National Aeronautics and
Space Administration

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P.O. Box 20
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April 27, 2023

Reply to Attn of: RE-23-075

Mr. Dave Cobrain, Acting Bureau Chief
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Subject: Response to Second Disapproval 200 and 600 Area Vapor Intrusion Assessment Report

NASA received NMED's *Disapproval 200 and 600 Area Vapor Intrusion Assessment Report* dated September 20, 2022, directing NASA to address three comments (Comment 1, Comment 2 Bullets a. through i., and Comment 3 Bullets a. through c.) and submit a revised report no later than April 28, 2023.

Enclosure 1 provides the response table with cross-references where NMED modifications were addressed in the report. Enclosure 2 provides a hard copy of the final report excluding Appendices. Enclosure 3 includes analytical lab reports in PDF format. Enclosure 4 provides input files and analytical data in Excel format. Enclosure 5 provides electronic copies of the revised final report, the redline-strikeout report version, the response table, Enclosure 4, and Enclosure 5 on CD-ROM.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions or comments concerning this submittal, please contact Antonette Doherty of my staff at 575–202–5406.

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Timothy J. Davis
Chief, Environmental Office

3 Enclosures

cc:
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Ms. Melanie Sandoval
Submitted electronically via NASA Box

National Aeronautics and Space Administration

200 and 600 Area
Vapor Intrusion Assessment Report

June 2018

Revised January 2020

Revised April 2023

NM8800019434

200 and 600 Area
Vapor Intrusion Assessment Report

June 2018

Revised January 2020

Revised April 2023

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

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Executive Summary

The results of the National Aeronautics and Space Administration (NASA) 200 Area Phase II Investigation Report (IR) submitted on June 29, 2015 indicated that concentrations of contaminants of potential concern (COPC) in soil vapor at the 200 Area Hazardous Waste Management Units (HWMUs) exceeded New Mexico Environment Department (NMED) and/or WSTF-specific screening criteria. NASA recommended a vapor intrusion assessment of the complete vapor pathway in the 200 Area. NASA submitted the 200 and 600 Area Vapor Intrusion Assessment Work Plan (VIAWP) on February 26, 2016, and this was approved by NMED on May 27, 2016.

This vapor intrusion assessment report (VIAR) follows a tiered vapor intrusion evaluation process. The two locations with the greatest potential for vapor intrusion were evaluated: the 200 Area on the west side of Building 200 at the location of the former Clean Room tank HWMU; and, 600 Area Building 637 located near the 600 Area HWMU. Additional evaluation to determine whether soil vapor is a potential source of unacceptable indoor air risks include a review of building foundations, building ventilation systems, a temporal trend analysis of VOC source concentrations in groundwater, characterization of the vertical distribution of vadose zone pore vapor, and comparison of the concentrations of COPCs in source media (soil vapor) and exposure media (indoor air) to assess the contribution of source area COPCs to indoor air risks.

Two semi-annual sampling events were performed in the summer (August 2017) and winter (February 2018). Soil vapor samples were analyzed using EPA Method TO-15. In the 200 Area, soil vapor samples were collected from the shallow ports of three MSVM wells on the west side of Building 200. Indoor samples were collected at locations in Building 200 above the subsurface footprint of the former 200 Area Clean Room Tank HWMU and outdoor air samples were collected adjacent to Building 200. In the 600 Area, samples were collected from the shallow ports in two MSVM wells on the west side of Building 637. Indoor air samples were collected in Building 637 along with outdoor air samples at adjacent locations. The 200 and 600 Area soil vapor risk and hazard results were combined with previous soils risk and hazard data. Risk screening evaluations for soil vapor include both carcinogenic and noncarcinogenic toxicity and were performed using ProUCL Version 5.2.

For the 200 and 600 Area vadose zone, TCE concentrations in soil vapor exceed the NMED VISL and in the 200 Area, WSTF RBC as well for both sampling events. PCE soil vapor concentrations exceed the VISL for both sampling events but are below the RBC at 25 ft bgs. The concentrations for the other remaining COPCs in vadose zone soil vapor are below the VISL (except 1,1-Dichloroethane in the 200 Area) and RBC. Concentrations in Building 200 outdoor and indoor air samples were generally non-detect or below 1 $\mu g/m^3$ for COPCs and below the VISL and RBC. Cumulatively, TCE and PCE are the risk drivers for soil vapor. Both individual and cumulative risk was exceeded by TCE concentrations for the residential and industrial scenarios in the 200 Area. Even though risk and hazard targets were exceeded for soil vapor, indoor air risk and hazard were below targets. Separate contaminant suites between indoor air and soil vapor, intact building foundations, robust ventilation systems, a generally increasing contaminant concentration trend with depth provide evidence that vapor intrusion is not a significant contributor to indoor air in Building 200 or Building 637.

From the Decision Rule: “If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below risk-based indoor air concentrations…, then current vapor intrusion risks are acceptable.” Based on this VIAR, NASA concludes that potential vapor intrusion into the buildings does not present a risk of industrial/occupational exposure to personnel, and no additional investigation or vapor intrusion mitigation is required.

The risk screening performed for this VIAR is not intended to be complete at this time, as continued monitoring is planned for the 200 and 600 Areas. NASA will perform continued risk and hazard screening, including soil-to-groundwater and an ecological assessment in accordance with the current NMED RA Guidance, Volumes I and II at an appropriate time to make corrective action decisions or to seek closure. At that time, NASA will provide a risk report in accordance with the WSTF Permit Section 6.5.

Table of Contents

List of Figures and Tables

List of Acronyms

µg	Microgram
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
AOI	Area of Interest
bgs	Below ground surface
BTV	Background Threshold Value
CAP	RCRA Corrective Action Program
CFR	Code of Federal Regulations
CH4	Methane
CO2	Carbon Dioxide
CoC	Chain-of-custody
COPC	Contaminant of Potential Concern
DQOs	Data Quality Objectives
EDD	Electronic Data Deliverable
EPA	Environmental Protection Agency
Freon 11	Trichlorofluoromethane
Freon 113	1,1,2-Trichloro-1,2,2-Trifluoroethane
ft	Feet/foot
GCL	Geosciences Consultants, Ltd.
GMP	Groundwater Monitoring Plan
GSA	Gardner Spring Arroyo
HAZWOPER	Hazardous Waste Operations and Emergency Response
HIS	Historical Information Summary
HVAC	Heating, Ventilation, and Air Conditioning
HWB	Hazardous Waste Bureau
HWMU	Hazardous Waste Management Unit
HWTL	Hazardous Waste Transmission Line
IDW	Investigation-Derived Waste
in.	Inch(es)
IR	Investigation Report
IWP	Investigation Work Plan
JDMB	Jornada del Muerto Basin
m	Meter
MSVGM	Multiport Soil Vapor and Groundwater Monitoring
MSVM	Multiport Soil Vapor Monitoring
NASA	National Aeronautics and Space Administration
NMED	New Mexico Environment Department
O2	Oxygen
ODEQ	Oregon Department of Environmental Quality
PCC	Post-Closure Care
PCE	Tetrachloroethene
PDF	Portable Document File
PEL	Permissible Exposure Limit(s)
PID	Photoionization Detector
PPE	Personal Protective Equipment
ppm	Part per million
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control

RBC	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
SAM	San Andres Mountains
SCEM	Site Conceptual Exposure Model
SHP	Safety and Health Plan
SOP	Standard Operating Procedure
sq ft	Square foot/feet
SSL	Soil Screening Level
SVE	Soil Vapor Extraction
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
TWA	Time Weighted Average
UST	Underground Storage Tank
VIAR	Vapor Intrusion Assessment Report
VIAWP	Vapor Intrusion Assessment Work Plan
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compounds
WSTF	White Sands Test Facility

1.0 Introduction

National Aeronautics and Space Administration (NASA) submitted the results of the 200 Area Phase II Investigation Report (IR; NASA, 2015b) to the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) on June 29, 2015. The IR described the most recent phase of a comprehensive 200 Area vadose zone investigation and included the results of the comprehensive soil vapor sampling event in the 200 and 600 Areas conducted in October 2014. Based on the results of the IR, NASA proposed a quantitative assessment of the potential complete vapor intrusion pathway for the Building 200 foundation near the location of the former Clean Room underground storage tank (UST; also known as the 200 Area West Closure hazardous waste management unit [HWMU]). NMED agreed with NASA's intent to address potential complete vapor intrusion pathways in their approval with modifications for the IR on November 30, 2015 (NMED, 2015b).

The additional assessment of potential vapor intrusion in the 600 Area was proposed following written communications between NASA and NMED. On April 16, 2015, NASA submitted the 600 Area Perched Groundwater Extraction Pilot Test Interim Status Report – Project Year 2 for NMED review (NASA, 2015a). NMED approved the report with modifications on July 15, 2015, and required further investigation of the source of contamination at or near the HWMU (NMED, 2015a). NASA has already performed several investigations at the 600 Area HWMU, and concluded there is not a continuing source of contamination in the vadose zone beneath the HWMU. In a November 25, 2015 letter to NMED (NASA, 2015d), NASA included a summary of the environmental investigations performed at the 600 Area HWMU, the findings of those investigations, and the NMED responses to NASA's conclusions.

However, it has yet to be determined whether the presence of volatile organic compounds (VOCs) in soil vapor presents a risk to human health. Building 637, located southeast of the Closure, is the closest potential structure that could provide a current pathway for receptor exposure in the 600 Area.

1.1 Facility Location and Description

NASA Johnson Space Center White Sands Test Facility (WSTF) is located at 12600 NASA Road in central Doña Ana County, New Mexico. The site is approximately 12 miles northeast of Las Cruces, New Mexico and 65 miles north of El Paso, Texas (Figure 1.1). The WSTF U.S. Environmental Protection Agency (EPA) Facility Identification Number is NM8800019434. The facility has supported testing of space flight equipment and hazardous materials since 1964. WSTF contains five closed HWMUs that are under post-closure care (PCC) and 37 solid waste management units (SWMUs) within the 200, 300, 400, and 600 Areas. PCC requirements are specified by the NASA WSTF Hazardous Waste Permit (Permit) issued by NMED (2023). Specific regulatory requirements are discussed in Section 1.3.

1.2 WSTF 200 Area and 600 Area Closure Conditions

The field activities performed for the vapor intrusion assessment did not compromise the integrity of the 200 Area former Clean Room Tank HWMU. The original closure cap was removed when the building extension was constructed in 1991. The 200 Area former Clean Room Tank excavation cannot be accessed as it is located under Building 200 which is still in operation. Multiport soil vapor monitoring (MSVM) well 200-SV-05 and multiport soil vapor and groundwater monitoring (MSVGM) well (200-LV-150) are located adjacent to the building. Their installation and sampling do not affect the closure cap.

Activities in the 600 Area for this assessment also did not compromise the integrity of the 600 Area closure cap. As directed by NMED, MSVM wells 600-SGW-2, 600-SGW-5, and 600-SGW-6 were installed through or adjacent to the cap during previous investigations, and no new wells were installed for this assessment. No unintentional damage to either of the HWMU closures was identified during a post-assessment evaluation of closure conditions.

1.3 Regulatory Requirements

The Permit requires that NASA investigate and address historical releases of hazardous waste and hazardous constituents that may have occurred at sites throughout WSTF as part of the Resource Conservation and Recovery Act (RCRA) corrective action process (CAP). The CAP consists of investigation, characterization, and, if necessary, cleanup. The principal components of the CAP are:

- RCRA Facility Assessment.
- RCRA Facility Investigation.
- Interim Corrective Measures (if necessary).
- Corrective Measures Study (if necessary).
- Corrective Measures Implementation (if necessary).

NMED guidance requires that a quantitative vapor intrusion pathway assessment be performed where a "complete pathway" category exists (NMED, 2022c). The Permit (NMED, 2023) does not include cleanup standards for soil vapor. However, NMED has issued the latest Risk Assessment Guidance for Site Investigations and Remediation Volume I (NMED, 2022c) and has directed NASA to use this latest guidance to provide specific information on the development of screening levels for soil vapor contaminants and for evaluating exposure pathways and receptors. These are termed WSTF risk-based concentrations (RBCs; NASA, 2019a, 2017a) (Table 1.1).

In the event the assessment indicates a complete pathway and unacceptable risk is present at either of the two target building locations in the 200 and 600 Areas, NASA would be required to work with NMED to perform a corrective measures evaluation in accordance with Section 3.12 of the Permit.

NMED presented the available vapor intrusion screening assessment criteria alternatives in their November 30, 2015, 200 Area Phase II Approval with Modifications (NMED, 2015b). In accordance with an NMED recommendation (NMED, 2015b), NASA updated existing RBCs using available 2018 data in conjunction with the pre-assessment planning and preparation activities for this vapor intrusion assessment. Updated RBCs were available for use as a component for this vapor intrusion screening assessment.

NASA routinely collects groundwater samples from a comprehensive network of monitoring wells at WSTF in accordance with the NMED-approved Groundwater Monitoring Plan (GMP; NASA, 2017b). Groundwater samples are collected for the analysis of the following primary constituents: VOCs; n-nitrosodimethylamine, bromacil, and metals. In addition to routine groundwater samples required by the GMP, samples for other chemical analyses are frequently collected at many of the groundwater monitoring wells. Because these samples are not a direct requirement of the GMP, the results of these analyses are provided in the appropriate project-specific report. This Vapor Intrusion Assessment Report (VIAR) was prepared in response to NMED's approval (NMED, 2016a) of the 200 Area and 600 Area Vapor Intrusion Assessment Work Plan (VIAWP; NASA, 2016b).

1.4 Purpose and Method of Vapor Intrusion Assessment

The process to assess and remediate vapor intrusion in buildings (if required) involves a tiered approach. Firstly, source area vadose zone soil and groundwater VOC concentrations are compared to available regulatory standards, in this case the NMED Soil Screening Levels (SSLs; NMED, 2022c) and WSTF groundwater cleanup levels (GMP; NASA, 2017b). Secondly, concentrations of VOCs in soil vapor are compared to the latest NMED Vapor Intrusion Screening Levels (VISLs) (NMED, 2022c) and WSTF RBCs (NASA, 2019a). Both of these comparisons were performed for the original submittal of this report, *200 Area and 600 Area Vapor Intrusion Assessment Report,* dated June 2018. However, as noted by NMED (NMED, 2019) in comments to the original submittal, these comparisons did not constitute a complete risk screening for soil vapor because total vapor risk was not calculated for the sum of all COPCs and because, as far as human health risk, the total vapor risk was not added to the soil risk (soil results had not been discussed at all in the June 2018 submittal). This revision revisits the risk screening as required by the NMED Risk Assessment Guidance.

Originally, because specific samples in the 200 Area were identified that exceeded soil vapor screening levels during both soil vapor screening processes (NASA, 2015c), NASA and NMED agreed that the next step in the investigation process would be a vapor intrusion assessment focused on the areas of greatest potential concern. The objective of the 2018 200 Area and 600 Area vapor intrusion assessment was to perform an evaluation of the vapor intrusion pathways at the priority locations within the 200 and 600 Areas that present the most likely routes for vapor intrusion based on previous investigations (Figure 1.2). The investigation and 2018 report moved directly to evaluating the potential for vapor to affect industrial/occupational indoor air in specific buildings in accordance with NMED guidance (NMED, 2022c). It was predicated that a complete vapor intrusion exposure pathway had already been established. These locations can be described specifically as follows.

- The 200 Area immediately adjacent to, and below the foundation of Building 200 above the location of the former Clean Room tank HWMU, and adjacent to soil borings 200-SB-05 (MSVM well 200-SV-05), 200-SB-06 (MSVGM well 200-LV-150), and 200-SB-09 (MSVM well 200-SV-09). This location provided the highest soil vapor concentrations in the 200 Area vadose zone for 1,1,2-trichloro-1,2,2-trifluoroethane (Freon®[1] 113), TCE, and tetrachloroethene (PCE) during the October 2014 comprehensive soil vapor sampling event (NASA, 2015c). According to the NMED Risk Assessment Guidance for Site Investigations and Remediation (NMED, 2022c), this location exceeded NMED industrial/occupational VISLs for Freon 113, TCE, and PCE, WSTF's RBC for TCE at a location that is immediately adjacent to a building, and falls into the "complete pathway" category for vapor intrusion.
- The 600 Area between the 600 Area HWMU and Building 637, located 150 feet (ft) to the southeast, near soil borings 600-SB-02 (MSVM well 600-SGW-02), 600-SB-05 (MSVM well 600-SGW-05), and 600-SB-06 (MSVM well 600-SGW-06). This location provided the highest soil vapor concentrations in the 600 Area vadose zone for TCE and some of the highest for Freon 113 during the October 2014 comprehensive soil vapor sampling event (NASA, 2015c). Building 637 is the most proximal structure to the southeast side of the 600 Area HWMU. This location also exceeded NMED industrial/occupational soil vapor VISLs for TCE and warrants assessment related to potential vapor intrusion.

Steps 1 through 3 listed below were performed as part of this assessment.

- Step 1: Using historical soil vapor investigation data, compare concentrations for vadose zone soil vapor to the corresponding NMED VISL and NMED-approved WSTF RBC to determine whether the vapor intrusion pathway must be evaluated for industrial workers in 200 or 600 Area buildings.

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[1] Freon is a registered trademark of The Chemours Company CF, LLC.

NMED VISLs and RBCs are presented in Table 1.1. This evaluation was performed in the June 2018 submittal of this report.

- Step 2: Evaluate the vapor intrusion pathway and perform human health risk screening for exposure pathways, including soil and soil vapor, using all COPCs, their additive nature, and the soil and soil vapor additive pathways. This evaluation was performed in the June 2018 submittal of this report, and is presented here. This corresponds to Step 1 of a quantitative soil vapor assessment described in Section 2.5.2.3 of NMED (2022b).
- Step 3: If a comparison to soil vapor screening criteria indicates potentially unacceptable risk, as was indicated in the June 2018 submittal of this report, obtain additional information and assess potential human health risks based on multiple lines of evidence. Accordingly, activities that were completed in accordance with the VIAR included visual evaluation of the building foundations and determination of any preferential pathways, identification of the building ventilation systems, collection of shallow soil vapor samples in nearby MSVM and MSVGM wells in conjunction with indoor and outdoor air sampling at the two building locations being evaluated, and evaluation of vertical soil vapor concentrations to determine origin and attenuation from vapor sources. Converging lines of evidence are used to determine whether there are potentially unacceptable risks to present-day industrial workers in the buildings. This corresponds to Step 2 of a quantitative soil vapor assessment described in Section 2.5.2.3 of NMED (2022b).

1.5 Vapor Intrusion Screening Levels and Risk Based Concentrations

WSTF industrial/occupational workers could be exposed to VOCs derived from the migration of subsurface soil vapor through pore spaces in the vadose zone and building foundations into indoor air. The NMED Risk Assessment Guidance for Investigations and Remediation (NMED, 2022c) provides preliminary criteria to determine when vapor intrusion pathways must be evaluated:

- If there are compounds present in subsurface media that are sufficiently volatile and toxic, and
- If there are existing or planned buildings where exposure could occur.

"A chemical is considered to be sufficiently volatile if its Henry's law constant is 1 x 10-5 atm-m^3/mole or greater and its molecular weight is approximately 200 g/mole or less. A chemical is considered to be sufficiently toxic if the vapor concentration of the pure component poses an incremental life time cancer risk greater than 1E-05 or the non-cancer hazard index is greater than 1.0" (NMED, 2022c).

In order to establish whether adverse human health risk is a factor at the 200 and 600 Areas, a risk screening evaluation in accordance with the RA Guidance is initially required. VISLs are not designed to be used as action standards or cleanup levels, but can be used as a tool for screening potential cumulative risks and/or hazards from exposure to volatile and toxic chemicals and to determine if further evaluation may be needed using site-specific data. NMED (2017) indicates that VISLs can be used as a first tier screening assessment under certain conditions, including; the absence of shallow groundwater, no shallow soil contamination within 10 ft of the foundation base, no buildings with subsurface openings, no significant vadose zone advective transport (from landfills producing methane or industrial sites with applicable vapor density), and no leaking vapors from gas transmission lines. NMED VISLs were used for first tier screening due to the following:

- The 200 and 600 Areas have relatively deep groundwater sources (greater than 100 ft) below the building foundation levels.
- Shallow soil contamination resulting in vapor sources was not identified during previous investigations, although samples are greater than 10 ft from the building foundations. The closest soil sample to Building 200 was in soil boring 200-SB-05 located 18 ft from the building at a

depth of 8 to 10 ft below ground surface (bgs). The closest soil sample to Building 637 was collected below the 600 Area Closure cap in soil boring 600-SB-05 located 181 ft from the building at a depth of 8 to 10 ft bgs.

- Buildings do not have significant known openings to the subsurface (no sumps or earthen floors) or other significant preferential pathways.
- No known sources exist for advective transport (no vapor-forming chemicals released within an enclosed space where vapors could migrate downward through cracks and openings in floors and into the vadose zone).
- No known leaking gas transmission lines exist at WSTF.

Annually updated WSTF soil vapor RBCs are preferred relative to the screening and evaluation of soil vapor intrusion (NASA, 2019a). WSTF RBCs represent the maximum VOC concentrations allowed in soil vapor at a given depth for a complete vapor intrusion pathway. A VISL is calculated with a depth at or just below the surface (sub-slab). Since RBCs are more site-specific to WSTF than the generic VISLs and are calculated for multiple depths, using RBCs is preferred at WSTF.

First developed in 2012, these RBCs were based on EPA ambient air regional screening levels. The WSTF RBC calculations were completed for multiple depths in the vadose zone to provide a direct reference against soil vapor samples collected at the equivalent depths. To provide the best understanding of potential exposure, soil vapor and air concentrations were referenced and compared to the latest WSTF RBCs for air contaminants (Table 1.1).

1.6 Vapor Intrusion Pathway

No significant concentrations of VOCs were detected in vadose zone soil samples collected during the 200 Area or 600 Area investigations (NASA, 2015c, 2011a). In the 200 Area, organic compounds with more than one detection in soil samples were limited to traces of toluene and acetone at concentrations several orders of magnitude below the applicable NMED SSLs. Traces of acetone were considered an artifact of the sampling and analytical processes. The random horizontal and vertical distribution of trace concentrations of toluene do not support a vadose zone contaminant source. In the 600 Area, traces of trichlorofluoromethane (Freon 11), Freon 113, TCE, and PCE were rarely reported in soil samples, again at concentrations orders of magnitude below applicable NMED SSLs. NMED approved “No Longer Contained in Determinations” for all soils from the 200 Area and 600 Area investigations (NMED, 2009b, 2011b, 2014b, 2014c). Soils were redistributed at the surface in the vicinity of the soil borings from which they were derived (NASA, 2015c, 2011a). However, VOCs were detected above the applicable NMED VISLs in soil vapor and above the TCE cleanup level for groundwater samples collected in conjunction with the soil samples during these previous investigations.

Chemical analytical data were also obtained from two types of sampling performed for the assessment of the vapor intrusion pathway: passive vadose zone soil vapor sampling and active indoor/outdoor air sampling. Passive vadose zone samples from MSVM and MSVGM wells were used to confirm the presence of VOCs and their relative concentrations at specific depths in the vadose zone. Active indoor and outdoor air samples collected within the target buildings are required for quantitative assessments. Chemicals that should be considered for the vapor intrusion pathway include both volatile and toxic constituents (NMED, 2017). For the 200 and 600 Area building assessments, the vapor intrusion pathway options considered were: 1) incomplete and no action required; 2) potentially complete and a qualitative evaluation required; or 3) complete and quantitative evaluation required.

1.7 Methodologies

The VIAR provides specific information on the following activities:

- Project planning and preparation; NASA developed the required internal planning documents and coordinated the assignment of on and off-site resources for the assessment.
- Assessment activities, including soil vapor sample collection from MSVM and MSVGM wells and indoor and outdoor air sample collection at and adjacent to the target buildings.
- Investigation-derived waste (IDW) management as described in the VIAWP IDW Management Plan (NASA, 2016b; Appendix A).
- Data evaluation to determine if there are COPC concentrations above screening levels for vadose zone soil vapor and/or indoor air at the target buildings, as well as in surface soil. If COPCs are detected at concentrations above screening levels, the data can be used to guide remedial action, if necessary.
- Development and submittal of the 200 Area and 600 Area VIAR to NMED.

2.0 Background

2.1 Soil Vapor Contamination

Concentrations of soil vapor contaminants in the WSTF source areas vadose zone are widespread and have been identified and delineated during previous soil vapor surveys (Geosciences Consultants, Ltd. [GCL], 1986; NASA, 2013b). The first shallow soil vapor survey performed at WSTF (GCL, 1986) incorporated all WSTF source areas and areas topographically and hydrologically downgradient to the west. A strong correlation between the footprint of the groundwater contaminant plume and the overlying soil vapor contaminant plume within the vadose zone was observed. Soil vapor concentrations decreased to the west as the depth to the groundwater table increased from approximately 140 ft bgs in the source areas to more than 400 ft bgs in the Jornada del Muerto Basin (JDMB), which was consistent with a groundwater source.

The most recent 200 Area vadose zone investigation included a soil vapor survey that was performed using a phased approach. Fieldwork and laboratory testing activities were completed between June 2012 and January 2013 (Phase I) and June 2014 through January 2015 (Phase II). NMED requested that NASA report the 200 Area Phase I investigation results separately prior to implementing Phase II of the investigation (NMED, 2012). This allowed NMED to evaluate the initial Phase I data and review NASA's strategy for the Phase II investigation.

The Phase I field investigation (NASA, 2013b) included the shallow soil vapor survey, which was performed on a grid across the WSTF 200 Area and portions of the adjacent 100, 600, and 800 Areas in order to derive shallow soil vapor isoconcentration maps and delineate additional areas of interest (AOIs). The survey was conducted in two sub-phases using Gore Modules emplaced at a depth of 2.5 ft bgs in a grid pattern on 250-ft centers to evaluate soil vapor adjacent to and surrounding three HWMUs (former 200 Area USTs and former 600 Area surface impoundments), SWMUs 4 through 9, portions of SWMU 10, SWMUs 19 and 20, and six additional targets identified in the 200 Area Historical Information Summary (HIS; NASA, 2012b). The initial survey incorporated 144 survey points. An additional 38 points were installed within the grid to further evaluate specific areas yielding the highest soil vapor concentrations. Each sample module was analyzed for a total of 45 VOCs using EPA Method 8260. Five VOCs showed consistent detections in the vadose zone: TCE; PCE; Freon 11; Freon 113; and total petroleum hydrocarbons (TPH). NASA submitted the results in the 200 Area Phase I Status Report on

January 30, 2013 (NASA, 2013b). Following NMED review (NMED, 2013a), NASA submitted a revised Phase I IR on August 6, 2013 (NASA, 2013d). The revised report was approved by NMED on October 22, 2013 (NMED, 2013b).

The Phase II field investigation comprised subsurface evaluation of 200 Area HWMUs, SWMUs, AOIs outlined in the Phase I IR, and additional locations required by NMED (2013b). Subsurface drilling with soil and bedrock core sampling was followed by the installation of MSVM or MSVGM wells in the boreholes, and finally soil vapor and groundwater sampling (NASA, 2015c). All targets identified for Phase II were evaluated to the depth of bedrock, with the exception of the two 200 Area HWMUs that were investigated to the upper groundwater table located at depth in fractured rock. Fieldwork and laboratory testing activities were performed between June and November 2014. The final component of the 200 Area Phase II investigation comprised a comprehensive vadose zone soil vapor sampling event (NASA, 2015c).

The concentrations of VOCs in soil vapor within the 200 and 600 Areas have declined since the initiation of soil vapor monitoring at WSTF in 2000 with installation of the first MSVGM wells within the 200 Area (NASA, 2004). Subsequent comprehensive soil vapor sampling incorporating all MSVM and MSVGM wells in the 200 and 600 Areas were performed during four semi-annual events (NASA, 2011b, 2012a, 2012d, 2013c) required by NMED as a follow up to the 600 Area Closure investigation (NASA, 2011a). Comprehensive soil vapor sampling culminated with the most recent event in October 2014, which was performed as a component of the 200 Area Phase II investigation (NASA, 2015b). A historical data trend analysis to demonstrate the declining concentrations over time between sequential sampling events is included on the vertical concentration profiles provided in Section 6.2 of this vapor intrusion assessment. The vertical concentration profiles demonstrate the decline in soil vapor concentrations over time for two of the primary and most widely distributed contaminants (Freon 113 and TCE) for sampling events performed in August 2010 (NASA, 2011b), March 2013 (NASA, 2013c), October 2014 (NASA, 2015b), and for this vapor intrusion assessment in August 2017 and February 2018.

Declines in soil vapor concentrations have been observed in conjunction with a corresponding decline in concentrations of the same contaminants in groundwater (NASA, 2016a). The maximum soil vapor concentrations measured during the most recent (October 2014) comprehensive survey, including the newly installed 200 Area Phase II wells, decreased toward the southwest through the area covered by existing 100 and 200 Area wells and into the 600 Area HWMU along the downgradient path for groundwater plume migration and contamination. NASA submitted the results in the 200 Area Phase II IR on June 29, 2015 (NASA, 2015c). The report was approved with modifications by NMED on November 30, 2015 (NMED, 2015b).

NASA compared these maximum soil vapor concentrations to the equivalent WSTF site-specific RBCs (NASA, 2012c; Figure 2.1 through Figure 2.3) during the last comprehensive soil vapor sampling event (NASA, 2015c). Results indicated that the maximum Freon 113 and PCE soil vapor concentrations measured were one to three orders of magnitude lower than the proposed site-specific WSTF RBCs at that time (NASA, 2012c). TCE is the primary soil vapor contaminant with respect to health risk from vapor intrusion in the 200 and 600 Areas (Figure 2.2). The most concentrated soil vapor areas for TCE exceeded both the NMED VISL and the equivalent WSTF RBCs in the 2014 soil vapor sampling event. Nine specific soil vapor points in seven different monitoring wells exceeded the RBCs and the VISL. These were grouped into three specific locations:

- The former Clean Room UST HWMU and surrounding area located adjacent to Apollo Boulevard on the northwest side of the Building 200 Clean Room (three wells: 200-SV-05, 200-LV-150, and 200-SV-09).

- The west side of the former 200 Area Evaporation Treatment Unit near the former 200 Area Burn Pit (SWMU 9) and the hazardous waste transmission lines (HWTLs) temporary tanker location (part of SWMU 10). This location (200-SG-3) is approximately 300 ft from the most proximal building, and as stated above, TCE concentrations decrease in this direction (from the 200 Area southwest to the 600 Area HWMU).
- The 200-D well cluster area immediately surrounding groundwater monitoring wells 200-D-109 and 200-D-240 (three wells: 200-SV-19, 200-SG-1, and 200-SG-4). This location is approximately 1,600 ft from the most proximal building.

Soil vapor concentrations at the 200 Area former Clean Room UST HWMU were of the greatest potential concern because they were the highest measured within the 200 and 600 Areas. VOC concentrations at this location are the most proximal to and potentially below the northwest side of Building 200. The NMED VISLs for Freon 113 and PCE (Figure 2.3) were also exceeded by the concentrations in the soil vapor at this location.

The highest concentrations of TCE at the 600 Area HWMU were identified within the wells located near the southeast boundary of the closure (Figure 2.2), which is in the closest proximity to Building 637 (wells 600-SGW-2, 600-SGW-5, and 600-SGW-6). Although TCE concentration at these wells exceeded the NMED VISL, they did not exceed the VISLs for Freon 11, Freon 113, or PCE. The concentrations of all four of these VOCs were also below the WSTF RBCs (Table 1.1). The closure boundary is located approximately 100 ft northeast of Building 637.

2.2 Rationale For Selection of Buildings for Vapor Intrusion Assessment

Supporting data and evaluations that demonstrate the rationale for the selection of Building 200 and Building 637 as the locations most likely to present a risk from vapor intrusion are documented in several previous investigations referenced within this report. Elevated concentrations of COPCs in shallow soil vapor in the 200 Area vicinity of Building 200 were most recently confirmed by the results of a qualitative shallow soil vapor survey performed on a grid across the 200 Area (discussed in Sections 2.3, 3.2 and 5.1.2 of the 200 Area Phase I Status Report [NASA, 2013b]). Elevated vadose zone soil vapor concentrations identified within MSVM and MSVGM wells subsequently installed in the 200 Area adjacent to Building 200 were discussed in Section 4.3.2.1 of the 200 Area Phase II Investigation Report (NASA, 2015b). Of particular interest is the soil vapor isopleth map for TCE discussed in Section 6.3.3 that identifies RBC exceedances at the former Clean Room Tank HWMU adjacent to Building 200. The elevated TCE concentrations on the northwest side of Building 200 and a comparison to WSTF RBCs are further discussed in Section 7.3.3. A recommendation in Section 8.3 identified the need for a quantitative assessment of the vapor pathway for Building 200 near the location of the former Clean Room Tank; also known as the 200 Area West Closure HWMU.

Soil vapor concentrations in the vadose zone below the 600 Area Closure were first evaluated during the 600 Area Closure Investigation (NASA, 2011a). NASA recommended interim vadose zone soil vapor and groundwater monitoring to assist with the upcoming implementation of the 200 Area investigations. Four *200/600 Area Semi-annual Soil Vapor and Groundwater Data Summaries* were subsequently provided to NMED, culminating with the fourth sample event in March 2013 (NASA, 2013c). MSVM well 600-SGW-2 located on the south corner of the closure was identified as the location well where a single COPC (TCE) exceeded the WSTF RBC. The maximum soil vapor concentration levels for Freon 11, Freon 113, and TCE in the 600 Area MSVM wells were subsequently identified in the deepest port of well 600-SGW-5 at 137.5 ft. These are discussed in Section 4.3.2.3 of the 200 Area Phase II Investigation Report (NASA, 2015b) and do not exceed WSTF RBCs.

The evaluation of potential vapor intrusion in the 600 Area was added to the VIAWP following communications between NASA and NMED following completion of the 200 area Phase II investigation (NASA, 2015b). Following several vadose zone investigations at the 600 Area HWMU, NASA concluded that the source of soil vapor contaminants beneath the 600 Area HWMU is the underlying groundwater. In a November 25, 2015 letter to NMED (NASA, 2015c), NASA proposed an assessment of the 600 Area Building 637, located southeast of the 600 Area HWMU, as the closest structure and primary potential target for exposure. The approach of utilizing Buildings 200 and 637 for the same assessment ensured consistent evaluation of the vapor intrusion pathway at the 200 West Closure and 600 Area HWMUs.

