 per SOP VOA-TO15 (CASS TO-15/GC-MS)

Last Update : Tue Oct 26 10:57:35 2021

Response Via : Initial Calibration

## Calibration Files

0.1 =10252113.D 0.2 =10252114.D 0.5 =10252115.D 1.0 =10252116.D 5.0 =10252117.D 25 =10252118.D  
 100 =10252120.D

Compound	0.1	0.2	0.5	1.0	5.0	25	50	100	Avg	%RSD
1) IR Bromochloromethane... -----ISTD-----										
2) T Propene	2.612	2.357	2.627	2.391	2.609	2.386	2.322	2.181	2.436	6.70
3) T Dichlorodifluo...	3.129	3.176	3.372	3.155	3.107	3.064	2.866	2.672	3.068	6.91
4) T Chloromethane	2.310	2.381	2.581	2.336	1.846	2.301	2.049	1.419	2.153	17.19
5) T 1,2-Dichloro-1...	1.205	1.168	1.247	1.209	1.181	1.177	1.183	1.183	1.194	2.12
6) T Vinyl Chloride	1.852	1.877	1.905	1.821	1.861	1.914	1.953	2.069	1.906	4.05
7) T 1,3-Butadiene	1.761	1.913	2.056	2.022	1.686	2.150	1.941	1.900	1.929	7.89
8) T Bromomethane	1.007	1.092	1.176	1.139	1.123	1.145	1.118	1.079	1.110	4.65
9) T Chloroethane	1.046	1.139	1.181	1.101	1.091	1.092	1.076	1.023	1.094	4.56
10) T Ethanol	1.821	1.750	1.762	1.583	1.650	1.633	1.560	1.430	1.649	7.70
11) T Acetonitrile	4.389	4.553	4.370	4.291	4.405	4.346	4.251	3.978	4.323	3.83
12) T Acrolein	1.050	1.064	1.125	1.130	1.176	1.191	1.159	1.097	1.124	4.54
13) T Acetone	1.420	1.353	1.343	1.254	1.245	1.205	1.140	1.030	1.249	10.07
14) T Trichlorofluor...	2.958	2.943	3.053	2.977	2.926	2.917	2.790	2.686	2.906	3.96
15) T 2-Propanol (Is...	5.877	6.056	4.951	5.490	5.233	5.584	5.180	4.597	5.371	8.94
16) T Acrylonitrile	2.327	2.448	2.613	2.466	2.589	2.561	2.479	2.334	2.477	4.37
17) T 1,1-Dichloroet...	1.109	1.202	1.282	1.203	1.240	1.257	1.243	1.214	1.219	4.29
18) T 2-Methyl-2-Pro...	4.578	4.882	4.593	4.442	3.256	4.230	3.237		4.174	15.88
19) T Methylene Chlo...	1.508	1.432	1.441	1.329	1.357	1.356	1.351	1.305	1.385	4.94
20) T 3-Chloro-1-pro...	2.880	3.005	3.189	3.005	3.179	3.223	3.125	2.965	3.071	4.05
21) T Trichlorotrifl...	1.159	1.161	1.200	1.136	1.111	1.137	1.109	1.102	1.139	2.91
22) T Carbon Disulfide	6.918	5.885	5.681	5.229	5.118	5.152	5.019	4.701	5.463	12.74
23) T trans-1,2-Dich...	2.166	2.351	2.518	2.333	2.402	2.479	2.430	2.339	2.377	4.57
24) T 1,1-Dichloroet...	2.878	2.944	3.071	2.888	2.868	2.886	2.794	2.659	2.874	4.09
25) T Methyl tert-Bu...	4.292	4.530	4.622	4.427	4.022	4.385	3.350	2.269	3.987	20.11
26) T Vinyl Acetate	0.232	0.252	0.285	0.278	0.302	0.312	0.306	0.293	0.282	9.79
27) T 2-Butanone (MEK)	0.885	0.949	0.986	0.950	1.001	1.001	0.980	0.927	0.960	4.20
28) T cis-1,2-Dichlo...	2.227	2.357	2.484	2.303	2.384	2.451	2.373	2.258	2.355	3.78
29) T Diisopropyl Ether	1.215	1.166	1.272	1.232	1.232	1.121	1.089	1.048	1.172	6.75
30) T Ethyl Acetate	0.615	0.638	0.685	0.633	0.673	0.647	0.598	0.534	0.628	7.53
31) T n-Hexane	3.043	3.054	3.112	2.993	3.016	2.878	2.658	2.374	2.891	8.73
32) T Chloroform	2.726	2.685	2.820	2.672	2.633	2.689	2.611	2.496	2.667	3.51
33) S 1,2-Dichloroet...	2.505	2.516	2.525	2.492	2.455	2.447	2.333	2.268	2.443	3.82
34) T Tetrahydrofura...	1.072	1.009	0.977	0.938	0.942	0.945	0.932	0.885	0.962	5.91
35) T Ethyl tert-But...	1.471	1.549	1.671	1.636	1.704	1.783	1.760	1.709	1.660	6.36
36) T 1,2-Dichloroet...	2.506	2.598	2.622	2.526	2.542	2.519	2.434	2.313	2.507	3.87

37) IR 1,4-Difluorobenzen... -----ISTD-----										
38) T 1,1,1-Trichlor...	0.544	0.553	0.562	0.553	0.533	0.545	0.520	0.490	0.538	4.30
39) T Isopropyl Acetate									0.000	-1.00
40) T 1-Butanol									0.000	-1.00
41) T Benzene	1.185	1.161	1.200	1.159	1.142	1.156	1.138	1.090	1.154	2.85
42) T Carbon Tetrach...	0.470	0.448	0.509	0.493	0.485	0.494	0.476	0.451	0.478	4.46
43) T Cyclohexane	0.390	0.396	0.431	0.419	0.420	0.434	0.419	0.392	0.412	4.25
44) T tert-Amyl Meth...	0.856	0.883	0.881	0.852	0.897	0.941	0.932	0.872	0.889	3.70
45) T 1,2-Dichloropr...	0.351	0.345	0.351	0.333	0.330	0.335	0.328	0.313	0.336	3.83
46) T Bromodichlorom...	0.444	0.446	0.469	0.449	0.458	0.467	0.457	0.438	0.453	2.46
47) T Trichloroethene	0.284	0.289	0.302	0.292	0.290	0.296	0.293	0.289	0.292	1.86
48) T 1,4-Dioxane	0.230	0.236	0.240	0.241	0.241	0.240	0.236	0.229	0.237	2.02
49) T 2,2,4-Trimethy...	1.550	1.500	1.597	1.571	1.564	1.581	1.536	1.421	1.540	3.68
50) T Methyl Methacr...	0.095	0.099	0.109	0.108	0.117	0.122	0.120	0.117	0.111	8.90
51) T n-Heptane	0.278	0.276	0.312	0.306	0.311	0.312	0.305	0.292	0.299	5.06
52) T cis-1,3-Dichlo...	0.434	0.461	0.487	0.470	0.504	0.522	0.514	0.498	0.486	Revised Report
53) T 4-Methyl-2-pen...	0.343	0.340	0.331	0.331	0.347	0.352	0.336	0.307	0.336	4.15
54) T trans-1,3-Dich...	0.415	0.422	0.450	0.473	0.506	0.532	0.524	0.510	0.479	9.58