2.3 Operational History

2.3.1 200 Area Activities

The operational history of the 200 Area is provided in the 200 Area HIS (NASA, 2012b). Descriptions are provided for the two 200 Area East Closure USTs, the two West Closure USTs, and seven SWMUs (SWMUs 4 through 10) as identified in the Permit. Six potential AOIs were identified within the HIS (the Chemistry Laboratory Acid Tank Drain Pipe, an additional Building 203 industrial drain pipe, the Chemical Storage Building 253, the 270 Area Military Transport Vehicle Fire Suppression Test Area, two additional 200 Area historical burn pits, and the 250 Area Possible Septic Tank Drainage Source). These areas were evaluated during the 200 Area Phase I shallow soil vapor field investigation.

The 200 Area became operational in 1964 to support propulsion testing facilities for the Apollo program. The Clean Room was first used for the precision cleaning of equipment in 1967 and began to evaluate flammability and toxicity characteristics of materials used in the Apollo spacecraft. By 1970, the Apollo program focused on materials' testing capability for oxygen and propellant-exposure environments. As materials' testing expanded at WSTF, five test facilities were developed, four within or near the 200 Area: the Chemistry and Metallurgical Laboratories (200 Area), the High-Flow Components Facility (250 Area), Hazardous Hypervelocity and Detonation Facilities (270 and 272 Areas), and the Materials Test Facility (800 Area). The 800 Area Materials Test Facility was completed between 1975 and 1979, the 250 High-Flow Components Area was completed between 1989 and 1990, and the 270 and 272 Hypervelocity and Detonation Areas were completed between 1987 and 1991.

In a pollution abatement report to NASA headquarters in June 1984, NASA proposed constructing aboveground evaporation tanks at WSTF to store hazardous waste in order to cease using the 200 Area USTs and the 600 Area surface impoundments (which were not specifically designed for hazardous waste disposal). In the interim, NASA proposed constructing a hazardous waste drain line that would transport (by gravity) 200 Area hazardous wastes directly to the 600 Area surface impoundments. On April 22, 1986, it was discovered that the 8-inch (in.) long vertical carbon steel nozzle on the Clean Room tank (II) had corroded away, and there was an elliptical breach approximately 8 in. by 10 in. in the top of the Clean Room tank (II). Both Clean Room tanks were removed, and the remaining tanks were drained in November 1986. During tank removal, it was discovered that the bottom portion of tank I had completely corroded.

2.3.2 600 Area Activities

The operational history of the 600 Area is summarized in the 600 Area Closure Investigation Work Plan (NASA, 2009). In the mid-1960s, the 600 Area surface impoundments were designed to contain the saltwater backwash produced from regenerating the zeolite beds in the WSTF water softening plant located to the south. The impoundments received the saltwater backwash through an 8-in. diameter pipeline from 1964 to 1984.

From 1968 to 1986, 4,000 to 12,000 gallons of hazardous waste were transported by tanker truck from the 200 Area Clean Room and Chemistry Laboratory Tanks to the surface impoundments per week. White Sands Missile Range's High Energy Laser System Test Facility also contributed process waste from September 1983 to June 1984. The Hazardous Waste Transmission Line (SWMU 10) was constructed in May of 1986 to transport waste from the 200 Area Laboratories to the 600 Area surface impoundments. One month later, on June 13, 1986, the 600 Area impoundments were closed in response to an EPA order, and the pipeline was re-routed to nearby stainless steel tankers for transportation of wastes to an off-site RCRA disposal facility.

2.4 Environmental Setting

The topography at WSTF is typical of the Basin and Range physiographic province of the southwestern United States. The area is characterized by late Tertiary extensional tectonism, with linear mountain ranges separated by broad intermontaine basins in a northwest-trending direction. The adjacent San Andres Mountains (SAM) adjacent and east of WSTF represent an uplifted northwest-trending mountain block that is separated from adjacent mountain ranges to the west by the southern JDMB. WSTF is located on the alluvial-covered bedrock pediment slope that separates the eastern foothills of the SAM from the JDMB.

2.4.1 200 Area and 600 Area Surface Conditions

The 200 Area industrial complex is constructed on a pediment of thin alluvium (18 to 50 ft in thickness) overlying Permian limestone bedrock (Figure 2.4) at an elevation of approximately 4,930 ft above mean sea level. Pennsylvanian to Permian limestones crop out approximately 1,000 ft to the east on the east side of Gardner Spring Arroyo (GSA). The 200 Area is located immediately west of and is bound on the south by the GSA drainage as it diverts westward and downgradient toward the axis of the JDMB (Figure 1.2). Gardner Spring is the only natural surface water feature in the area and is located approximately 2,000 ft northeast of the 200 Area industrial complex within GSA. It is an intermittent spring and ceases to flow for long periods of up to several years between rare periods of heavy mountain-front rainfall.

The 600 Area complex in the vicinity of Building 637 is located on top of an alluvial pediment approximately 150 ft thick overlying Tertiary andesitic bedrock (Figure 2.5) at an elevation of approximately 4,755 ft above mean sea level. No significant drainages are present within the immediate area, and GSA is located approximately 1,500 ft north of the 600 Area HWMU as it moves west toward the JDMB.

Soils in the vicinity of the 200 and 600 Areas are classified as Tencee-Nickel Association Gently Sloping and Steep units (United States Department of Agriculture Soil Conservation Service, 1976). The Tencee Series is comprised of shallow, well-drained soils which formed in calcareous gravelly loamy alluvial sediments on old alluvial fans. The soil is slightly hard, dry, and very friable with common interstitial pores. The soil is approximately 30 to 45% caliche and gravel, is strongly calcareous, and has nearly continuous lime coatings on all clasts. The Nickel series soils comprise deep, well-drained soils on old alluvial fans. They are gravelly, medium textured alluvial sediments with gravel contents to 50%. The Tencee-Nickel, Gently Sloping unit is approximately 65% Tencee Very Gravelly Loam and 20% Nickel Fine Sandy Loam. The soil is nearly level to gently sloping and occurs on old alluvial fans. Included within these soils are arroyo bottoms and areas of soils similar to Tencee and Nickel soils except that they contain less than 35% coarse fragments. The Tencee-Nickel, Steep unit is approximately 45% Tencee Very Gravelly Loam and 40% Nickel Fine Sandy Loam.

The area is characterized by a Chihuahuan Desert Shrub climate, with abundant sunshine, low humidity, slight rainfall, and a large day-to-night temperature variance. The adjacent mountainous terrain influences the climate by blocking the incursion of moisture laden maritime air masses. Sparse biotic resources are typical of those found in the arid southwest. The average rainfall of 10 in. per year makes it difficult to support agriculture. As is typical with all deserts and semi-arid areas, the overall species diversity is low. Vegetation includes a combination of woody shrubs and grasses. These shrubs include Louisiana white sage, creosote bush, honey mesquite, tarbush, broom snakeweed, and lotebush. Common grasses include alkali sacaton, side-oats grama, fluff grass, tobosa grass, and purple three awn. Plant species biodiversity is low relative to that in better drained upland slopes. Shrubs provide a microhabitat for warm season grasses and forbs as well as herptiles and small mammals. WSTF is considered to be a low affectability area, with little capacity to be influenced by physical stimuli. The facility receives little use by wildlife species because it has been physically altered by human disturbance.

2.4.2 200 Area and 600 Area Subsurface Conditions

The predominant alluvial lithology across the area is the poorly indurated piedmont slope facies of the Camp Rice Formation (Seager, 1981). Vadose zone alluvium in the 200 Area (Figure 2.4) and 600 Area (Figure 2.5) near the buildings of interest consists of coalescent alluvial fan deposits derived from the adjacent SAM to the east. The alluvium is an unconsolidated to locally cemented, poorly sorted polygenetic pebble to boulder conglomerate. Lenticular sandy to clayey gravels, sandy silt, and silty clays are interbedded with the conglomerate. Clast lithologies include varieties of subrounded to subangular granite, rhyolite, siltstone, and micritic limestone in sand to boulder-size clasts.

2.4.2.1 200 Area

Previous 200 Area vadose zone investigations have identified moderately cemented caliche horizons a few inches thick at depths ranging from 2 ft bgs to 65 ft bgs. Significant barriers to soil vapor migration have not been encountered within 200 or 600 Area soil borings (e.g., NASA, 1996, 2015c). Well-formed drainages like the GSA that drains south and subsequently west between the 200 Area and 600 Area HWMUs host younger piedmont slope alluvium, characterized by unconsolidated silt, sand, gravel, and loam within the arroyo floor. Alluvial fan materials visible in cut sections of the GSA are indicative of irregular channeled morphologies with grain sizes ranging from clay to well-graded sandy gravel.

Alluvium overlies Pennsylvanian to Permian age limestone bedrock, which occurs at variable depths due to faulting in the area and irregular erosion of the pre-alluvial bedrock surface. The 200 Area bedrock has been fractured pervasively, predominantly on an orthogonal system, with one fracture set trending northeast-southwest and the other fracture set trending northwest-southeast. The shallowest bedrock in the industrialized 200 Area is located in the vicinity of SWMU 4, the Clean Room Discharge Pipe (14 ft bgs), southwest across Road L at well 200-F (17 ft bgs), and at the adjacent 200 Area Clean Room Tank across Apollo Boulevard to the east (18 ft bgs). This accounts for the primary bedrock high in the vicinity of the 200 Area West Closure.

2.4.2.2 600 Area

Alluvium in the vicinity of the 600 Area HWMU is between 140 and 160 ft thick and overlies poorly fractured Tertiary Orejon Andesite bedrock. Fracturing is sparse based on the observation of camera logs recorded in 600 Area HWMU boreholes utilized for groundwater wells, with individual calcite-filled hairline fractures often separated by several tens of feet. Permian limestone is topographically and hydrologically upgradient, juxtaposed against the andesite along the Hardscrabble Hill Fault which lies east of the 600 Area HWMU and Building 637.

2.5 200 Area and 600 Area HWMU Description

2.5.1 200 Area Clean Room Tank Location and Use

A detailed description of the 200 Area Clean Room Tank located in Building 200 is provided in the HIS (NASA 2012b). Activities in the 200 Area Clean Room included the precision cleaning of propulsion system components using solvents and degreasers. Wastes included dilute solutions of organic solvents, heavy metals, inorganic salts and various formulations of Oakite Brand cleaning solutions. Wastes generated from cleaning activities were gravity fed through single-walled stainless steel pipes to the UST located west of the former front of Building 200, in front of the laboratories complex.

The original carbon steel Clean Room tank (I) had a 2,000-gallon capacity, was 14 ft long by 5 ft in diameter, and was installed in 1964. Drawings for this tank do not show corrosion protection. This original Clean Room tank (I) was used until late 1978 or early 1979 and abandoned in place. A new underground Clean Room tank (II) was installed in late 1978 or early 1979 approximately 50 ft to the west of the original tank (I). This carbon steel tank had a 4,000-gallon capacity and was 19 ft long, 6 ft in diameter with a 5/16-in. thick shell. This new tank is believed to have contained external corrosion protection. Wastes were gravity-drained from 50-gallon sinks and the sump of the outdoor Clean Room pad to the tank using 3-in. diameter, schedule 10, grade 304 stainless steel lines. The tank was connected to the drain lines using 3-in. schedule 40 carbon steel. Prior to 1968, excess wastes from the original Clean Room tank (I) were discharged to grade. This process was discontinued in 1968, and the Clean Room tank was used as temporary storage.

2.5.2 600 Area Surface Impoundments Location and Use

A detailed description of the 600 Area HWMU is provided in the 600 Area Closure Investigation Report (NASA, 2011a). The surface impoundments, constructed in 1964, consisted of two adjacent individual 150 ft x 350 ft x 3 ft deep cells, separated by a narrow central berm, and lined with an 8-mil polyvinyl chloride (PVC) liner. This liner was protected by an overlying layer of rip-rap, consisting of large gravel and wire mesh, and sand. The cells received saltwater backwash through an 8-in. diameter pipeline from 1964 to 1984. There is no indication that this pipeline was used at any time for hazardous waste. HWMU closure activities commenced on November 7, 1988, and following construction of the closure, vent wells were installed on May 26, 1989. Concrete lined drainage ditches were constructed along the north, south and east sides of the cap to support the drainage of surface water.

2.6 Previous Vadose Zone Investigations Delineating Contaminant Distribution

The concentrations and distribution of vadose zone soil vapor contaminants in the 200 and 600 Area HWMUs have been defined by previous comprehensive vadose zone investigations (NASA, 2011a, 2013b, 2015b) that have all been approved with modifications by NMED (NMED, 2011a, 2013b, 2015a, 2015b). Subsequent monitoring of 200/600 Area soil vapor distribution has been performed through contemporaneous semi-annual sampling of all accessible multiport soil vapor monitoring ports in the 200 and 600 Areas along with groundwater sampling at underlying or nearby locations (NASA, 2012a, 2012d, 2013c, 2015b). The 200 Area Phase II IR (NASA, 2015b) presented the results of the latest comprehensive soil vapor sampling event in the 200 and 600 Areas conducted in October 2014.

2.7 Contaminants of Potential Concern

The VIAWP (NASA, 2016) presented a list of 13 VOCs known to have been managed in the 200 Area USTs and potentially discharged at SWMUs during historical operations including: TCE; PCE; Freon 11; Freon 113; 2-butanone (methyl ethyl ketone); 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene;

toluene; xylenes; acetone; and 2-propanol (isopropyl alcohol). Waste management practices at WSTF have been continually modified and improved through time to effectively minimize, document, store, and dispose of wastes. Wastes generated in the 200 Area were transported to the 600 Area surface impoundments. The VOCs placed in the 600 Area impoundments were the same as those stored in 200 Area USTs.

2.8 Site Conceptual Exposure Model

A preliminary site conceptual exposure model (SCEM) was developed as part of the 200 and 600 Area VIAWP (NASA, 2016b; Figure 2.6) to provide an understanding of the potential for exposure to hazardous contaminants at the site based on the source of contamination, the release mechanism, the exposure pathway, and the potential receptor(s). Please see Section 6.1 for the SCEM revised based on the results of this investigation.

2.8.1 Contamination Sources

The former UST locations at the 200 Area Clean Room tanks and the 600 Area surface impoundments were the primary contaminant sources. Secondary sources include groundwater directly impacted by releases and soil vapor derived from groundwater that filled fractures within bedrock and pore space within the overlying soils. Subsurface vadose zone soils in the 200 and 600 Areas that were once impacted by the releases have been evaluated through sampling extensively. The soils have been shown to be non-hazardous in nature and are not considered a continuing source of contaminants to groundwater (NASA 2015c, 2011a).

2.8.2 Release Mechanisms

Vadose zone contamination at the 200 Area Clean Room HWMU and 600 Area surface impoundments HWMU resulted from the release of hazardous constituents into the vadose zone between 1964 and 1986. Release mechanisms comprised the infiltration of liquid-phase contaminants into the vadose zone, downward to the groundwater table by the hydrodynamic processes of gravity and precipitation, and infiltration of the vadose zone pore space as vapor-phase contamination.

2.8.3 Potential Exposure Pathways and Receptors

Potential present-day receptors identified in the vicinity of the 200 and 600 Area HWMUs are industrial/occupational workers who occupy buildings adjacent to the HWMU areas while performing their daily duties. The primary potential present-day exposure pathway for these WSTF industrial/occupational site personnel in the 200 and 600 Area buildings addressed in this investigation is the inhalation of volatile contaminants derived from soil vapor and potentially present in indoor air. Soil vapor contamination has been identified from past investigations in the vadose zone near WSTF industrial area buildings (NASA, 2015c, 2011a). Additionally, present-day receptors in Buildings 200 and 637 are potentially exposed to residual soil contamination in the vicinity of these buildings.

Building 637 is situated approximately 100 ft away from the 600 Area surface impoundments HWMU that is the source of VOC releases. In the future, if the HWMU closure cap is removed or compromised and a building is situated at that location, building occupants could be exposed to VOCs when entering that building through vapor intrusion. Because Building 200 is adjacent to the former 200 Area West UST that is the source of VOC releases from the 200 Area Clean Room, potential future receptors for this HWMU are identical to present-day receptors.

There are no current or future residential land use scenarios anticipated in the vicinity of the 200 or 600 Area HWMUs. WSTF is a controlled test site located on the U.S. Army White Sands Missile Range. There are no encroaching residential areas and no present or future residential land use scenarios in this SCEM, though contaminants were screened to the most conservative residential levels. A cumulative risk screen evaluation in conformance with Risk Assessment Guidance has been provided in Section 6.1 as a supporting line of evidence for acceptable risk levels.

The groundwater underlying much of the WSTF industrialized source areas is known to be contaminated and its future use and potential risk to receptors are part of ongoing site-wide evaluations and corrective actions. The water supply wells for the 200 and 600 Areas are located several miles to the west of the investigation areas and are not contaminated. These wells are monitored regularly for the presence of known WSTF groundwater contaminants. A groundwater assessment was not conducted specifically as part of the vapor intrusion assessment. Groundwater assessment activities are regularly reported in NASA’s quarterly Periodic Monitoring Reports (NASA, 2018a). These data are also available for review in conjunction with results of the VIAR.

3.0 Scope of Activities

The area of concern on the west side of Building 200 is located directly above the footprint of the 200 Area Clean Room Tank HWMU adjacent to MSVM wells 200-SV-05 and 200-SV-09, and MSVGM well 200-LV-150 (Figure 3.1). The area of concern within Building 637 is approximately 100 ft southeast of the southeast margin of the 600 Area HWMU in close proximity to MSVM wells 600-SGW-1, 600-SGW-2, and 600-SGW-5 (Figure 3.2).

The following additional sampling activities were performed as part of this assessment to evaluate the existence of a complete exposure pathway.

- Sample and evaluate VOC concentrations (including COPCs) in soil vapor in the upper vadose zone utilizing MSVM and MSVGM well ports located in the vicinity of the buildings.
- Sample and evaluate VOC concentrations (including COPCs) in indoor air and outdoor air.

The following activities were performed as part of the vapor intrusion assessment. Some of the preliminary required vapor intrusion activities identified in Steps 1 and 2 of Section 1.4 had already been performed as part of previous investigations in the 200 and 600 Areas (NASA, 2013b, 2015c, 2011a).

- Identification of the appropriate vadose zone soil vapor sampling locations (based on the previous 200 Area HIS, 200 and 600 Area IRs, and soil vapor sampling events in the 200 and 600 Areas).
- Determination of a representative number of soil vapor and air samples, specification of the frequency and duration of sampling, and identification of the sampling and analytical methods to be employed.
- Daily planning sessions and health and safety briefings.
- Field collection of soil vapor samples from the uppermost vadose zone located adjacent to the target buildings.
- Field collection of indoor air samples within the buildings and outdoor samples adjacent and upgradient of the buildings.
- Documentation, management, and shipment of soil vapor and indoor and outdoor air samples (including field quality control [QC] samples).

- Performance of laboratory analyses by an accredited laboratory (including laboratory QC samples), analytical reporting, and data processing using the established WSTF data management system.
- Evaluation and interpretation of technical and analytical data for use in development of a final VIAR.

3.1 Data Quality Objectives

The assessment approach was based on "Guidance on Systematic Planning Using the Data Quality Objectives Process" (DQOs; EPA, 2006), the Corrective Action Site Investigations requirements of the Permit (NMED, 2023; Part 3), and Risk Assessment Guidance for Site Investigations and Remediation (NMED, 2022c). The data acquisition plan (i.e., sampling design) is based on the data quality objective process. The DQOs addressed the qualitative and quantitative nature of the sampling data to ensure that any data collected was appropriate for the intended purpose. Development of the DQOs considers precision, accuracy, representativeness, completeness, comparability of the data, sampling locations, laboratory analyses, detection limits, data quality, and the employment of adequate quality assurance/quality control measures. The VIAR documents the DQO procedures that were followed to assess the potential migration pathway between vadose zone soil vapor contamination and indoor air.

3.1.1 Problem Statements

The 200 Area Clean Room HWMU USTs leaked contaminants to the vadose zone, comprising approximately 18 ft of porous alluvial soil overlying fractured limestone bedrock. The tanks were located at a depth of between 8 and 12 ft bgs. The water table is located at a depth of 140 ft bgs. Soil samples collected during the installation of adjacent soil borings indicated that soil samples did not exceed the regulatory criteria applicable at the time of the investigation and soil remedial action was not required (NASA, 2015c). Groundwater in the area exceeds the NMED cleanup level for TCE. Soil vapor concentrations from samples collected in adjacent MSVM wells and a MSVGM well exceeds NMED VISLs for TCE, PCE, and Freon 113 and the WSTF RBC for TCE. The HWMU is located directly below a northwestern extension of Building 200 that is currently operated by an industrial/occupational labor force. The inaccessible location of this HWMU is the primary constraint to the vapor intrusion assessment (Figure 2.4).

Contaminants from the 600 Area HWMU may have been leaked to the vadose zone characterized by approximately 146 ft of porous alluvial soil overlying poorly-fractured andesite bedrock. A perched (and potentially temporary) water table is currently encountered at a depth of 143 ft bgs, which may be sourced from groundwater recharge during heavy rainfall and up to this time from the adjacent 600 Area Overflow Lagoons that are currently in the process of being removed. Soil samples collected during the installation of soil borings through the Closure cap to bedrock indicated that soil samples did not exceed the regulatory criteria applicable at the time of the investigation and soil remedial action was not required (NASA, 2011a). Groundwater in the area exceeds the New Mexico cleanup level for TCE. Soil vapor concentrations from samples collected in adjacent MSVM and MSVGM wells historically exceed NMED VISLs for TCE, PCE, and Freon 113. The 600 Area HWMU is located approximately 160 ft from Building 637 that is operated by an industrial/occupational labor force.

3.1.2 Study Goals

The primary decision is whether additional corrective actions are warranted at the 200 and 600 Area targets (identified through previous investigation) as a result of the intrusion of soil vapor VOCs from the vadose zone into nearby buildings affecting the indoor air quality. Alternative actions for the decisions include:

- Consider a "Corrective Action Complete" status determination.
- If required, perform a corrective measures evaluation for the site(s) to identify remedial options for mitigation of source(s) of continuing contamination or human health risk.

3.1.3 Information Inputs

The results of previous investigations performed in the 200 and 600 Areas provide information for this VIAR. The results of these previous investigations are documented within the 200 Area HIS (NASA, 2012b), the 200 Area Phase I Status Report (NASA, 2013b), the 200 Area Phase II IR (NASA, 2015c), and the 600 Area Closure IR (NASA, 2011a), including:

- Detailed investigation pertinent to the establishment and operational history of the 200 and 600 Area HWMUs.
- Analytical data sets for soil (as part of the risk/hazard screening), soil vapor, and groundwater samples collected during previous investigations at the 200 and the 600 Area HWMUs.

The primary data inputs for the VIAR are the analytical results of soil vapor, indoor air, and outdoor air sampling described in Sections 3.0 and 4.0 of this report.

Two types of soil vapor screening criteria are used as inputs to assess potential risks related to the soil vapor data. These include NMED VISLs (NMED, 2022c) and WSTF RBCs (NASA, 2019a). NMED VISLs are applicable to soil vapor concentrations present immediately below a building foundation, from where vapors may enter a building. WSTF RBCs are calculated for various depths below a building foundation, and therefore can potentially be applied to assess soil vapor risks from data collected at different depths. Indoor air screening criteria used in this VIAR are taken from NMED (2022c), and the EPA (EPA, 2019) if no values were provided by NMED. See also Table 1.1 and Section 1.5.

3.1.4 Spatial Extent of Assessment

The horizontal study boundaries are shown in Figure 1.2. The vapor intrusion pathway that is considered a primary potential threat and requires priority assessment is typically for buildings located within 100 ft of the vadose zone soil vapor plume that exceeds established soil vapor RBCs. In this case, NMED VISLs and WSTF RBCs were utilized to identify the targets of greatest concern.

In the 200 Area, soil vapor from the three most proximal MSVM and MSVGM wells located within 85 ft of the former Clean Room Tanks HWMU and air from the most proximal tier of indoor rooms on the west side of Building 200 within a distance of 100 ft of the footprint of the HWMU was evaluated (Figure 2.4). In the 600 Area, soil vapor from the three most proximal MSVM wells within 240 ft of Building 637, and the indoor air within Building 637 (Figure 2.5) were evaluated.

The vertical boundaries of the study are constrained between a maximum depth of 34 ft in the vadose zone as characterized by the maximum depth of upper ports in MSVM and MSVGM wells utilized and the industrial/occupational worker breathing zone of between 3 and 5 ft above ground surface.

3.1.5 Decision Rule

The vapor intrusion assessment addresses COPC soil vapor concentrations within the upper vadose zone surrounding the target buildings and COPC air concentrations inside the buildings. The assessment was performed to determine if a complete pathway is present and whether contaminants are present at concentrations at or above the latest NMED VISLs (NMED, 2022c) and WSTF RBCs (NASA, 2019a).

Updated RBCs were determined concurrently with the pre-assessment planning and preparation phase for this vapor intrusion assessment.

Decisions were structured as follows.

- If the subsurface vadose zone VOC contribution to indoor air levels exceeds indoor air NMED VISLs and updated NMED-approved WSTF RBCs as a result of a confirmed complete exposure pathway under the industrial/occupational worker scenario, then there is an unacceptable current and future risk to building occupants. These levels must be specific to vapor intrusion as opposed to an artifact of an alternate process identified within the building. Corrective action, removal and/or remediation are necessary.
- If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below indoor air NMED VISLs and WSTF RBCs, then current vapor intrusion risks are acceptable.
- If the vapor intrusion assessment fails to fully determine the nature, source, and extent of indoor air contamination, additional investigative measures may be required.

3.2 Assessment Activities

Two semi-annual sampling events (seasonal events within the summer [August 2017] and winter [February 2018]) were performed to address the potential issue of seasonal building pressure gradients that can influence vapor intrusion into buildings. Indoor and outdoor air pressures were not observed to vary significantly (all readings were approximately 30 in. of mercury for both sampling events). Early morning outside temperatures for the August event (67-70 degrees Fahrenheit) were significantly higher than for the February 2018 event (34 to 37 degrees Fahrenheit), with indoor air temperatures maintained in the vicinity of 70 degrees Fahrenheit for both buildings. VOC levels in ambient air can vary over time and may fluctuate diurnally due to the ebb and flow of industrial/occupational activity, and as a result of atmospheric heating and cooling cycles, air pressure changes, and wind speed. During winter months, heated air rises within buildings and exits through the roof. This reduces indoor air pressure, may draw in soil vapor, and potentially increases vapor intrusion rates.

3.2.1 Vadose Zone Soil Vapor Sample Locations and Schedule

Soil vapor samples were collected from the shallowest soil vapor port within the three MSVM or MSVGM wells located closest to the 200 Area and 600 Area target buildings. In the 200 Area, the three wells are all located within 84 ft of the west side of Building 200. In the 600 Area, the three wells are all located within 260 ft of Building 637. The soil vapor wells and specific ports that were sampled are listed below.

- Adjacent to the 200 Area Clean Room Tank HWMU (Figure 3.1, Table 3.1)
    - 200-SV-05 at 9 ft
    - 200-SV-09 at 19 ft
    - 200-LV-150 at 34 ft
- Nearby the 600 Area HWMU (Figure 3.2, Table 3.1)
    - 600-SGW-1 at 12.5 ft
    - 600-SGW-2 at 12.5 ft
    - 600-SGW-5 at 7.5 ft

Six vadose zone samples from the vapor monitoring well network and one duplicate sample were collected from the 200 and 600 Area MSVM and MSVGM wells for each soil vapor sampling event. Additional field QC samples are provided in Section 3.2.3. Two consecutive semi-annual sampling events were performed in August 2017] and February 2018. A total of 14 vadose zone soil vapor samples were collected.

3.2.2 Indoor and Outdoor Air Sample Locations and Schedule

The number and locations of indoor and outdoor air samples was established in the VIAWP (NASA, 2016b) based on building size, proximity to the potential intrusion source, the scale of the vadose zone vapor impact, subsurface heterogeneity, and sample purpose. Increased sample density is typical of a nearby spill or release and heterogeneity in the subsurface. Because no releases have been identified in soil, the soils are relatively homogeneous and porous, and a fractured bedrock and groundwater VOC source is inferred, sample densities were compared to standard guidance (e.g., ODEQ, 2010). Typical sample densities in buildings between 1,000 square feet (sq ft) and 10,000 sq ft in size are one sample per 1,500 sq ft. The sample locations identified in this VIAR (Figure 3.1, Figure 3.2) have a greater density than the standard guidance.

Where rooms exceed 500 sq ft in size as in the case of Building 200, samples were collected at a frequency of approximately one sample per 500 sq ft. Samples were collected within the normal breathing zone at a height of between 3 to 5 ft above the building floor. Ambient outdoor air samples were collected at the same time and using the same method as the indoor samples at each of the two building locations. Indoor and outdoor air sample locations are summarized below.

- Building 200 – Preparation Building (Figure 3.1, Table 3.2)
    - Eight indoor air samples within individual rooms in the areas above and adjacent to the subsurface footprint of the former 200 Area Clean Room Tank HWMU.
    - Two outdoor air samples adjacent to Building 200 near the former 200 Area Clean Room Tank HWMU at locations upgradient of the prevailing wind direction on the day of sampling.
    - One sample duplicate.
- Building 637 – Groundwater Assessment Building (Figure 3.2, Table 3.2)
    - Four indoor air samples in Building 637 distributed in the four quadrants of the single room building.
    - Two outdoor air samples adjacent to the Building 637 on the northeast side at locations upgradient of the prevailing wind direction on the day of sampling.
    - One sample duplicate.

A total of 16 indoor and outdoor air samples and two duplicate samples were collected for each sampling event performed for a total of 18 samples during each event. Two consecutive semi-annual indoor and outdoor air sampling events were performed in August 2017 and February 2018. A total of 36 indoor and outdoor air samples were collected during vapor intrusion assessment fieldwork.

3.2.3 Sampling Procedures

NASA has developed comprehensive internal procedures for soil vapor sample collection and management. These procedures provide specific information on sample management and related documentation, including instructions for sample custody (internal to NASA and external during shipment), storage, packaging, shipment, delivery tracking, and related recordkeeping. These procedures were followed during this assessment to ensure appropriate sample management. Sampling procedures and the equipment used follows generally accepted EPA guidance (EPA, 2015a). Sample collection techniques and flow rates conformed to the specifications for the appropriate EPA sample collection method. Soil vapor samples from MSVM and MSVGM wells, indoor samples, and outdoor samples for each area was collected contemporaneously on the same day within each area. Samples from the 200 and 600 Areas were collected on consecutive days for both semi-annual sampling events. The two semi-annual sampling events were 182 days apart. The following generalized procedures were followed:

- Sampling start times and the initial vacuum gauge readings were recorded in the field sampling logbook and on the internal chain-of-custody (CoC) form.
- For indoor and outdoor air samples, a flow-controller was to be affixed to the canister prior to sampling at a rate pre-set by the laboratory to provide for collection of the samples over an 8-hour period. The indoor and outdoor sampling periods were the same in length, but the outdoor air samples were initiated approximately one hour before starting the indoor samples to reduce potential errors. The EPA estimates that indoor air undergoes a complete exchange every one to two hours. Initiating outdoor air sampling early compensated for this potential lag time.
- Sample valves on each canister were opened to perform sample collection.
- Upon the completion of vadose zone, indoor air, and outdoor air sampling, the valve on the passivated stainless steel canister was closed and the time and ending vacuum pressure recorded in the field sampling logbook and on the internal CoC form.
- Canisters and flow-controllers were shipped back as a single shipment to the analytical laboratory for each of the two semi-annual sampling events.

Disposable gloves were worn to collect soil vapor and indoor air samples and were changed between sampling locations. Gloves and other disposable materials contacting the samples were collected and managed in accordance with the IDW Management Plan in the VIAWP (NASA, 2016b; Appendix A).

Field QC samples were collected to ensure high quality data are generated during the assessment, and were analyzed for the same parameters as the primary samples.

- Indoor and outdoor duplicate samples were collected at a rate of 10% of the project sampling locations (two samples per sampling event).
- Field blanks (one outdoor and one indoor for each of the two target buildings in the 200 Area and 600 Areas at a rate of four samples per sampling event).
- Trip blanks (one per sample shipment).

The samples were managed according to established site procedures that included labeling, CoC documentation, storage, packing, and expedited overnight shipment to the analytical laboratory for analysis.

3.2.4 Analytical Tasks

Soil vapor samples were analyzed using EPA Method TO-15 in order to achieve the assessment DQOs. NASA typically contracts services from off-site National Environmental Laboratory Accreditation Program-accredited analytical laboratories as required to support program and project needs. The analytical tasks required to achieve the project objectives was awarded to the ALS Environmental laboratory. Potential laboratories must respond to a comprehensive statement of work developed to meet the project objectives defined in this VIAR. Analytical standard operating procedures (SOPs), laboratory quality manuals, and other laboratory-specific documentation are provided by the analytical laboratory following award of the contract and are not available in advance. These documents are retained in the project record and are available for NMED review as required.

The overall objective for laboratory analysis is to produce data of known and sufficient quality. Appropriate procedures and QC checks were used so that known and acceptable levels of accuracy and precision are maintained for each data set. All samples were analyzed by a fully qualified laboratory in accordance with the laboratory's Quality Plan, which ensures that the contract laboratory adheres to standardized analytical protocols and reporting requirements and is capable of producing accurate analytical data.

Method blanks and laboratory QC samples are prepared and analyzed in accordance with the laboratory's method-specific SOPs. The analytical results of method blanks were reviewed to evaluate the possibility of contamination caused by analytical procedures. At a minimum, the laboratory analyzed method blanks and laboratory control samples at a frequency of 1 in 20 for all batch runs.

3.2.5 Health and Safety

Field activities were conducted in accordance with requirements of Occupational Safety and Health Administration Standards for Hazardous Waste Operations and Emergency Response ([HAZWOPER]; 29 Code of Federal Regulations [CFR] 1910.120 [a] – [o], 2013). The WSTF environmental contractor's corporate-wide Safety and Health Plan (SHP) was augmented with site-specific Job Hazard Analyses to address potential hazards foreseeable for the project and was followed in accordance with applicable requirements of the standards. The augmented SHP addressed safety and health issues pertaining to work activities, including known and reasonably anticipated hazards associated with project scope of work as well as contingencies for unexpected conditions. Project field personnel were required to be current in HAZWOPER training. The SHP was reviewed and approved by the contractor Health and Safety Manager, and no new hazards were encountered that were not addressed by the SHP.