55)	T	1,1,2-Trichlor...	0.288	0.285	0.282	0.281	0.280	0.283	0.277	0.268	0.280	2.06
56)	IR	Chlorobenzene-d5 (...	-----ISTD-----									
57)	S	Toluene-d8 (SS2)	4.480	4.473	4.411	4.436	4.437	4.488	4.575	4.670	4.496	1.91
58)	T	Toluene	4.839	4.763	4.705	4.572	4.583	4.729	4.722	4.686	4.700	1.88
59)	T	2-Hexanone	4.527	4.667	3.826	3.841	4.067	4.096	3.911	3.486	4.053	9.52
60)	T	Dibromochlorom...	1.274	1.228	1.295	1.306	1.356	1.416	1.430	1.448	1.344	6.00
61)	T	1,2-Dibromoethane	1.211	1.150	1.213	1.180	1.204	1.261	1.276	1.293	1.224	4.02
62)	T	n-Butyl Acetate	5.131	5.294	4.155	4.240	4.530	4.639	4.409	3.854	4.532	10.73
63)	T	n-Octane	1.185	1.157	1.175	1.223	1.240	1.280	1.256	1.214	1.216	3.47
64)	T	Tetrachloroethene	1.291	1.360	1.344	1.328	1.310	1.362	1.385	1.437	1.352	3.39
65)	T	Chlorobenzene	2.955	3.050	3.059	2.915	2.970	3.078	3.121	3.191	3.042	3.02
66)	T	Ethylbenzene	5.241	5.178	5.405	5.335	5.538	5.762	5.746	5.624	5.479	4.08
67)	T	m- & p-Xylenes	4.107	4.392	4.373	4.289	4.404	4.602	4.593	4.463	4.403	3.65
68)	T	Bromoform	1.053	1.126	1.215	1.185	1.276	1.385	1.416	1.475	1.266	11.73
69)	T	Styrene	2.615	2.724	2.743	2.876	3.165	3.392	3.391	3.430	3.042	11.18
70)	T	o-Xylene	4.127	4.173	4.439	4.399	4.482	4.676	4.641	4.597	4.442	4.61
71)	T	n-Nonane	3.067	3.319	3.477	3.404	3.570	3.588	3.408	3.085	3.365	5.91
72)	T	1,1,2,2-Tetrac...	1.809	1.898	1.923	1.896	1.947	2.019	2.012	2.015	1.940	3.81
73)	S	Bromofluoroben...	1.454	1.474	1.462	1.490	1.502	1.531	1.547	1.602	1.508	3.31
74)	T	Cumene	4.932	5.159	5.352	5.300	5.425	5.631	5.594	5.511	5.363	4.36
75)	T	alpha-Pinene	2.422	2.459	2.433	2.467	2.726	2.920	2.909	2.942	2.660	8.98
76)	T	n-Propylbenzene	6.382	6.447	6.724	6.666	6.918	7.162	7.018	6.667	6.748	4.01
77)	T	3-Ethyltoluene									0.000	-1.00
78)	T	4-Ethyltoluene	4.751	4.915	5.099	5.094	5.365	5.613	5.588	5.543	5.246	6.25
79)	T	1,3,5-Trimethy...	4.138	4.064	4.349	4.344	4.539	4.775	4.793	4.775	4.472	6.55
80)	T	alpha-Methylst...									0.000	-1.00
81)	T	2-Ethyltoluene									0.000	-1.00
82)	T	1,2,4-Trimethy...	4.191	4.307	4.464	4.431	4.767	5.034	5.048	4.890	4.642	7.22
83)	T	n-Decane									0.000	-1.00
84)	T	Benzyl Chloride			3.287	3.494	4.194	4.685	4.692	4.209	4.094	14.42
85)	T	1,3-Dichlorobe...	2.597	2.616	2.580	2.567	2.592	2.739	2.797	2.831	2.665	4.01
86)	T	1,4-Dichlorobe...	2.499	2.634	2.491	2.480	2.611	2.751	2.757	2.875	2.637	5.54
87)	T	sec-Butylbenzene	5.581	5.754	5.848	5.923	6.193	6.395	6.370	6.162	6.028	4.92
88)	T	4-Isopropyltol...	4.774	5.011	5.044	5.133	5.429	5.659	5.686	5.570	5.288	6.47
89)	T	1,2,3-Trimethy...									0.000	-1.00
90)	T	1,2-Dichlorobe...	2.493	2.490	2.428	2.395	2.543	2.628	2.668	2.711	2.545	4.49
91)	T	d-Limonene	1.517	1.614	1.660	1.712	1.960	2.098	2.091	2.011	1.833	12.67
92)	T	1,2-Dibromo-3-...	1.006	0.980	0.913	0.969	1.062	1.137	1.164	1.210	1.055	10.04
93)	T	n-Undecane									0.000	-1.00
94)	T	1,2,4-Trichlor...	2.367	2.318	2.013	2.158	2.379	2.553	2.687	2.668	2.393	9.92
95)	T	Naphthalene	6.437	6.390	5.161	5.558	6.352	6.677	6.873	6.660	6.264	9.48
96)	T	n-Dodecane									0.000	-1.00
97)	T	Hexachlorobuta...	1.668	1.788	1.680	1.677	1.757	1.829	1.914	2.008	1.790	6.85
98)	T	Cyclohexanone									0.000	-1.00
99)	T	tert-Butylbenzene	4.100	4.217	4.337	4.292	4.523	4.718	4.709	4.578	4.434	5.21
100)	T	n-Butylbenzene	4.788	5.021	5.177	5.074	5.457	5.612	5.537	5.306	5.246	5.40
101)	T	1,1,1,2-Tetrac...	1.101	1.170	1.195	1.161	1.162	1.205	1.213	1.224	1.179	3.33

(#) = Out of Range

R13102521.M Tue Oct 26 11:03:32 2021

Data File : I:\MS13\DATA\2021 11\02\11022101.D  
 Acq On : 2 Nov 2021 2:30  
 Sample : CCV R13110221 25ng  
 Misc : S35-10202101/S35-10252101 (11/24)

Vial: 1  
 Operator: JMM  
 Inst : GCMS13

JMM 11/2/21

Quant Time: Nov 02 09:14:38 2021  
 Quant Method : I:\MS13\METHODS\R13102521.M  
 Quant Title : EPA TO-15 per SOP VOA-TO15 (CASS TO-15/GC-MS)  
 QLast Update : Tue Oct 26 13:32:19 2021  
 Response via : Initial Calibration  
 DataAcq Meth:TO15.M

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.33min  
 Max. RRF Dev : 30% Max. Rel. Area : 200%

	Compound	AvgRF	CCRF	%Dev	Area%	Dev (min)
1 IR	Bromochloromethane (IS1)	1.000	1.000	0.0	88	0.00
2 T	Propene	2.436	2.279	6.4	84	0.00
3 T	Dichlorodifluoromethane (CF	3.068	2.527	17.6	73	0.00
4 T	Chloromethane	2.153	2.018	6.3	77	0.00
5 T	1,2-Dichloro-1,1,2,2-tetra	1.194	1.038	13.1	78	0.00
6 T	Vinyl Chloride	1.906	2.082	-9.2	96	0.00
7 T	1,3-Butadiene	1.929	1.892	1.9	78	0.00
8 T	Bromomethane	1.110	0.989	10.9	76	0.00
9 T	Chloroethane	1.094	0.944	13.7	76	0.00
10 T	Ethanol	1.649	1.575	4.5	85	0.00
11 T	Acetonitrile	4.323	4.293	0.7	87	0.00
12 T	Acrolein	1.124	1.083	3.6	80	0.00
13 T	Acetone	1.249	1.170	6.3	86	0.00
14 T	Trichlorofluoromethane	2.906	2.403	17.3	73	0.00
15 T	2-Propanol (Isopropanol)	5.371	5.444	-1.4	86	0.00
16 T	Acrylonitrile	2.477	2.363	4.6	81	0.00
17 T	1,1-Dichloroethene	1.219	1.113	8.7	78	0.00
18 T	2-Methyl-2-Propanol (tert-B	4.174	3.230	22.6	67	0.00
19 T	Methylene Chloride	1.385	1.259	9.1	82	0.00
20 T	3-Chloro-1-propene (Allyl C	3.071	3.262	-6.2	89	0.00
21 T	Trichlorotrifluoroethane	1.139	0.958	15.9	74	0.00
22 T	Carbon Disulfide	5.463	4.781	12.5	82	0.00
23 T	trans-1,2-Dichloroethene	2.377	2.215	6.8	79	0.00
24 T	1,1-Dichloroethane	2.874	2.567	10.7	78	0.00
25 T	Methyl tert-Butyl Ether	3.987	3.321	16.7	67	0.00
26 T	Vinyl Acetate	0.282	0.295	-4.6	83	0.00
27 T	2-Butanone (MEK)	0.960	0.952	0.8	84	0.00
28 T	cis-1,2-Dichloroethene	2.355	2.205	6.4	79	0.00
29 T	Diisopropyl Ether	1.172	1.097	6.4	86	0.00
30 T	Ethyl Acetate	0.628	0.687	-9.4	94	0.00
31 T	n-Hexane	2.891	3.039	-5.1	93	0.00
32 T	Chloroform	2.667	2.394	10.2	78	0.00
33 S	1,2-Dichloroethane-d4 (SS1)	2.443	2.326	4.8	84	0.00
34 T	Tetrahydrofuran (THF)	0.962	0.898	6.7	84	0.00
35 T	Ethyl tert-Butyl Ether	1.660	1.635	1.5	81	0.00
36 T	1,2-Dichloroethane	2.507	2.266	9.6	79	0.00
37 IR	1,4-Difluorobenzene (IS2)	1.000	1.000	0.0	86	0.00
38 T	1,1,1-Trichloroethane	0.538	0.458	14.9	72	0.00
39 T	Isopropyl Acetate	0.000	0.000	0.0	81	0.00
40 T	1-Butanol	0.000	0.000	0.0	79	0.00
41 T	Benzene	1.154	1.085	6.0	81	0.00
42 T	Carbon Tetrachloride	0.478	0.417	12.8	73	0.00
43 T	Cyclohexane	0.412	0.418	-1.5	83	0.00
44 T	tert-Amyl Methyl Ether	0.889	0.870	2.1	79	0.00
45 T	1,2-Dichloropropane	0.336	0.307	8.6	79	0.00
46 T	Bromodichloromethane	0.453	0.426	6.0	78	0.00
47 T	Trichloroethene	0.292	0.271	7.2	79	0.00
48 T	1,4-Dioxane	0.237	0.222	6.3	80	0.00
49 T	2,2,4-Trimethylpentane (Iso	1.540	1.488	3.4	81	0.00
50 T	Methyl Methacrylate	0.111	0.110	0.9	78	0.00
51 T	n-Heptane	0.299	0.303	-1.3	83	0.00
52 T	cis-1,3-Dichloropropene	0.486	0.491	-1.0	81	0.00
53 T	4-Methyl-2-pentanone	0.336	0.355	-5.7	87	0.00
54 T	trans-1,3-Dichloropropene	0.479	0.487	-1.7	79	0.00
55 T	1,1,2-Trichloroethane	0.280	0.264	5.7	80	0.00

Revised Report

Data File : I:\MS13\DATA\2021 11\02\11022101.D  
 Acq On : 2 Nov 2021 2:30  
 Sample : CCV R13110221 25ng  
 Misc : S35-10202101/S35-10252101 (11/24)

Vial: 1  
 Operator: JMM  
 Inst : GCMS13

Quant Time: Nov 02 09:14:38 2021  
 Quant Method : I:\MS13\METHODS\R13102521.M  
 Quant Title : EPA TO-15 per SOP VOA-TO15 (CASS TO-15/GC-MS)  
 QLast Update : Tue Oct 26 13:32:19 2021  
 Response via : Initial Calibration  
 DataAcq Meth:TO15.M

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.33min  
 Max. RRF Dev : 30% Max. Rel. Area : 200%