3.2.6 Field Documentation

The field geologist ensured that activities related to this assessment were documented using a field logbook, field data records, and/or any required site-specific procedural documentation. Logbook entries included, as applicable, information such as:

- Standard Daily Header – project name, logbook number, date, weather conditions, team members present and their affiliations (including subcontractors), sample location identification, day's task(s), daily safety meeting topics, required personal protective equipment (PPE), equipment in use, and any calibration information, if applicable.
- Daily activities (time and observations recorded) – site arrival and departure, visitors and the purpose of their visit, vapor sampling information, decontamination (i.e., method, equipment cleaned), reference data sheets or maps, if applicable.
- Daily summary – action items, materials used, changes or deviations made from planned protocol, plan for next day.
- Signatures (field personnel and logbook reviewer).

At a minimum, field records included observations of environmental conditions, sampling conditions, and sample documentation. For analytical samples, the date, location, depth, sample type, collection method, identification number, sampler, and any circumstances, events, or decisions that could impact sample quality were documented by the on-site geologist in the project field logbook. Even though each case may be unique, the geologist must document any conditions that precipitated any decisions for the unsuitability of samples for analyses. In addition to the field logbook entries for sampling events, CoC forms were completed for analytical samples and maintained with project documentation.

Evidential records for the entire project are maintained in hard copy or electronic form and consist of:

- Project VIAR with NMED modifications or deviations redlined.
- Site-specific internal procedural documentation or plans.
- Project logbooks.
- Field data records.
- Sample CoC forms.
- NMED correspondence.
- Final analytical data packages.
- Reports.
- Miscellaneous related records such as photos, maps, drawings, etc.

3.2.7 Investigation-Derived Waste Management Plan

As required in Permit Part 6 (Section 6.2.13; NMED, 2023), the IDW Management Plan for this vapor intrusion assessment was provided to NMED in the *200 and 600 Area Vapor Intrusion Assessment Work Plan* (NASA, 2016b, Appendix A). The IDW Management Plan provided a description of the potential wastes that could be generated from the 200 and 600 Area as well as procedures for waste management, waste characterization, and waste disposition. Wastes that were generated as part of the assessment comprised: used sampling equipment; PPE; and alcohol free moist wipes used for equipment decontamination.

4.0 Field Data Collection, Assessment, and Review

4.1 Project Documentation

All facets of this assessment were documented in detail by the responsible project personnel. Records are retained in the WSTF Operating Record and can be accessed at any time by authorized WSTF personnel. Sample information and field measurements were recorded in the field logbook by the responsible project field personnel. Records were reviewed by knowledgeable project personnel on a regular basis during the assessment and are retained in the project file. The sample information and field measurements are ultimately archived in the WSTF Records Management System as part of the Operating Record. As required for reporting, these data are also transferred to and archived in operational and historical databases.

4.2 Building Walkthrough Inspections

For most sites, detecting specific COPCs inside a building is not definitive evidence of vapor intrusion since VOCs can also be common contaminants in ambient air and may also have other sources inside buildings. Approximately two weeks prior to collecting the first semi-annual set of indoor and outdoor air samples at Building 200 and Building 637, a pre-sampling inspection was performed to identify conditions that may affect or interfere with the proposed sampling, and where possible to provide temporary mitigation of these conditions. A standard building inspection form (Appendix A; developed from ODEQ, 2010) was used to evaluate the type of structure, floor layout, physical conditions, and airflow of the buildings being studied. The 200 Area building complex includes a network of laboratories and cleaning rooms that contain several of the COPCs identified in Section 2.2 that are commonly used as laboratory chemicals (e.g., acetone, methyl ethyl keytone, isopropyl alcohol).

Potential COPC sources were evaluated within the building by conducting a product inventory and recording the results on the building survey form. The primary objective of the product inventory is to identify potential air sampling interference by characterizing the occurrence and use of chemicals and products throughout the building. This information helped formulate the indoor environment profile. Both Building 200 and Building 637 are single floor structures. Individual rooms were carefully inspected for products and an inventory provided as products stored in another area of the building can affect the air of the room being tested.

An MSA Altair®[2] 5X photo ionization detector (PID) was used for the indoor and outdoor air screening of potential air contaminants (oxygen, carbon monoxide, carbon dioxide, hydrogen sulfide, sulfur dioxide, ammonia, chlorine, and VOCs) at concentrations as low as 1 part per million (ppm). Dry decontamination followed. An alcohol-free moist wipe was used for the PID between screening readings. Any waste materials removed from the equipment and the wipes used were disposed of as IDW and managed in accordance with the VIAWP (NASA, 2016b; Appendix A).

Portable vapor monitoring equipment readings using the PID and a description of any odors present were used to help evaluate potential indoor sources. Where available, chemical ingredients of interest were recorded for each product as best possible. If the ingredients are not listed on the label, each product's exact and full name, and the manufacturer's name, address and phone number, if available were recorded on product inventory forms (Table 4.1, Table 4.2, Appendix A).

Building walkthrough inspections were performed at Building 200 on June 21, 2017, and at Building 637 on June 26, 2017. The junction between walls and the building foundation of the west side of Building 200 and surrounding 600 Area Building 637 were visually evaluated at this time to the best extent possible for structural integrity, staining, or any other visible defects. No significant foundation issues were identified at either building.

Walkthrough observations were documented using building inspection forms for each of the two buildings (Appendix A) to support evaluation of the vapor intrusion pathway. Each building inspection form includes a product inventory form listing the specific products found in each building that have the potential to affect air quality. Photographs recorded during and immediately following the initial building inspections on June 28, 2017, are provided in Appendix B: Photographs 1 through 18 were taken at Building 200; and Photographs 19 through 26 were taken at Building 637.

4.2.1 Building 200

Building 200 is an industrial building used primarily as a laboratory. The northwest side of the building incorporates machine shops, equipment and materials storage, utility rooms, photo lab, garage, and offices (Appendix A). The building is an insulated single floor structure that was constructed in 1965 The portion of Building 200 on the west side that is of interest relative to the vapor intrusion study is approximately 11,000 square feet in size. The building is cooled using forced refrigerated air through a central air system, with outdoor air infiltration restricted to open doors, door thresholds, windows, and potentially any cracks in the structure walls. Above grade construction comprises sealed concrete walls with some metal paneling in the North Highbay. The floor is composed of poured concrete covered with concrete

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[2] Altair is a registered trademark of MSA Technology, LLC.

sealant and 9-in. x 9-in. x 1/16-in. vinyl tile. The heating system relies upon hot air circulation generated using natural gas, which is also used to heat water. The heating and cooling systems are typically run 24 hours a day, seven days a week due to operation of the building as a laboratory. Room 206B (Figure 3.1) was constructed directly above the former fenced yard that was the location for the Clean Room tank HWMU installed in the mid-1960s. The machine shop is equipped with a drill, lathe, and a variety of lubricating oils.

The building is a non-smoking facility and is cleaned as required and on a daily basis on workdays (Monday through Friday) using commercial cleaning materials. A cleaning room is also present for advanced equipment cleaning operations that are performed regularly during the work week. Cosmetics and air fresheners are used regularly by employees. No painting had been performed within the six months preceding the first sampling event, and no new textiles had been installed. Several flume hoods are present on the peripheral interior walls and vent to the outside of the building. Pesticides are applied on a quarterly schedule to address problems with stinging insects, spiders, and scorpions. During the walkthrough, it was noted that several odors were present in the building, which is not atypical of a chemical laboratory. Many individual rooms had distinct odors related to the specific supplies stored within the room. Chemical supplies included solvents and volatile chemicals that are components of oils, lubricants, paints, and adhesives. Potable water is provided by the WSTF supply wells located within the JDMB approximately 5 miles to the west. Sewage is managed through the City of Las Cruces public sanitary system that was connected to the building in 2015. Table 4.1 provides a summary of the products contained within Building 200 as listed within the product inventory form of Appendix A. The products included a variety of glues, acids, paints, flammables, oils, and Freon. Photographs 1 through 18 were taken within a variety of rooms during the walkthrough inspection and are provided in Appendix B.

4.2.2 Building 637

Building 637 is a relatively small and isolated industrial building approximately 1,200 square feet in size (Appendix A). It is used by the WSTF Environmental Department for the groundwater assessment program, primarily for the storage and management of soil, soil vapor, and groundwater sampling equipment and laboratory-provided sample containers. The building is a single floor structure with insulated walls that was constructed in 1992 Airflow through the building is generated by forced air through two evaporative coolers located on the north wall of the building, with outdoor air infiltration through a door and single garage bay door on the northwest side. The above grade construction consists of poured concrete footing and corrugated metal siding sealed with paint. The floor comprises a concrete slab with concrete sealant. Heating is provided by hot air circulation fueled by natural gas. The air conditioning system is typically operated between 7 a.m. to 4 p.m. on workdays on an as-needed basis. The system is usually shut down at weekends when the building is unoccupied. The building contains a workbench with tools and a variety of lubricants in the west corner of the building.

The building is a non-smoking facility. Cleaning products are regularly used to clean work surfaces when required. No cosmetic products are used, no painting had been performed in the six months preceding the first sampling event, no air fresheners are used, and no carpets, drapes, or textiles are present. A pesticide application was performed within a month prior to the building inspection for insects and rodents. Trace odors are present in the building, usually related to chemical preservatives (dilute acids) used for groundwater samples. Potable water is supplied by the WSTF supply wells located within the JDMB approximately five miles to the west. No restroom facilities are present in the building and no sewage management is required. Table 4.2 provides a summary of the products contained within Building 637 as listed within the product inventory form of Appendix A. The products included dilute acid preservatives, cleaning products, oils, lubricants, compressed gas (nitrogen), and fuel in an adjacent outside storage building (gasoline). Photographs 19 through 26 were taken inside and outside Building 637 during the walkthrough inspection and are included in Appendix B.

4.3 Preparation of Buildings

The pre-sampling inspection provided adequate advance notice to the local workforce to minimize potential background sources prior to air sampling through best management practices. At a minimum, it was ensured that containers were tightly sealed. However, no potential sources were actually removed from Building 200 or Building 637. The inability to eliminate potential interference is considered justification for not testing, especially when testing for similar compounds at low levels. Although Freon was observed to be stored in Room 202 where sample B200-IA-05 was located, sample collection proceeded as planned. Room 202 is the former etching room that has been converted to a storage area for various solvents (Appendix A).

Once interfering background sources were removed or minimized to the extent possible, the building ventilation system in Building 200 continued to operate under normal conditions for approximately 48 hours (Friday and Saturday) prior to testing to eliminate residual contamination in the indoor air. Ventilation was accomplished by operating the building’s heating ventilation and air conditioning (HVAC) system. Air samples were intended to represent typical exposure in a mechanically ventilated building, and the operation of HVAC systems during sampling was noted. It was ensured that the building’s HVAC system was operating under normal conditions. In addition, steps were taken to avoid any painting, cleaning, pesticide spraying, or air freshening activities at least two weeks prior to air sampling. No exceptions were noted.

4.4 Field Preparation and Sampling

Vapor intrusion assessment fieldwork included preparation of the buildings to be assessed, sample planning and preparation activities, and sample collection and management. Field activities commenced following appropriate planning and preparation activities and NMED approval of the VIAWP (NMED, 2016a). Field assessment activities required approximately six months in order to complete two semi-annual soil vapor sampling events that were performed in consecutive summer (August 2017) and winter (February 2018) seasons.

4.4.1 Summer Semi-Annual Sampling Event (August 2017)

- Monday August 21 – analytical laboratory sampling equipment and containers shipped to WSTF.
- Friday August 25 – non-working day at WSTF. Buildings 200 and 637 experienced minimal occupation or traffic. HVAC system operating normally 24-7 in Building 200 laboratories. Building 637 HVAC system shut off for weekend.
- Saturday August 26 – Building 637 sampling event performed starting at 0700 hours, completed at 1700 hours.
- Sunday August 27 – Building 200 sampling event performed starting at 0700 hours, completed at 1730 hours.
- Weather conditions at 0700 hours (both days): clear skies, outdoor air pressure approximately 30 in. of mercury, warm with outside temperature 67 to 70 degrees Fahrenheit, trace winds from the northeast at < 2 miles per hour.

4.4.2 Winter Semi-Annual Sampling Event (February 2018)

- Tuesday February 20 – analytical laboratory sampling equipment and containers shipped to WSTF.

- Friday February 23 – non-working day at WSTF. Buildings 200 and 637 experienced minimal occupation or traffic. HVAC system operating normally 24-7 in Building 200 laboratories. Building 637 HVAC system shut off for weekend.
- Saturday February 24 – Building 637 sampling event performed starting at 0700 hours, completed at 1630 hours.
- Sunday February 25 – Building 200 sampling event performed starting at 0640 hours, completed at 1730 hours.
- Weather conditions at 0700 hours (both days): clear skies, outdoor air pressure approximately 30 in. of mercury, outside temperature 34-37 degrees Fahrenheit, no winds.

4.5 Vapor Intrusion Assessment Sampling

The vapor intrusion assessment incorporated soil vapor samples from MSVM and MSVGM wells, outdoor air samples, and indoor air samples. The objective of this sampling was to determine whether indoor air in Building 200 and Building 637 is impacted by intrusion of VOCs from soil vapor. Laboratory containers and analysis were provided by the ALS Environmental Laboratory in Simi Valley, California. Soil vapor grab samples were collected from ports in MSVM and MSVGM wells utilizing 1-liter evacuated canisters provided by the laboratory. Outdoor and indoor air samples for the two buildings targeted for air intrusion analysis (200 Area Building 200 and 600 Area Building 637) were collected in 6-liter canisters equipped with 8-hour flow controllers. All samples were analyzed using EPA Method TO-15 in order to achieve the vapor intrusion assessment DQOs.

4.6 Vadose Zone Soil Vapor Sampling

Soil vapor sampling was conducted following standard site procedures for each of the MSVM or MSVGM well sampling ports. Critical information describing the sampling event was recorded in the field sampling logbooks. Vadose zone soil vapor samples were collected in laboratory-evacuated stainless steel electropolished passivated vessels (passivated stainless steel canisters) certified as clean and provided by the laboratory. The stainless steel construction ensures soil vapor and air samples did not permeate through the vessel wall or degrade due to exposure to light during shipment to the laboratory. Standard 1-liter canisters were used for soil vapor grab sampling from MSVM and MSVGM wells. These samples were anticipated to be more concentrated than the corresponding indoor and outdoor air samples.

Immediately prior to sampling, the ambient barometric pressure was recorded and vacuum conditions within the passivated stainless steel canisters recorded. Three tubing volumes of air were purged from each sampling port and stainless steel tubing using a LANDTEC®[3] GEM 2000+ gas analyzer to ensure the removal of stagnant air. The pump on a gas analyzer was used to purge the soil vapor well tubing for a minimum of five minutes per zone to evacuate at least three volumes of the ¼ in. tubing and soil vapor port. During purging, concentrations of methane (CH4), carbon dioxide (CO2), and oxygen (O2) indicator parameters were monitored. Each parameter is required to be stable prior to sampling; additional purging was performed as required. A passivated stainless steel canister was then attached to the sampling port, opened, and filled to capacity (Appendix B, Photograph 27). Field QC samples were collected to ensure high quality data were generated during the assessment (Section 3.3.7).

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[3] LANDTEC is a registered trademark of Q.E.D. Environmental Systems, Inc.

4.7 Indoor and Outdoor Air Sampling

Passivated stainless steel canisters were utilized for indoor and outdoor air sampling. Six-liter volume canisters were used due to the relatively low concentration of analytes anticipated in the indoor and outdoor samples, the 8-hour sampling duration, preferred sampling flow rate for this type of sample, and the sample volume required for the sampling period. Six-liter canisters are typically used to obtain the integrated time-weighted average ambient air samples at sampling times of up to 24 hours. High quality valves were utilized that resist human error in sample collection activities (e.g., over tightening that potentially could cause leaks). Low-flow precision regulators were used with each of the canisters to ensure a consistent airflow over the designated eight-hour sampling duration.

Sample collection intakes were located to approximate the breathing zone for building occupants at heights of 3 to 5 ft above the building floor. Indoor air samples were collected during typical working hours to be representative of typical exposure in a manner as to minimize disruptions to normal building activities (Appendix B, Photograph 28). Outdoor air samples were collected starting one-hour earlier but otherwise at the same times as the indoor samples (Appendix B, Photograph 29). Sampling technicians did not remain in the immediate area of the canisters when samples were being collected.

4.8 Soil Sampling

For the cumulative soil risk screening, soil data for the 200 Area came from the 200 Area Phase II Investigation Report, Appendix E (NASA, 2015b) and soil data for the 600 Area came from the 600 Area Closure Investigation Report, Appendix 13.B (NASA, 2011a). The soil analytical data used is provided in Excel format and included in Enclosure 4.

4.9 Off-site Laboratory Data

Data packages from the laboratory consisted of two primary components: comprehensive reports submitted as Adobe portable document files (PDF) for review and archiving (provided as an enclosure to this report); and electronic data deliverable (EDD) files to facilitate transfer of chemical analytical data into WSTF's analytical database(s). The PDF reports included the laboratory name, report date, sample-specific information, analyte names and Chemical Abstract Service numbers, analytical results, QC sample results, data qualifiers and narratives, pertinent analytical notes, laboratory reviewer signatures, and a variety of other information specific to the laboratory and analytical method. The EDD files include the associated electronic data and follow the same review and approval cycle as the PDF report.

4.10 Data Assessment and Review

A quality assurance (QA) specialist evaluated the sample data, field, and laboratory QC results for acceptability with respect to the project quality objectives. Chemical analytical data was compared with the project DQOs and evaluated using the data validation guidelines contained in EPA guidance documents, the latest version of SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," and industry-accepted QA/QC methods and procedures (EPA, 2013). A QA report for the vapor data and a second report for the previous soil data are provided in Appendix C.

A comprehensive review of sample analytical data was conducted. Prior to conducting the review, the following information (where required and applicable) was compiled and provided.

- The NMED-approved VIAWP.
- Field sampling and geologist logs.

- Laboratory reports.
- Statements of work and the laboratory Quality Management Plan.
- EDD Files.
- SOPs.
- Data tools.

Data review elements included:

Step I: Verification – Verification (review for completeness) is the confirmation by examination and provision of objective evidence that the specified requirements (sampling and analytical) have been completed (EPA, 2005).

Data verification is the process of determining whether data have been collected or generated as required by the project documents. The process consists of the following categories: 1) verifying that field sampling operations were performed as outlined in the vapor intrusion assessment Investigation Work Plan (IWP; NASA 2016b); 2) verifying that the data collection procedures and protocols were followed; 3) verifying completeness to establish that sufficient data necessary to meet project objectives have been collected; and 4) checking that QC sample results meet control limits defined in the analytical methods.

Step II: Validation – Validation is the confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Validation is a sampling and analytical process that includes evaluating compliance with method, procedure, or contract requirements and extends to evaluating against criteria based on the quality objectives developed (EPA, 2005).

The purpose of validation is to assess the performance of the sampling and analysis processes to determine the quality of specified data. Data validation consists of the following objectives: 1) verifying that measurements (field and laboratory) meet the user's needs; and 2) providing information to the data user regarding data quality by assignment of individual data qualifiers based on the associated degree of variability. Data management personnel performed data validation in accordance with the requirements in this IWP and existing WSTF procedures.

Step III: Usability Assessment – Usability assessment is the determination of the adequacy of data, based on the results of validation and verification, for the decisions being made. The usability process involves assessing whether the process execution and resulting data meet project quality objectives (EPA, 2005).

The goal of the usability assessment is to determine the quality of each data point and to identify data that are not acceptable to support project quality objectives. Data may be qualified as being unusable or rejected (R), as based on established quality review protocols. Data qualified as estimated concentrations (J) are less precise, or less accurate, than unqualified data but are still acceptable for use. The data users, with support from the contractor environmental data management staff, are responsible for assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses. The data reporting included a discussion of data limitations and their effect on data interpretation activities.

A review of COPC detection limits obtained from the laboratory compared to regulatory screening levels was conducted. Several COPCs in the 200 Area had dilution issues for the soil vapor samples where detection limits reached were higher than regulatory screening levels. The issue arises when there are very high concentrations of a VOC in a sample. For the instruments to read the contaminants, the sample must be diluted, and sometimes diluted by orders of magnitude. However, this can cause other VOCs to be masked, since dilution raises the detection limits for other VOCs. Soil vapor samples from well 200-LV-150 at 34 ft bgs contain high concentrations of VOCs. The August 2017 samples contain a dilution of 6600, and in February 2018, a dilution of 1530 was needed. These dilutions resulted in VOC detection limits greater than VISLs or air RSLs. Detection limits higher than applicable regulatory screening levels are highlighted in yellow on Table 4.3 and provided with dilutions on Table 4.4. COPCs affected include carbon tetrachloride, chloroform, ethylbenzene, heptane, 2-hexanone, 2-propanol, TCE, and 1,2,4-trimethylbenzene.

Examples to illustrate the elevated dilution and detection limits include TCE and chloroform. TCE detection limits were 920 µg/m^3 for August 2017 and 430 µg/m^3 for February 2018. These detection limits are above the residential cancer and noncancer VISLs (69.5 and 147 µg/m^3, respectively) and the industrial noncancer VISL (328 µg/m^3). However, the very high concentrations of TCE detected in the 200-LV-150 samples required the large dilutions (410,000 µg/m^3 and 140,000 µg/m^3). These large dilutions (6600 and 1530) also caused elevated detection limits for other VOCs, such as chloroform. The August 2017 and February 2018 detection limits for chloroform for soil vapor in well 200-LV-150 were 1,100 and 260 µg/m^3, which are above the residential and industrial cancer VISLs of 40.7 µg/m^3 and 199 µg/m^3. Chloroform was not detected in soil vapor samples in 200-LV-150. However, due to the high detection limits, it is not possible to determine if chloroform was present in 200-LV-150 samples above regulatory cancer limits. Table 4.4 provides details of the other six affected constituents.

5.0 Summary of Soil Vapor, Outdoor Air, and Indoor Air Data

The chemical analytical results from the two semi-annual soil vapor sampling events were verified, validated, and used to develop the final VIAR. Laboratory reports for the two semi-annual sampling events (Sampling Event #1 in August 2017 and Sampling Event #2 in February 2018) are provided as an enclosure to this report. A complete set of tabulated analytical results for all soil vapor and air samples is provided as an enclosure to this report.

5.1 200 Area Soil Vapor, Outdoor Air, and Indoor Air Sampling

Figure 5.1 posts the analytical results for soil vapor, indoor air, and outdoor air samples in association with the sample locations within and immediately surrounding Building 200 in the 200 Area. Analytical results for the four primary COPCs anticipated to be present (TCE, PCE, Freon 11, and Freon 113) are shown for both semi-annual sampling events performed on August 27, 2017 and February 25, 2018.

Table 4.3 provides a summary of the maximum observed contaminant concentrations for subsurface soil vapor within wells adjacent to Building 200, the maximum contaminant concentrations for outdoor air adjacent to Building 200, and the maximum contaminant concentrations for indoor air samples. Results are provided for all 13 COPCs identified in Section 2.6 of this report (TCE; PCE; Freon 11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) for the August 2017 and February 2018 semi-annual sampling events. Table 4.3 also compares the maximum contaminant concentrations reported to the available vapor intrusion screening levels: NMED VISLs and WSTF RBCs (Section 1.5).

5.1.1 200 Area Soil Vapor Analytical Results

For both semi-annual sampling events, the TCE soil vapor concentrations from well 200-LV-150 at 34 ft (410,000 and 140,000 µg/m^3), well 200-SV-05 at 9 ft (40,000 and 26,000 µg/m^3), and well 200-SV-09 at 19 ft (35,000 and 31,000 µg/m^3) significantly exceeded both the NMED residential and industrial VISLs (69.5 µg/m^3 noncancer, 147 µg/m^3 cancer, 328 µg/m^3 noncancer, and 1,120 µg/m^3 cancer). For WSTF RBCs, well 200-LV-150 significantly exceeded the appropriate RBCs at 25 ft bgs (residential: 4,900 μg/m^3 noncancer and 11,000 μg/m^3 cancer; industrial: 84,000 μg/m^3 noncancer and 280,000 μg/m^3 cancer).

For wells 200-SV-05 and 200-SV-09, residential RBCs were exceeded (1,500 μg/m^3 noncancer and 3,400 μg/m^3 cancer at 5 ft bgs; and 2,300 μg/m^3 noncancer and 5,400 μg/m^3 cancer at 10 ft bgs), but not all industrial RBCs were exceeded. In well 200-SV-05 (at 9 ft), concentrations (40,000 and 26,000 μg/m^3) exceeded the industrial noncancer RBC (18,000 μg/m^3 at 5 ft) but not the industrial cancer RBCs (60,000 μg/m^3 at 5 ft). In well 200-SV-09 (at 19 ft), the August 2017 sample (35,000 μg/m^3) exceeded only the industrial noncancer RBC (34,000 μg/m^3 at 10 ft) but not the industrial cancer RBC (120,000 μg/m^3 at 10 ft). In February 2018, the 200-SV-09-19 sample concentration (31,000 μg/m^3) was below both industrial RBCs (34,000 μg/m^3 noncancer and 120,000 μg/m^3 cancer at 10 ft).PCE soil vapor concentrations exceeded the NMED residential noncancer and cancer and industrial noncancer VISLs (1,390 μg/m^3 noncancer, 3,600 μg/m^3 cancer, and 6,550 μg/m^{3}noncancer) in all three soil vapor wells for the August 2017 sampling event (200-LV-150 at 34 ft was 57,000 μg/m^3; 200-SV-05 at 9 ft was 9,500 μg/m^3; and 200-SV-09 at 19 ft was 6,600 μg/m^3). The industrial cancer VISL (17,600 μg/m^3) was exceeded only in well 200-LV-150 in August 2017.

For the February 2018 sampling event, PCE exceeded all the NMED VISLs (residential: 1,390 μg/m^3 noncancer, 3,600 μg/m^3 cancer; industrial: 6,550 μg/m^3 noncancer, 17,600 μg/m^3 cancer) in well 200-LV-150 (36,000 μg/m^3) and the residential VISLs in 200-SV-05 and 200-SV-09 (5,300 and 5,400 μg/m^3, respectively). February 2018 concentrations of PCE were below industrial VISLs.

Both August 2017 (well 200-LV-150 at 34 ft was 57,000 μg/m^3; well 200-SV-05 at 9 ft was 9,500 μg/m^3; and well 200-SV-09 at 19 ft was 6,600 μg/m^3) and February 2018 concentrations of PCE (well 200-LV-150 at 34 ft was 36,000 μg/m^3; well 200-SV-05 at 9 ft was 5,300 μg/m^3; and well 200-SV-09 at 19 ft was 5,400 μg/m^3) in all soil vapor wells are all below the WSTF RBCs at the appropriate corresponding depths (residential: 340,000 cancer and 130,000 μg/m^3 noncancer at 25 ft bgs; 93,000 cancer and 35,000 μg/m^3 noncancer at 5 ft; and 150,000 cancer and 58,000 μg/m^3 noncancer at 10 ft. Industrial: 2,300,000 μg/m^3 noncancer and 6,000,000 μg/m^3 cancer at 25 ft; 460,000 μg/m^3 noncancer and 12,000,000 μg/m^3 cancer at 5 ft; and 910,000 μg/m^3 noncancer and 2,400,000 μg/m^3 cancer at 10 ft).

All 11 remaining maximum concentrations for COPCs in vadose zone soil vapor (Freon11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) are below the corresponding NMED VISL and WSTF RBC.

5.1.2 Building 200 Outdoor Air Analytical Results

Outdoor air samples were either non-detect or below 1 μg/m^3 for TCE, PCE, Freon 113, 1,1,1-trichloroethane, chloroform, benzene, ethylbenzene, toluene, xylenes, acetone, and 2-propanol. Traces of Freon 11 (maximum 1.2 μg/m^3 in August 2017 and February 2018) and 2-Butanone (maximum 3 μg/m^3 in August 2017) were also detected.

5.1.3 Building 200 Indoor Air Analytical Results

No indoor air concentrations exceeded NMED VISLs. The maximum concentration for indoor air samples were non-detect or below 1 μg/ m^3 for four COPCs: PCE; 1,1,1-trichloroethane; chloroform; and ethylbenzene. Trace concentrations were observed for eight COPCs: TCE (maximum 1.3 μg/m^3 in February 2018); Freon 11 (maximum 22 μg/m^3 in August 2017); 2-Butanone (maximum 8.7 μg/m^3 in August 2017); benzene (maximum 1.6 μg/m^3 in February 2018); toluene (maximum 22 μg/m^3 in August 2017); xylenes (maximum 1.5 μg/m^3 in August 2017); acetone (maximum 29 μg/m^3 in August 2017); and 2-propanol (maximum 68 μg/m^3 in August 2017). The highest concentration of Freon 113 of 3,200 μg/m^3

was reported in August 2017 from sample location 200-IA-5. This maximum concentration is one and two orders of magnitude below the NMED VISL for residential and industrial indoor air of 31,300 and 147,000 µg/m^3, respectively.

5.1.4 Building 200 Trends and Observations

The following section describes trends and observations for the 200 Area vapor analytical results.

- Soil vapor COPC concentrations were higher in the summer semi-annual sampling event (August 2017), characterized by elevated outdoor temperatures, compared to the winter sampling event for all four WSTF primary COPCs detected: (TCE, PCE, Freon 11, and Freon 113).
- The highest concentrations detected in vapor in the investigation were for TCE, PCE, and Freon 113. Maximum concentrations for TCE, PCE, and Freon 113 were reported from well 200-LV-150-34, and the maximum concentration for Freon 11 from well 200-SV-05. These wells are both located downgradient of the former Clean Room Tank HWMU with respect to surface topography, bedrock topography, and groundwater flow. From the 200 Area Phase II investigation (NASA, 2015b), residual concentrations of the primary COPCs are present within microfractures of vadose zone bedrock, as demonstrated through core analysis.
- The highest indoor air concentration for Freon 113 of 3,200 µg/m^3 (in August 2017) was reported from sample location 200-IA-5 within Room 202 (Figure 5.1). The product inventory form (Table 4.1) indicates that steel canisters containing Freon are stored in this secure, unoccupied storage room. Room 202 is used exclusively for materials storage and is utilized periodically for chemical storage and chemical management activities.
- The trace indoor air concentration for 2-propanol of 68 µg/m^3 reported in August 2017 is from sample location 200-IA-3 within the equipment storage area of Room 205. 2-propanol is used in the manufacture of a wide variety of industrial and household chemicals and is a common ingredient in chemicals such as antiseptics, disinfectants and detergents that are stored in this room. Room 205 is used exclusively for equipment and storage and is occupied only during maintenance activities.
- Indoor air concentrations of COPCs were generally slightly higher than the contemporaneous outdoor air samples collected, but well below the concentrations observed within soil vapor in the shallow vadose zone reported from MSVM and MSVGM wells.

5.2 600 Area Soil Vapor, Outdoor Air, and Indoor Air

The analytical results for all soil vapor and air sample locations within and immediately surrounding Building 637 in the 600 Area are provided in Figure 5.2. The concentrations of the primary WSTF COPCs (TCE, PCE, Freon 11, and Freon 113) are provided for two semi-annual sampling events performed on August 26, 2017 and February 24, 2018.

Table 5.1 summarizes the maximum contaminant concentrations observed for subsurface soil vapor within the MSVM wells located closest to Building 637, the maximum contaminant concentrations for outdoor air adjacent to Building 637, and the maximum contaminant concentrations for indoor air samples for both of the semi-annual sampling events. Results are provided for all COPCs identified in Section 2.6 of this report (TCE; PCE; Freon11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) with a comparison to the available vapor intrusion screening levels: NMED VISLs and WSTF RBCs (Section 1.5).

5.2.1 600 Area Soil Vapor Analytical Results

TCE concentrations in well 600-SGW-1 (480 and 740 µg/m^3) exceed residential VISLs (69.5 and 147 µg/m^3) and the industrial noncancer VISL (328 µg/m^3), but not the industrial cancer VISL (1,120 µg/m^3) for both sampling events. Well 600-SGW-2 TCE concentrations (330 and 270 µg/m^3) exceed the residential VISLs for both sampling events, but only exceed the industrial noncancer VISL for the August 2017 event (330 µg/m^3). TCE concentrations were below the industrial noncancer VISL in February 2018 and the industrial cancer VISL in both 2017 and 2018. TCE soil vapor concentrations were below RBCs at 10 ft bgs (residential: 2,300 µg/m^3 noncancer and 5,400 µg/m^3 cancer; industrial: 34,000 µg/m^3 noncancer and 120,000 µg/m^3 cancer). Well 600-SGW-5 TCE concentrations (44 and 42 µg/m^3) were below all VISLs.

All other maximum concentrations for the 12 remaining COPCs for both the August 2017 and February 2018 sampling events (PCE; Freon 11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) are below the respective NMED VISLs and WSTF RBCs at the appropriate depths.

5.2.2 Building 637 Outdoor Air Analytical Results

The concentrations of COPCs in outdoor air samples were either non-detect or below 1 µg/m^3 for 10 of the 13 COPCs (TCE, PCE, Freon 113, 1,1,1-trichloroethane, chloroform, benzene, ethylbenzene, toluene, xylenes, and 2-propanol). Traces of Freon 11 (maximum 1.2 µg/m^3 in August 2017), 2-Butanone (maximum 2.4 µg/m^3 in August 2017), and acetone (maximum 10 µg/m^3 in August 2017) were also detected.

5.2.3 Building 637 Indoor Air Analytical Results

The maximum concentration for indoor air samples were non-detect or below 1 µg/m^3 for nine of the 13 COPCs: TCE; PCE; Freon 113; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; and, xylenes. Trace concentrations of three COPCs were also observed: Freon 11 (maximum 1.4 µg/m^3 in February 2018); 2-Butanone (maximum 5.3 µg/m^3 in August 2017); acetone (maximum 16 µg/m^3 in August 2017); and, 2-propanol (maximum 3.4 µg/m^3 in August 2017). No indoor air concentrations exceeded NMED VISLs.

5.2.4 Building 600 Trends and Observations

The following section describes trends and observations for the 600 Area vapor analytical results.

- The indoor air concentrations for specific COPCs were slightly above the contemporaneous outdoor air samples collected, but significantly below the concentrations observed within soil vapor in the shallow vadose zone reported from MSVM wells.
- The higher concentrations for COPCs in the vadose zone MSVM wells are variable between the summer (August 2017) and winter (February 2018) sampling events characterized by significantly different ambient outdoor temperatures. Of the four primary COCs, TCE and PCE are slightly higher for February 2017, and Freon 11 and Freon 113 are slightly higher for August 2017. This irregularity is true for 12 of the 13 COPCs detected in the vadose zone. The rationale may be related to limited amounts of groundwater available as a source for contaminants within poorly fractured andesite bedrock, and lower concentrations of VOCs in the local aquifer. The effect of increased volatilization during hotter (summer) months is less apparent than higher flow/higher contaminant concentrations areas such as the 200 Area fractured limestone aquifer.

- Analytical results for the four indoor air sample locations are also compatible with each other due to the open nature of the building with no divides or separate offices.

5.3 Potential Bias due to Field Sampling Conditions

The VIAWP was followed at all times including the performance of field sampling, and no potential biases due to field conditions were reported. The same analytical laboratory, sampling containers, and supplies were used for both the August 2017 and February 2018 sampling events. The same facility preparation and sampling protocol was also followed at Buildings 200 and 637 for each of the two events. Climatic conditions remained favorable throughout. The two semi-annual sampling events were performed 182 days apart during the summer and winter seasons as required by the VIAWP.

6.0 Screening Level Risk Assessment, Uncertainties, and Lines of Evidence

6.1 Screening Level Risk Assessment

This investigation was designed to evaluate whether there was unacceptable risk or hazard to WSTF workers in the most likely location at WSTF for current vapor intrusion, buildings adjacent to the 200 Area west closure HWMU and the 600 Area HWMU. A comprehensive risk/hazard screening assessment was not planned nor originally performed, and no soil borings were planned nor completed for this vapor intrusion investigation. However, in the disapproval of the initial VIAR, NMED requested that NASA perform a combined health risk and hazard screening evaluating soil vapor combined with soil data (NMED, 2019). Since no soil data was collected as part of the vapor intrusion field work, additional data collected prior to 2017 was used for soil risk and hazard screening. The soil data used was collected under NMED-approved work plans (*200 Area Investigation – Phase II Investigation Work Plan* [NASA, 2013a] and *NASA Response to NMED 03/19/09 Comments on the 600 Area Closure Investigation* [NASA, 2009]). This additional soil data was also previously included in NMED-approved reports (*NASA WSTF 200 Area Phase II Investigation Report* [NASA, 2015b] and *600 Area Closure Investigation Report Provided in Response to a NMED Notice of Disapproval* [NASA, 2011a]. Soil vapor and indoor air data used in the risk and hazard screening evaluation were collected for this investigation in 2017 and 2018 only. Analytical data used are provided in Excel format in Enclosure 4.

As requested, and per NMED Guidance (NMED, 2022c), a cumulative screening risk assessment is conducted at both the 200 and 600 Areas for the following potential exposure pathways: inhalation of intruding soil vapors, inhalation of indoor air, and the ingestion, dermal contact, or inhalation of chemicals present in soils. Figure 6.1 is the SCEM revised based on the results of this investigation and risk assessment.

Consistent with Section 2.8.2 of the NMED Risk Assessment Guidance (2022c), soil data from samples at any depth within 0 to 10 ft of the ground surface can be screened using residential or construction worker scenarios, whereas data from the 0 to 1 ft interval are applicable for evaluating industrial exposures. However, soil samples for the 200 and 600 Area investigations were not collected in the 0 to 1 ft depth range. The 200 and 600 Area investigations were originally designed to identify the locations of the greatest soil contamination. Samples were obtained where contamination was suspected. Since WSTF sites have been used for multiple purposes over time, surface soils have been disturbed and clean fill added at multiple WSTF sites. Due to the disturbed surface soils and the goal of locating the highest soil contaminant concentrations, surface soils were not collected for the 200 and 600 Area investigations, and the industrial pathway was not initially evaluated. In addition, no soil vapor wells on site at WSTF were designed with ports in the 0 to 1 ft bgs depth range. However, for this revision per NMED comments in the NMED Disapproval (NMED, 2022b), the industrial pathway was evaluated using the shallowest soil and vapor samples collected for the 200 and 600 Area investigations, even though the depths sampled were greater than 1 ft bgs. (The shallowest depths are: 200 Area soils: 8 and 16 ft bgs; 600 Area soils: 3, 4, 6, and 10 ft bgs; 200 Area soil vapor: 9, 19, and 34 ft bgs; and 600 Area soil vapor: 7.5 and 12.5 ft bgs).

In accordance with NMED Risk Assessment Guidance Section 2.8.4 (NMED, 2022c), when a constituent's maximum detected value exceeded or neared NMED screening levels, an exposure point concentration (EPC) can be calculated. If sufficient data are available, EPA's ProUCL software (most recent version EPA, 2022a) is used to calculate the constituent's 95 percent Upper Confidence Limit (UCL95) of the mean concentration. Ideally, a minimum of eight samples collected with at least five detections is preferred for calculating statistics. The UCL95 is then compared to the applicable screening level. When a detected constituent has no NMED screening level, EPA screening levels (EPA, 2022b) are used. Finally, WSTF RBCs (NASA, 2022) can be used for soil vapor as screening levels containing more site-specific criteria and should be compared against if NMED screening targets are not met. If less than eight samples or less than five detections were present for constituents, the maximum concentration was used as the EPC.

The cumulative screening risk assessment is performed with vapor analytical data from this investigation, as well as soil data from previous investigations conducted in the 200 and 600 Areas (NASA, 2015b; 2011a). Soil vapor and indoor air quality data collected during this investigation are the most relevant to the goals of this risk screening and are therefore used as key input parameters in the cumulative screening assessments.

6.1.1 200 Area Screening Risk Assessment

6.1.1.1 200 Area – Soil Vapor Screening Risk Assessment

For this investigation, soil vapor samples were collected from the shallowest vapor ports in three wells in the 200 Area. Since two separate sampling events (August 2017 and February 2018) were conducted, there is a total of six samples per constituent for the 200 Area. Per NMED (2022c) and EPA (2022a) guidance, six samples are not a sufficient number to perform reliable statistics. Therefore, the maximum concentration per constituent was used in all screening for 200 Area soil vapor.

Table 6.1 contains the 200 Area residential soil vapor cancer risk screening compared to NMED VISLs. Benzene, tetrachloroethene (PCE) and trichloroethylene (TCE) are the only carcinogenic constituents detected. Benzene has a residential cancer risk of 6.67E-06. PCE and TCE are the risk drivers, each having a cancer risk that exceeds the target if 1E-05 (1.58E-04 and 2.79E-02, respectively). The total cancer risk is 2.81E-02, which exceeds the target of 1E-05 set by the NMED (NMED, 2022c).

Table 6.2 contains the 200 Area industrial soil vapor cancer risk screening compared to NMED VISLs. Like the residential scenario, the industrial scenario risk drivers are PCE and TCE, each exceeding the risk target (3.24E-05 and 3.66E-03, respectively). The total soil vapor industrial risk is 3.69E-03, which exceeds the target of 1E-05.

Since both the residential and industrial pathways exceeded the cancer target compared to NMED VISLs, 200 Area maximum soil vapor concentrations were compared to more site-specific and approved WSTF RBCs (NASA, 2022; NMED, 2022a). Table 6.3 compares the maximum concentration to the RBC at the next shallowest depth. For example, the maximum benzene concentration was detected at 19 ft bgs, and this was compared to the RBC at 10 ft bgs. The risk driver for maximum concentrations compared to WSTF RBCs remains TCE at an individual risk of 3.73E-04. The total risk for 200 Area residential soil vapor is 3.75E-04, which exceeds the risk target of 1E-05. Table 6.4 presents the 200 Area industrial soil vapor cancer risk screening results compared with WSTF RBCs. TCE is near the target risk level at 1.46E-05, and the total risk is 1.48E-05, which equals or just exceeds the NMED target of 1E-05.

The 200 Area residential soil vapor noncancer hazard screening comparing maximum concentrations to NMED VISLs is shown in Table 6.5. Eight constituents are detected, with PCE, TCE, and 1,1-Dichloroethene exceeding their respective NMED VISLs. The total hazard for 200 Area residential soil vapor is 5.94E+03, which exceeds the NMED hazard index of 1E+00.

Table 6.6 presents the 200 Area maximum soil vapor concentrations compared to industrial noncancer VISLs for the six detected constituents. PCE and TCE exceeded the NMED hazard index of 1 (at 8.70E+00 and 1.25E+03, respectively). The total hazard is 1.26E+03.

Since NMED targets for hazard were exceeded using the VISLs, the data are compared against more site-specific WSTF RBCs, as shown in Table 6.7. The RBCs take into account site-specific conditions and are expected to better reflect the actual risk to human health and hazard on-site (NASA, 2019a). Constituents are compared against the RBC value at the nearest depth shallower than the sample depth since shallower RBCs are smaller numbers (more conservative; NASA, 2022). The cumulative hazard is reduced to 8.42E+01, which still exceeds the respective NMED screening target of 1E+00. TCE is the only constituent that independently exceeds screening levels, and is a risk driver (at 8.37E+01 individually).

Table 6.8 shows the 200 Area industrial soil vapor hazard screening using WSTF RBCs. TCE still exceeds the NMED target of 1E+00 (at 4.88E+00) and results in a total hazard of 4.91E+00.

6.1.1.2 200 Area - Indoor Air Screening Risk Assessment

Table 6.9 contains the residential cancer risk screening for 200 Area indoor air. All eight detected constituents are below their respective NMED indoor air screening levels. The total cancer risk is 1.24E-05, which approximately equals the target of 1E-05 set by the NMED.

The 200 Area industrial indoor air cancer risk is calculated using maximum concentrations compared to NMED indoor air VISLs in Table 6.10. No individual constituent nor the total combined cancer risk (2.31E-06) exceeds the NMED target of 1E-05.

Table 6.11 contains the screening residential hazard assessment for the 200 Area indoor air. There are 29 detected constituents, all of which are below their respective NMED indoor air screening levels. Because a sufficient number of samples were present to obtain reliable statistical results, UCL95 values are calculated for 14 constituents. The other 10 constituents did not have enough detections to perform reliable statistics and therefore, the maximum concentrations were used. The output files for UCL95 calculations are provided in Appendix D. The cumulative residential indoor air hazard is 6.09E-01 which is below the target of 1.0E+00 set by the NMED.

Table 6.12 provides the 200 Area industrial indoor air hazard screening. This table uses the same UCL95 calculated concentrations or maximum concentrations as Table 6.11. For the industrial indoor air pathway, no individual or combined hazard (2.73E-01) exceeded the NMED target of 1E+00.

6.1.1.3 200 Area – Soils Screening Risk Assessment

Figure 6.2 shows the WSTF background soil areas. The 200 Area is within WSTF background Area 2. Table 6.13 shows the 200 Area maximum soil concentrations versus the Area 2 Background Threshold Value (BTV) comparisons that are used to determine what COPCs are initially indicative of WSTF background and are therefore not COPCs in the 200 Area. Table 6.14 contains the maximum detected 200 Area soil concentrations for essential nutrients compared to WSTF BTVs for Area 2. If maximum detected values for a constituent are below previously established background concentrations within the same depth range, the constituent is no longer considered to be a COPC. Using maximum 200 Area soil concentrations compared to BTVs, the only COPCs were mercury and nitrate/nitrite. Mercury was detected in one sample in the 200 Area (at 0.003 mg/kg) and must be retained as a COPC because mercury was not detected in background Area 2 in sufficient enough quantity to calculate a BTV or compare populations in the 8 to 12 ft depth range. Using ProUCL software, the populations of nitrate/nitrite were compared between WSTF background Area 2 and the 200 Area soil data. When duplicate data are present, the most conservative value of the sample and duplicate was used. For background soil Area 2, the lower of the two concentrations was used, and the maximum 200 Area investigation soil concentration of the sample and duplicate was used. Nitrate/nitrite in 200 Area soils were not greater than background nitrate/nitrite Area 2 concentrations. Therefore, nitrate/nitrite was not retained as a 200 Area soil COPC (Table 6.15). The ProUCL data input file is provided as an enclosure and all ProUCL output files are provided in Appendix D.

Table 6.16 contains the residential cancer risk screening for the 200 Area soils. Risk was calculated using data from soil borings 200-SB-05 through 200-SB-13, shown in Figure 6.3 (wells 200-SB-6 and 200-SB-7 subsequently renamed 200-LV-150 and 200-KV-150, respectively), at depths between 0-10 ft bgs, except for soil boring 200-SB-10, for which no sample was collected within the 0 to 10 ft interval. For this well, the shallowest sample (collected at 16 ft bgs) was used for the 200 Area risk/hazard screening. All 200 Area soil samples used in this screening were collected during the 200 Area Phase II Investigation (NASA, 2015b). 200 Area soil analytical data from the Phase II investigation are provided in excel format in Enclosure 4. The only COPCs detected in 200 Area soils for the residential scenario were dioxins and furans. The toxicity equivalents were calculated per the NMED Guidance (NMED, 2022c) and are presented in Appendix D. For this revision, toxicity equivalents (TEQs) were updated to exclude total dioxin/furan data. Per Section 2.1 of the NMED Guidance (NMED, 2022c), only individual congeners were evaluated. As required, the maximum dioxin/furan TEQ concentration was used for the risk screening and compared to 2,3,7,8-TCDD (Tetrachlorodibenzo –p-dioxin). The resulting total cancer risk is 6E-08 (Table 6.16) which is below the respective target of 1E-05 set by the NMED.

Table 6.17 provides the 200 Area industrial soil cancer risk for dioxins and furans. The risk of 1E-08 does not exceed the NMED target of 1E-05.

Table 6.18 contains the 200 Area residential soils hazard screening, calculated using the same soil data from the 200 Area Phase II Investigation Report (provided in excel format in Enclosure 4). Three COPCs (mercury, toluene and dioxins/furans) are detected in these soil samples, all of which are below their respective NMED SSLs. The TEQs for the dioxins/furans were calculated (Appendix D) and then compared to the NMED residential noncancer SSL. The total hazard is 6.67E-03 which is below the target of 1.0E+00 set by the NMED (NMED, 2022c).

Table 6.19 compares the 200 Area maximum soil concentrations of mercury, toluene, and dioxins and furans to the industrial hazard screening levels. The total hazard is 5.47E-04, which is below the target of 1E+00.

6.1.1.4 200 Area – Cumulative Screening Risk Assessment for Residential Exposure

A screening of worker risks related to both indoor inhalation and soil exposure pathways for the 200 Area is provided in this section for both the residential and industrial exposure scenarios. Table 6.20 shows summed cancer risk and hazard for exposure to soil vapor and soil for the residential scenario in the 200 Area. The 200 Area has cumulative cancer risk of 4E-04 and a cumulative chemical hazard of 8E+01. Table 6.21 shows the summed cancer risk and hazard for exposure to soil vapor and soil for the industrial scenario in the 200 Area. The 200 Area cumulative industrial cancer risk is 1.48E-05, and the cumulative industrial hazard is 4.91E+00. All cumulative risk and hazard exceed targets.

All analytical data for the 200 Area cumulative screening risk assessment are included as an enclosure to this report (vapor laboratory reports are in Enclosure 3 and analytical data in excel format are in Enclosure 4).

6.1.2 600 Area Screening Risk Assessment

6.1.2.1 600 Area – Soil Vapor Screening Risk Assessment

For this investigation, soil vapor samples were collected from the shallowest vapor ports in three wells in the 600 Area (600-SGW-1 at 12.5 ft bgs, 600-SGW-2 at 12.5 ft bgs, and 600-SGW-5 at 7.5 ft bgs). Since two separate sampling events (August 2017 and February 2018) were conducted, there is a total of six samples per constituent for the 600 Area. Per NMED (2022c) and EPA (2022a) guidance, six samples are not a sufficient number to perform reliable statistics. Therefore, the maximum concentration per constituent was used in all screening for 600 Area soil vapor.

The 600 Area risk/hazard screening was performed in the same way that the 200 Area risk/hazard screening was done. 600 Area soil vapor analytical data was compared to NMED VISLs (and EPA RSLs if no VISL was available) as a first screen. Table 6.22 contains the 600 Area residential soil vapor cancer risk compared to NMED VISLs. There are 11 detected constituents, all of which are below their respective NMED VISLs, except TCE (5.03E-05). The total cancer risk is 6.15E-05, which exceeds the NMED target risk of 1E-05 (NMED, 2022c).

Table 6.23 provides the comparison of the maximum concentrations to industrial VISLs for soil vapor in the 600 Area. All of the 11 detected constituents are below their respective NMED VISLs, and the total 600 Area industrial soil vapor cancer risk of 8.90E-06 is below the NMED target of 1E-05.

Since the total risk for the 600 Area residential soil vapor pathway exceeded the target compared to VISLs, the more site-specific WSTF RBCs were used for comparison to maximum soil vapor concentrations in Table 6.24. The total 600 Area residential soil vapor cancer risk is 2.20E-06, which is below the target cancer risk of 1E-05 (NMED, 2022c).

Table 6.25 contains the residential hazard assessment for soil vapor in the 600 Area. There are 28 constituents detected with only TCE exceeding its NMED VISL (1.06E+01). The total hazard for the 600 Area soil vapor is 1.08E+01, which exceeds the NMED target hazard of 1E+00 (NMED, 2022c).

The 600 Area industrial soil vapor hazard is shown in Table 6.26. Like the residential scenario, TCE is the only constituent that exceeded the individual noncancer VISLs (2.26E+00). The total hazard is 2.30E+00, which also exceeds the target of 1E+00 (NMED, 2022c).

The 600 Area soil vapor hazard assessment using WSTF RBCs is shown in Table 6.27. The RBCs take into account site specific conditions and are expected to better reflect the actual risk to human health on-site than NMED VISLs (NASA, 2022c). Constituents are compared against the RBC value at the nearest depth shallower than the sample depth since shallower RBCs are more conservative. There are no available RBCs for 1,2-Dichloroethane, 1,4-Dichlorobenzene, Ethylbenzene, Toluene, m,p-Xylene, and o-Xylene, so the NMED VISLs were used as screening levels for these constituents. For cis-1,2-dichloroethene and 1,2,4-Trimethylbenzene, the EPA RSL for resident air was used since there were no RBCs or NMED VISLs established. The cumulative hazard is reduced to 3.63E-01, which is below the NMED target hazard of 1E+00 (NMED, 2022c). There are no constituents that exceed WSTF RBCs.

Table 6.28 presents the 600 Area industrial soil vapor maximum concentrations to WSTF RBCs. All constituents were below the corresponding WSTF RBC for the industrial scenario, and the total hazard for soil vapor is 3.25E-02, also below the target to 1E+00 (NMED, 2022c).

6.1.2.2 600 Area – Indoor Air Risk Assessment

Table 6.29 contains the 600 Area residential indoor air cancer risk screening assessment. The four detected constituents are below their respective NMED indoor air screening levels. The total cancer risk is 2.49E-06 which is below the NMED target risk of 1E-05 (NMED, 2022c).

Table 6.30 contains the 600 Area industrial indoor air cancer risk screening. All four detected constituents are below their respective NMED indoor air industrial screening levels, and the total cancer risk is 5.09E-07, which is also below the 1E-05 target (NMED, 2022c).

Table 6.31 contains the residential hazard assessment for 600 Area indoor air. There are 16 detected constituents, all of which are below their respective NMED indoor air screening levels. The cumulative hazard is 1.05E-01 which is below the NMED target hazard of 1E+00 (NMED, 2022c).

The 600 Area industrial indoor air hazard screening is presented in Table 6.32. No constituent exceeded any individual VISLs. The total hazard (6.44E-02) also was below the target of 1E+00 (NMED, 2022c).

6.1.2.3 600 Area – Soils Risk Assessment

Figure 6.2 shows the WSTF background soil areas. The 600 Area is within WSTF background Area 4. Table 6.33 shows BTV comparisons that are used to determine background constituents in the 600 Area. If maximum detected values for a constituent are below previously established background concentrations within the same depth range (NASA, 2015d), the constituent is no longer considered to be a COPC. Using maximum 600 Area soil concentrations compared to BTVs, potential COPCs were antimony, barium, beryllium, boron, cadmium, chromium, cobalt, copper, manganese, mercury, molybdenum, NO_2/NO_3, perchlorate, thallium, tin, and zinc. Essential nutrient maximum concentrations that exceeded BTVs were magnesium, potassium, and sodium (Table 6.34). Following comparison of 600 Area soils data to the BTVs, the two populations of data were compared for 600 Area soil constituents that had a maximum concentration that exceeded the BTV. Using ProUCL software (Version 5.2), the populations were compared between WSTF background Area 4 and the 600 Area soil data. When duplicate data are present, the most conservative value between the sample and duplicate was used. (For background soil Area 4, the lower of the two concentrations was used, and the maximum 600 Area investigation soil concentration of the sample and duplicate was used.) Antimony, boron, cadmium, chromium, NO_2/NO_3, perchlorate, thallium, and tin in 600 Area soils were retained as COPCs (Table 6.33 and Table 6.35). Sodium was also retained as an essential nutrient (Also shown on Table 6.35).

Table 6.36 and Table 6.37 contain the cancer risk screenings for the 600 Area soils, calculated using data from soil borings 600-SB-1 through 600-SB-10, shown in Figure 6.4, collected between 0 to 10 ft bgs in the 600 Area Closure Investigation Report (NASA, 2011a). There are six detected carcinogenic constituents, all of which are below their respective NMED SSLs (residential in Table 6.36 and industrial in Table 6.37). The cumulative cancer risk is 1.80E-06 for residential risk and 3.40E-07 for industrial risk, which are both below the NMED target risk of 1E-05 (NMED, 2022c).

Table 6.38 contains the residential hazard assessment for the 600 Area soils calculated using data from the 600 Area Closure Investigation Report (NASA, 2011a). There are 19 constituents detected in these soil samples, of which thallium is the only analyte to exceed its respective NMED residential SSL

(6.63E+00). The total residential hazard including thallium is 6.66E+00, which exceeds the target of 1E+00.

Table 6.39 shows 600 Area industrial soil hazard. All constituents, including thallium, are below the target of 1E+00. is 2.8E-02. The total industrial hazard is 4.01E-01, which is also below the 1E+00 target (NMED, 2022c).

6.1.2.4 600 Area – Cumulative Screening Risk Assessment for all Exposure Pathways

A screening of worker risks related to both indoor inhalation and soil exposure pathways for the 600 Area is provided here. Table 6.40 shows summed cancer risk and chemical hazard for exposure to soil vapor and soil in the 600 Area. The 600 Area has a cumulative cancer risk of 4E-06 and a chemical hazard of 7E+00.

All analytical data (vapor laboratory reports and an Excel file data summary for vapor and soils) for the 600 Area cumulative screening risk assessment are included as an enclosure to this report. Data for statistics for the 600 Area are provided in Appendix D.

6.2 Uncertainties

6.2.1 Constituents without Published Screening Values

The only detected constituents found in vapor throughout this investigation for which no published inhalation screening level is available are 2,2,4-Trimethylpentane, ethanol, and Freon 21. The organic chemical 2,2,4-Trimethylpentane is a component of gasoline and diesel but is not associated with any historical operations related to the 200 and 600 Area HWMUs that are the focus of this investigation. The relatively low measured concentrations (0.36 to 0.39 $\mu g/m^3$) and few detections (2 of 52 samples, both with J QA flags and adjacent to each other in the 200 Area Building [samples 200-IA-3 and 200-IA-4; Figure 3.1]) indicate that this chemical is unlikely to present significant health risks/hazards.

All three constituents (Ethanol, Freon 12, 2,2,4-Trimethylpentane) were detected in low concentrations (Ethanol: 1.5-9.6 $\mu g/m^3$; Freon 21: 0.84-6 $\mu g/m^3$ detected 6 out of 52 samples; 2,2,4-Trimethylpentane: 0.36 and 0.39 $\mu g/m^3$, detected 2 out of 52 samples), and none were detected in soils, likely indicating there is not a continuous soil source. In addition, the hazard calculations using approved WSTF RBCs included Ethanol (using methanol as a surrogate) and Freon 21 (using Freon 12 as a surrogate). No significant hazard was contributed by either ethanol or Freon 21 (Table 6.27 and Table 6.28).

6.2.2 Small Sample Sizes

The goal of the 200/600 VI investigation was to obtain indoor air, outdoor air, and soil vapor samples at the 200 and 600 Area over two seasonal changes and compare results to NMED VISLs and RBCs (if there were VISL exceedances). This could determine if further evaluation was warranted. Performing a comprehensive health risk was not part of the original scope. However, NASA was directed by NMED to perform health risk for this investigation, which usually involves performing statistical calculations. Both NMED and EPA recommend a minimum of 8 to 10 samples to perform reliable statistics. Only two sets of samples within three soil vapor wells per area were collected for this investigation (resulting in a total of 6 samples per constituent). Therefore, no EPCs such as UCL95 could be calculated for soil vapor. Since the maximum concentrations were used for risk and hazard, this creates uncertainty (biased high) in the risk and hazard results. A receptor is unlikely to be exposed to only the maximum concentrations of constituents, so the risk and hazard are currently conservative and likely do not represent real conditions.

6.2.3 Industrial Pathway Sample Depths

The initial 200 Area Phase II and 600 Area HWMU investigations were not designed specifically for risk assessment. Since they were designed to find the greatest concentrations of contaminants and WSTF soils have historically been disturbed, removed, and clean fill added, neither soil samples nor soil vapor samples were collected from the 0-1 ft bgs depth range for this investigation. The shallowest soils depths sampled and used for this risk screening were 8 and 16 ft bgs for the 200 Area and 3, 4, 6, and 10 ft bgs for the 600 Area. For soil vapor, the 200 Area was sampled at 9, 19, and 34 ft bgs, and the 600 Area was sampled at 7.5 and 12.5 ft bgs. This imparts uncertainty to the risk and hazard for the industrial pathway. Lines of evidence can support risk and hazard conclusions.

6.2.4 Large Dilution and Elevated Detection Limits

When a laboratory needs to dilute a sample a large amount due to very high concentrations of one or more VOCs, this causes the detection limits of other VOCs to be artificially raised. Especially when the detection limits are greater than corresponding regulatory screening levels, this creates uncertainty for the health risk and hazard evaluations. It cannot be stated that the constituent is not present in the sample in greater concentrations than the screening level. This could potentially bias the risk and hazard screening low, meaning there could be more contamination at higher risk and hazards than the risk screening indicates. For this evaluation, eight VOC constituents had detection limits greater than NMED VISLs due to large dilutions for soil vapor samples in well 200-LV-150 (sampled at 34 ft bgs).

6.3 Lines of Evidence

Since there are always uncertainties associated with risk and hazard screenings, lines of evidence can be applied to provide more confidence in the risk and hazard screening conclusions. The following lines of evidence can be applied for this 200/600 Area VIAR.

6.3.1 Conservative Risk Using Maximum Concentrations

When either an individual COPC or the combined sum exceeds NMED screening levels, risk, or hazard using maximum COPC concentrations, further evaluation is required. As stated in Section 2.8.4 of the NMED Guidance, UCL95 (the 95 percent upper confidence limit of the arithmetic mean) concentration of a contaminant may be calculated to represent an average concentration likely to be contacted over time. However, due to small sample size, UCL95 values could not be calculated for soil vapor. In addition, many constituents were only detected once or only a few times, requiring retaining the maximum concentration as the EPC. This will result in conservative estimates of risk/hazard.

6.3.2 Soil Vapor Vertical Concentration Profiles

Soil vapor vertical concentration profiles for 200 and 600 Area wells were constructed to present the distribution of COPCs in the vadose zone and identify any sourcing relationships to the local contaminated groundwater aquifer. The evaluation includes a temporal element with comparison of shallow soil vapor port analytical results generated specifically for the VI assessment to historical soil vapor analytical data collected for previous investigations (NASA, 2011b; NASA, 2013c; and NASA, 2015b). Historical soil vapor sampling events included all accessible ports within 200 and 600 Area MSVM and MSVGM wells that were sampled collectively as single events in order to provide a results snapshot using soil vapor isopleth maps. Vertical concentration profiles also incorporate soil sample analytical results collected during borehole installation, the soil porosity from geotechnical soil sample analyses, and groundwater analytical results from contemporaneous sampling events performed to support the soil vapor investigations. COPC concentrations in groundwater were used to calculate the equivalent soil vapor concentrations in equilibrium with groundwater using Henry's Coefficient (NMED, 2019). The calculated values are compared to soil vapor concentrations from the most proximal port located above groundwater.

With the exception of TCE, soil vapor analytical results for the majority of COPCs for the VI assessment and historical sampling events (PCE; Freon11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) are below the respective NMED VISL and WSTF RBC in soil vapor. For the optimum vertical concentration profiling of soil vapor, the COPCs Freon 113 and TCE were selected as they consistently display greater frequency of detection, relatively high concentrations, and more widespread vertical distribution. Freon 113 and TCE also represent two of the primary COPCs known to have been released from historical activities within the 200 and 600 Areas (NASA, 2012b). Vertical concentration profiles for select 200 and 600 Area wells are provided in Appendix E, with a summary of the profiles presented in Table 6.42.

6.3.2.1 200 Area - Wells 200-SG-2 and 200-SG-3

MSVGM wells 200-SG-2 and 200-SG-3 were utilized for vertical concentration profiles for the 200 Area vadose zone, in lieu of VI assessment wells 200-SV-05 and 200-SV-09 located adjacent to Building 200. Wells 200-SV-05 and 200-SV-09 comprise single port constructions directly above Permian Hueco limestone bedrock at 9 ft and 19 ft respectively, which preclude the ability to plot vertical concentration profiles. VI assessment MSVGM well 200-LV-150 was also not utilized for vertical concentration profiles because the shallow port at 34 ft was blocked during the only comprehensive sampling event performed (NASA, 2015), leaving only two lower ports accessible at 64 ft and 84 ft. The three ports are also all located below shallow alluvium - Permian Hueco Limestone bedrock interface at 18 ft, with bedrock elevated as a geological horst block along two subparallel faults below the industrialized 200 Area. The bedrock vadose zone in this area is not characterized by the high porosity and permeability of the relatively thick vadose zone alluvial section found in other parts of the 200 Area and the 600 Area. The bedrock vadose zone below the former Clean Room Tank HWMU located adjacent to Building 200 has been demonstrated to host residual COPCs within irregular low permeability bedrock fractures sampled in cores (NASA, 2015b).

Wells 200-SG-2 and 200-SG-3 were not utilized for shallow soil vapor sampling as part of the vapor intrusion assessment due to their distance from Building 200 of approximately 1,200 ft and 700 ft, respectively. The wells were installed in 1998 as part of the well 200-D area vadose zone investigation (NASA, 2004), through a thicker section of vadose zone alluvium peripheral to the industrialized 200 Area. Well 200-SG-2 was installed south of the industrialized 200 Area within a borehole drilled to a depth of 240 ft bgs. The borehole intercepted Permian Hueco Limestone bedrock at 90 ft bgs, and groundwater was initially identified at 230 ft bgs during drilling. The confined groundwater subsequently increased in elevation to a depth of 83 ft bgs. Three soil vapor ports were positioned at depths of 30 ft, 60 ft, and 84 ft bgs. The first two ports are located within the alluvial vadose zone, and the deep port is located within bedrock comprising interbedded limestone, shale, and sandstone. A screened groundwater monitoring zone is present at a depth of 85 ft to 100 ft bgs. Because confined groundwater increased in elevation above the bottom port, it became submerged and non-operational. The middle soil vapor port positioned approximately 23 ft above the local water table is now utilized as the deep port.

MSVGM well 200-SG-3 was installed south of the 200 Area buildings in the vicinity of the former hazardous waste evaporation tanks within a borehole drilled to a depth of 250 ft bgs. The borehole intercepted Permian Hueco Limestone bedrock at 80 ft bgs, and groundwater at 190 ft bgs during drilling. The groundwater table subsequently increased in elevation to a depth of 164 ft bgs. Five soil vapor ports were located at depths of 30 ft, 60 ft, 90 ft, 120 ft (reported as blocked following installation), and 154 ft bgs. The shallow two ports are located within the alluvial vadose zone, and the three deeper ports are located within bedrock comprising interbedded limestone, shale, and sandstone. A screened groundwater monitoring zone is present between 155 ft and 170 ft bgs, with the deep soil vapor port located 10 ft above the local groundwater table.

Evaluation of the vertical concentration profiles in the 200 Area at wells 200-SG-2 and 200-SG-3 (Appendix E, Table 6.42) indicate variable and complex relationships between soil vapor in the vadose zone and groundwater. Proximal to Building 200, residual COPCs sourced from the former Clean Room Tank HWMU characterize fractured Permian Hueco limestone bedrock. Relatively low and variable permeability in the fractured interbedded limestone, sandstone, and shale comprises the majority of the vadose zone along and within the horst block. Adjacent to the industrialized 200 Area where the alluvial vadose zone is thicker, shallower soil vapor ports located within alluvium or proximal to the upper bedrock section (well 200-SG-3, port at 90 ft) display generally increasing trends with depth, that are characteristic of the vadose zone at the 600 Area Closure (Section 6.2.2).

Soil vapor ports within the fractured limestone section do not display the same increasing COPC concentration trend as the alluvial vadose zone and are more irregular in profile. This trend could potentially be attributed to irregular vadose zone sources in the fractured bedrock vadose zone and local groundwater aquifer. Localized sources in these areas may be sourced by the infiltration of COPCs observed at surface (NASA, 2012b) through the alluvial soil to the bedrock interface, with subsequent migration down dip along relatively low permeability bedding planes or within bedding plane solution channels saturated below the local groundwater table. Vertical concentration profiles generally demonstrate declining soil vapor concentrations over time since the inception of soil vapor sampling in this area, which coincides with declining COPC trends in groundwater (NASA, 2019a). Where COPC concentrations in groundwater were used to calculate the equivalent equilibrium soil vapor concentrations, the results for the deep port in the respective well were within one order of magnitude for Freon 113 and the same order of magnitude for TCE.

6.3.2.2 600 Area - Wells 600-SGW-1 and 600-SGW-5

600 Area MSVM wells 600-SGW-1 and 600-SGW-5 were utilized for vertical concentration profiles in the vicinity of Building 637. The shallow port in each well (12.5 ft and 7.5 ft, respectively) was used to collect shallow soil vapor samples as part of the VI assessment. Well 600-SGW-1 was installed in 2009 as part of a closure investigation through the 600 Area closure cap within a borehole drilled to 135 ft bgs. The borehole was not advanced to the projected depth of bedrock (anticipated at between 160 ft and 170 ft) due to drilling difficulties with the sonic drilling method. Three soil vapor ports were located at 12.5 ft, 57.5 ft, and 117.5 ft bgs. Well 600-SGW-1 is located 184 ft from Building 637, and all vapor ports within the well have been sampled several times during previous investigations, providing a record of historical vertical profiles.