Compound	AvgRF	CCRF	%Dev	Area%	Dev (min)
56 IR Chlorobenzene-d5 (IS3)	1.000	1.000	0.0	97	0.00
57 S Toluene-d8 (SS2)	4.496	4.054	9.8	88	0.00
58 T Toluene	4.700	3.949	16.0	81	0.00
59 T 2-Hexanone	4.053	4.122	-1.7	98	0.00
60 T Dibromochloromethane	1.344	1.162	13.5	80	0.00
61 T 1,2-Dibromoethane	1.224	1.068	12.7	82	0.00
62 T n-Butyl Acetate	4.532	4.653	-2.7	98	0.00
63 T n-Octane	1.216	1.102	9.4	84	0.00
64 T Tetrachloroethene	1.352	1.072	20.7	77	0.00
65 T Chlorobenzene	3.042	2.568	15.6	81	0.00
66 T Ethylbenzene	5.479	4.737	13.5	80	0.00
67 T m- & p-Xylenes	4.403	3.851	12.5	81	0.00
68 T Bromoform	1.266	1.107	12.6	78	0.00
69 T Styrene	3.042	2.816	7.4	81	0.00
70 T o-Xylene	4.442	3.869	12.9	80	0.00
71 T n-Nonane	3.365	3.590	-6.7	97	0.00
72 T 1,1,2,2-Tetrachloroethane	1.940	1.854	4.4	89	0.00
73 S Bromofluorobenzene (SS3)	1.508	1.359	9.9	86	0.00
74 T Cumene	5.363	4.707	12.2	81	0.00
75 T alpha-Pinene	2.660	2.474	7.0	82	0.00
76 T n-Propylbenzene	6.748	6.132	9.1	83	0.00
77 T 3-Ethyltoluene	0.000	0.000	0.0	81	0.00
78 T 4-Ethyltoluene	5.246	4.760	9.3	82	0.00
79 T 1,3,5-Trimethylbenzene	4.472	3.983	10.9	81	0.00
80 T alpha-Methylstyrene	0.000	0.000	0.0	87	0.00
81 T 2-Ethyltoluene	0.000	0.000	0.0	81	0.00
82 T 1,2,4-Trimethylbenzene	4.642	4.413	4.9	85	0.00
83 T n-Decane	0.000	0.000	0.0	100	0.00
84 T Benzyl Chloride	4.094	4.020	1.8	83	0.00
85 T 1,3-Dichlorobenzene	2.665	2.361	11.4	84	0.00
86 T 1,4-Dichlorobenzene	2.637	2.312	12.3	82	0.00
87 T sec-Butylbenzene	6.028	5.569	7.6	85	0.00
88 T 4-Isopropyltoluene (p-Cymen)	5.288	4.689	11.3	81	0.00
89 T 1,2,3-Trimethylbenzene	0.000	0.000	0.0	82	0.00
90 T 1,2-Dichlorobenzene	2.545	2.280	10.4	84	0.00
91 T d-Limonene	1.833	1.989	-8.5	92	0.00
92 T 1,2-Dibromo-3-Chloropropane	1.055	0.971	8.0	83	0.00
93 T n-Undecane	0.000	0.000	0.0	72	0.00
94 T 1,2,4-Trichlorobenzene	2.393	2.100	12.2	80	0.00
95 T Naphthalene	6.264	5.408	13.7	79	0.00
96 T n-Dodecane	0.000	0.000	0.0	78	0.00
97 T Hexachlorobutadiene	1.790	1.324	26.0	70	0.00
98 T Cyclohexanone	0.000	0.000	0.0	85	-0.01
99 T tert-Butylbenzene	4.434	4.032	9.1	83	0.00
100 T n-Butylbenzene	5.246	4.880	7.0	85	0.00
101 T 1,1,1,2-Tetrachloroethane	1.179	0.985	16.5	80	0.00

(#) = Out of Range

SPCC's out = 0 CCC's out = 0

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Sample ID:** IA01-C19-211022

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

ALS Sample ID: P2105652-001

Test Code: EPA TO-15 SIM

Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19

Analyst: Topacio Zavala

Sample Type: 6.0 L Summa Canister

Test Notes:

Container ID: AC01910

Date Collected: 10/22/21

Date Received: 10/26/21

Date Analyzed: 11/2/21

Volume(s) Analyzed: 0.20 Liter(s)

Initial Pressure (psig): -1.04      Final Pressure (psig): 3.85

Container Dilution Factor: 1.36

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	MDL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.17	0.082	ND	0.067	0.032	
75-34-3	1,1-Dichloroethane	ND	0.17	0.056	ND	0.042	0.014	
156-59-2	cis-1,2-Dichloroethene	ND	0.17	0.049	ND	0.043	0.012	
107-06-2	1,2-Dichloroethane	ND	0.17	0.056	ND	0.042	0.014	
71-55-6	1,1,1-Trichloroethane	ND	0.17	0.061	ND	0.031	0.011	
71-43-2	Benzene	<b>0.57</b>	0.51	0.10	<b>0.18</b>	0.16	0.032	
79-01-6	Trichloroethene	<b>0.060</b>	0.17	0.052	<b>0.011</b>	0.032	0.0097	<b>J</b>
123-91-1	1,4-Dioxane	ND	0.68	0.059	ND	0.19	0.016	
127-18-4	Tetrachloroethene	ND	0.17	0.11	ND	0.025	0.016	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Sample ID:** IA02-C19-211022

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

ALS Sample ID: P2105652-002

Test Code: EPA TO-15 SIM

Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19

Analyst: Topacio Zavala

Sample Type: 6.0 L Summa Canister

Test Notes:

Container ID: AC02357

Date Collected: 10/22/21

Date Received: 10/26/21

Date Analyzed: 11/2/21

Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -1.02      Final Pressure (psig): 3.92

Container Dilution Factor: 1.36

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	MDL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.034	0.016	ND	0.013	0.0064	
75-34-3	1,1-Dichloroethane	ND	0.034	0.011	ND	0.0084	0.0028	
156-59-2	cis-1,2-Dichloroethene	ND	0.034	0.0098	ND	0.0086	0.0025	
107-06-2	1,2-Dichloroethane	<b>0.12</b>	0.034	0.011	<b>0.029</b>	0.0084	0.0028	
71-55-6	1,1,1-Trichloroethane	<b>0.019</b>	0.034	0.012	<b>0.0036</b>	0.0062	0.0022	<b>J</b>
71-43-2	Benzene	<b>1.3</b>	0.10	0.020	<b>0.42</b>	0.032	0.0064	
79-01-6	Trichloroethene	<b>0.038</b>	0.034	0.010	<b>0.0070</b>	0.0063	0.0019	
123-91-1	1,4-Dioxane	ND	0.14	0.012	ND	0.038	0.0033	
127-18-4	Tetrachloroethene	<b>0.073</b>	0.034	0.022	<b>0.011</b>	0.0050	0.0032	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.



# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Sample ID:** IA03-C19-211022

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

ALS Sample ID: P2105652-003

Test Code: EPA TO-15 SIM

Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19

Analyst: Topacio Zavala

Sample Type: 6.0 L Summa Canister

Test Notes:

Container ID: AC02512

Date Collected: 10/22/21

Date Received: 10/26/21

Date Analyzed: 11/2/21

Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -1.60      Final Pressure (psig): 3.83

Container Dilution Factor: 1.41

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	MDL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.035	0.017	ND	0.014	0.0066	
75-34-3	1,1-Dichloroethane	ND	0.035	0.012	ND	0.0087	0.0029	
156-59-2	cis-1,2-Dichloroethene	ND	0.035	0.010	ND	0.0089	0.0026	
107-06-2	1,2-Dichloroethane	<b>0.069</b>	0.035	0.012	<b>0.017</b>	0.0087	0.0029	
71-55-6	1,1,1-Trichloroethane	<b>0.024</b>	0.035	0.013	<b>0.0044</b>	0.0065	0.0023	<b>J</b>
71-43-2	Benzene	<b>0.69</b>	0.11	0.021	<b>0.22</b>	0.033	0.0066	
79-01-6	Trichloroethene	<b>0.043</b>	0.035	0.011	<b>0.0080</b>	0.0066	0.0020	
123-91-1	1,4-Dioxane	ND	0.14	0.012	ND	0.039	0.0034	
127-18-4	Tetrachloroethene	<b>0.049</b>	0.035	0.023	<b>0.0072</b>	0.0052	0.0033	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Sample ID:** AA-C19-211022

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

ALS Sample ID: P2105652-005

Test Code: EPA TO-15 SIM

Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19

Analyst: Topacio Zavala

Sample Type: 6.0 L Summa Canister

Test Notes:

Container ID: AC01466

Date Collected: 10/22/21

Date Received: 10/26/21

Date Analyzed: 11/2/21

Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -1.52      Final Pressure (psig): 3.81

Container Dilution Factor: 1.40

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	MDL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.035	0.017	ND	0.014	0.0066	
75-34-3	1,1-Dichloroethane	ND	0.035	0.011	ND	0.0087	0.0028	
156-59-2	cis-1,2-Dichloroethene	ND	0.035	0.010	ND	0.0088	0.0025	
107-06-2	1,2-Dichloroethane	<b>0.042</b>	0.035	0.012	<b>0.010</b>	0.0087	0.0029	
71-55-6	1,1,1-Trichloroethane	ND	0.035	0.013	ND	0.0064	0.0023	
71-43-2	Benzene	<b>0.39</b>	0.11	0.021	<b>0.12</b>	0.033	0.0066	
79-01-6	Trichloroethene	ND	0.035	0.011	ND	0.0065	0.0020	
123-91-1	1,4-Dioxane	<b>0.014</b>	0.14	0.012	<b>0.0039</b>	0.039	0.0034	<b>J</b>
127-18-4	Tetrachloroethene	<b>0.045</b>	0.035	0.022	<b>0.0066</b>	0.0052	0.0033	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Sample ID:** Method Blank

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

ALS Sample ID: P211101-MB

Test Code: EPA TO-15 SIM

Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19

Analyst: Topacio Zavala

Sample Type: 6.0 L Summa Canister

Test Notes:

Date Collected: NA

Date Received: NA

Date Analyzed: 11/1/21

Volume(s) Analyzed: 1.00 Liter(s)