MSVM well 600-SGW-5 was also installed as part of the closure investigation immediately adjacent to the east corner of the 600 Area closure cap within a borehole drilled to 156 ft bgs. The well comprises four soil vapor ports located at 7.5 ft, 52.5 ft, 102.5 ft, and 137.5 ft. During borehole installation, perched groundwater was encountered at 144 ft on top of the alluvium-poorly fractured Tertiary Orejon andesite interface at 148 ft bgs. Well 600-SGW-5 is the most proximal well to building 637 at a distance of 181 ft, and was historically sampled as part of the same events as well 600-SGW-1. Because of the identification of perched groundwater in the borehole, the well was twinned with monitoring well 600-G-138 in 2011 to evaluate the perched groundwater. The results for Freon 113 and TCE for groundwater samples collected from 600-G-138 within the same timeframe as the soil vapor samples from well 600-SGW-5 are used to compare the soil vapor COPC concentration in equilibrium with groundwater to soil vapor in the deepest port at 137.5 ft.

The vertical concentration profiles in the 600 Area evaluated for wells 600-SGW-1 and 600-SGW-5 (Appendix E, Table 6.42) indicate a relationship between soil vapor in the vadose zone and groundwater. Both wells are located within an area characterized by an alluvial vadose zone with high porosity and permeability. The spectrum of soil vapor ports in these wells show consistently increasing COPC concentrations with depth and proximity to either perched groundwater or the local groundwater table. Vertical concentration profiles also demonstrate declining soil vapor concentrations over time since the inception of soil vapor sampling in this area that coincides with local declines in COPC concentrations in groundwater. Where COPC concentrations in groundwater at well 600-G-138 were used to calculate the equivalent equilibrium soil vapor concentrations, the results were comparable and within the same order of magnitude for the deep port in well 600-SG-5 located 7 ft above perched groundwater.

6.3.3 Integrity of Building Slabs

Building 200 was constructed in 1964 as a semi-permanent structure with a reinforced concrete floor (NASA, 1994). The concrete slab floor is 6 in. in thickness. The facility was intended for its present use as a laboratory with offices and is fully suitable for this use. Details of the Building 200 construction characteristics identified through the building inspection performed for the vapor intrusion assessment are provided in Appendix A. The floor is composed of a poured concrete slab covered with concrete sealant and 9-in. x 9-in. x 1/16-in. vinyl tiling. No significant cracks were observed in the concrete foundation slab during the building inspection around the outside periphery of Building 200 or inside within areas of exposed concrete floor. Therefore, known vapor intrusion routes of entry through the foundation slab are limited to diffusion through the concrete slab.

Building 637 was built in 1991 as a semi-permanent structure with a reinforced concrete floor (NASA, 1994). The concrete slab floor is 6 in. in thickness. The facility was intended for its present use for sample storage and is fully suitable for this use. Details of the Building 637 construction characteristics are provided in Appendix A. The floor comprises a poured concrete slab covered with concrete sealant. No significant cracks were observed in the concrete foundation during the building inspection around the outside periphery of the building or within the interior concrete floor. Therefore, known vapor intrusion routes of entry through the foundation slab are limited to diffusion through the concrete slab.

6.3.4 Ventilation Systems

Building 200 comprises a single floor structure. Airflow is through cycled air, and outdoor air infiltration can enter the building through open doors, door thresholds, and air ducts in the roof. Heating is through hot air circulation sourced by natural gas, and air conditioning is provided through central air. The HVAC systems run constantly throughout the day in order to preserve the laboratory environment (Appendix A).

Building 637 comprises a single floor structure. During summer months, airflow is through forced central air generated by evaporative coolers located on the ground on the north side of the building. Outdoor air infiltration could potentially be generated through the evaporative cooler intakes or on occasions when the bay door on the west side of the building is open. Heating is through hot air circulation sourced by natural gas. The HVAC systems run intermittently due to the irregular usage of the building on working days (Appendix A).

6.3.5 Personnel Management Practices

The practices for chemical storage and chemical waste management in Buildings 200 and 637 have been continually modified and improved through time at WSTF as part of the ongoing health, safety, and environmental culture. Personnel management practices have effectively promoted the minimization, documentation, storage, and disposal of wastes. These practices include: the training of WSTF employees operating within the target buildings to manage potential chemical sources of vapors appropriately; communication of best practices for chemicals management from managers through supervisors to workers; communication of the safety culture awareness; establishing chemical best management policies; and, providing constant supervision and monitoring of the work environment. Development and streamlining of the personnel management practices has helped minimize the potential for vapor intrusion into the buildings and vapor circulation within the buildings.

6.3.6 Indoor Air Quality – Risk to Worker

In Building 200, the concentration of 3,200 µg/m^3 of Freon 113 reported in August 2017 from sample location 200-IA-5 within Room 202 is two orders of magnitude below the NMED VISL for industrial indoor air of 147,000 µg/m^3 (Table 4.3). The product inventory form (Table 4.1) indicates that steel canisters containing Freon are stored in this secure, unoccupied storage room. A trace indoor air concentration for 2-propanol of 68 µg/m^3 reported in August 2017 from sample location 200-IA-3 within Room 205 is one order of magnitude below the residential and industrial RSLs (Table 4.3). 2-propanol is a common ingredient in chemicals such as antiseptics, disinfectants and detergents that are stored in this room. Room 205 is used exclusively for equipment and storage and is occupied only during maintenance activities. The workers are protected under this scenario.

In Building 637, a trace indoor air concentration for acetone of 16 µg/m^3 reported in August 2017 from sample location 600-IA-2 is four orders of magnitude below the NMED VISL for industrial indoor air of 152,000 µg/m^3 (Table 5.1). Acetone is a common solvent used for cleaning tools occasionally used in the building. The workers are protected under this scenario.

6.3.7 Concentration Ratios of Detected Constituents in Soil Vapor and Indoor Air

If vapor intrusion impacted indoor air quality in Building 200 or 637 one would expect to see a similar detection pattern and ratio of constituent concentrations for indoor air and soil vapor samples. However, analytical results from the two semi-annual indoor air and soil vapor sampling events show that the types and concentrations of VOCs in indoor air in Buildings 200 and 637 are unrelated to soil vapor measurements in those areas. This supports a conclusion that any constituents detected in indoor air samples did not enter the building through vapor intrusion from the vadose zone. The trace level constituents present within the buildings are not unexpected due to the inventoried storage of chemicals within the Building 200 laboratories and Building 637 sample storage areas (see Section 6.6 and Appendix A).

TCE, PCE, and 1,1-Dichloroethene were the three primary risk drivers which exceeded screening levels in the 200 Area soil vapor samples as follows:

- TCE was detected in all eight of the vadose zone soil vapor samples collected. Of the 18 indoor air samples, TCE was only detected in eight of the samples.
- PCE was again detected in all eight of the vadose zone soil vapor samples collected. There was only one detection of PCE within the 18 indoor air samples, and the detection was a trace amount (0.28 ug/m^3).
- 1,1-Dichloroethene was detected again in all eight of the soil vapor samples, while the constituent was non-detect for all 18 indoor air samples.

6.4 Assessment of Worker Risks for Occupants of Buildings 200 and 637

The three constituents which exceed NMED screening levels in 200 Area soil vapor coexist in all of the soil vapor samples. This same correlation between these constituents does not exist in indoor air samples, indicating that soil vapor is not the source of the trace indoor detections.

The primary risk driver that exceeded NMED VISLs in the 600 area was TCE. TCE was detected in each of the eight soil vapor samples collected within the 600 Area during this investigation. However, TCE was not detected in any of the ten indoor air samples that were collected in Building 637. The absence of TCE in indoor air samples is a strong line of evidence that TCE in soil vapor in the 600 Area does not present a risk to present-day workers.

Industrial/occupational workers at WSTF who occupy buildings in the vicinity of the former 200 Area Clean Room Tank HWMU and the 600 Area HWMU while performing their daily duties are the primary potential receptors for COPC vapor intrusion. RA Guidance Section 2.5.2.1 (NMED, 2022c) states that the vapor intrusion pathway may only be considered incomplete if all soil vapor sample concentrations results are 100 percent non-detect. A cumulative health risk assessment was requested as part of the vapor intrusion investigation by the NMED (NMED, 2022c). The assessment was included in the revised report, and was completed in accordance with the RA Guidance to evaluate the pathway between soil vapor in the 200 and 600 Area vadose zones and indoor air in the vicinity of adjacent Buildings 200 and 637. Lines of evidence considered include:

- A cumulative screening level risk assessment.
- Evaluation of vertical concentration profiles within the 200 and 600 Areas.
- The results of the visual inspection of the buildings including the integrity of the building foundations, quality of the ventilation systems, and an evaluation of personnel management practices.
- Quantitative screening assessment of vadose zone soil vapor, outdoor air, and indoor air laboratory results with comparison to available vapor intrusion soil vapor screening levels and industrial exposure scenario air screening levels.

Evaluation of the lines of evidence support the conclusion that no additional investigation or vapor intrusion mitigation is required in Building 200 or Building 637.

Although vadose zone soil vapor concentrations of PCE and/or TCE at the locations of the 200 West Closure and 600 Area HWMUs exceeded NMED VISLs and updated NMED-approved WSTF RBCs as expected, indoor air exposure within Buildings 200 and 637 presents no unacceptable risk. The subsurface contribution to indoor VOC levels is below the equivalent indoor air screening levels.

Table 6.20, Table 6.21, Table 6.40, and Table 6.41 show the cumulative risk of soil and soil vapor within the 200 and 600 Areas, respectively. This calculation does not include results from indoor air sampling and is therefore representative of future risk. The same risk drivers remain present in this assessment.

7.0 Summary and Conclusions

7.1 Summary of Soil Vapor, Outdoor Air, and Indoor Air Sampling and Screening Criteria

The investigation reported in this VIAR used a tiered approach to evaluate the potential for vapor intrusion in the WSTF 200 and 600 Areas. The vapor intrusion pathway between soil vapor in the vadose zone and industrial/occupational indoor air at two locations identified through previous investigations was evaluated by comparing the maximum detected concentrations to the corresponding NMED VISLs, and

WSTF RBCs. Additional lines of evidence were reviewed including evaluation of the building foundations and ventilation systems, and evaluation of the results of indoor and outdoor air sampling at these locations.

Adjacent to the 200 Area Clean Room Tank HWMU, soil vapor samples were collected from shallow soil vapor ports in MSVM wells 200-SV-05 at 9 ft bgs, 200-SV-09 at 19 ft bgs, and MSVGM well 200-LV-150 at 34 ft bgs. All three wells are located within 85 ft of the west side of Building 200. Air samples were collected simultaneously with the vadose zone samples. Indoor air samples were collected at locations in Building 200 above and adjacent to the subsurface footprint of the former 200 Area Clean Room Tank HWMU along with outdoor air samples adjacent to Building 200.

In the 600 Area, soil vapor samples were collected from shallow soil vapor ports in MSVM wells 600-SGW-1 at 12.5 ft bgs, 600-SGW-2 at 12.5 ft bgs, and 600-SGW-5 at 7.5 ft bgs, all located within 210 ft of Building 637. Indoor air samples were collected in Building 637 within the single room of the building, along with outdoor air samples at adjacent locations.

Sample collection activities at both locations were performed as two single semi-annual events in the summer (August 2017) and winter (February 2018) to address potential seasonal differences in HVAC performance and related air pressure fluctuations that could affect vapor intrusion. Vadose zone, indoor air, and outdoor air samples were collected over non-working three-day weekends on the same day within each area, and on consecutive days for both sampling events. Indoor and outdoor air sampling procedures were performed to assess the potential contribution of background levels of VOCs in ambient air to measured VOC concentrations in indoor air. Soil vapor samples were analyzed using EPA Method TO-15 in order to achieve the project DQOs. 2022 NMED VISLs and 2022 WSTF RBCs (submitted to NMED for review December 14, 2021; memorandum approved with modification by NMED on February 11, 2022, and resubmitted May 10, 2022), which incorporate new toxicity data and exposure factors, were used for screening soil vapor data. Potential health effects related to inhalation of indoor air data were screened using NMEDs air screening levels. NMED industrial soil screening levels were used to support the all-pathways cumulative screening assessment.

7.2 Conclusions

7.2.1 200 Area

7.2.1.1 Vadose Zone Soil Vapor

The shallow soil vapor port within three wells adjacent to Building 200 (and the location of the former Clean Room Tank HWMU) were utilized for the air intrusion evaluation. All three wells (200-LV-150-34, 200-SV-05, and 200-SV-09) have historically shown TCE soil vapor concentrations that exceed WSTF RBCs (NASA, 2015, Phase II report). Vadose zone TCE concentrations in soil vapor from MSVM wells 200-SV-05 at 9 ft bgs, 200-SV-09 at 19 ft bgs, and 200-LV-150 at 34 ft bgs exceed NMED VISL (11,000 and 280,000 µg/m^3 cancer and 69.5 and 328 µg/m^3 noncancer) and WSTF RBC at 25 ft bgs (4,900 and 84,000 µg/m^3 noncancer) for the August 2017 and February 2018 semi-annual sampling events performed for this vapor intrusion assessment. PCE soil vapor concentrations exceed the NMED VISL (3,600 and 17,600 µg/m^3 cancer and 1,390 and 6,550 µg/m^3 noncancer) in all three wells for the August 2017 sampling event but are below the WSTF RBC at 25 ft bgs (340,000 and 6,000,000 cancer and 130,000 and 2,300,000 µg/m^3 noncancer). In February 2018, only the PCE sample from 200-LV-150 at 34 ft bgs exceeded the NMED VISLs. The concentrations for the other remaining COPCs in vadose zone soil vapor are below the corresponding NMED VISLs (except 1,1-Dichloroethane) and WSTF RBCs.

7.2.1.2 Outdoor Air

Concentrations in Building 200 outdoor air samples were generally either non-detect or below 1 µg/m^3 for COPCs. Traces of Freon 11 (maximum 1.2 µg/m^3 in August 2017 and February 2018) and 2-Butanone (maximum 3 µg/m^3 in August 2017) were observed. Based on this simple comparison, NASA concludes that outdoor air does not present a significant risk of industrial/occupational exposure and no additional investigation or mitigation is required at this time.

7.2.1.3 Indoor Air

Concentrations in Building 200 indoor air samples were generally non-detect or present at trace concentrations for COPCs. One low concentration of Freon 113 of 3,200 µg/m^3 was reported in August 2017 at location 200-IA-5. This concentration is two orders of magnitude below the NMED VISL for industrial indoor air (147,000 µg/m^3). All indoor air concentrations for all COPCs were well below NMED VISLs. As stated in the NMED Risk Assessment Guidance for Site Investigations and Remediation (NMED, 2022c), the "application of the VISLs is appropriate as a first-tier screening assessment." Although the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, the subsurface contribution to indoor VOC levels is below indoor air NMED VISLs and WSTF RBCs.

The Decision Rule from the approved work plan (provided in Section 3.1.4) states that "If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below indoor air NMED VISLs and WSTF RBCs, then current vapor intrusion risks are acceptable." Based on the results of a visual inspection of the structural stability WSTF Building 200, an evaluation of personnel management practices, and the quantitative assessment of soil vapor and air sample laboratory results with comparison to available vapor intrusion screening levels including NMED VISLs and WSTF RBC, NASA concludes the following:

- According to NMED Guidance on vapor intrusion pathway designation (NMED, 2022c), there is a complete exposure pathway in the 200 Area.
- Potential vapor intrusion into Building 200 does not present a risk of industrial/occupational exposure to personnel working in the building.
- No additional investigation or vapor intrusion mitigation is required in Building 200.

7.2.2 600 Area

7.2.2.1 Vadose Zone Soil Vapor

The shallow soil vapor ports within three wells located on the 600 Area HWMU adjacent to Building 637 were sampled as part the air intrusion evaluation. Well 600-SGW-2 has periodically yielded concentrations of TCE that have exceeded WSTF site-specific RBCs (NASA, 2013c 200/600 semi-annual fourth report), although TCE concentrations remained below the RBC for the last sampling event (NASA, 2015 Phase II report). TCE concentrations within soil vapor for well 600-SGW-1-12.5 (480 µg/m^3 in August 2017 and 740 µg/m^3 in February 2018) and well 600-SGW-2-12.5 (330 µg/m^3 in August 2017) exceed the NMED VISL (69.5 and 328 µg/m^3), but are significantly below the WSTF RBC at 10 ft bgs (5,400 µg/m^3). All other maximum concentrations for the remaining COPCs for both the August 2017 and February 2018 sampling events are below the respective NMED VISL and WSTF RBC in soil vapor. Based on the historical soil vapor data and soil vapor results presented in the VIAR, NASA concludes that activities related to the ongoing 600 Area Perched Groundwater Extraction Pilot Test (NASA, 2018b) and upcoming 600 Area Perched Groundwater Investigation (NMED, 2017b) will address concerns related to the presence of VOCs in soil vapor in the area.

7.2.2.2 Outdoor Air

The concentrations for COPCs for Building 600 outdoor air samples were generally non-detect or below 1 µg/m^3 for the COPCs. Traces of Freon 11 (maximum 1.2 µg/m^3 in August 2017), 2-butanone (maximum 2.4 µg/m^3 in August 2017), and acetone (maximum 10 µg/m^3 in August 2017) were reported.. Based on this comparison, NASA concludes that outdoor air does not present a significant risk of industrial/occupational exposure and no additional investigation or mitigation is required at this time.

7.2.2.3 Indoor Air

The Building 600 indoor air concentrations for specific COPCs were slightly above the contemporaneous outdoor air samples collected, but significantly below the concentrations observed within soil vapor in the shallow vadose zone reported from MSVM wells. The maximum concentration for indoor air samples were generally non detect or below 1 µg/m^3 for the COPCs. Trace concentrations were observed for three COPCs: Freon 11 (maximum 1.4 µg/m^3 in February 2018); 2-Butanone (maximum 5.3 µg/m^3 in August 2017); acetone (maximum 16 µg/m^3 in August 2017); and 2-propanol (maximum 3.4 µg/m^3 in August 2017). No concentrations of indoor air COPCs exceeded the NMED VISLs.

The Decision Rule from the approved work plan (provided in Section 3.1.4) states that "If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below indoor air NMED VISLs and WSTF RBCs, then current vapor intrusion risks are acceptable." Based on the results of a visual inspection of the structural stability WSTF Building 637, an evaluation of personnel management practices, and the quantitative assessment of soil vapor and air sample laboratory results with comparison to available vapor intrusion screening levels including NMED VISLs and WSTF RBC, NASA concludes the following:

- According to NMED Guidance on vapor intrusion pathway designation (NMED, 2022c), there is a complete exposure pathway in the 600 Area.
- Potential vapor intrusion into Building 637 does not present a risk of industrial/occupational exposure to personnel working in the building.
- No additional investigation or vapor intrusion mitigation is required in Building 637.

8.0 Recommendations

Based on the background data presented in this report, the comparison of analytical results to applicable regulatory screening level criteria, and the performance of a cumulative screening level risk assessment, NASA concludes that there is a complete vapor intrusion pathway within the 200 and 600 areas, but there is no unacceptable impact to human health within Building 200 and 637, respectively.

From the Decision Rule: "If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below risk-based indoor air concentrations shown in Table A-4 of NMED's Soil Screening Guidance for Human Health Risk Assessments VISLs and WSTF RBCs, then current vapor intrusion risks are acceptable." No further soil vapor investigation or corrective actions are recommended for Building 200 and Building 637 due to the lack of unacceptable health risk of soil vapor COPCs from the vadose zone into the target buildings.

The risk screening performed for this VIAR is not intended to be complete at this time, as continued monitoring is planned for the 200 and 600 Areas. NASA will perform continued risk and hazard screening, including soil-to-groundwater and an ecological assessment in accordance with the current NMED RA Guidance, Volumes I and II at an appropriate time to make corrective action decisions or to seek closure. At that time, NASA will provide a risk report in accordance with the WSTF Permit Section 6.5.

In accordance with Permit Sections 2.3, 7.3.5, and Attachment 5 (NMED, 2023), NASA will continue to perform the necessary post-closure care inspections and activities at both the 200 Area and 600 Area closures. Planned activities include continued groundwater monitoring in accordance with Permit Section 3.3, 4.3, and 7.3.4, surface impoundment requirements of Section 7.3.5.1, landfill requirements of Section 7.3.5.2, and the security measures described in Section 7.3.5.4. NASA will continue to perform inspections and maintenance as specified in Permit Attachment 5.

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Figures

Figure 1.1 **WSTF Location Map**

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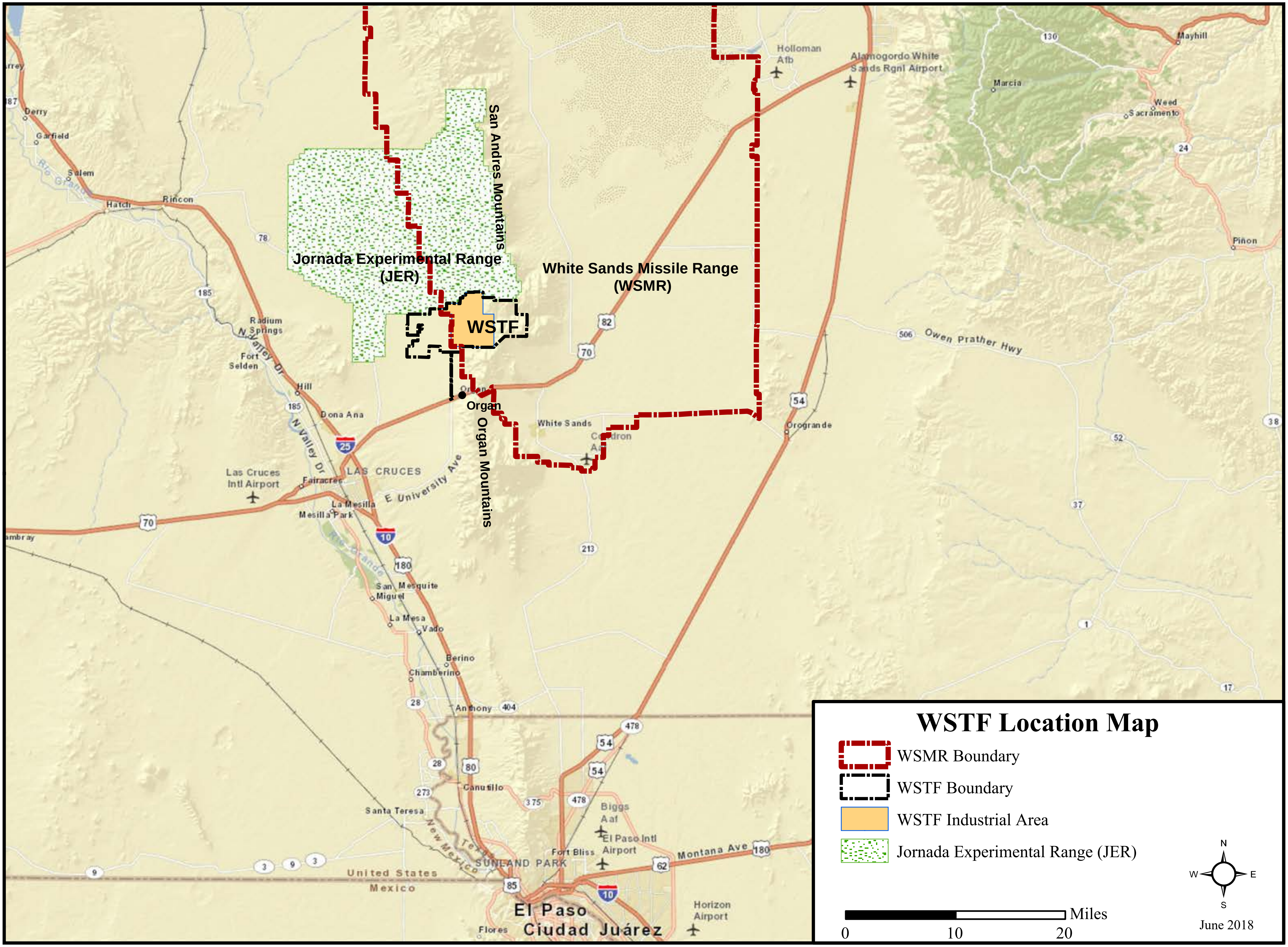
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
Miles
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June 2018
WSTF
Jornada Experimental Range (JER)
White Sands Missile Range (WSMR)
San Andres Mountains
Organ Mountains
Organ
Holloman Afb
Alamogordo White Sands Rgnl Airport
Mayhill
Marcia
Weed
Sacramento
Pinon
Derry
Garfield
Salem
Rio Grande
Hatch
Rincon
Radium Springs
Fort Selden
N Valley Dr
Hill
Dona Ana
LAS CRUCES
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La Mesilla
Mesilla Park
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Orogrande
Owen Prather Hwy
San Miguel
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78
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24
506
38
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85
9
3

Figure 1.2 Vapor Intrusion Assessment Building Location Map

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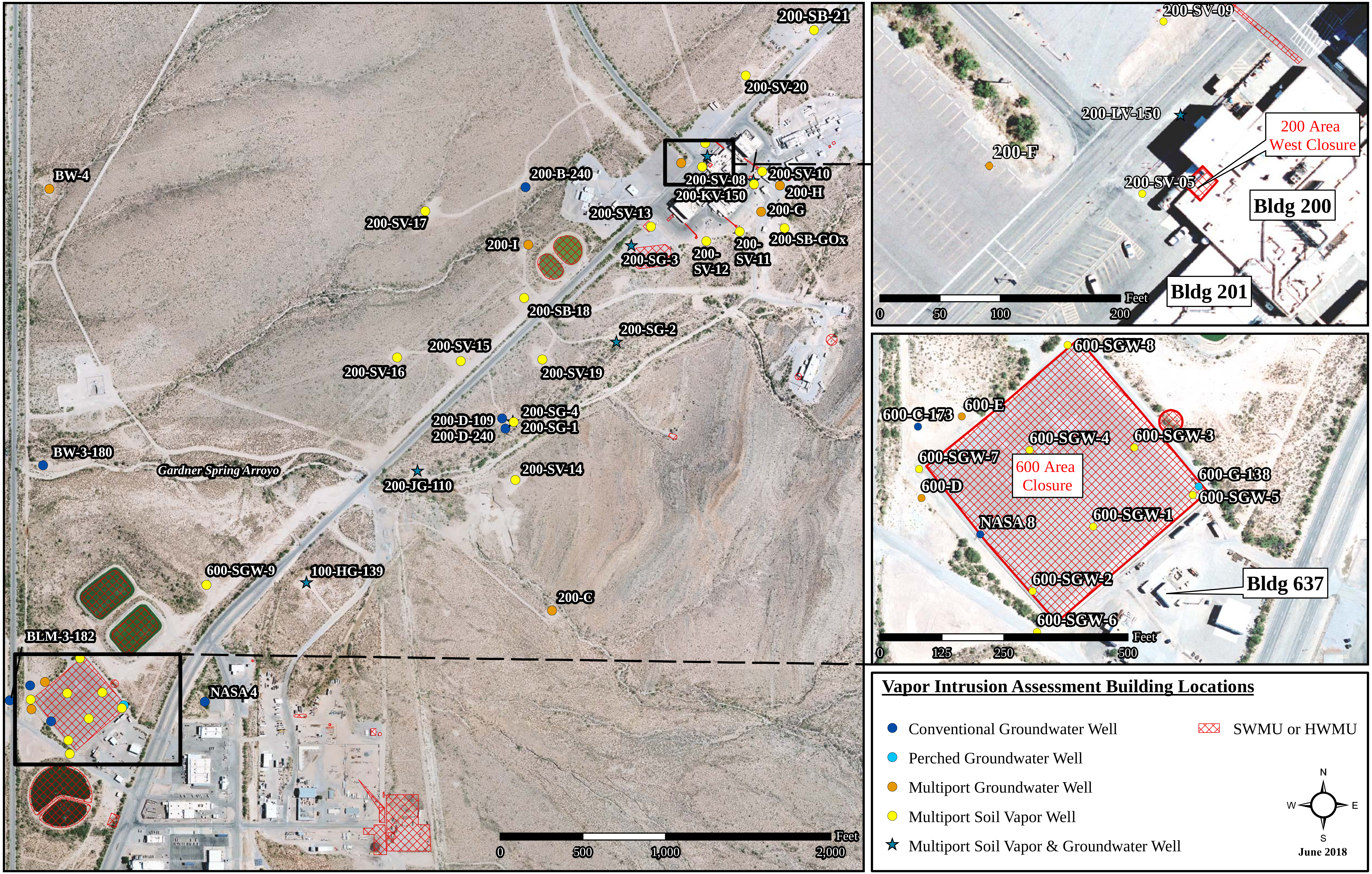

Vapor Intrusion Assessment Building Locations

Figure 2.1 Freon 113 Soil Vapor and Groundwater Concentrations (Oct-14)

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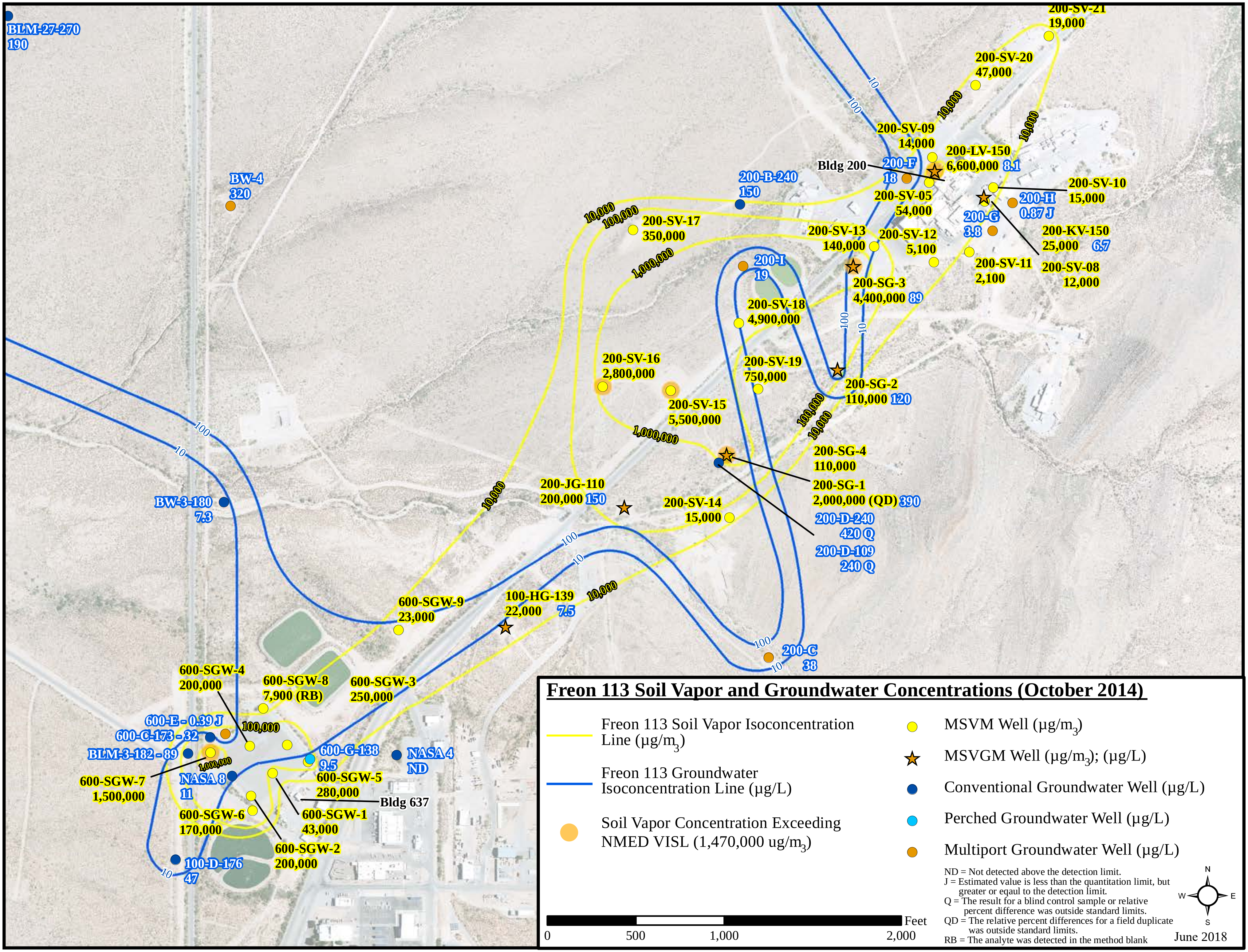


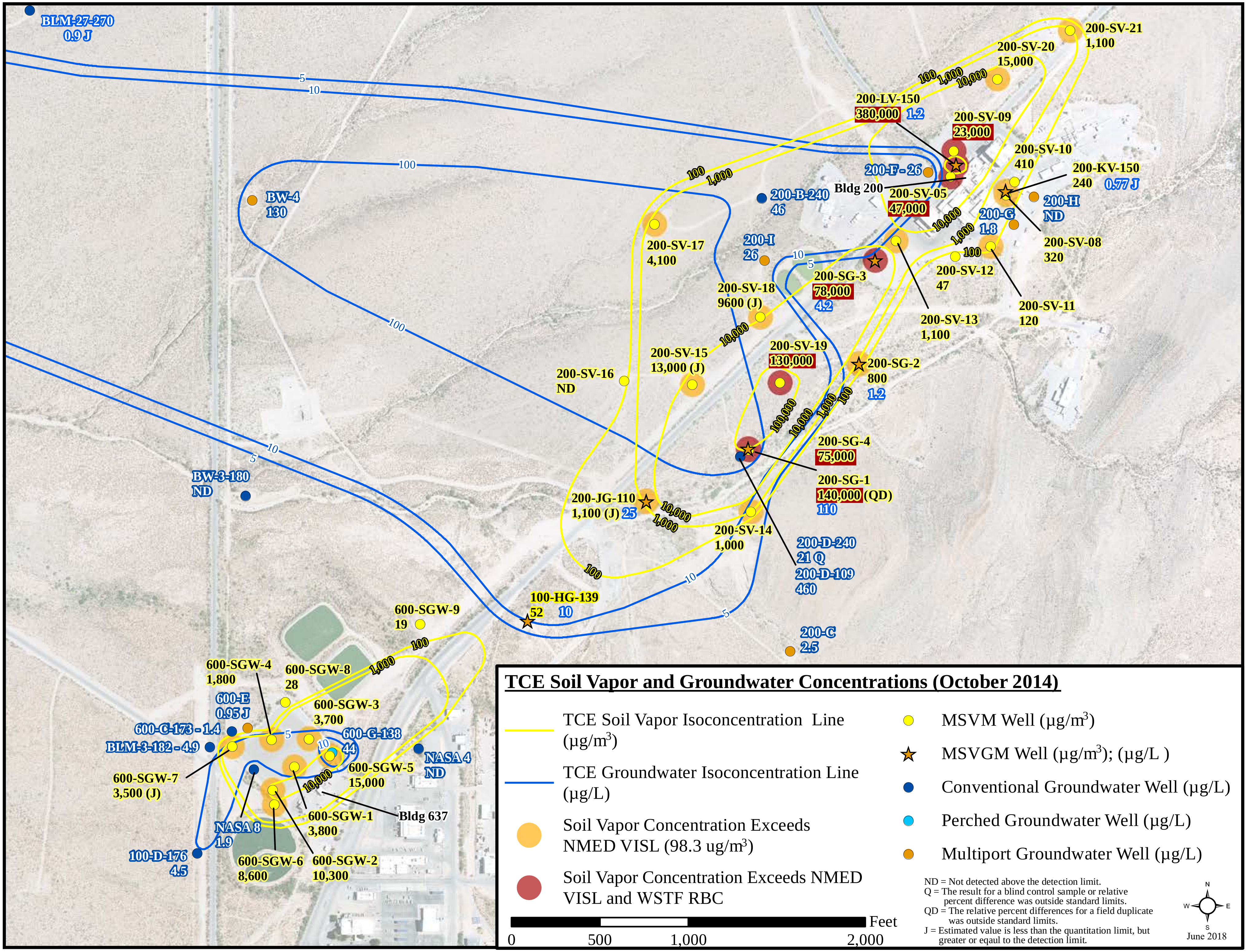
Freon 113 Soil Vapor and Groundwater Concentrations (October 2014)

ND = Not detected above the detection limit.
J = Estimated value is less than the quantitation limit, but greater or eqaul to the detection limit.
Q = The result for a blind control sample or relative percent difference was outside standard limits.
QD = The relative percent differences for a field duplicate was outside standard limits.
RB = The analyte was detected in the method blank

June 2018

Figure 2.2 Trichloroethene Soil Vapor and Groundwater Concentrations (Oct-14)

(SEE NEXT PAGE)



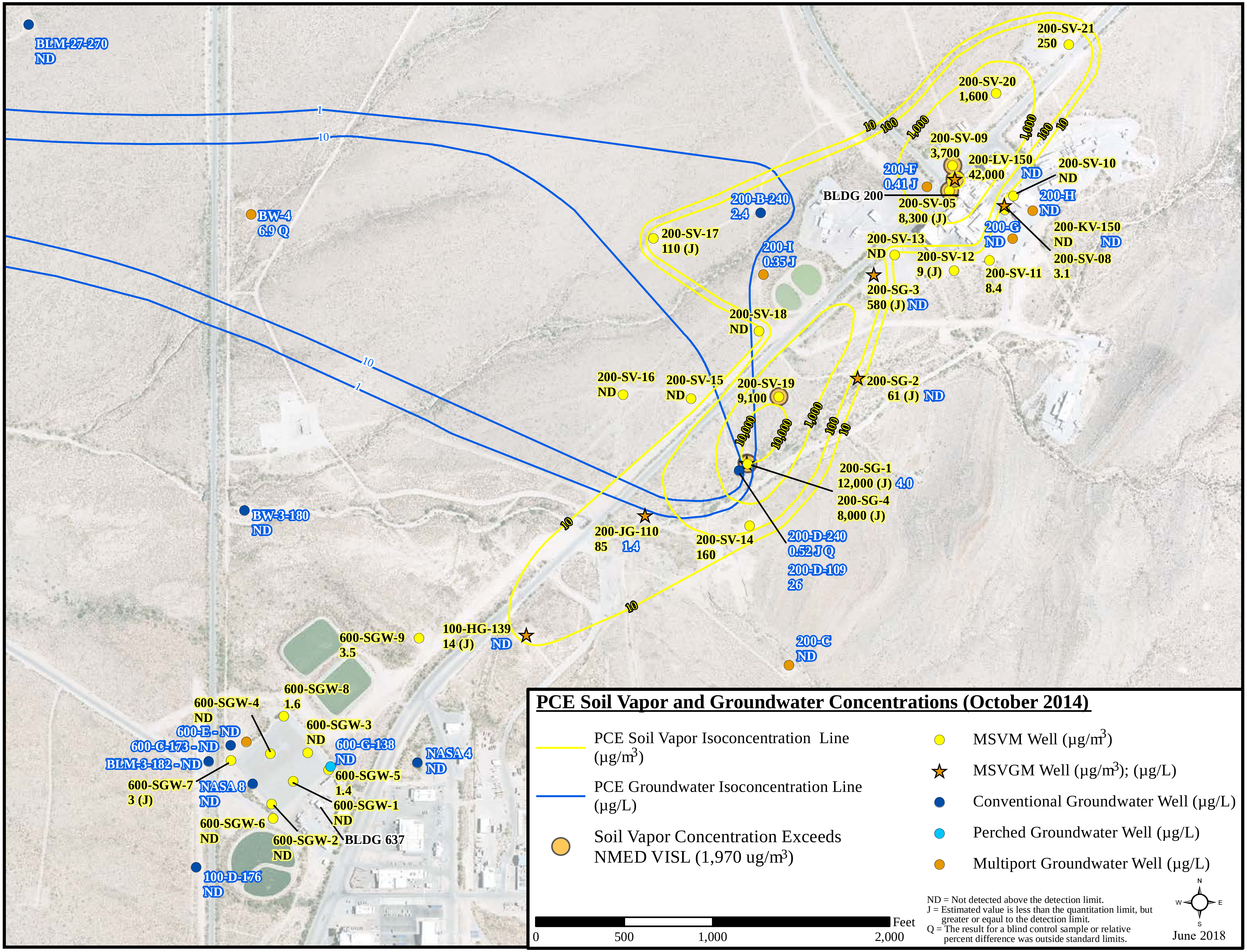
TCE Soil Vapor and Groundwater Concentrations (October 2014)

ND = Not detected above the detection limit.
Q = The result for a blind control sample or relative percent difference was outside standard limits.
QD = The relative percent differences for a field duplicate was outside standard limits.
J = Estimated value is less than the quantitation limit, but greater or eqaul to the detection limit.

June 2018

Figure 2.3 Tetrachloroethene Soil Vapor and Groundwater Concentrations (Oct-14)

(SEE NEXT PAGE)



PCE Soil Vapor and Groundwater Concentrations (October 2014)

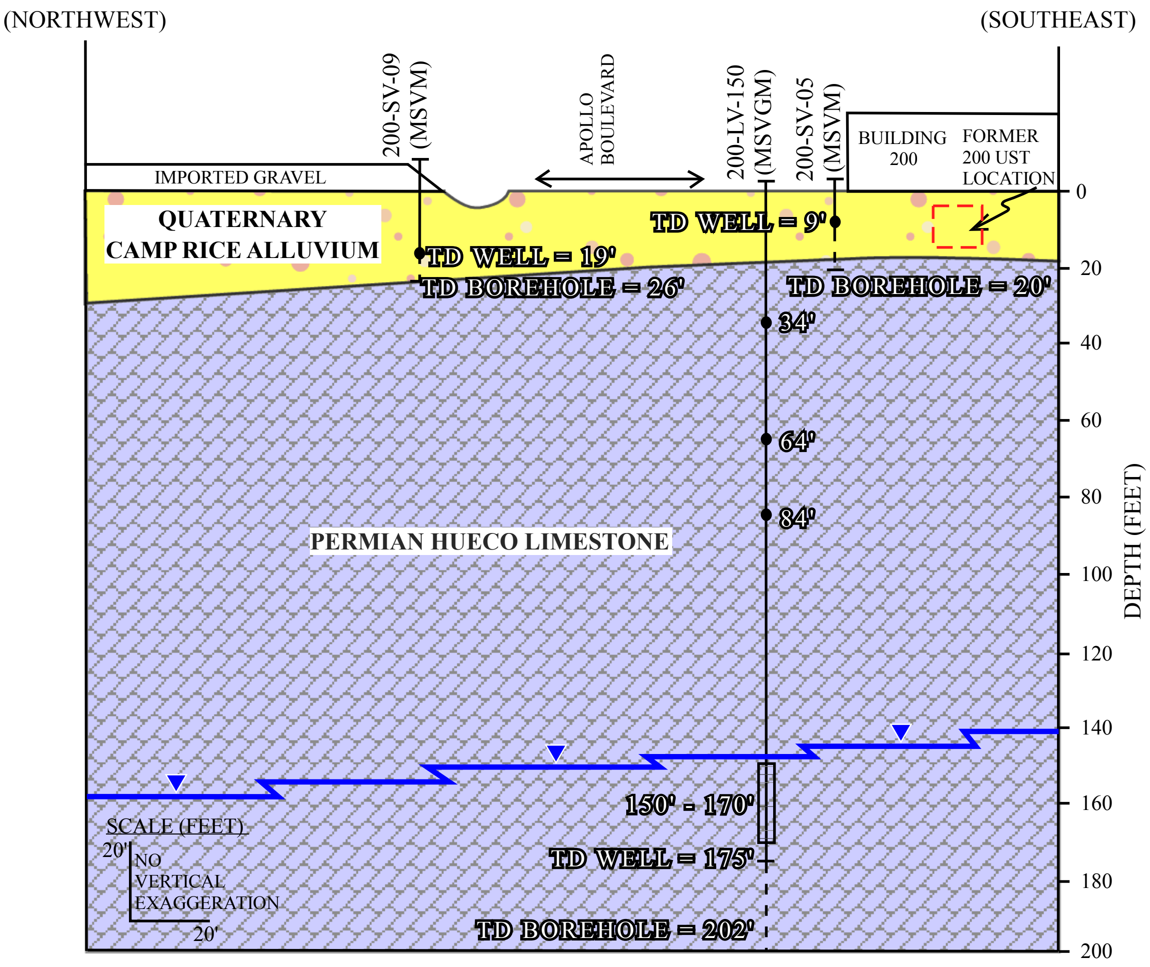
ND = Not detected above the detection limit.
J = Estimated value is less than the quantitation limit, but greater or eqaul to the detection limit.
Q = The result for a blind control sample or relative percent difference was outside standard limits.

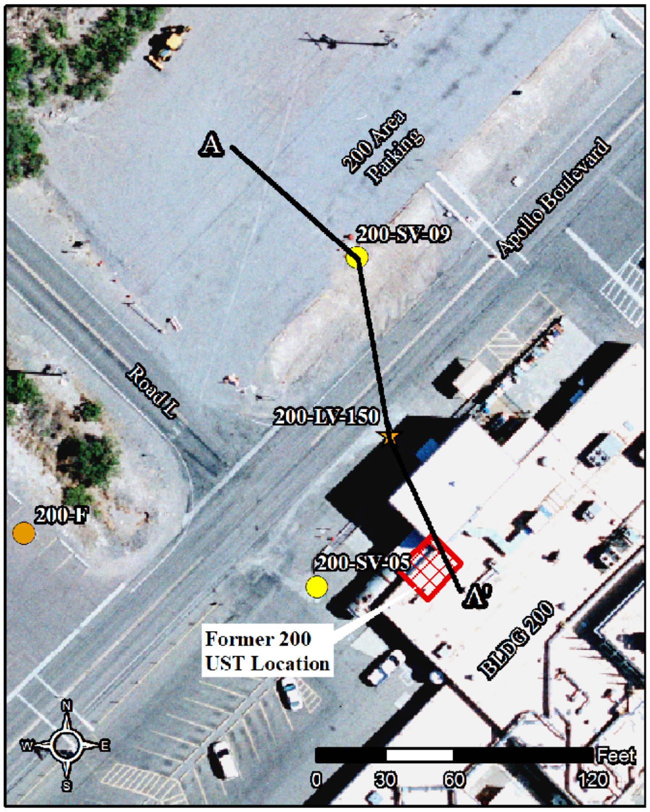
June 2018

Figure 2.4 **Building 200 Site Conditions**

(SEE NEXT PAGE)

Building 200 Site Conditions



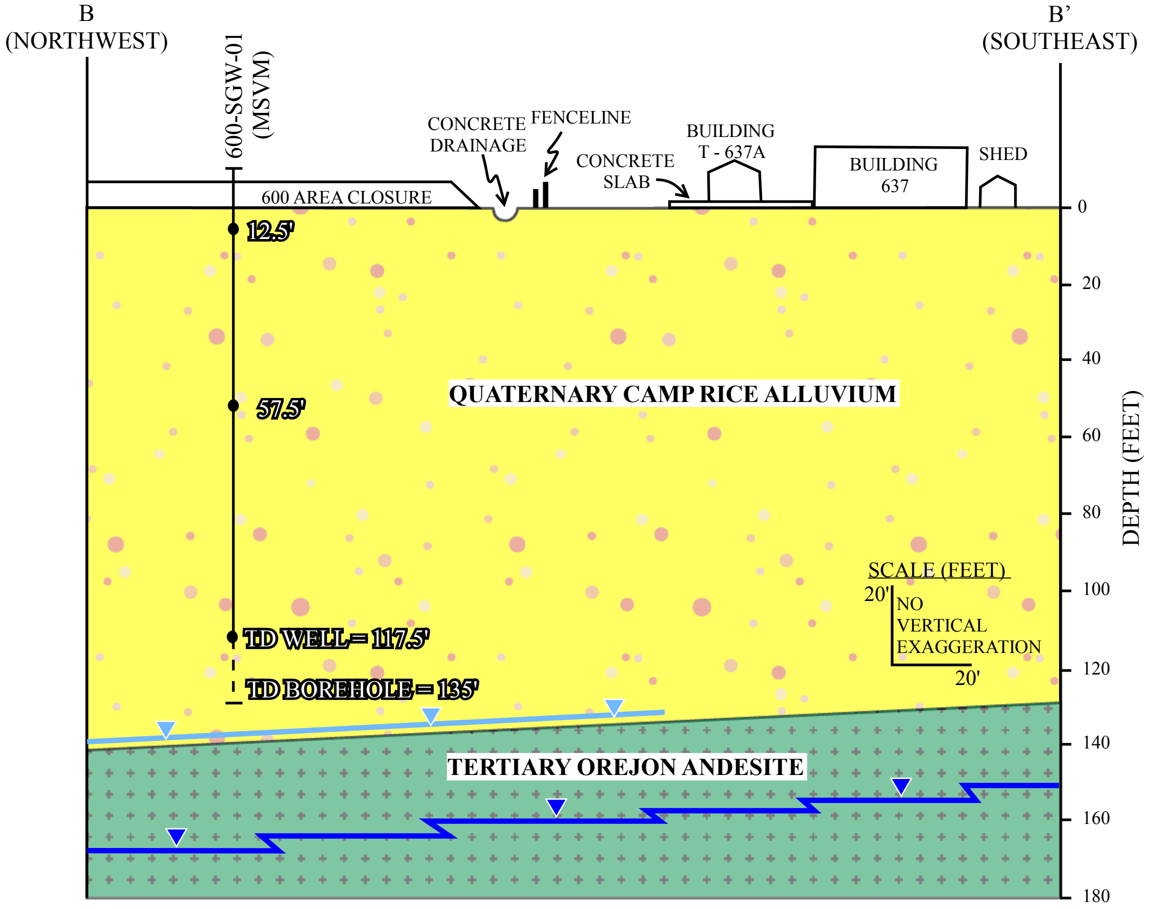


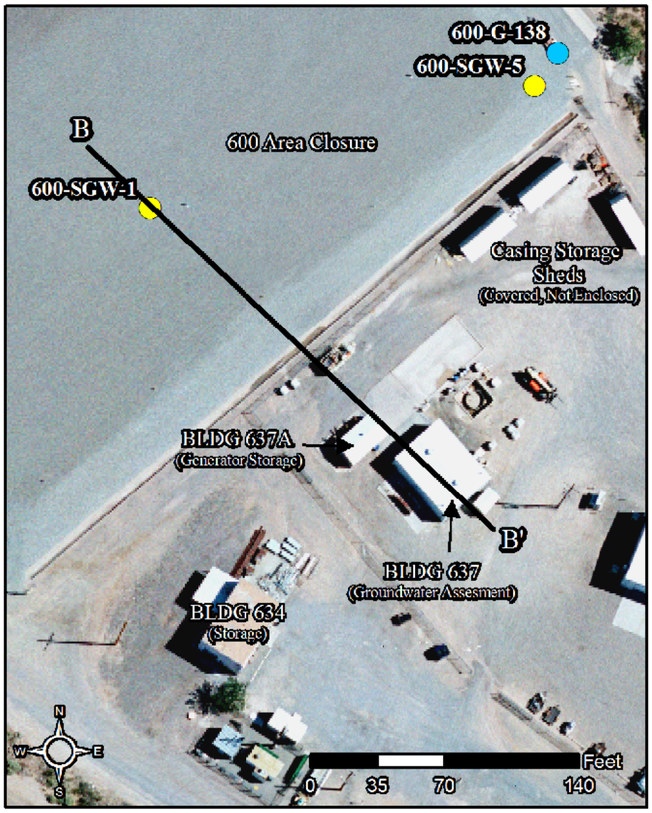
TD WELL =9' TD BOREHOLE =20'	MSVM WELL WITH VAPOR PORTS (DEPTH IN FEET)
84' 150' - 170' TD WELL =9' TD BOREHOLE =20'	MSVGM WELL WITH VAPOR PORTS AND GROUNDWATER MONITORING ZONES (DEPTH IN FEET)
🟨	QUATERNARY CAMP RICE ALLUVIUM
▨	PERMIAN HUECO LIMESTONE
▼	WATER TABLE (INFERRED FROM MONITORING WELL DATA)
—	CROSS-SECTION EXTENT (A-A')
🟥	HWMU
●	MULTIPORT GROUNDWATER WELL
★	MSVGM WELL
●	MSVM WELL

Figure 2.5 **Building 637 Site Conditions**

(SEE NEXT PAGE)

Building 637 Site Conditions





TD WELL =9' TD BOREHOLE =20'	MSVM WELL WITH VAPOR PORTS (DEPTH IN FEET)
🟨	QUATERNARY CAMP RICE ALLUVIUM
🟩	TERTIARY OREJON ANDESITE
▼	WATER TABLE (INFERRED FROM MONITORING WELL DATA)
▼	PERCHED WATER TABLE (INFERRED FROM WELL 600-G-138)
━	CROSS-SECTION EXTENT (B-B')
●	MSVM WELL
●	PERCHED GROUNDWATER WELL

Figure 2.6 **Site Conceptual Exposure Model**

(SEE NEXT PAGE)

Site Conceptual Exposure Model

Source of Contamination

Soil vapor contamination at the former Clean Room USTs location in the 200 Area and at the 600 Area Surface Impoundments

Release Mechanism

Infiltration of contaminants into groundwater and into vadose zone pore space as vapor-phase contamination in the vicinity of 200 Area Building 200 and 600 Area Building 637

Potential Exposure Pathway

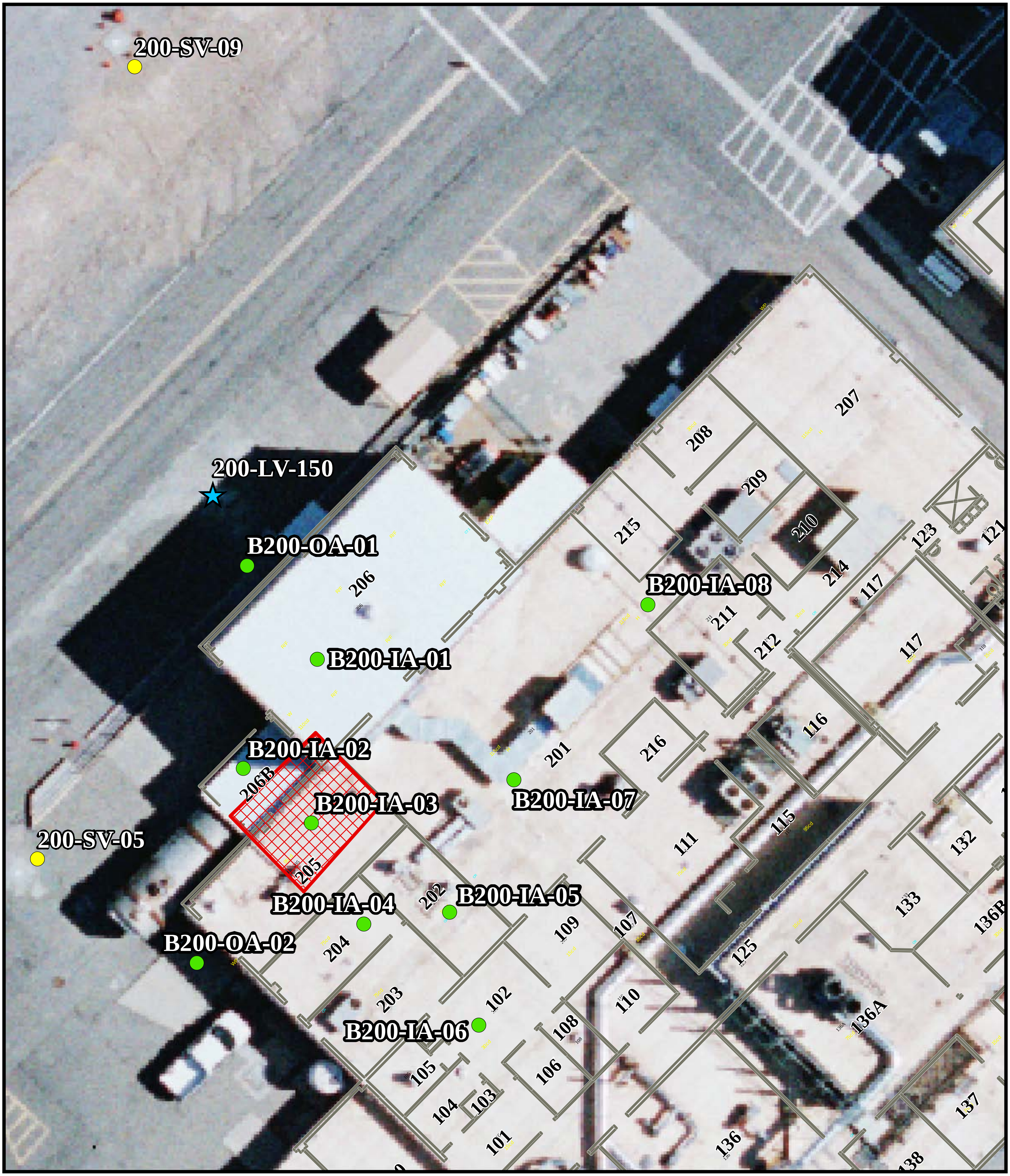
Inhalation of contaminated soil vapor migrating through building foundation or walls into indoor airspace

Industrial Potential Receptors

Industrial / occupational workers who utilize buildings in the adjacent areas in order to perform their daily duties

Figure 3.1 West Building 200 Soil Vapor and Air Sampling Locations

(SEE NEXT PAGE)



West Building 200 Soil Vapor and Air Sampling Locations

🟢 Air Sample Location

★ MSVGM Well Sample

▨ HWMU

🟡 MSVM Sample

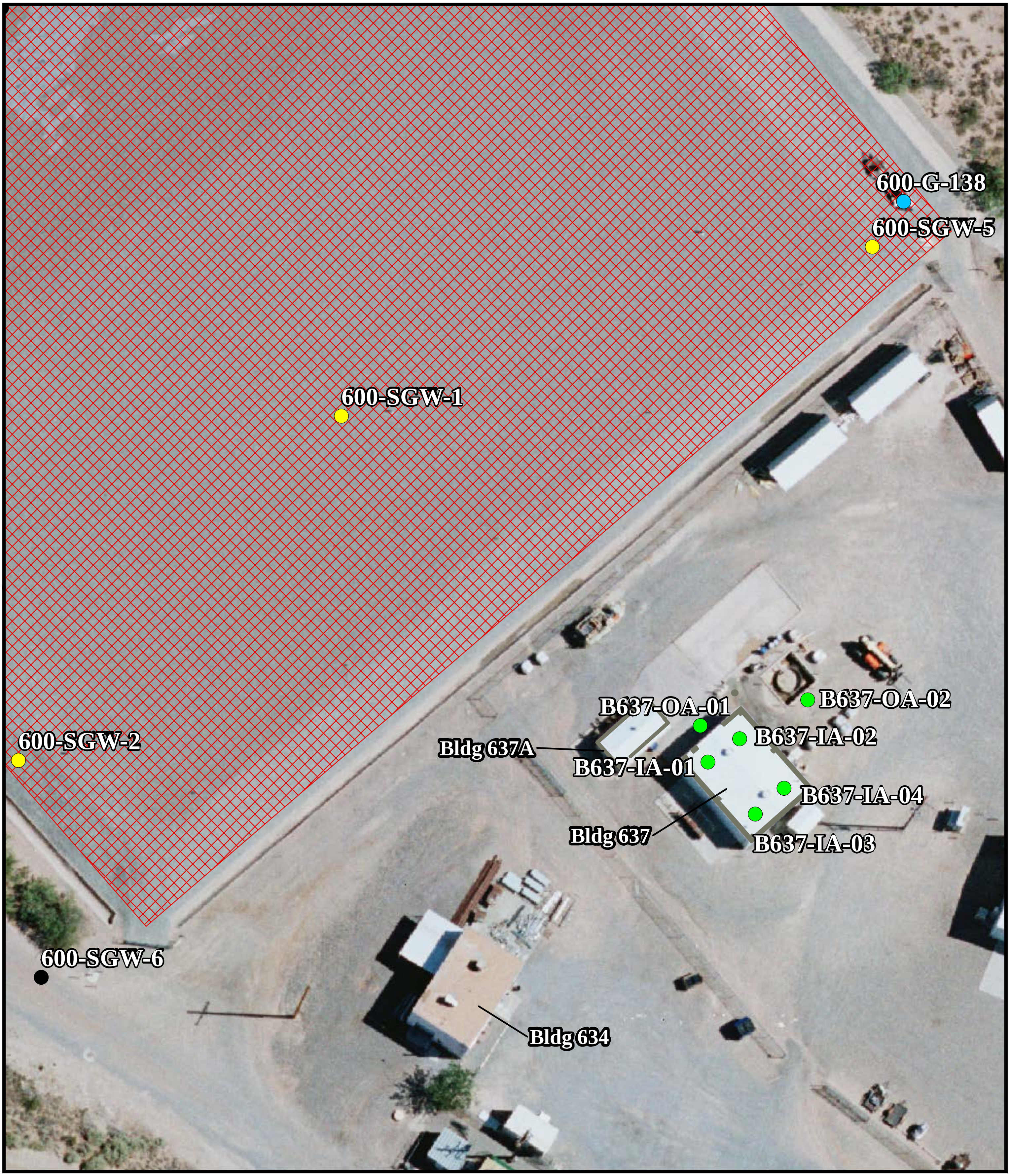
0 10 20 40 Feet

N S W E

June 2018

Figure 3.2 **Building 637 Soil Vapor and Air Sampling Locations**

(SEE NEXT PAGE)



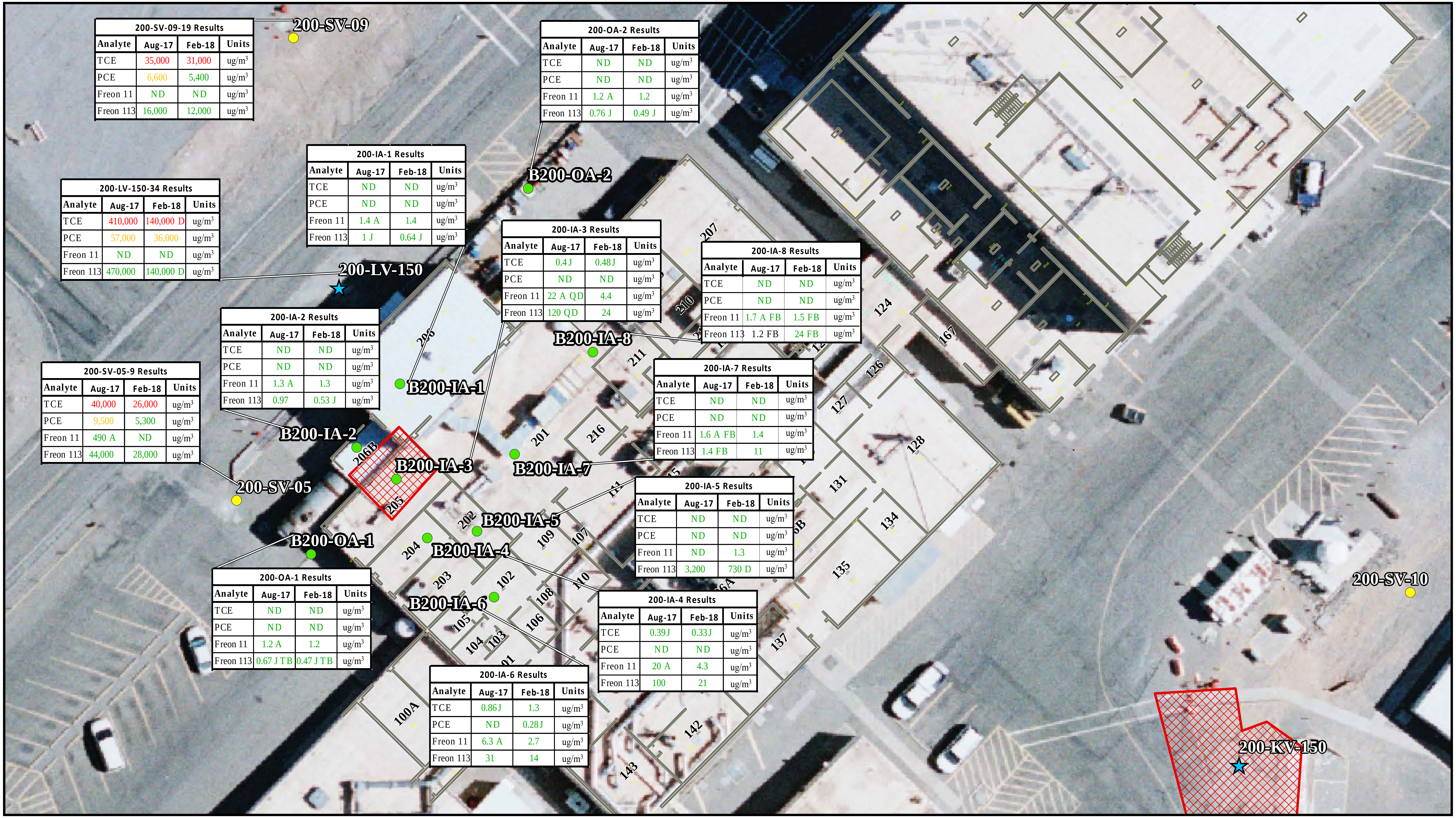
Building 637 Soil Vapor and Air Sampling Locations

●	Air Sample Location	●	MSVGM Well	▨	SWMU
●	MSVM Well Sample	●	Perched GW Monitoring Well		

June 2018

Figure 5.1 West Building 200 Soil Vapor and Air Sampling Locations and Analytical Results

(SEE NEXT PAGE)



200-SV-09-19 Results			
Analyte	Aug-17	Feb-18	Units
TCE	35,000	31,000	ug/m^3
PCE	6,600	5,400	ug/m^3
Freon 11	ND	ND	ug/m^3
Freon 113	16,000	12,000	ug/m^3

200-OA-2 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.2 A	1.2	ug/m^3
Freon 113	0.76 J	0.49 J	ug/m^3

200-IA-1 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.4 A	1.4	ug/m^3
Freon 113	1 J	0.64 J	ug/m^3

200-LV-150-34 Results			
Analyte	Aug-17	Feb-18	Units
TCE	410,000	140,000 D	ug/m^3
PCE	57,000	36,000	ug/m^3
Freon 11	ND	ND	ug/m^3
Freon 113	470,000	140,000 D	ug/m^3

200-IA-3 Results			
Analyte	Aug-17	Feb-18	Units
TCE	0.4 J	0.48 J	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	22 A QD	4.4	ug/m^3
Freon 113	120 QD	24	ug/m^3

200-IA-8 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.7 A FB	1.5 FB	ug/m^3
Freon 113	1.2 FB	24 FB	ug/m^3

200-IA-2 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.3 A	1.3	ug/m^3
Freon 113	0.97	0.53 J	ug/m^3

200-SV-05-9 Results			
Analyte	Aug-17	Feb-18	Units
TCE	40,000	26,000	ug/m^3
PCE	9,500	5,300	ug/m^3
Freon 11	490 A	ND	ug/m^3
Freon 113	44,000	28,000	ug/m^3

200-IA-7 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.6 A FB	1.4	ug/m^3
Freon 113	1.4 FB	11	ug/m^3

200-IA-5 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	ND	1.3	ug/m^3
Freon 113	3,200	730 D	ug/m^3

200-OA-1 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.2 A	1.2	ug/m^3
Freon 113	0.67 J TB	0.47 J TB	ug/m^3

200-IA-4 Results			
Analyte	Aug-17	Feb-18	Units
TCE	0.39 J	0.33 J	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	20 A	4.3	ug/m^3
Freon 113	100	21	ug/m^3

200-IA-6 Results			
Analyte	Aug-17	Feb-18	Units
TCE	0.86 J	1.3	ug/m^3
PCE	ND	0.28 J	ug/m^3
Freon 11	6.3 A	2.7	ug/m^3
Freon 113	31	14	ug/m^3