Container Dilution Factor: 1.00

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	MDL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.025	0.012	ND	0.0098	0.0047	
75-34-3	1,1-Dichloroethane	ND	0.025	0.0082	ND	0.0062	0.0020	
156-59-2	cis-1,2-Dichloroethene	ND	0.025	0.0072	ND	0.0063	0.0018	
107-06-2	1,2-Dichloroethane	ND	0.025	0.0083	ND	0.0062	0.0021	
71-55-6	1,1,1-Trichloroethane	ND	0.025	0.0090	ND	0.0046	0.0017	
71-43-2	Benzene	ND	0.075	0.015	ND	0.023	0.0047	
79-01-6	Trichloroethene	ND	0.025	0.0077	ND	0.0047	0.0014	
123-91-1	1,4-Dioxane	ND	0.10	0.0087	ND	0.028	0.0024	
127-18-4	Tetrachloroethene	ND	0.025	0.016	ND	0.0037	0.0024	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Sample ID:** Method Blank

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

ALS Sample ID: P211102-MB

Test Code: EPA TO-15 SIM

Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19

Analyst: Topacio Zavala

Sample Type: 6.0 L Summa Canister

Test Notes:

Date Collected: NA

Date Received: NA

Date Analyzed: 11/2/21

Volume(s) Analyzed: 1.00 Liter(s)

Container Dilution Factor: 1.00

CAS #	Compound	Result µg/m <sup>3</sup>	MRL µg/m <sup>3</sup>	MDL µg/m <sup>3</sup>	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.025	0.012	ND	0.0098	0.0047	
75-34-3	1,1-Dichloroethane	ND	0.025	0.0082	ND	0.0062	0.0020	
156-59-2	cis-1,2-Dichloroethene	ND	0.025	0.0072	ND	0.0063	0.0018	
107-06-2	1,2-Dichloroethane	ND	0.025	0.0083	ND	0.0062	0.0021	
71-55-6	1,1,1-Trichloroethane	ND	0.025	0.0090	ND	0.0046	0.0017	
71-43-2	Benzene	ND	0.075	0.015	ND	0.023	0.0047	
79-01-6	Trichloroethene	ND	0.025	0.0077	ND	0.0047	0.0014	
123-91-1	1,4-Dioxane	ND	0.10	0.0087	ND	0.028	0.0024	
127-18-4	Tetrachloroethene	ND	0.025	0.016	ND	0.0037	0.0024	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

**ALS ENVIRONMENTAL**

SURROGATE SPIKE RECOVERY RESULTS

Page 1 of 1

**Client:** Landau Associates, Inc.  
**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

Test Code: EPA TO-15 SIM  
 Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19  
 Analyst: Topacio Zavala  
 Sample Type: 6.0 L Summa Canister(s)  
 Test Notes:

Date(s) Collected: 10/22/21  
 Date(s) Received: 10/26/21  
 Date(s) Analyzed: 11/1 - 11/2/21

Client Sample ID	ALS Sample ID	1,2-Dichloroethane-d4	Toluene-d8	Bromofluorobenzene	Acceptance Limits	Data Qualifier
		% Recovered	% Recovered	% Recovered		
Method Blank	P211101-MB	83	103	109	70-130	
Method Blank	P211102-MB	92	106	94	70-130	
Lab Control Sample	P211101-LCS	84	96	128	70-130	
Lab Control Sample	P211102-LCS	94	99	110	70-130	
Duplicate Lab Control Sample	P211101-DLCS	84	96	128	70-130	
Duplicate Lab Control Sample	P211102-DLCS	93	99	110	70-130	
IA01-C19-211022	P2105652-001	96	101	101	70-130	
IA02-C19-211022	P2105652-002	88	100	115	70-130	
IA03-C19-211022	P2105652-003	88	101	111	70-130	
AA-C19-211022	P2105652-005	92	103	109	70-130	

Surrogate percent recovery is verified and accepted based on the on-column result.

Reported results are shown in concentration units and as a result of the calculation, may vary slightly from the on-column percent recovery.

# ALS ENVIRONMENTAL

## LABORATORY CONTROL SAMPLE / DUPLICATE LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

**Client:** Landau Associates, Inc.  
**Client Sample ID:** Duplicate Lab Control Sample  
**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652  
 ALS Sample ID: P211101-DLCS

Test Code: EPA TO-15 SIM  
 Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19  
 Analyst: Topacio Zavala  
 Sample Type: 6.0 L Summa Canister  
 Test Notes:

Date Collected: NA  
 Date Received: NA  
 Date Analyzed: 11/1/21  
 Volume(s) Analyzed: 0.050 Liter(s)

CAS #	Compound	Spike Amount		Result		% Recovery		ALS		Data Qualifier
		LCS / DLCS µg/m <sup>3</sup>	LCS µg/m <sup>3</sup>	DLCS µg/m <sup>3</sup>	LCS	DLCS	Acceptance Limits	RPD	RPD Limit	
75-01-4	Vinyl Chloride	20.8	15.9	16.2	<b>76</b>	<b>78</b>	43-138	3	25	
75-34-3	1,1-Dichloroethane	21.4	19.1	19.0	<b>89</b>	<b>89</b>	62-123	0	25	
156-59-2	cis-1,2-Dichloroethene	20.6	20.4	20.1	<b>99</b>	<b>98</b>	69-123	1	25	
107-06-2	1,2-Dichloroethane	21.0	18.4	18.1	<b>88</b>	<b>86</b>	68-118	2	25	
71-55-6	1,1,1-Trichloroethane	20.8	19.3	19.1	<b>93</b>	<b>92</b>	73-124	1	25	
71-43-2	Benzene	20.8	18.7	18.3	<b>90</b>	<b>88</b>	60-122	2	25	
79-01-6	Trichloroethene	20.4	21.4	21.1	<b>105</b>	<b>103</b>	71-119	2	25	
123-91-1	1,4-Dioxane	20.6	18.8	18.6	<b>91</b>	<b>90</b>	69-119	1	25	
127-18-4	Tetrachloroethene	21.2	22.0	21.6	<b>104</b>	<b>102</b>	72-122	2	25	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.  
 Reported results are shown in concentration units and as a result of the calculation, may vary slightly.

**ALS ENVIRONMENTAL**

LABORATORY CONTROL SAMPLE / DUPLICATE LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

**Client:** Landau Associates, Inc.  
**Client Sample ID:** Duplicate Lab Control Sample  
**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652  
 ALS Sample ID: P211102-DLCS

Test Code: EPA TO-15 SIM  
 Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19  
 Analyst: Topacio Zavala  
 Sample Type: 6.0 L Summa Canister  
 Test Notes:

Date Collected: NA  
 Date Received: NA  
 Date Analyzed: 11/2/21  
 Volume(s) Analyzed: 0.050 Liter(s)

CAS #	Compound	Spike Amount		Result		% Recovery		ALS		Data Qualifier
		LCS / DLCS µg/m <sup>3</sup>	LCS µg/m <sup>3</sup>	DLCS µg/m <sup>3</sup>	LCS	DLCS	Acceptance Limits	RPD	RPD Limit	
75-01-4	Vinyl Chloride	20.8	15.2	15.2	<b>73</b>	<b>73</b>	43-138	0	25	
75-34-3	1,1-Dichloroethane	21.4	21.9	21.9	<b>102</b>	<b>102</b>	62-123	0	25	
156-59-2	cis-1,2-Dichloroethene	20.6	21.2	21.3	<b>103</b>	<b>103</b>	69-123	0	25	
107-06-2	1,2-Dichloroethane	21.0	20.7	20.5	<b>99</b>	<b>98</b>	68-118	1	25	
71-55-6	1,1,1-Trichloroethane	20.8	20.2	20.1	<b>97</b>	<b>97</b>	73-124	0	25	
71-43-2	Benzene	20.8	20.4	20.2	<b>98</b>	<b>97</b>	60-122	1	25	
79-01-6	Trichloroethene	20.4	20.9	20.8	<b>102</b>	<b>102</b>	71-119	0	25	
123-91-1	1,4-Dioxane	20.6	19.6	19.5	<b>95</b>	<b>95</b>	69-119	0	25	
127-18-4	Tetrachloroethene	21.2	21.4	21.3	<b>101</b>	<b>100</b>	72-122	1	25	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.  
 Reported results are shown in concentration units and as a result of the calculation, may vary slightly.

**ALS ENVIRONMENTAL**

RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.  
**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032 ALS Project ID: P2105652

**Method Blank Summary**

Test Code: EPA TO-15 SIM  
Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19 Lab File ID: 11012105.D  
Analyst: Topacio Zavala Date Analyzed: 11/1/21  
Sample Type: 6.0 L Summa Canister(s) Time Analyzed: 10:55  
Test Notes:

<b>Client Sample ID</b>	<b>ALS Sample ID</b>	<b>Lab File ID</b>	<b>Time Analyzed</b>
Lab Control Sample	P211101-LCS	11012106.D	11:26
Duplicate Lab Control Sample	P211101-DLCS	11012107.D	11:57
IA02-C19-211022	P2105652-002	11012131.D	01:11
IA03-C19-211022	P2105652-003	11012132.D	02:00
AA-C19-211022	P2105652-005	11012133.D	02:32



# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.  
**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032 ALS Project ID: P2105652

### Method Blank Summary

Test Code: EPA TO-15 SIM  
Instrument ID: Tekmar AUTOCAN/Agilent 5973N/HP6890A/MS19 Lab File ID: 11022105.D  
Analyst: Topacio Zavala Date Analyzed: 11/2/21  
Sample Type: 6.0 L Summa Canister(s) Time Analyzed: 04:59  
Test Notes:

Client Sample ID	ALS Sample ID	Lab File ID	Time Analyzed
Lab Control Sample	P211102-LCS	11022106.D	05:30
Duplicate Lab Control Sample	P211102-DLCS	11022107.D	06:01
IA01-C19-211022	P2105652-001	11022111.D	09:47

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

### Internal Standard Area and RT Summary

Test Code: EPA TO-15 SIM

Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/7890A/MS19

Lab File ID: 11012102.D

Analyst: Topacio Zavala

Date Analyzed: 11/1/21

Sample Type: 6.0 L Summa Canister(s)

Time Analyzed: 09:20

Test Notes:

	IS1 (BCM)		IS2 (DFB)		IS3 (CBZ)	
	AREA #	RT #	AREA #	RT #	AREA #	RT #
<b>24 Hour Standard</b>	24988	9.61	124492	11.56	23487	15.90
<b>Upper Limit</b>	34983	9.94	174289	11.89	32882	16.23
<b>Lower Limit</b>	14993	9.28	74695	11.23	14092	15.57

Client Sample ID		IS1 (BCM)	IS2 (DFB)	IS3 (CBZ)
		AREA #	RT #	AREA #
01	Method Blank	23431	9.62	103900
02	Lab Control Sample	23866	9.61	118822
03	Duplicate Lab Control Sample	24464	9.61	121705
04	IA02-C19-211022	27916	9.61	140840
05	IA03-C19-211022	27209	9.61	135559
06	AA-C19-211022	27100	9.61	133715
07				
08				
09				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

IS1 (BCM) = Bromochloromethane

IS2 (DFB) = 1,4-Difluorobenzene

IS3 (CBZ) = Chlorobenzene-d5

AREA UPPER LIMIT = 140% of internal standard area

AREA LOWER LIMIT = 60% of internal standard area

RT UPPER LIMIT = 0.33 minutes of internal standard RT

RT LOWER LIMIT = 0.33 minutes of internal standard RT

# Column used to flag values outside QC limits with an I.

I = Internal standard not within the specified limits. See case narrative.

# ALS ENVIRONMENTAL

## RESULTS OF ANALYSIS

Page 1 of 1

**Client:** Landau Associates, Inc.

**Client Project ID:** C-19 Indoor Air Evaluation / 0222027.030.032

ALS Project ID: P2105652

### Internal Standard Area and RT Summary

Test Code: EPA TO-15 SIM

Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/7890A/MS19

Lab File ID: 11022102.D

Analyst: Topacio Zavala

Date Analyzed: 11/2/21

Sample Type: 6.0 L Summa Canister(s)

Time Analyzed: 03:24

Test Notes:

	IS1 (BCM)		IS2 (DFB)		IS3 (CBZ)						
	AREA	#	RT	#	AREA	#	RT	#			
<b>24 Hour Standard</b>	25842		9.61		130571		11.56		27660		15.90
<b>Upper Limit</b>	36179		9.94		182799		11.89		38724		16.23
<b>Lower Limit</b>	15505		9.28		78343		11.23		16596		15.57

Client Sample ID		IS1 (BCM)	IS2 (DFB)	IS3 (CBZ)			
		AREA	RT	AREA	RT	AREA	RT
01	Method Blank	24320	9.62	109107	11.57	25768	15.91
02	Lab Control Sample	24742	9.61	125873	11.56	26974	15.90
03	Duplicate Lab Control Sample	25307	9.61	127548	11.57	27413	15.90
04	IA01-C19-211022	27483	9.61	136285	11.56	30860	15.90
05							
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

IS1 (BCM) = Bromochloromethane

IS2 (DFB) = 1,4-Difluorobenzene

IS3 (CBZ) = Chlorobenzene-d5

AREA UPPER LIMIT = 140% of internal standard area

AREA LOWER LIMIT = 60% of internal standard area

RT UPPER LIMIT = 0.33 minutes of internal standard RT

RT LOWER LIMIT = 0.33 minutes of internal standard RT

# Column used to flag values outside QC limits with an I.

I = Internal standard not within the specified limits. See case narrative.

T 10/27/21

Method Path : I:\MS19\METHODS\  
 Method File : S19102621.M  
 Title : EPA TO-15 per SOP VOA-TO15 (CASS TO-15/GC-MS)  
 Last Update : Wed Oct 27 10:48:57 2021  
 Response Via : Initial Calibration

## Calibration Files

20 =10262109.D 50 =10262110.D 100 =10262122.D 500 =10262112.D 1000=10262113.D 5000=10262114.D 10K =10262116.D

Compound	20	50	100	500	1000	5000	10K	Avg	%RSD
1) I Bromochloromethane...	-----ISTD-----								
2) T Dichlorodifluo...	3.505	3.247	3.181	3.820	3.446	3.026	2.759	3.283	10.53
3) T Chloromethane	0.864	0.766	0.332	1.011	0.883	0.803	0.675	0.762	28.42
4) T 1,2-Dichloro,1...	3.199	3.160	2.910	3.809	3.406	3.029	2.724	3.177	11.14
5) T Vinyl Chloride	3.068	3.369	3.184	4.325	3.899	3.483	3.131	3.494	13.22
6) T 1,3-Butadiene		1.372	1.386	2.035	2.565	1.759	1.739	1.809	24.71
7) T Bromomethane	0.905	1.091	0.792	1.308	1.166	0.890	0.996	1.021	17.51
8) T Chloroethane	0.680	0.878	0.693	1.174	0.971	0.766	0.871	0.862	20.11
9) T Acrolein	0.499	0.507	0.464	0.901	0.707	0.731	0.748	0.651	25.12
10) T Acetone	0.870	0.771	0.856	1.227	0.920	0.913	0.867	0.918	15.79
11) T Trichlorofluor...	1.920	1.952	1.915	2.906	2.207	2.118	1.964	2.140	16.59
12) T 1,1-Dichloroet...	1.000	1.005	1.053	1.354	1.278	1.278	1.214	1.169	12.54
13) T Methylene Chlo...	1.377	1.300	1.317	1.640	1.524	1.488	1.405	1.436	8.50
14) T Trichlorotrifl...	0.924	0.951	0.945	1.161	1.076	1.040	0.995	1.013	8.37
15) T trans-1,2-Dich...	0.906	1.033	1.084	1.436	1.366	1.357	1.298	1.211	16.66
16) T 1,1-Dichloroet...	2.085	2.199	2.207	2.912	2.701	2.595	2.420	2.446	12.43
17) T Methyl tert-Bu...	2.544	2.679	3.130	4.093	4.042	4.342	4.151	3.569	21.31
18) T cis-1,2-Dichlo...	1.003	1.048	1.340	1.553	1.455	1.490	1.433	1.332	16.44
19) T Chloroform	2.169	2.214	2.632	2.902	2.698	2.646	2.486	2.535	10.47
20) S 1,2-Dichloroet...	2.291	2.311	1.997	2.284	2.294	2.225	2.131	2.219	5.22
21) T 1,2-Dichloroet...	1.667	1.685	1.821	2.420	2.254	2.170	2.015	2.005	14.58
22) T 1,1,1-Trichlor...	1.858	1.861	1.956	2.447	2.283	2.256	2.151	2.116	10.83
23) T Benzene	6.191	5.478	5.127	6.358	6.005	5.993	5.770	5.846	7.28
24) T Carbon Tetrach...	1.633	1.632	1.518	1.917	1.783	1.780	1.709	1.710	7.62
25) I 1,4-Difluorobenzen...	-----ISTD-----								
26) T 1,2-Dichloropr...	0.238	0.252	0.306	0.330	0.304	0.342	0.309	0.297	12.98
27) T Bromodichlorom...	0.349	0.348	0.403	0.437	0.406	0.445	0.425	0.402	9.83
28) T Trichloroethene	0.215	0.216	0.255	0.283	0.263	0.296	0.267	0.256	12.10
29) T 1,4-Dioxane		0.160	0.211	0.229	0.221	0.264	0.254	0.223	16.57
30) T cis-1,3-Dichlo...		0.254	0.355	0.422	0.414	0.465	0.471	0.397	20.51
31) T trans-1,3-Dich...		0.199	0.273	0.392	0.362	0.429	0.435	0.348	27.04
32) T 1,1,2-Trichlor...	0.191	0.210	0.247	0.298	0.247	0.244	0.238	0.239	14.08
33) T Toluene-d8 (SS2)	1.028	1.174	1.148	1.111	1.108	1.118	1.131	1.117	4.08
34) T Toluene	0.874	1.009	1.218	1.234	1.156	1.195	1.177	1.123	11.82
35) T Dibromochlorom...	0.187	0.222	0.260	0.284	0.264	0.280	0.281	0.254	14.38
36) T 1,2-Dibromoethane	0.163	0.219	0.270	0.301	0.284	0.298	0.298	0.262	19.89
37) T Tetrachloroethene	0.178	0.216	0.249	0.258	0.234	0.237	0.238	0.230	11.42
38) I Chlorobenzene-d5 (...)	-----ISTD-----								

39)	T	Chlorobenzene	2.665	2.733	3.418	3.406	3.191	3.326	3.407	3.164	10.35
40)	T	Ethylbenzene		4.107	5.234	5.543	5.513	6.225	6.117	5.456	13.98
41)	T	m,p-Xylene		2.870	4.101	4.647	4.492	4.994	4.910	4.336	18.13
42)	T	Styrene			2.329	2.794	2.942	3.677	3.711	3.091	19.27
43)	T	o-Xylene			1.892	2.105	2.080	2.315	2.286	2.135	8.04
44)	T	1,1,2,2-Tetrac...	1.646	1.755	2.329	2.427	2.303	2.425	2.348	2.176	15.16
45)	S	Bromofluoroben...	1.128	1.169	1.152	1.287	1.305	1.748	1.604	1.342	18.00
46)	T	1,3,5-Trimethy...			3.486	4.618	5.384	5.953	5.163	4.921	18.98
47)	T	1,2,4-Trimethy...			3.518	4.462	5.552	6.269	5.676	5.095	21.53
48)	T	1,3-Dichlorobe...	1.636	1.468	2.078	2.442	2.921	3.237	2.801	2.369	28.24
49)	T	1,4-Dichlorobe...	2.096	1.612	2.121	2.472	2.876	3.212	2.693	2.440	22.18
50)	T	1,2-Dichlorobe...	1.932	1.594	2.105	2.414	2.336	3.157	2.739	2.325	22.27
51)	T	1,2-Dibromo-3-...	0.592	0.480	0.647	0.773	0.772	1.115	0.957	0.762	28.54
52)	T	1,2,4-Trichlor...	1.062	0.815	1.106	1.216	1.235	1.938	1.702	1.296	30.03
53)	T	Naphthalene			3.668	4.109	4.504	7.105	6.273	5.132	28.87
54)	T	Hexachlorobuta...	0.929	0.694	0.756	0.980	0.800	1.123	0.907	0.884	16.56