West Building 200 Soil Vapor and Air Sampling Locations and Analytical Results

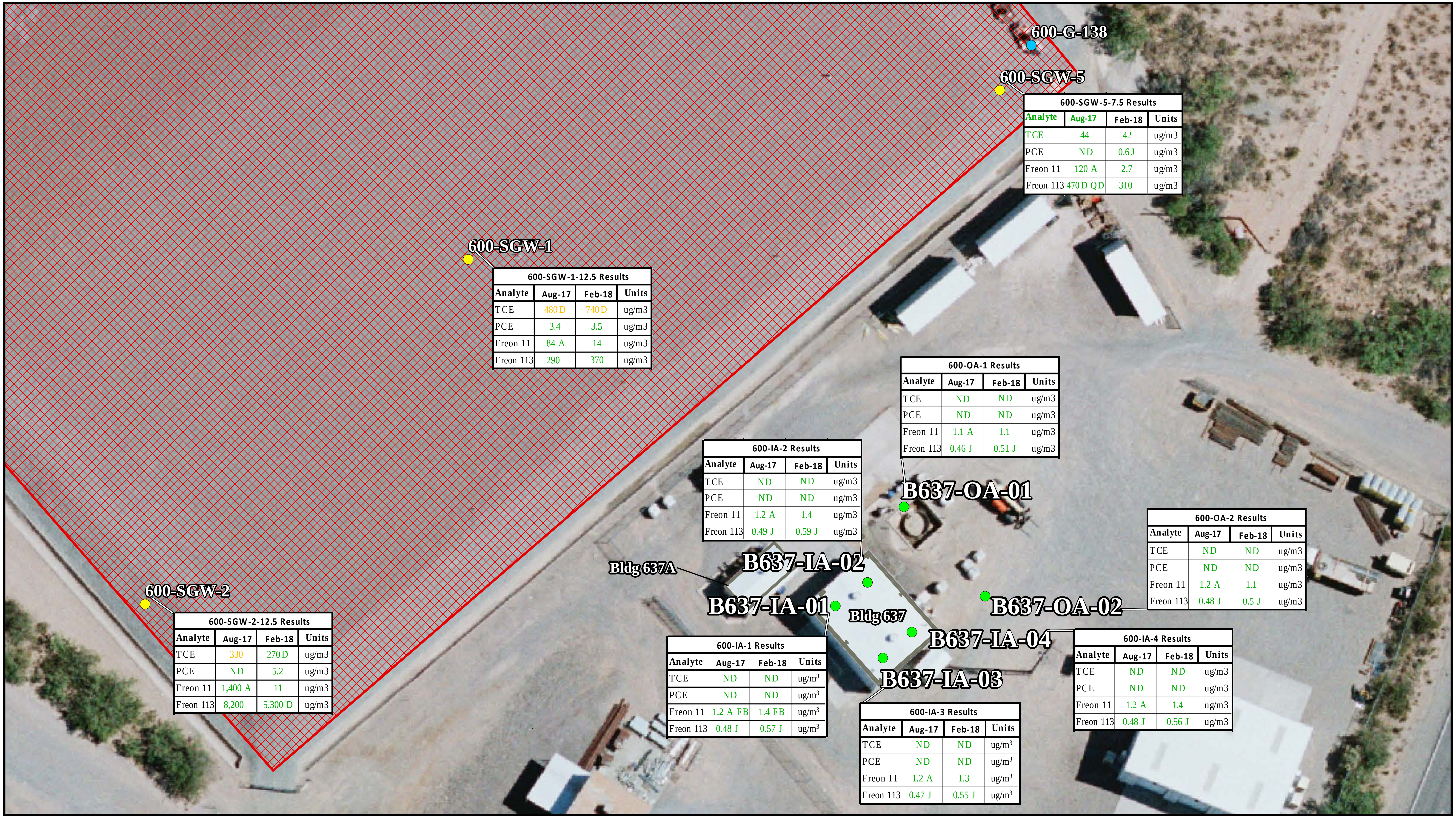
●	Air Sample Location
●	MSVM Sample
★	MSVGM Well Sample
▨	HWMU

Notes: 100 Concentration below NMED VISL and WSTF RBC 1,000 Concentration exceeds NMED VISL 10,000 Concentration exceeds NMED VISL and WSTF RBC
See Table 5.1 for Data Flags (A,D,FB,J,TB)

January 2020

Figure 5.2 Building 637 Soil Vapor and Air Sampling Locations and Analytical Results

(SEE NEXT PAGE)



600-SGW-5-7.5 Results

Analyte	Aug-17	Feb-18	Units
TCE	44	42	ug/m3
PCE	ND	0.6 J	ug/m3
Freon 11	120 A	2.7	ug/m3
Freon 113	470 D QD	310	ug/m3

600-SGW-1-12.5 Results

Analyte	Aug-17	Feb-18	Units
TCE	480 D	740 D	ug/m3
PCE	3.4	3.5	ug/m3
Freon 11	84 A	14	ug/m3
Freon 113	290	370	ug/m3

600-OA-1 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m3
PCE	ND	ND	ug/m3
Freon 11	1.1 A	1.1	ug/m3
Freon 113	0.46 J	0.51 J	ug/m3

600-IA-2 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m3
PCE	ND	ND	ug/m3
Freon 11	1.2 A	1.4	ug/m3
Freon 113	0.49 J	0.59 J	ug/m3

600-OA-2 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m3
PCE	ND	ND	ug/m3
Freon 11	1.2 A	1.1	ug/m3
Freon 113	0.48 J	0.5 J	ug/m3

600-SGW-2-12.5 Results

Analyte	Aug-17	Feb-18	Units
TCE	330	270 D	ug/m3
PCE	ND	5.2	ug/m3
Freon 11	1,400 A	11	ug/m3
Freon 113	8,200	5,300 D	ug/m3

600-IA-1 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.2 A FB	1.4 FB	ug/m^3
Freon 113	0.48 J	0.57 J	ug/m^3

600-IA-4 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m3
PCE	ND	ND	ug/m3
Freon 11	1.2 A	1.4	ug/m3
Freon 113	0.48 J	0.56 J	ug/m3

600-IA-3 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.2 A	1.3	ug/m^3
Freon 113	0.47 J	0.55 J	ug/m^3

Building 637 Soil Vapor and Air Sampling Locations and Analytical Results

● Air Sample Location
● MSVM Well Sample
● Perched GW Monitoring Well
▨ HWMU

0 25 50 100 Feet

N
W E
S

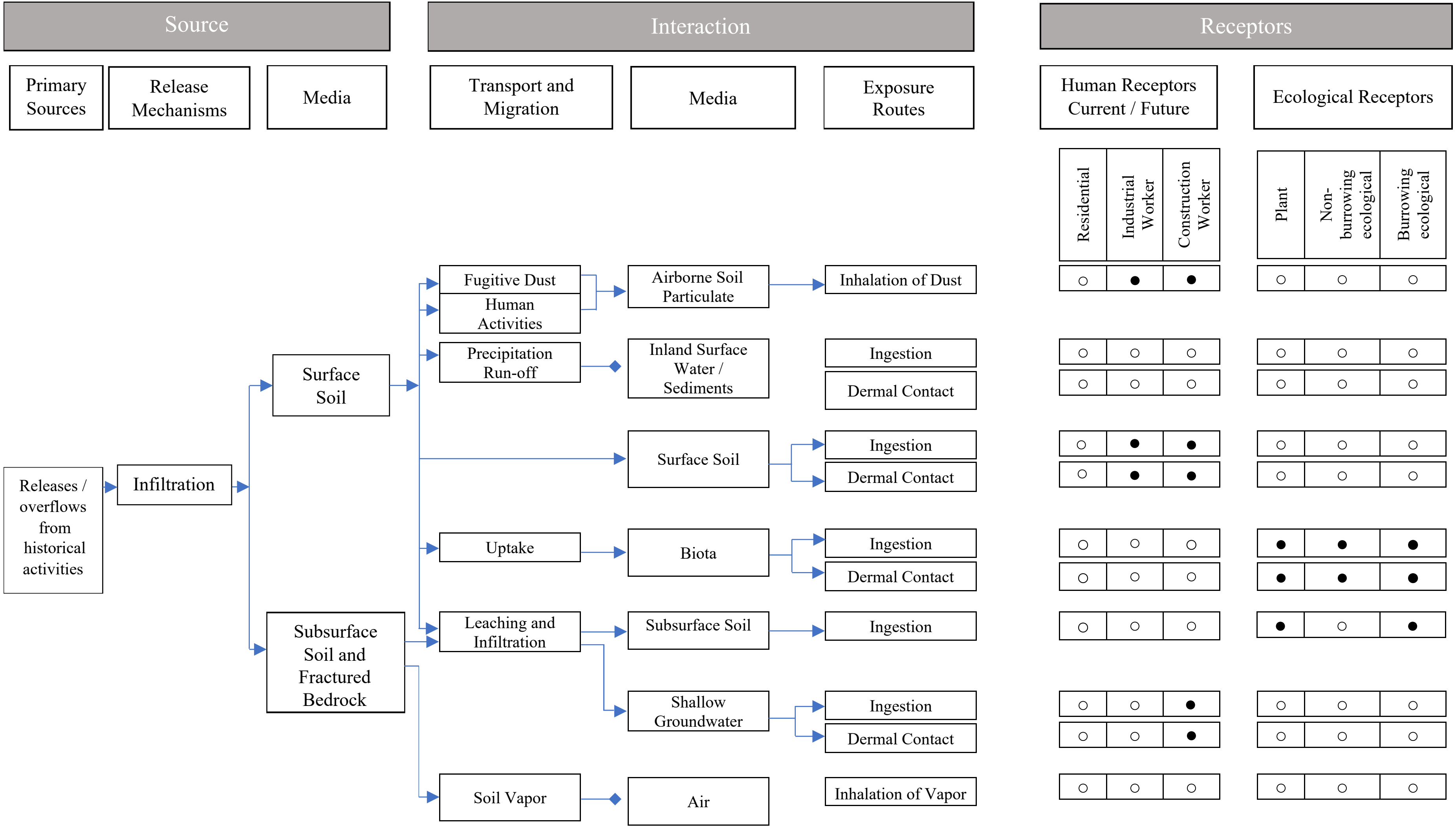
Notes: 100 Concentration below NMED VISL and WSTF RBC 1,000 Concentration exceeds NMED VISL 10,000 Concentration exceeds NMED VISL270 D and WSTF RBC
See Table 5.1 for Data Flags (A,D,FB,J)

June 2018

Figure 6.1 **Revised Site Conceptual Exposure Model**

(SEE NEXT PAGE)

Figure 2.2 Site Conceptual Exposure Model 200 and 600 Areas Vapor Intrusion



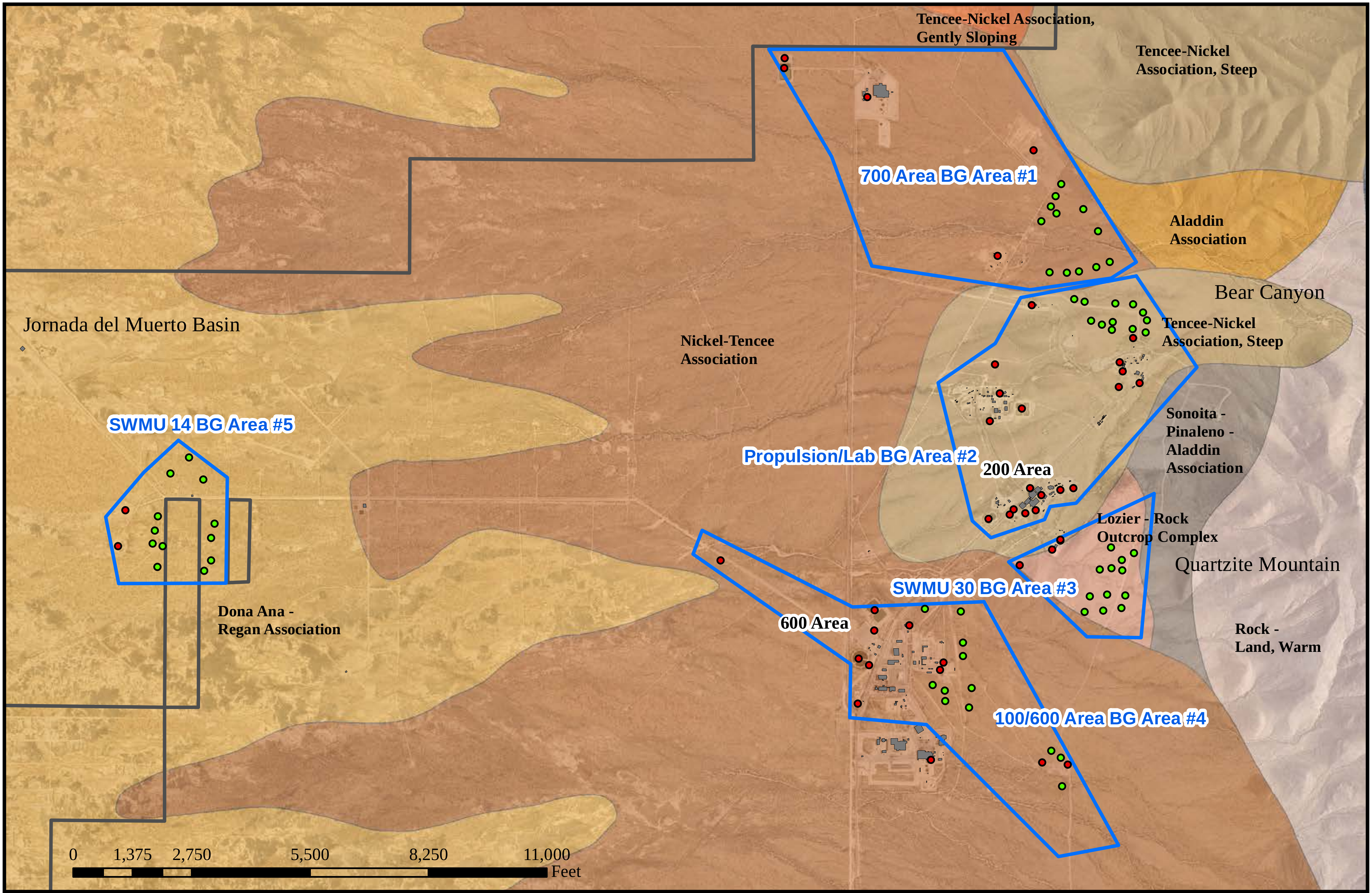
Media	Exposure Routes	Human Receptors Current / Future			Ecological Receptors		
		Residential	Industrial Worker	Construction Worker	Plant	Non-burrowing ecological	Burrowing ecological
Airborne Soil Particulate	Inhalation of Dust	○	●	●	○	○	○
Inland Surface Water / Sediments	Ingestion	○	○	○	○	○	○
	Dermal Contact	○	○	○	○	○	○
Surface Soil	Ingestion	○	●	●	○	○	○
	Dermal Contact	○	●	●	○	○	○
Biota	Ingestion	○	○	○	●	●	●
	Dermal Contact	○	○	○	●	●	●
Subsurface Soil	Ingestion	○	○	○	●	○	●
Shallow Groundwater	Ingestion	○	○	●	○	○	○
	Dermal Contact	○	○	●	○	○	○
Air	Inhalation of Vapor	○	○	○	○	○	○

LEGEND

———◆	Flow-chart stops here; incomplete pathway
———▶	Flowchart continues; potentially complete pathway
●	Potential pathway
○	Incomplete pathway

Figure 6.2 **WSTF Background Soil Area Map**

(SEE NEXT PAGE)



WSTF Soil Background Areas

January 2020

Figure 6.3 **200 Area Soil Boring Locations**

(SEE NEXT PAGE)

200 Area Soil, Soil Vapor, and Groundwater Monitoring Locations

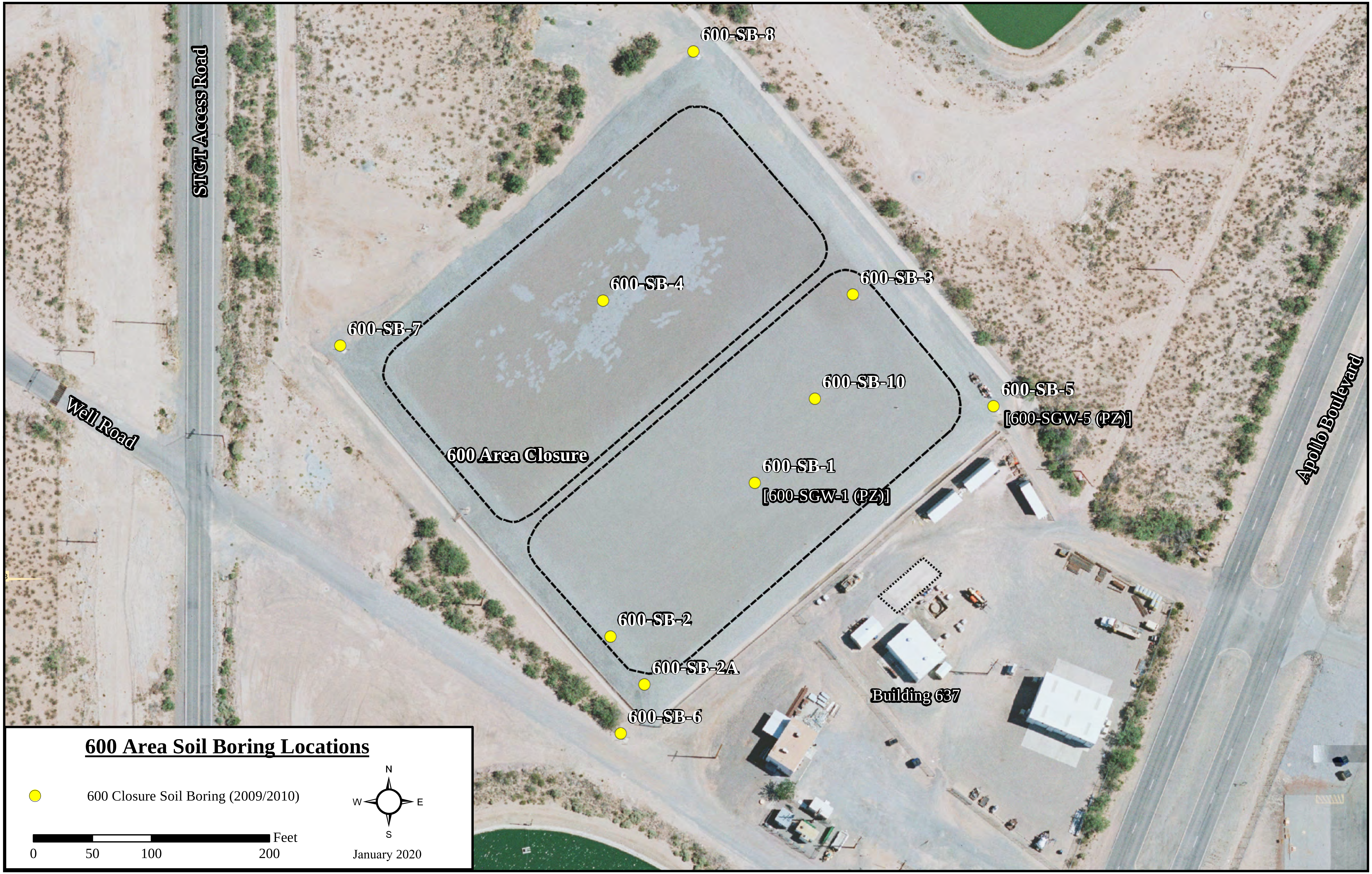
★ MSVM Boring/Well

■ MSVGM Boring/Well

April 2023

Figure 6.4 **600 Area Soil Boring Locations**

(SEE NEXT PAGE)



600 Area Soil Boring Locations

● 600 Closure Soil Boring (2009/2010)

January 2020

Tables

Table 1.1 Comparison of Soil Vapor and Air Concentration Guidance Levels

Chemical	NMED VISLs[1]		WSTF RBCs[2,3]	
	Industrial/ Occupational Indoor Air (µg/m^3)		Commercial Worker @ 5-ft bgs (µg/m^3)	Commercial Worker @ 10-ft bgs (µg/m^3)
TCE	9.83	328	18,000[2] *(8,800[3])*	34,000[2] *(14,000[3])*
PCE	197	6,550	460,000[2] *(210,000[3])*	910,000[2] *(350,000)*
Freon 11	3,440	115,000	6,400,000[2] *(130,000,000[3])*	13,000,000[2] *(210,000,000[3])*
Freon 113	147,000	4,920,000	440,000,000[2] *(180,000,000[3])*	900,000,000[2] *(310,000,000[3])*

Notes:

[1] = NMED, 2022c.

[2] = NASA, 2019a (NASA WSTF NMED-approved Soil Vapor RBCs for 2018)

[3] = NASA, 2017a (NASA WSTF NMED-approved Soil Vapor RBCs for 2017).

Table 3.1 Soil Vapor Monitoring Well Sampling Locations

Well ID	Location Description	Well Type	Soil Vapor Sample Port Locations (ft bgs)	Groundwater Sample Location (ft bgs)	Horizontal Distance to Building (ft)	Concentrations for Primary Contaminants from Oct-14 ($\mu g/m^3$)
200 Area in the vicinity of the Clean Room Tank HWMU Located Below the East Side of Building 200						
200-SV-05	West side of B. 200 southwest of the former Clean Room Tank location	MSVM	9	---	28	Freon 11 = 160 (J) Freon 113 = 54,000 TCE = 47,000 PCE = 8,300 (J)
200-LV-150	Immediately west and adjacent to B. 200 at the former Clean Room Tank location	MSVGM	34, 64, 84	150 - 170	18	Freon 11 = ND Freon 113 = 6,600,000 TCE = 380,000 PCE = 42,000
200-SV-09	Across Apollo Boulevard to the west of B. 200 at location for former Clean Room Discharge pipe	MSVM	19	---	84	Freon 11 = ND Freon 113 = 14,000 TCE = 23.000 PCE = 3,700
600 Area in the Vicinity of the Southeast Side of the 600 Area Closure Near Building 637						
600-SGW-1	Northwest of B. 637 within southeast cell of former 600 Area surface impoundments	MSVM	12.5, 57.5, 117.5	---	184	Freon 11 = ND Freon 113 = 43,000 TCE = 3,800 PCE = ND
600-SGW-2	West of B. 637 along southwest side of southeast cell of former 600 Area surface impoundments	MSVM	12.5, 47.5, 107.5, 150	---	260	Freon 11 = ND Freon 113 = 200,000 TCE = 10,300 PCE = ND
600-SGW-5	North of B. 637 at east corner of southeast cell of former 600 Area Surface Impoundments	MSVM	7.5, 52.5, 102.5, 137.5	---	181	Freon 11 = 1,200 (J) Freon 113 = 280,000 TCE = 15,000 PCE = 1.4

Notes:

(J) = Estimated value is less than the quantitation limit, but greater than or equal to the detection limit.

MSVM = Multiport Soil Vapor Monitoring, MSVGM = Multiport Soil Vapor and Groundwater Monitoring

- Two semi-annual sampling rounds are proposed to provide seasonal samples. Indoor and outdoor air pressure will be monitored during sampling.
- Approximately seven vadose zone samples (one duplicate) per semi-annual sampling event and 14 samples total.

Table 3.2 Indoor and Outdoor Air Sampling Locations

Indoor Air (IA)/ Outdoor Air (OA) Sample ID	Horizontal Distance from Primary Vadose Zone Vapor Source* (ft)	Sample Type and Frequency	Indoor/ Outdoor Air Sample Collection Location	Sample Collection Strategies	Sample Container and Analysis	Sample Notes
Building 200 (West Side 200 Area) in the Vicinity of the Clean Room Tank HWMU						
B200-IA-01	13	Indoor/outdoor air grab sample. Two semi-annual sampling events in the summer and winter seasons.	3 to 5 ft above ground surface in typical breathing zone	Indoor samples will be collected with outer wall windows and doors closed to minimize any contribution from outside air and will be distributed through rooms as applicable. Outdoor air samples from a representative upwind location away from any wind obstructions.	3-Liter passivated stainless steel canister, analysis by TO-15	Flow controller over 8-hour period
B200-IA-02	4					
B200-IA-03	0					
B200-IA-04	12					
B200-IA-05	22					
B200-IA-06	40					
B200-IA-07	24					
B200-IA-08	60					
B200-OA-01	33					
B200-OA-02	23					
Building 637 in the Vicinity of the Southeast Side of the 600 Area Closure						
B637-IA-01	92	Indoor/outdoor air grab sample. Two semi-annual sampling events in the summer and winter seasons.	3 to 5 ft above ground surface in typical breathing zone	Indoor samples will be collected with outer wall windows and doors closed to minimize any contribution from outside air and will be distributed through rooms as applicable. Outdoor air samples from a representative upwind location away from any wind obstructions.	3-Liter passivated stainless steel canister, analysis by TO-15	Flow controller over 8-hour period
B637-IA-02	93					
B637-IA-03	118					
B637-IA-04	118					
B637-OA-01	100					
B637-OA-02	100					

Notes:

* = Primary elevated vapor source in the 200 Area is the footprint of the former Clean Room Tank excavation (HWMU). Primary elevated vapor source in the 600 Area is MSVM well 600-SGW-05.

- Two semi-annual sampling rounds are proposed to provide seasonal samples. Indoor and outdoor air pressure will be monitored during sampling.
- Approximately 18 indoor and outdoor air samples (two duplicates) per semi-annual sampling event and 36 samples total.

Table 4.1 Product Inventory Form for 200 Area Building 200 on 6/21/2017

Room Location/ (Sample Location)	Product Description	Size (units)	Condition	Chemical Ingredients	MSA Altair 5X PID Reading (ppm)	Photo Y/N
Photo Lab Rm 102 (B200-IA-06)	Glue Paper		In Use	Heat-activated Adhesive	0	Y
	Flammables Cabinet	~3 ft^3	In Use	Various chemicals	1	
	Fire Extinguisher		Unopened	Possible fluorocarbon propelling agent	0	
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
	Hand Sanitizer	2 liters	In Use	Ethyl Alcohol	0	
Photo Lab Room 203	Fire Extinguisher		Ready to Use	Possible fluorocarbon propelling agent	0	Y
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
	Gator Board		In Use	Adhesive Backing	0	
Photo Lab Room 204, Storage Shelves (B200-IA-04)	Adhesive Tape	50 ft roll	Open & Unopened	Adhesive Backing	0	Y
	Dry Erase Markers		Unopened	Solvent (ethanol ?)	0	
	Kodak Lens Cleaner		Unopened		0	
Room 202 (B200-IA-05)	Sure Coat	5 gal buckets	Unopened & Used	Epoxy	0	Y
	Freon	Steel canisters	Unopened	Freon	0	
Room 201	FilterMate Vapor Extractor	Machine	In Use	?	0	Y
	Hydraulic Drill Press	Machine	In Use	Lubes/Oils	0	
Room 111	Cleaners	Open Vats	In Use	Oakite, oxidizers, sulfuric acids	0	Y
Room 201 (B200-IA-08) (B200-IA-07)	drain to sanitary sewer (outside room 111)	Utility Sink	In Use	?	0	Y
	Flammable Cabinets #2 & #3	1 large, 1 small	In Use	Alcohols, chlorinated solvents, Rustoleum spray paints, WD-40	0	
	Flammable Cabinet #1	Small	In Use	Paints, solvents, lubes	0	

Room Location/ (Sample Location)	Product Description	Size (units)	Condition	Chemical Ingredients	MSA Altair 5X PID Reading (ppm)	Photo Y/N
Room 216 Assembly Room	Krytox		In Use	?	0	Y
Room 206 (CSS HighBay) (B200-IA-01)	Several products		In Use	Oakite, IPA, Acids, Satellite Accumulation Area containing chemical ingredients identified for other rooms.	0	Y
Room 206B Workbench Area (B200-IA-02)	Marker Pens Oils used for assembly	Small	In Use	?	0	Y
Room 205 Utility Room (B200-IA-03)	Active Drain to Sewer Bags of water softening pellets		In Use	Citric acid anhydrous	0	Y
Room 204	Various		In Use	Full of petrochemicals, acids, corrosives, vacuum pump oils.	0	Y

Table 4.2 Product Inventory form for 200 Area Building 637 on 6/26/2017

Room Location/ (Sample Location)	Product Description	Size (units)	Condition	Chemical Ingredients	MSA Altair 5X PID Reading (ppm)	Photo Y/N
Building 637 (B637-IA-1 B637-IA-2 B637-IA-3 B637-IA-4)	Sample Bottles (with Preservative)	40 mL – 1 L	Unopened	Dilute hydrochloric acid, sulfuric acid, sodium hydroxide	0	Y
	Fire Extinguisher	0.5 cu ft	Unopened	Possible fluorocarbon propelling agent	0	
	Hand Sanitizer	1 L	In Use	Ethyl Alcohol	0	
Building T-637A	Flammables Cabinet	0.25 L – 1 L	In Use	Silicone spray, isopropyl alcohol, gasoline, Rustoleum products	0	Y
	Corrosives Cabinet	14 oz	In Use	Sodium hydroxide	0	
	Generators	8 cu ft	In Use	Gasoline and oil	0	
	Steam Cleaners	8 cu ft	In Use	Gasoline and oil	0	
	Oils/Lubricants	1 L	Unopened	Various motor oils and lubricants (WD40)	0	
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
Building T-637B	Groundwater Sampling Equipment Electronics	50 ft – 500 ft reels	In Use		0	Y
Compressed Nitrogen Storage Area Adjacent to B637	Compressed Gas Cylinders	1.5 cu ft	In Use	Nitrogen	0	N

Table 4.3 Summary of 200 Area Building 200 and Vicinity Soil Vapor, Outdoor Air, and Indoor Air Analytical Results

COPC	Sample Type	8/27/17 Sample Event (µg/m^{3})	Sample Location	Method Detection Limit (µg/m^{3})	2/25/18 Sample Event (µg/m^{3})	Sample Location	Method Detection Limit (µg/m^{3})	NMED VISL or RSL* Residential Soil Vapor nc / c (µg/m^{3})^{1}	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^{3})^{1}	NMED VISL or RSL* Industrial Soil Vapor nc / c (µg/m^{3})^{1}	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^{3})^{1}	WSTF RBC Residential ft bgs nc / c (µg/m^{3})^{2}	WSTF RBC Industrial ft bgs nc / c (µg/m^{3})^{2}	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
TCE	Soil Vapor (MSVM Well) Maximum	410,000	200-LV-150-34	920	140,000 (D)	200-LV-150-34	430	69.5 / 147	NA	328 / 1,120	NA	4,900 / 11,000	84,000 / 280,000	Yes: Res risk VISLs (2.79E-02) Res risk RBCs (3.73E-04) Res haz VISLs (5.90E+03) Res haz RBCs (8.37E+01) Indus risk VISLs (3.66E-03) Indus haz VISLs (1.25E+03) Indus haz RBCs (4.88E+00)
	B200 Outdoor Air Maximum	<0.26	200-OA-1	0.26	<0.21	200-OA-1	0.21	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	0.86	200-IA-6	0.27	1.3	200-IA-6	0.20	NA	2.09 / 4.42	NA	9.83 / 33.6	NA	NA	No
PCE	Soil Vapor (MSVM Well) Maximum	57,000	200-LV-150-34	920	36,000	200-LV-150-34	210	1,390 / 3,600	NA	6,550 / 17,600	NA	130,000 / 340,000	2,300,000 / 6,000,000	Yes: Res risk VISLs (1.58E-04) Res haz VISLs (4.10E+01) Indus risk VISLs (3.24E-05) Indus haz VISLs (8.70E+00)
	B200 Outdoor Air Maximum	<0.26	200-OA-1	0.26	<0.21	200-OA-1	0.21	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	ND	200-IA-6	0.27	0.28 (J)	200-IA-6	0.20	NA	41.7 / 108	NA	197 / 529	NA	NA	No
Freon 11	Soil Vapor (MSVM Well) Maximum	490 (A)	200-SV-05-9	94	<52	200-SV-05-9	52	24,300 / ---	NA	115,000 / ---	NA	530,000 / ---	6,400,000 / ---	No
	B200 Outdoor Air Maximum	1.2 (A)	200-OA-1	0.32	1.2	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	22 (A, QD)	200-IA-3	0.32	4.4	200-IA-3	0.26	NA	730 / ---	NA	3,440 / ---	NA	NA	No
Freon 113	Soil Vapor (MSVM Well) Maximum	470,000	200-LV-150-34	1,100	140,000 (D)	200-LV-150-34	520	1,040,000 / ---	NA	4,920,000 / ---	NA	120,000,000 / ---	2,300,000,000 / ---	No
	B200 Outdoor Air Maximum	0.76 (J)	200-OA-2	0.29	0.49 (J)	200-OA-2	0.26	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	3,200	200-IA-5	6.6	730 (D)	200-IA-5	2.7	NA	31,300 / ---	NA	147,000 / ---	NA	NA	No
2-Butanone	Soil Vapor (MSVM Well) Maximum	<1,400	200-LV-150-34	1,400	<320	200-LV-150-34	320	174,000 / ---	NA	819,000 / ---	NA	9,600,000 / ---	160,000,000 / ---	No
	B200 Outdoor Air Maximum	3 (J, TB)	200-OA-1	0.39	0.42	200-OA-2	0.32	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	8.7	200-IA-3	0.30	2 (J)	200-IA-2	0.36	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No
1,1,1-trichloroethane	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	174,000 / ---	NA	819,000 / ---	NA	13,000,000 / ---	220,000,000 / ---	No
	B200 Outdoor Air Maximum	<0.32	200-OA-1	0.32	<0.25	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RSL* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RSL* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential ft bgs nc / c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc / c (µg/m^3)[2]	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
1,1,1-trichloroethane	B200 Indoor Air Maximum	<0.38	200-IA-1	0.38	<0.27	200-IA-1	0.27	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No
Chloroform	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	3,410 / 40.7	NA	16,100/199	NA	210,000 / 2,500	3,700,000 / 46,000	No
	B200 Outdoor Air Maximum	0.35 (J)	200-OA-1	0.32	ND	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	0.33 (J)	200-IA-3	0.25	0.39 (J)	200-IA-3	0.26	NA	102 / 1.22	NA	5.98 / 5.98	NA	NA	No
Benzene	Soil Vapor (MSVM Well) Maximum	80 (J)	200-SV-09-19	67	<52	200-SV-09-19	52	1,040 / 120	NA	4,920 / 588	NA	29,000 / 3,400	400,000 / 49,000	No
	B200 Outdoor Air Maximum	<0.27	200-OA-2	0.27	0.3 (J)	200-OA-2	0.24	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	1.1	200-IA-4	0.29	1.6	200-IA-8	0.27	NA	31.3 / 3.60	NA	17.6 / 17.6	NA	NA	No
Ethylbenzene	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<240	200-LV-150-34	240	34,800 / 374	NA	164,000 / 1,840	NA	---	---	No
	B200 Outdoor Air Maximum	<0.30	200-OA-1	0.30	<0.24	200-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	0.47 (J)	200-IA-3	0.23	<0.30	200-IA-3	0.30	NA	1,040 / 11.2	NA	55.1 / 55.1	NA	NA	No
Toluene	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	174,000 / ---	NA	819,000 / ---	NA	---	---	No
	B200 Outdoor Air Maximum	0.39 (J, TB)	200-OA-1	0.32	<0.25	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	7.2 (J)	200-IA-5	6.6	1.1	200-IA-3	0.26	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No
Xylenes	Soil Vapor (MSVM Well) Maximum	<2,000	200-LV-150-34	2,000	<460	200-LV-150-34	460	3,480 / ---	NA	16,400 / ---	NA	---	---	No
	B200 Outdoor Air Maximum	<0.56	200-OA-1	0.56	<0.44	200-OA-1	0.44	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.5	200-IA-3	0.44	<0.47	200-IA-3	0.47	NA	104 / ---	NA	492 / ---	NA	NA	No
Acetone	Soil Vapor (MSVM Well) Maximum	<5,100	200-LV-150-34	5,100	<1,200	200-LV-150-34	1,200	1,080,000 / ---	NA	5,080,000 / ---	NA	53,000,000 / ---	860,000,000 / ---	No
	B200 Outdoor Air Maximum	13 (TB)	200-OA-1	1.4	2.4	200-OA-2	1.2	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	29 (QD)	200-IA-3	1.4	8.7	200-IA-2	1.3	NA	32,300 / ---	NA	152,000 / ---	NA	NA	No
2-propanol	Soil Vapor (MSVM Well) Maximum	<2,800	200-LV-150-34	2,800	<640	200-LV-150-34	640	210* / ---	NA	880* / ---	NA	350,000 / ---	5,600,000 / ---	No
	B200 Outdoor Air Maximum	4.3	200-OA-2	0.71	<0.66	200-OA-2	0.66	NA	NA	NA	NA	NA	NA	NA