-----  
 (#) = Out of Range

S19102621.M Wed Oct 27 14:02:56 2021

Data File : I:\MS19\DATA\2021 11\01\11012102.D  
 Acq On : 1 Nov 2021 9:20  
 Sample : CCV S19110121 1000pg  
 Misc : S34-10062101/S34-10252104 (11/24)

Vial: 16  
 Operator: TZ  
 Inst : MS19

TZ 11/1/21

Quant Time: Nov 01 09:45:25 2021  
 Quant Method : I:\MS19\METHODS\S19102621.M  
 Quant Title : EPA TO-15 per SOP VOA-TO15 (CASS TO-15/GC-MS)  
 QLast Update : Wed Oct 27 10:48:57 2021  
 Response via : Initial Calibration  
 DataAcq Meth:TO15SIM.M

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.33min  
 Max. RRF Dev : 30% Max. Rel. Area : 200%

	Compound	AvgRF	CCRF	%Dev	Area%	Dev (min)
1 I	Bromochloromethane (IS1)	1.000	1.000	0.0	168	-0.02
2 T	Dichlorodifluoromethane (CF	3.283	2.722	17.1	133	-0.04
3 T	Chloromethane	0.762	0.569	25.3	109	-0.05
4 T	1,2-Dichloro,1,1,2,2-tetra	3.177	2.310	27.3	114	-0.03
5 T	Vinyl Chloride	3.494	2.622	25.0	113	-0.05
6 T	1,3-Butadiene	1.809	2.011	-11.2	132	-0.06
7 T	Bromomethane	1.021	0.875	14.3	126	-0.05
8 T	Chloroethane	0.862	0.745	13.6	129	-0.05
9 T	Acrolein	0.651	0.606	6.9	144	0.01
10 T	Acetone	0.918	0.788	14.2	144	-0.08
11 T	Trichlorofluoromethane	2.140	1.971	7.9	150	-0.02
12 T	1,1-Dichloroethene	1.169	1.189	-1.7	157	-0.04
13 T	Methylene Chloride	1.436	1.341	6.6	148	-0.03
14 T	Trichlorotrifluoroethane	1.013	1.058	-4.4	165	-0.02
15 T	trans-1,2-Dichloroethene	1.211	1.266	-4.5	156	-0.05
16 T	1,1-Dichloroethane	2.446	2.273	7.1	142	-0.02
17 T	Methyl tert-Butyl Ether	3.569	3.653	-2.4	152	-0.05
18 T	cis-1,2-Dichloroethene	1.332	1.358	-2.0	157	-0.03
19 T	Chloroform	2.535	2.286	9.8	143	-0.01
20 S	1,2-Dichloroethane-d4 (SS1)	2.219	1.874	15.5	138	0.00
21 T	1,2-Dichloroethane	2.005	1.800	10.2	134	-0.02
22 T	1,1,1-Trichloroethane	2.116	2.042	3.5	151	0.00
23 T	Benzene	5.846	5.220	10.7	146	-0.02
24 T	Carbon Tetrachloride	1.710	1.642	4.0	155	0.00
25 I	1,4-Difluorobenzene (IS2)	1.000	1.000	0.0	162	0.00
26 T	1,2-Dichloropropane	0.297	0.268	9.8	143	-0.02
27 T	Bromodichloromethane	0.402	0.363	9.7	145	-0.02
28 T	Trichloroethene	0.256	0.269	-5.1	166	-0.02
29 T	1,4-Dioxane	0.223	0.211	5.4	154	-0.04
30 T	cis-1,3-Dichloropropene	0.397	0.391	1.5	153	-0.04
31 T	trans-1,3-Dichloropropene	0.348	0.349	-0.3	156	-0.07
32 T	1,1,2-Trichloroethane	0.239	0.223	6.7	146	-0.02
33 S	Toluene-d8 (SS2)	1.117	1.072	4.0	157	0.00
34 T	Toluene	1.123	1.069	4.8	150	-0.01
35 T	Dibromochloromethane	0.254	0.264	-3.9	162	-0.02
36 T	1,2-Dibromoethane	0.262	0.277	-5.7	158	-0.02
37 T	Tetrachloroethene	0.230	0.249	-8.3	172	0.00
38 I	Chlorobenzene-d5 (IS3)	1.000	1.000	0.0	137	0.00
39 T	Chlorobenzene	3.164	3.661	-15.7	157	0.00
40 T	Ethylbenzene	5.456	6.107	-11.9	152	-0.02
41 T	m,p-Xylene	4.336	4.890	-12.8	149	-0.02
42 T	Styrene	3.091	3.432	-11.0	160	-0.03
43 T	o-Xylene	2.135	2.350	-10.1	155	0.00
44 T	1,1,2,2-Tetrachloroethane	2.176	2.438	-12.0	145	0.00
45 S	Bromofluorobenzene (SS3)	1.342	1.720	-28.2	181	0.00
46 T	1,3,5-Trimethylbenzene	4.921	5.103	-3.7	130	0.00
47 T	1,2,4-Trimethylbenzene	5.095	5.172	-1.5	128	0.00
48 T	1,3-Dichlorobenzene	2.369	2.890	-22.0	136	0.00
49 T	1,4-Dichlorobenzene	2.440	2.892	-18.5	138	0.00
50 T	1,2-Dichlorobenzene	2.325	2.819	-21.2	166	0.00
51 T	1,2-Dibromo-3-chloropropane	0.762	0.990	-29.9	176	0.00
52 T	1,2,4-Trichlorobenzene	1.296	1.641	-26.6	182	-0.02
53 T	Naphthalene	5.132	5.639	-9.9	172	-0.04
54 T	Hexachlorobutadiene	0.884	1.069	-20.9	183	0.00

Revised Report

Evaluate Continuing Calibration Report

Data File : I:\MS19\DATA\2021 11\01\11012102.D  
Acq On : 1 Nov 2021 9:20  
Sample : CCV S19110121 1000pg  
Misc : S34-10062101/S34-10252104 (11/24)

Vial: 16  
Operator: TZ  
Inst : MS19

Quant Time: Nov 01 09:45:25 2021  
Quant Method : I:\MS19\METHODS\S19102621.M  
Quant Title : EPA TO-15 per SOP VOA-TO15 (CASS TO-15/GC-MS)  
QLast Update : Wed Oct 27 10:48:57 2021  
Response via : Initial Calibration  
DataAcq Meth:TO15SIM.M

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.33min  
Max. RRF Dev : 30% Max. Rel. Area : 200%

Compound	AvgRF	CCRF	%Dev Area%	Dev(min)
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(#) = Out of Range

SPCC's out = 0 CCC's out = 0

Data File : I:\MS19\DATA\2021 11\02\11022102.D  
 Acq On : 2 Nov 2021 3:24  
 Sample : CCV S19110221 1000pg  
 Misc : S34-10062101/S34-10252104 (11/24)

Vial: 16  
 Operator: TZ  
 Inst : MS19

Quant Time: Nov 02 08:02:08 2021  
 Quant Method : I:\MS19\METHODS\S19102621.M  
 Quant Title : EPA TO-15 per SOP VOA-TO15 (CASS TO-15/GC-MS)  
 QLast Update : Wed Oct 27 10:48:57 2021  
 Response via : Initial Calibration  
 DataAcq Meth:TO15SIM.M

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.33min  
 Max. RRF Dev : 30% Max. Rel. Area : 200%

	Compound	AvgRF	CCRF	%Dev	Area%	Dev (min)
1 I	Bromochloromethane (IS1)	1.000	1.000	0.0	174	-0.01
2 T	Dichlorodifluoromethane (CF	3.283	2.776	15.4	140	-0.04
3 T	Chloromethane	0.762	0.654	14.2	129	-0.05
4 T	1,2-Dichloro,1,1,2,2-tetra	3.177	2.141	32.6#	109	-0.03
5 T	Vinyl Chloride	3.494	2.583	26.1	115	-0.05
6 T	1,3-Butadiene	1.809	1.906	-5.4	129	-0.05
7 T	Bromomethane	1.021	0.902	11.7	135	-0.05
8 T	Chloroethane	0.862	0.850	1.4	152	-0.05
9 T	Acrolein	0.651	0.706	-8.4	174	0.01
10 T	Acetone	0.918	0.916	0.2	173	-0.08
11 T	Trichlorofluoromethane	2.140	2.019	5.7	159	-0.02
12 T	1,1-Dichloroethene	1.169	1.234	-5.6	168	-0.03
13 T	Methylene Chloride	1.436	1.434	0.1	164	-0.03
14 T	Trichlorotrifluoroethane	1.013	1.054	-4.0	171	-0.02
15 T	trans-1,2-Dichloroethene	1.211	1.323	-9.2	169	-0.04
16 T	1,1-Dichloroethane	2.446	2.577	-5.4	166	-0.01
17 T	Methyl tert-Butyl Ether	3.569	3.980	-11.5	171	-0.04
18 T	cis-1,2-Dichloroethene	1.332	1.411	-5.9	169	-0.02
19 T	Chloroform	2.535	2.439	3.8	157	0.00
20 S	1,2-Dichloroethane-d4 (SS1)	2.219	2.071	6.7	157	0.00
21 T	1,2-Dichloroethane	2.005	2.007	-0.1	155	-0.01
22 T	1,1,1-Trichloroethane	2.116	2.105	0.5	160	0.00
23 T	Benzene	5.846	5.661	3.2	164	-0.01
24 T	Carbon Tetrachloride	1.710	1.656	3.2	162	0.00
25 I	1,4-Difluorobenzene (IS2)	1.000	1.000	0.0	170	0.00
26 T	1,2-Dichloropropane	0.297	0.302	-1.7	169	-0.01
27 T	Bromodichloromethane	0.402	0.377	6.2	158	-0.01
28 T	Trichloroethene	0.256	0.264	-3.1	171	-0.01
29 T	1,4-Dioxane	0.223	0.218	2.2	168	-0.04
30 T	cis-1,3-Dichloropropene	0.397	0.416	-4.8	171	-0.03
31 T	trans-1,3-Dichloropropene	0.348	0.368	-5.7	173	-0.06
32 T	1,1,2-Trichloroethane	0.239	0.235	1.7	162	-0.02
33 S	Toluene-d8 (SS2)	1.117	1.103	1.3	169	0.00
34 T	Toluene	1.123	1.116	0.6	164	-0.01
35 T	Dibromochloromethane	0.254	0.259	-2.0	167	-0.02
36 T	1,2-Dibromoethane	0.262	0.279	-6.5	167	-0.02
37 T	Tetrachloroethene	0.230	0.243	-5.7	176	0.00
38 I	Chlorobenzene-d5 (IS3)	1.000	1.000	0.0	162	0.00
39 T	Chlorobenzene	3.164	3.287	-3.9	166	0.00
40 T	Ethylbenzene	5.456	5.669	-3.9	166	-0.02
41 T	m,p-Xylene	4.336	4.541	-4.7	163	-0.01
42 T	Styrene	3.091	3.111	-0.6	171	-0.03
43 T	o-Xylene	2.135	2.135	0.0	166	0.00
44 T	1,1,2,2-Tetrachloroethane	2.176	2.303	-5.8	162	0.00
45 S	Bromofluorobenzene (SS3)	1.342	1.492	-11.2	185	0.00
46 T	1,3,5-Trimethylbenzene	4.921	4.695	4.6	141	0.00
47 T	1,2,4-Trimethylbenzene	5.095	4.746	6.8	138	0.00
48 T	1,3-Dichlorobenzene	2.369	2.573	-8.6	142	0.00
49 T	1,4-Dichlorobenzene	2.440	2.578	-5.7	145	0.00
50 T	1,2-Dichlorobenzene	2.325	2.518	-8.3	174	0.00
51 T	1,2-Dibromo-3-chloropropane	0.762	0.877	-15.1	184	0.00
52 T	1,2,4-Trichlorobenzene	1.296	1.476	-13.9	193	-0.02
53 T	Naphthalene	5.132	5.078	1.1	182	-0.04
54 T	Hexachlorobutadiene	0.884	0.985	-11.4	199	0.00



Evaluate Continuing Calibration Report

Data File : I:\MS19\DATA\2021 11\02\11022102.D  
Acq On : 2 Nov 2021 3:24  
Sample : CCV S19110221 1000pg  
Misc : S34-10062101/S34-10252104 (11/24)

Vial: 16  
Operator: TZ  
Inst : MS19

Quant Time: Nov 02 08:02:08 2021  
Quant Method : I:\MS19\METHODS\S19102621.M  
Quant Title : EPA TO-15 per SOP VOA-TO15 (CASS TO-15/GC-MS)  
QLast Update : Wed Oct 27 10:48:57 2021  
Response via : Initial Calibration  
DataAcq Meth:TO15SIM.M

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.33min  
Max. RRF Dev : 30% Max. Rel. Area : 200%

Compound	AvgRF	CCRF	%Dev Area%	Dev(min)
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(#) = Out of Range

SPCC's out = 0 CCC's out = 0

# Survey Data Results

**Attachment 4**  
**Survey Data Results**  
**Building C-19 Indoor Air Evaluation**  
**Snohomish County Airport – Everett, Washington**

**ASPI Job No. 19-012**                      **Project Surveyor: Matt Schneiders, PLS (425-252-1884)**  
**ASPI, LLC 5205 S 2nd Ave, Ste A. Everett, WA 98203**

Horizontal Datum: Washington State Plane Coordinate System of 1983, North Zone, NAD83-2011  
 Epoch 2010.00  
 Vertical Datum: NAVD88  
 Monitoring well points located on the top north side of the PVC piping inside the well monument casing. All others at center of bore patch.

<b>Monitoring Well</b>	<b>Date</b>	<b>Northing</b>	<b>Easting</b>	<b>Elevation</b>	<b>Point No.</b>
RIGW-1	12/07/21	331345.31	1286825.37	600.84	1002
RISB-48	12/07/21	331614.62	1286995.24	601.83	1003
RIGW-2	12/07/21	331495.39	1286672.42	599.50	1007
RISB-51	12/07/21	331563.07	1287145.80	604.27	1008
RISB-40	12/07/21	331488.51	1287244.58	601.79	1010
RISB-61	12/07/21	331585.89	1287239.24	602.20	1011
RISB-37	12/07/21	331477.00	1287059.58	604.38	1012
RISB-53	12/07/21	331396.71	1287054.30	604.40	1013
RISB-38	12/07/21	331432.74	1287102.40	604.42	1014
RISB-16	12/07/21	331242.45	1287002.99	601.88	1015
RISB-60	12/06/21	331295.49	1287227.76	601.69	1016
RISB-21	12/07/21	331099.59	1287028.93	603.52	1020
RISB-49	12/07/21	331167.71	1287011.76	602.21	1021
RISB-07	12/07/21	331046.65	1287197.81	601.44	1022
RISB-13	12/7/2021	331150.81	1287102.14	601.93	1026
RISB-25	12/07/21	331122.10	1287184.85	602.16	1029
RISB-15	12/07/21	331252.11	1287195.20	601.55	1031

**Abbreviations and Acronyms:**

NAD83 = North American Datum of 1983  
 NAVD88 = North American Vertical Datum of 1988  
 PVC = polyvinyl chloride

ATTACHMENT 5

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## **Well Completion Logs**

# Soil Classification System

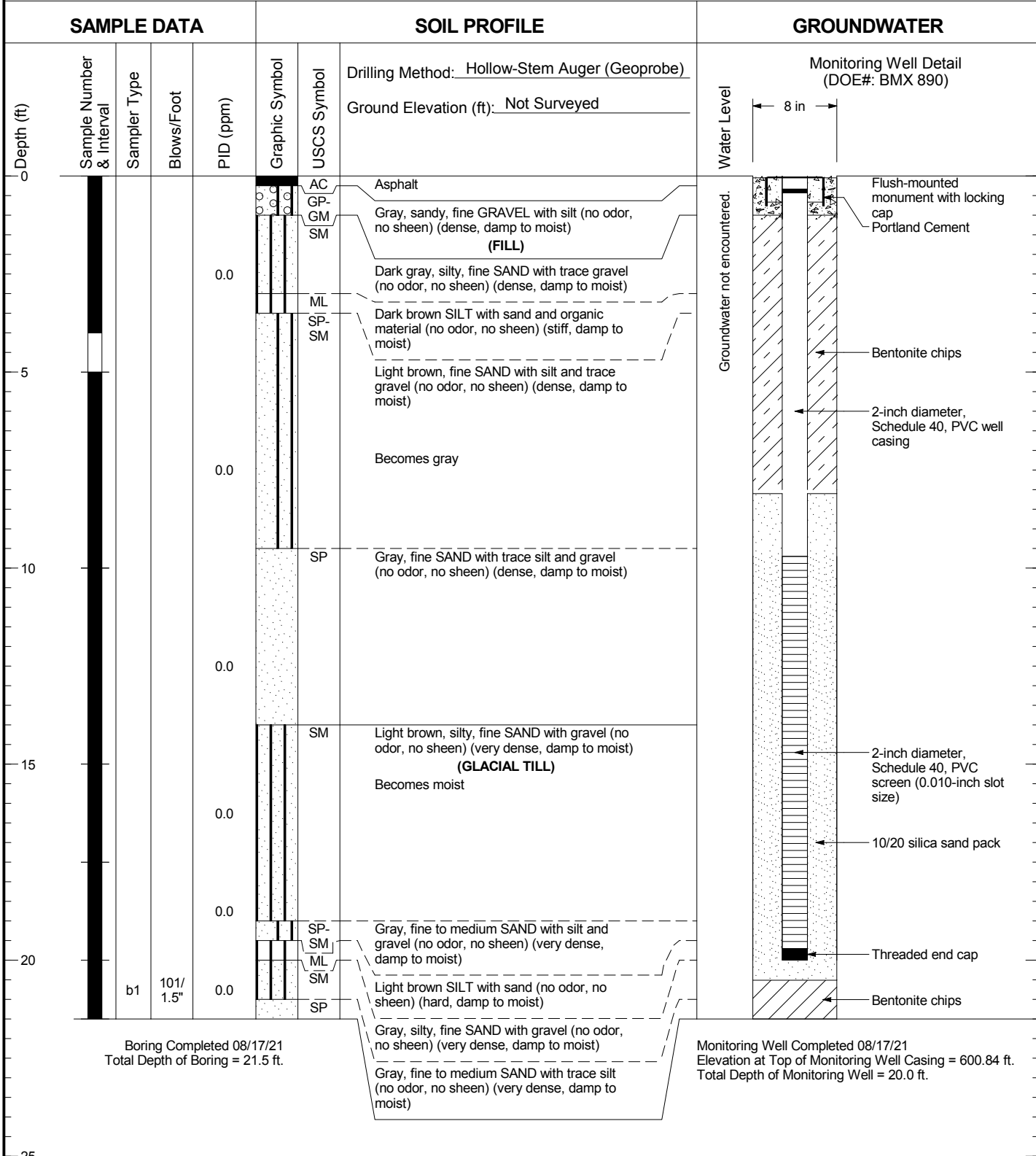
	MAJOR DIVISIONS	CLEAN GRAVEL (Little or no fines)	GRAPHIC SYMBOL	LETTER SYMBOL <sup>(1)</sup>	TYPICAL DESCRIPTIONS <sup>(2)(3)</sup>
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL  (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		<b>GW</b>	Well-graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		<b>GP</b>	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		<b>GM</b>	Silty gravel; gravel/sand/silt mixture(s)
	SAND AND SANDY SOIL  (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		<b>SW</b>	Well-graded sand; gravelly sand; little or no fines
		CLEAN SAND (Little or no fines)		<b>SP</b>	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		<b>SM</b>	Silty sand; sand/silt mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY  (Liquid limit less than 50)	SILT AND CLAY (Liquid limit less than 50)		<b>ML</b>	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
		SILT AND CLAY (Liquid limit less than 50)		<b>CL</b>	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
		SILT AND CLAY (Liquid limit less than 50)		<b>OL</b>	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY  (Liquid limit greater than 50)	SILT AND CLAY (Liquid limit greater than 50)		<b>MH</b>	Inorganic silt; micaceous or diatomaceous fine sand
		SILT AND CLAY (Liquid limit greater than 50)		<b>CH</b>	Inorganic clay of high plasticity; fat clay
		SILT AND CLAY (Liquid limit greater than 50)		<b>OH</b>	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL		<b>PT</b>	Peat; humus; swamp soil with high organic content	

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		<b>AC or PC</b>	Asphalt concrete pavement or Portland cement pavement
ROCK		<b>RK</b>	Rock (See Rock Classification)
WOOD		<b>WD</b>	Wood, lumber, wood chips
DEBRIS		<b>DB</b>	Construction debris, garbage

- Notes:
- USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
  - Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
  - Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:
    - Primary Constituent: > 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
    - Secondary Constituents: > 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
    - > 15% and ≤ 30% - "gravelly," "sandy," "silty," etc.
    - Additional Constituents: > 5% and ≤ 15% - "with gravel," "with sand," "with silt," etc.
    - ≤ 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.
  - Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key		Field and Lab Test Data																																																				
SAMPLER TYPE	SAMPLE NUMBER & INTERVAL																																																					
<table border="0" style="width: 100%;"> <tr> <td style="width: 5%;">Code</td> <td>Description</td> </tr> <tr> <td>a</td> <td>3.25-inch O.D., 2.42-inch I.D. Split Spoon</td> </tr> <tr> <td>b</td> <td>2.00-inch O.D., 1.50-inch I.D. Split Spoon</td> </tr> <tr> <td>c</td> <td>Shelby Tube</td> </tr> <tr> <td>d</td> <td>Grab Sample</td> </tr> <tr> <td>e</td> <td>Single-Tube Core Barrel</td> </tr> <tr> <td>f</td> <td>Double-Tube Core Barrel</td> </tr> <tr> <td>g</td> <td>2.50-inch O.D., 2.00-inch I.D. WSDOT</td> </tr> <tr> <td>h</td> <td>3.00-inch O.D., 2.375-inch I.D. Mod. California</td> </tr> <tr> <td>i</td> <td>Other - See text if applicable</td> </tr> <tr> <td>1</td> <td>300-lb Hammer, 30-inch Drop</td> </tr> <tr> <td>2</td> <td>140-lb Hammer, 30-inch Drop</td> </tr> <tr> <td>3</td> <td>Pushed</td> </tr> <tr> <td>4</td> <td>Vibrocore (Rotasonic/Geoprobe)</td> </tr> <tr> <td>5</td> <td>Other - See text if applicable</td> </tr> </table>	Code	Description	a	3.25-inch O.D., 2.42-inch I.D. Split Spoon	b	2.00-inch O.D., 1.50-inch I.D. Split Spoon	c	Shelby Tube	d	Grab Sample	e	Single-Tube Core Barrel	f	Double-Tube Core Barrel	g	2.50-inch O.D., 2.00-inch I.D. WSDOT	h	3.00-inch O.D., 2.375-inch I.D. Mod. California	i	Other - See text if applicable	1	300-lb Hammer, 30-inch Drop	2	140-lb Hammer, 30-inch Drop	3	Pushed	4	Vibrocore (Rotasonic/Geoprobe)	5	Other - See text if applicable		<table border="0" style="width: 100%;"> <tr> <td style="width: 5%;">Code</td> <td>Description</td> </tr> <tr> <td>PP = 1.0</td> <td>Pocket Penetrometer, tsf</td> </tr> <tr> <td>TV = 0.5</td> <td>Torvane, tsf</td> </tr> <tr> <td>PID = 100</td> <td>Photoionization Detector VOC screening, ppm</td> </tr> <tr> <td>W = 10</td> <td>Moisture Content, %</td> </tr> <tr> <td>D = 120</td> <td>Dry Density, pcf</td> </tr> <tr> <td>-200 = 60</td> <td>Material smaller than No. 200 sieve, %</td> </tr> <tr> <td>GS</td> <td>Grain Size - See separate figure for data</td> </tr> <tr> <td>AL</td> <td>Atterberg Limits - See separate figure for data</td> </tr> <tr> <td>GT</td> <td>Other Geotechnical Testing</td> </tr> <tr> <td>CA</td> <td>Chemical Analysis</td> </tr> </table>	Code	Description	PP = 1.0	Pocket Penetrometer, tsf	TV = 0.5	Torvane, tsf	PID = 100	Photoionization Detector VOC screening, ppm	W = 10	Moisture Content, %	D = 120	Dry Density, pcf	-200 = 60	Material smaller than No. 200 sieve, %	GS	Grain Size - See separate figure for data	AL	Atterberg Limits - See separate figure for data	GT	Other Geotechnical Testing	CA	Chemical Analysis
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# RIGW-1



Boring Completed 08/17/21  
Total Depth of Boring = 21.5 ft.

Monitoring Well Completed 08/17/21  
Elevation at Top of Monitoring Well Casing = 600.84 ft.  
Total Depth of Monitoring Well = 20.0 ft.

- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
  2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
  3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

222057. 12/14/21 N:\PROJECTS\222057.010.GPJ WELL LOG

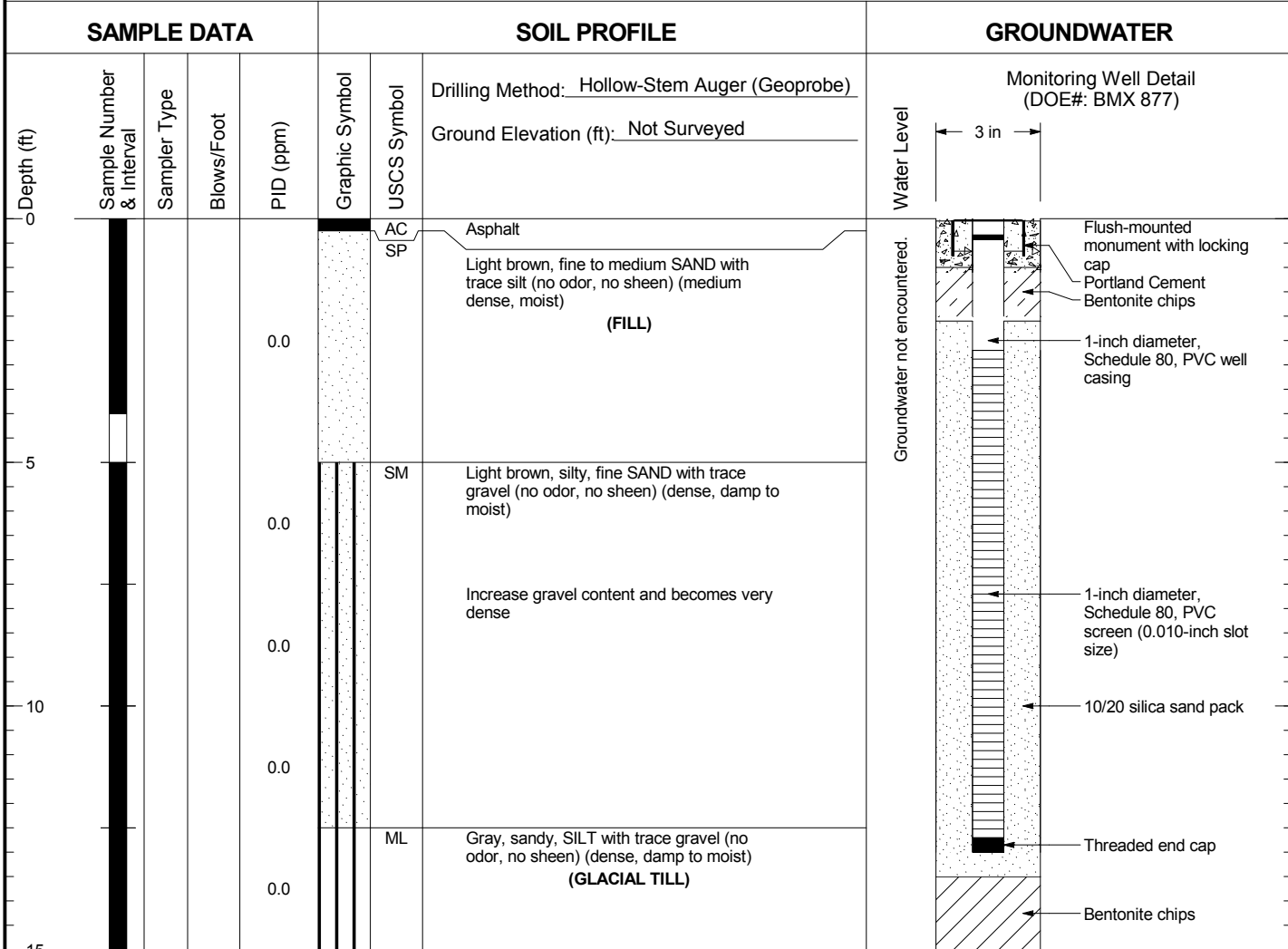


TECT Aerospace Leasehold  
Everett, Washington

Log of Monitoring Well RIGW-1

Figure  
**5-2**

# RIGW-2



- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
  2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
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222057\_12/14/21 N:\PROJECTS\222057\_010.GPJ WELL LOG



TECT Aerospace Leasehold  
Everett, Washington

Log of Monitoring Well RIGW-2

Figure  
**5-3**