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RSL* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RSL* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential ft bgs nc / c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc / c (µg/m^3)[2]	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
2-propanol	B200 Indoor Air Maximum	68 (QD)	200-IA-3	0.61	4.3	200-IA-1	0.67	NA	210* / ---	NA	880* / ---	NA	NA	No
1,1-Dichloroethene	Soil Vapor (MSVM Well) Maximum	12,000	200-LV-150-34	1,100	7,500	200-LV-150-34	260	6,950 / ---	NA	32,800 / ---	NA	400,000 / ---	6,700,000 / ---	Yes: Res haz VISLs (1.73E+00)
	B.200 Outdoor Air Maximum	<0.32	200-OA-1	0.32	<0.25	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	<0.38	200-IA-1	0.38	<0.27	200-IA-1	0.27	NA	209 / ---	NA	983 / ---	NA	NA	No
1,2,4-Trimethylbenzene[3]	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	63 / ---	NA	260 / ---	NA	---	---	No
	B.200 Outdoor Air Maximum	<0.28	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.92	200-IA-3	0.22	ND	200-IA-1	0.24	NA	63 / ---	NA	260 / ---	NA	NA	No
2,2,4-Trimethylpentane	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	---	NA	---	NA	---	---	No
	B.200 Outdoor Air Maximum	<0.28	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.39 (J)	200-IA-3	0.28	<0.24	200-IA-1	0.24	NA	---	NA	---	NA	NA	No
2-Hexanone	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<240	200-LV-150-34	240	31* / ---	NA	130*/ ---	NA	7,1000 / ---	1,200,000 / ---	No
	B.200 Outdoor Air Maximum	0.62 (J)	200-OA-1	0.30	<0.24	200-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.1	200-IA-3	0.30	0.39 (J)	200-IA-2	0.28	NA	31* / ---	NA	130* / ---	NA	NA	No
4-Methyl-2-pentanone (methyl isobutyl ketone)	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<240	200-LV-150-34	240	104,000 / ---	NA	492,000 / ---	NA	7,200,000 / ---	120,000,000 / ---	No
	B.200 Outdoor Air Maximum	0.42	200-OA-1	0.30	<0.24	200-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	24	200-IA-3	0.23	<0.25	200-IA-1	0.25	NA	3,130 / ---	NA	14,700 / ---	NA	NA	No
Carbon Disulfide	Soil Vapor (MSVM Well) Maximum	64 (J)	200-SV-09-19	63	<230	200-LV-150-34	230	24,300 / ---	NA	115,000 / ---	NA	610,000 / --- 1,200,000 / ---	8,100,000 / ---19,000,000 / ---	No
	B.200 Outdoor Air Maximum	0.73 (J A TB)	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.47 (J A)	200-IA-1	0.33	<0.24	200-IA-1	0.24	NA	730 / ---	NA	3,440 / ---	NA	NA	No
Carbon Tetrachloride	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	3,480 / 156	NA	16,400 / 765	NA	---	---	No
	B.200 Outdoor Air Maximum	0.41	200-OA-2	0.25	0.4	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RSL* Residential Soil Vapor nc / c (µg/m^3)^1	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)^1	NMED VISL or RSL* Industrial Soil Vapor nc / c (µg/m^3)^1	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)^1	WSTF RBC Residential ft bgs nc / c (µg/m^3)^2	WSTF RBC Industrial ft bgs nc / c (µg/m^3)^2	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
	B.200 Indoor Air Maximum	0.45	200-IA-1	0.33	0.41	200-IA-3	0.23	NA	104 / 4.68	NA	22.9 / 22.9	NA	NA	No
Chloromethane	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	3,130 / 520	NA	14,700 / 2,550	NA	140,000 / 22,000	2,100,000 / 370,000	No
	B.200 Outdoor Air Maximum	0.42 (J TB)	200-OA-1	0.28	0.57 (J)	200-OA-2	0.23	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.37 (J)	200-IA-6	0.29	0.6 (J)	200-IA-3	0.23	NA	93.9 / 15.6	NA	76.5 / 76.5	NA	NA	No
Ethanol	Soil Vapor (MSVM Well) Maximum	<5,300	200-LV-150-34	5,300	<1,200	200-LV-150-34	1,200	---	NA	---	NA	26,000,000 / ---	400,000,000 / ---	No
	B.200 Outdoor Air Maximum	56	200-OA-1	1.5	<1.2	200-OA-1	1.2	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	23	200-IA-3	1.2	11	200-IA-1	1.3	NA	---	NA	---	NA	NA	No
Freon 12 (Dichloro-difluoro-methane)	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	1,200	200-LV-150-34	260	3,480 / ---	NA	16,400 / ---	NA	220,000 / ---	3,800,000 / ---	No
	B.200 Outdoor Air Maximum	2.3 (TB)	200-OA-1	0.32	2.4	200-OA-1	0.25 (TB)	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	2.7	200-IA-4	0.31	2.7	200-IA-3	0.26	NA	104 / ---	NA	492 / ---	NA	NA	No
Freon 21 (Dichloro-fluoromethane)	Soil Vapor (MSVM Well) Maximum	<1,600	200-LV-150-34	1,600	<370	200-LV-150-34	370	---	NA	---	NA	220,000 / ---	4,300,000 / --	No
	B.200 Outdoor Air Maximum	<0.45	200-OA-1	0.45	<0.35	200-OA-1	0.35	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	3.5	200-IA-3	0.45	<0.38	200-IA-1	0.38	NA	---	NA	---	NA	NA	No
Heptane	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	420* / ---	NA	1,800* / ---	NA	1,000,000 / ---	18,000,000 / ---	No
	B.200 Outdoor Air Maximum	<0.32	200-OA-1	0.32	<0.25	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.33 (J)	200-IA-3	0.25	<0.27	200-IA-1	0.27	NA	420* / ---	NA	1,800* / ---	NA	NA	No
Hexane	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	24,300 / ---	NA	115,000 / ---	NA	1,600,000 / ---	28,000,000 / ---	No
	B.200 Outdoor Air Maximum	0.35 (J TB)	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.2	200-IA-3	0.22	1.1	200-IA-3	0.25	NA	730 / ---	NA	3,440 / ---	NA	NA	No
Methylene Chloride	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	20,900 / 33,800	NA	98,300 / 459,000	NA	1,100,000 / 1,700,000	18,000,000 / 79,000,000	No
	B.200 Outdoor Air Maximum	<0.32	200-OA-1	0.32	0.42 (J)	200-OA-2	0.26	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.6	200-IA-4	0.31	0.43 (J)	200-IA-2	0.29	NA	626 / 1,010	NA	2,950 / 13,800	NA	NA	No

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RSL* Residential Soil Vapor nc / c (µg/m^3)^1	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)^1	NMED VISL or RSL* Industrial Soil Vapor nc / c (µg/m^3)^1	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)^1	WSTF RBC Residential ft bgs nc / c (µg/m^3)^2	WSTF RBC Industrial ft bgs nc / c (µg/m^3)^2	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
Styrene	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	34,800 / ---	NA	164,000 / ---	NA	---	---	No
	B.200 Outdoor Air Maximum	<0.28	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.9	200-IA-3	0.22	<0.24	200-IA-1	0.24	NA	1,040 / ---	NA	4,920 / ---	NA	NA	No
Tetrahydrofuran	Soil Vapor (MSVM Well) Maximum	<1,300	200-LV-150-34	1,300	<310	200-LV-150-34	310	2,100* / ---	NA	1,800* / ---	NA	3,600,000 / ---	59,000,000 / ---	No
	B.200 Outdoor Air Maximum	<0.38	200-OA-1	0.38	1.2	200-OA-2	0.30	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.29 (J)	200-IA-3	0.29	<0.32	200-IA-1	0.32	NA	2,100* / ---	NA	1,800* / ---	NA	NA	No
trans-1,2-Dichloroethene	Soil Vapor (MSVM Well) Maximum	<1,300	200-LV-150-34	1,300	<290	200-LV-150-34	290	1,390 / ---	NA	6,550 / ---	NA	---	---	No
	B.200 Outdoor Air Maximum	<0.36	200-OA-1	0.36	<0.28	200-OA-1	0.28	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	2.2 (FB)	200-IA-8	0.36	1.8 (FB)	200-IA-8	0.32	NA	41.7 / ---	NA	197 / ---	NA	NA	No

Notes:
Red = VISL or RBC exceeded.
Yellow = Detection limit exceeds VISL or RBC.
Flags = (D) reported result is from a dilution, (J) result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit, (A) result of an analyte for a laboratory control sample (LCS), initial calibration verification (ICV) or continuing calibration verification (CCV) was outside standard limits, (QD) relative percent difference for a field duplicate was outside standard limits, (TB) analyte was detected in the trip blank, (FB) analyte was detected in the field blank.
--- = Not available.
NA = Not applicable.
nc / c = noncancer / cancer
[1] = NMED VISLs taken from Risk Assessment Guidance for Site Investigations and Remediation November 2022 (NMED, 2022c).
[2] = WSTF RBCs for soil vapor taken from NASA WSTF NMED-approved Soil Vapor RBCs for 2022 (NASA, 2022), approved with modification February 11, 2022 (NMED, 2022a). The RBC listed corresponds to the closest depth bgs the sample was collected. For each sample, the next shallowest depth to the sample depth was chosen to be conservative, e.g., sampled at 34 ft bgs, the 25 ft RBC depth was used.
* = No NMED VISL was listed, so EPA RSL for air was used (EPA, 2022b).

Table 4.4 Detection Limits Exceeding Screening Levels Well 200-LV-150

Constituent	Detected?	Detection Limit	Screening Level Exceeded ($\mu g/m^3$)	Dilution
Carbon tetrachloride	No	990 and 230 990	Residential cancer VISL 156; Industrial cancer VISL 765	6600 and 1530
Chloroform	No	1,100 and 260	Resident cancer VISL 40.7; Industrial cancer VISL 199	6600 and 1530
Ethylbenzene	No	1,100	Residential cancer VISL 374	6600
Heptane	No	1,100	Residential air (noncancer) RSL 420	6600
2-Hexanone	No	1,100 and 240	Residential air (noncancer) RSL 31; Industrial air (noncancer) RSL 130	6600 and 1530
2-Propanol (Isopropanol)	No	2,800 and 640 2,800	Residential air (noncancer) RSL 210; Industrial air (noncancer) RSL 880	6600 and 1530
Trichloroethylene (TCE)	Yes	920 and 430	Residential noncancer VISL 69.5; Residential cancer VISL 147; Industrial noncancer VISL 328	6600 and 3060
1,2,4-Trimethylbenzene	No	990 and 230 990	Residential air (noncancer) RSL 63; Industrial air (noncancer) RSL 260	6600 and 1530

Note: Well was sampled at 34 ft bgs.

Table 5.1 Summary of 600 Area Building 637 and Vicinity Soil Vapor, Outdoor Air, and Indoor Air Analytical Results

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential ft bgs nc /c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (µg/m^3)[2]	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
TCE	Soil Vapor (MSVM Well) Maximum	480 (D)	600-SGW-1-12.5	5.8	740 (D)	600-SGW-1-12.5	5.3	69.5 / 147	NA	328 / 1,120	NA	2,300 / 5,400	34,000 / 120,000	Yes: Res cancer VISLs (5.03E-05) Res nonc VISLs (1.06E+01) Indus nonc VISLs (2.26E+00)
	B637 Outdoor Air Maximum	<0.29	600-OA-1	0.29	<0.21	600-OA-1	0.21	NA	NA	NA	NA	NA	NA	NA
	B637 Indoor Air Maximum	<0.24	600-IA-1	0.24	<0.22	600-IA-1	0.22	NA	2.09 / 4.42	NA	9.83 / 33.6	NA	NA	No
PCE	Soil Vapor (MSVM Well) Maximum	3.4	600-SGW-1-12.5	0.58	5.2	600-SGW-2-12.5	0.53	1,390 / 3,600	NA	6,550 / 17,600	NA	58,000 / 150,000	910,000 / 2,400,000	No
	B637 Outdoor Air Maximum	<0.29	600-OA-1	0.29	<0.21	600-OA-1	0.21	NA	NA	NA	NA	NA	NA	NA
	B637 Indoor Air Maximum	<0.24	600-IA-1	0.24	<0.22	600-IA-1	0.22	NA	41.7 / 108	NA	197 / 529	NA	NA	No
Freon 11	Soil Vapor (MSVM Well) Maximum	1,400 (A)	600-SGW-2-12.5	18	14	600-SGW-1-12.5	0.65	24,300 / ---	NA	115,000 / ---	NA	840,000 / ---	31,000,000 / ---	No
	B637 Outdoor Air Maximum	1.2 (A)	600-OA-2	0.31	1.1	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B637 Indoor Air Maximum	1.2 (A)	600-IA-2	0.29	1.4	600-IA-2	0.26	NA	730 / ---	NA	3,440 / ---	NA	NA	No
Freon 113	Soil Vapor (MSVM Well) Maximum	8,200	600-SGW-2-12.5	18	5,300 (D)	600-SGW-2-12.5	17	1,040,000 / ---	NA	4,920,000 / ---	NA	55,000,000 / ---	900,000,000 / ---	No
	B637 Outdoor Air Maximum	0.48 (J)	600-OA-2	0.31	0.51 (J)	200-OA-2	0.25	NA	NA	NA	NA	NA	NA	NA
	B637 Indoor Air Maximum	0.49 (J)	600-IA-2	0.29	0.59 (J)	600-IA-2	0.26	NA	31,300 / ---	NA	147,000 / ---	NA	NA	No
2-Butanone	Soil Vapor (MSVM Well) Maximum	12 (J, FB)	600-SGW-1-12.5	0.87	5 (J)	600-SGW-5-7.5	0.81	174,000 / ---	NA	819,000 / ---	NA	4,800,000 / --- 3,200,000 / ---	66,000,000 / --- 35,000,000 / ---	No
	B637 Outdoor Air Maximum	2.4 (J)	600-OA-1	0.44	0.42 (J)	600-OA-2	0.31	NA	NA	NA	NA	NA	NA	NA
	B637 Indoor Air Maximum	5.3 (J)	600-IA-4	0.44	0.52 (J, FB)	600-IA-1	0.34	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No
1,1,1-trichloroethane	Soil Vapor (MSVM Well) Maximum	0.76 (J)	600-SGW-1-12.5	0.70	3.6	600-SGW-2-12.5	0.65	174,000 / ---	NA	819,000 / ---	NA	6,100,000 / ---	90,000,000 / ---	No
	B637 Outdoor Air Maximum	<0.36	600-OA-1	0.36	<0.25	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.29	600-IA-1	0.29	<0.29	600-IA-1	0.29	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (µg/m^3)^1	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)^1	NMED VISL or RBC* Industrial Soil Vapor nc / c (µg/m^3)^1	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)^1	WSTF RBC Residential ft bgs nc /c (µg/m^3)^2	WSTF RBC Industrial ft bgs nc /c (µg/m^3)^2	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
Chloroform	Soil Vapor (MSVM Well) Maximum	31	600-SGW-1-12.5	0.70	41	600-SGW-1-12.5	0.65	3,410 / 40.7	NA	199 / 3,200	NA	100,000 / 1,200	1,500,000 / 19,000	No
	B.637 Outdoor Air Maximum	<0.36	600-OA-1	0.36	<0.25	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.29	600-IA-1	0.29	<0.27	600-IA-1	0.27	NA	102 / 1.22	NA	5.98 / 5.98	NA	NA	No
Benzene	Soil Vapor (MSVM Well) Maximum	3.2 (FB)	600-SGW-1-12.5	0.66	1.3 (J, FB)	600-SGW-1-12.5	0.61	1,040 / 120	NA	4,920 / 588	NA	29,000 / 3,400	400,000 / 49,000	No
	B.637 Outdoor Air Maximum	<0.34	600-OA-1	0.34	0.25 (J)	600-OA-2	0.24	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	0.33 (J)	600-IA-4	0.26	0.4 (J)	600-IA-1	0.26	NA	31.3 / 3.60	NA	17.6 / 17.6	NA	NA	No
Ethylbenzene	Soil Vapor (MSVM Well) Maximum	1.6 (J)	600-SGW-1-12.5	0.66	<0.61	600-SGW-1-12.5	0.61	34,800 / 374	NA	164,000 / 1,840	NA	---	---	No
	B.637 Outdoor Air Maximum	<0.34	600-OA-1	0.34	<0.24	600-OA-2	0.24	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.28	600-IA-1	0.28	<0.26	600-IA-1	0.26	NA	1,040 / 11.2	NA	55.1 / 55.1	NA	NA	No
Toluene	Soil Vapor (MSVM Well) Maximum	0.87 (J)	600-SGW-5-7.5	0.67	<0.65	600-SGW-1-12.5	0.65	174,000 / ---	NA	819,000 / ---	NA	---	---	No
	B.637 Outdoor Air Maximum	0.35 (J)	600-OA-2	0.31	<0.25	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	0.6 (J)	600-IA-4	0.36	0.32 (J)	600-IA-4	0.25	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No
Xylenes	Soil Vapor (MSVM Well) Maximum	<1.1	600-SGW-1-12.5	1.1	<32	600-SGW-1-12.5	32	3,480 / ---	NA	16,400 / ---	NA	---	---	No
	B.637 Outdoor Air Maximum	<0.63	600-OA-1	0.63	<0.44	600-OA-1	0.44	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.52	600-IA-1	0.52	<0.48	600-IA-1	0.48	NA	104 / ---	NA	492 / ---	NA	NA	No
Acetone	Soil Vapor (MSVM Well) Maximum	22	600-SGW-5-7.5	3.0	27	600-SGW-5-7.5	3.0	1,080,000 / ---	NA	5,080,000 / ---	NA	19,000,000 / ---	200,000,000 / ---	No
	B.637 Outdoor Air Maximum	10 (J)	600-OA-1	1.6	2.2 (J)	600-OA-1	1.1	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	28	600-IA-4	1.2	4.7 (J, FB)	600-IA-1	1.1	NA	32,300 / ---	NA	152,000 / ---	NA	NA	No

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential ft bgs nc /c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (µg/m^3)[2]	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
2-propanol (Isopropanol or Isopropyl alcohol)	Soil Vapor (MSVM Well) Maximum	<1.6	600-SGW-1-12.5	1.6	<45	600-SGW-2-12.5	45	210* / ---	NA	880* / ---	NA	180,000 / ---	2,400,000 / ---	No
	B.637 Outdoor Air Maximum	<0.88	600-OA-1	0.88	0.66 (J)	600-OA-2	0.62	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	3.4	600-IA-4	0.88	1.1 (J)	600-IA-4	0.62	NA	210* / ---	NA	880* / ---	NA	NA	No
1,1-Dichloroethane	Soil Vapor (MSVM Well) Maximum	5.7	600-SGW-1-12.5	0.66	5.2	600-SGW-1-12.5	0.61	--- / 585	NA	---2,870	NA	--- / 17,000	--- / 250,000	No
	B.637 Outdoor Air Maximum	<0.34	600-OA-1	0.34	<0.24	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.28	600-IA-1	0.28	<0.27	600-IA-1	0.27	NA	--- / 17.5	NA	--- / 86	NA	NA	No
1,2,4-Trimethyl-benzene[3]	Soil Vapor (MSVM Well) Maximum	0.92 (J)	600-SGW-1-12.5	0.62	<0.57	600-SGW-1-12.5	0.57	63 / ---	NA	260 / ---	NA	---	---	No
	B.637 Outdoor Air Maximum	<0.32	600-OA-1	0.32	<0.22	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.26	600-IA-1	0.26	<0.26	600-IA-1	0.26	NA	63 / ---	NA	260 / ---	NA	NA	No
1,2-Dichloroethane	Soil Vapor (MSVM Well) Maximum	0.73 (J)	600-SGW-1-12.5	0.66	<0.61	600-SGW-1-12.5	0.61	243 / 36	NA	1,150 / 176	NA	---	---	No
	B.637 Outdoor Air Maximum	<0.34	600-OA-1	0.34	<0.24	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.28	600-IA-1	0.28	<0.27	600-IA-1	0.27	NA	7.30 / 1.08	NA	5.29 / 5.29	NA	NA	No
1,4-Dichlorobenzene	Soil Vapor (MSVM Well) Maximum	1.9 (J)	600-SGW-1-12.5	0.58	<0.58	600-SGW-1-12.5	0.58	27,800 / 85.1	NA	131,000 / 417	NA	---	---	No
	B.637 Outdoor Air Maximum	<0.29	600-OA-1	0.29	<0.29	600-OA-1	0.29	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.24	600-IA-1	0.24	<0.24	600-IA-1	0.24	NA	834 / 2.55	NA	12.5 / 12.5	NA	NA	No
2-Hexanone	Soil Vapor (MSVM Well) Maximum	<0.66	600-SGW-1-12.5	0.66	1 (J)	600-SGW-5-7.5	0.62	31* / ---	NA	130* / ---	NA	34,000 / --- 22,000 / ---	490,000 / --- 250,000 / ---	No
	B.637 Outdoor Air Maximum	<0.34	600-OA-1	0.34	<0.24	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	1.1	600-IA-4	0.26	<0.27	600-IA-1	0.27	NA	31* / ---	NA	130* / ---	NA	NA	No

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential ft bgs nc /c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (µg/m^3)[2]	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
4-Methyl-2-pentanone methyl isobutyl ketone)	Soil Vapor (MSVM Well) Maximum	<0.66	600-SGW-1-12.5	0.66	<0.61	600-SGW-1-12.5	0.61	104,000 / ---	NA	492,000 / ---	NA	3,500,000 / ---	51,000,000 / ---	No
	B.637 Outdoor Air Maximum	<0.34	600-OA-1	0.34	<0.24	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	0.5 (J)	600-IA-4	0.34	<0.27	600-IA-1	0.27	NA	3,130 / ---	NA	14,700 / ---	NA	NA	No
Bromodichloromethane	Soil Vapor (MSVM Well) Maximum	0.62 (J)	600-SGW-1-12.5	0.62	0.59 (J)	600-SGW-1-12.5	0.57	--- / 25.3	NA	--- / 124	NA	--- / 980	--- / 15,000	No
	B.637 Outdoor Air Maximum	<0.32	600-OA-1	0.32	<0.22	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.26	600-IA-1	0.26	<0.26	600-IA-1	0.26	NA	--- / 0.759	NA	3.72 / 3.72	NA	NA	No
Carbon Disulfide	Soil Vapor (MSVM Well) Maximum	86 (A FB)	600-SGW-1-12.5	0.62	<0.57	600-SGW-1-12.5	0.57	24,300 / ---	NA	115,000 / ---	NA	610,000 / ---	8,100,000 / ---	No
	B.637 Outdoor Air Maximum	<0.32	600-OA-1	0.32	<0.22	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.26	600-IA-1	0.26	<0.26	600-IA-1	0.26	NA	730 / ---	NA	3,440 / ---	NA	NA	No
Carbon Tetrachloride	Soil Vapor (MSVM Well) Maximum	<0.62	600-SGW-1-12.5	0.62	<0.57	600-SGW-1-12.5	0.57	3,480 / 156	NA	16,400 / 765	NA	---	---	No
	B.637 Outdoor Air Maximum	0.41 (J)	600-OA-1	0.32	0.4 (J)	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	0.41 (J)	600-IA-1	0.26	0.45 (J)	600-IA-1	0.24	NA	104 / 4.68	NA	22.9 / 22.9	NA	NA	No
Chloroethane (Ethyl chloride)	Soil Vapor (MSVM Well) Maximum	2 (J)	600-SGW-1-12.5	0.70	1.7 (J)	600-SGW-1-12.5	0.65	348,000 / ---	NA	1,640,000 /	NA	8,900,000 / ---	120,000,000 / ---	No
	B.637 Outdoor Air Maximum	<0.36	600-OA-1	0.36	<0.25	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.29	600-IA-1	0.29	<0.27	600-IA-1	0.27	NA	10,400 / ---	NA	49,200 / ---	NA	NA	No
Chloromethane	Soil Vapor (MSVM Well) Maximum	1.5 (J FB)	600-SGW-1-12.5	0.62	1.2 (J FB)	600-SGW-1-12.5	0.57	3,130 / 520	NA	14,700 / 2,550	NA	72,000 / 12,000	900,000 / 160,000	No
	B.637 Outdoor Air Maximum	0.39 (J)	600-OA-1	0.32	0.63 (J)	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	0.33 (J)	600-IA-4	0.32	0.65 (J)	600-IA-4	0.22	NA	93.9 / 15.6	NA	76.5 / 76.5	NA	NA	No
cis-1,2-Dichloroethene	Soil Vapor (MSVM Well) Maximum	0.82 (J)	600-SGW-1-12.5	0.66	<0.61	600-SGW-1-12.5	0.61	42* / ---	NA	180* / ---	NA	---	---	No
	B.637 Outdoor Air Maximum	<0.34	600-OA-1	0.34	<0.24	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.28	600-IA-1	0.28	<0.26	600-IA-1	0.26	NA	42* / ---	NA	180* / ---	NA	NA	No

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential ft bgs nc /c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (µg/m^3)[2]	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
Ethanol	Soil Vapor (MSVM Well) Maximum	9.6 (J FB)	600-SGW-1-12.5	3.3	<3.0	600-SGW-1-12.5	3.0	NE	NA	NE	NA	15,000,000 / ---	170,000,000 / ---	No
	B.637 Outdoor Air Maximum	3.5 (J)	600-OA-2	1.5	2.6 (J)	600-OA-2	1.2	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	20	600-IA-4	1.7	4.2 (J FB)	600-IA-1	1.3	NA	NA	NA	NA	NA	NA	No
Freon 12 (Dichlorodifluoromethane)	Soil Vapor (MSVM Well) Maximum	2.4	600-SGW-5-7.5	0.67	2.2 (FB)	600-SGW-1-12.5	0.65	3,480 / ---	NA	16,400 / ---	NA	70,000 / --- 110,000 / ---	810,000 / --- 1,600,000 / ---	No
	B.637 Outdoor Air Maximum	2.3	600-OA-1	0.36	2.1	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	2.3 (FB)	600-IA-1	0.29	2.3 (FB)	600-IA-1	0.27	NA	104 / ---	NA	492 / ---	NA	NA	No
Freon 21 (Dichlorofluoro-methane)	Soil Vapor (MSVM Well) Maximum	10	600-SGW-1-12.5	0.99	6	600-SGW-1-12.5	0.91	NE	NA	NE	NA	120,000 / ---	1,800,000 / ---	No
	B.637 Outdoor Air Maximum	<0.50	600-OA-1	0.50	<0.35	600-OA-1	0.35	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.41	600-IA-1	0.41	<0.38	600-IA-1	0.38	NA	NA	NA	NA	NA	NA	No
Heptane	Soil Vapor (MSVM Well) Maximum	<0.70	600-SGW-1-12.5	0.70	<0.65	600-SGW-1-12.5	0.65	420* / ---	NA	1,800* / ---	NA	490,000 / ---	7,300,000 / ---	No
	B.637 Outdoor Air Maximum	<0.36	600-OA-1	0.36	<0.25	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	0.3 (J)	600-IA-4	0.28	<0.27	600-IA-1	0.27	NA	420* / ---	NA	1,800* / ---	NA	NA	No
Hexane	Soil Vapor (MSVM Well) Maximum	1.5 (J FB)	600-SGW-1-12.5	0.62	<0.57	600-SGW-1-12.5	0.57	24,300 / ---	NA	115,000 / ---	NA	780,000 / ---	11,000,000 / ---	No
	B.637 Outdoor Air Maximum	0.82 (J)	600-OA-1	0.32	<0.22	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	0.79 (J)	600-IA-4	0.32	<0.24	600-IA-1	0.24	NA	730 / ---	NA	3,440 / ---	NA	NA	No
Methylene Chloride	Soil Vapor (MSVM Well) Maximum	24	600-SGW-1-12.5	0.70	24	600-SGW-1-12.5	0.65	20,900 / 33,800	NA	98,300 / 459,000	NA	550,000 / 870,000	7,400,000 / 33,000,000	No
	B.637 Outdoor Air Maximum	<0.36	600-OA-1	0.36	0.43 (J)	600-OA-2	0.25	NA	NA	NA	NA	NA	NA	NA
	B.637 Indoor Air Maximum	<0.29	600-IA-1	0.29	0.55 (J FB)	600-IA-1	0.27	NA	626 / 1,010	NA	2,950 / 13,800	NA	NA	No
Tetrahydrofuran	Soil Vapor (MSVM Well) Maximum	0.85 (J)	600-SGW-1-12.5	0.83	<0.76	600-SGW-1-12.5	0.76	2,100* / ---	NA	1,800* / ---	NA	1,800,000 / ---	24,000,000 / ---	No
	B.637 Outdoor Air Maximum	1.1	600-OA-1	0.42	<0.29	600-OA-1	0.29	NA	NA	NA	NA	NA	NA	NA

COPC	Sample Type	8/27/17 Sample Event (μg/m^3)	Sample Location	Method Detection Limit (μg/m^3)	2/25/18 Sample Event (μg/m^3)	Sample Location	Method Detection Limit (μg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (μg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (μg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (μg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (μg/m^3)[1]	WSTF RBC Residential ft bgs nc /c (μg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (μg/m^3)[2]	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
	B.637 Indoor Air Maximum	<0.34	600-IA-1	0.34	<0.32	600-IA-1	0.32	NA	2,100* / ---	NA	1,800* / ---	NA	NA	No

Notes:
Red = VISL or RBC exceeded.
Flags = (D) reported result is from a dilution, (J) result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit, (A) result of an analyte for a laboratory control sample (LCS), initial calibration verification (ICV) or continuing calibration verification (CCV) was outside standard limits, (QD) relative percent difference for a field duplicate was outside standard limits, (TB) analyte was detected in the trip blank, (FB) analyte was detected in the field blank.
--- = Not available
NA = Not applicable
NE = Not Established
[1] = NMED VISLs taken from Risk Assessment Guidance for Site Investigations and Remediation November 2022 (NMED, 2022c).
[2] = WSTF RBCs for soil vapor taken from NASA WSTF NMED-approved Soil Vapor RBCs for 2022 (NASA, 2022), approved with modification February 2022 (NMED, 2022a). The RBC listed corresponds to the closest depth bgs the sample was collected. For each sample, the next shallowest depth to the sample depth was chosen to be conservative, e.g., sampled at 34 ft bgs, the 25 ft RBC depth was used
* = No NMED VISL was listed, so EPA RSL for air was used (EPA, 2022b).

Table 6.1 200 Area Soil Vapor: Residential Cancer Risk (VISLs)

Constituent	Maximum Concentration ($\mu g/m^3$)	VISL[2] ($\mu g/m^3$)	Cancer Risk[1]
Benzene	8.00E+01	1.20E+02	6.67E-06
PCE	5.70E+04	3.60E+03	1.58E-04
TCE	4.10E+05	1.47E+02	2.79E-02
Total 200 Area Residential Soil Vapor Cancer Risk			2.81E-02

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Residential Vapor Intrusion Screening Levels (NMED, 2022c)

Table 6.2 200 Area Soil Vapor: Industrial Cancer Risk (VISLs)

Constituent	Maximum Concentration ($\mu g/m^3$)	VISL[2] ($\mu g/m^3$)	Cancer Risk[1]
Benzene	8.00E+01	5.88E+02	1.36E-06
PCE	5.70E+04	1.76E+04	**3.24E-05**
TCE	4.10E+05	1.12E+03	**3.66E-03**
Total 200 Area Industrial Soil Vapor Cancer Risk			**3.69E-03**

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Industrial Vapor Intrusion Screening Levels (NMED, 2022c)

Bold values indicate an exceedance of screening levels.

Table 6.3 200 Area Soil Vapor: Residential Cancer Risk (RBCs)

Constituent	Maximum Concentration ($\mu g/m^3$)	Depth Maximum Detected (ft bgs)	RBC[2] ($\mu g/m^3$)	RBC Depth Used (ft bgs)	Cancer Risk[1]
Benzene	8.00E+01	19	3.40E+03	10	2.35E-07
PCE	5.70E+04	34	3.40E+05	25	1.68E-06
TCE	4.10E+05	34	1.10E+04	25	**3.73E-04**
Total 200 Area Residential Soil Vapor Cancer Risk					**3.75E-04**

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table 2a, Derivation of Vapor Risk-Based Concentrations: Resident (NASA, 2022).

Bold values indicate an exceedance of screening levels.

RBC – WSTF Risk Based Concentration

Table 6.4 200 Area Soil Vapor: Industrial Cancer Risk (RBCs)

Constituent	Maximum Concentration (µg/m³)	Depth Maximum Detected (ft bgs)	RBC[2] (µg/m³)	RBC Depth Used (ft bgs)	Cancer Risk[1]
Benzene	8.00E+01	19	4.90E+04	10	1.63E-08
PCE	5.70E+04	34	6.00E+06	25	9.50E-08
TCE	4.10E+05	34	2.80E+05	25	**1.46E-05**
Total 200 Area Industrial Soil Vapor Cancer Risk					**1.48E-05**

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table 3a, Derivation of Vapor Risk-Based Concentrations: Commercial Worker (NASA, 2022).

Bold values indicate an exceedance of screening levels.

RBC – WSTF Risk Based Concentration

Table 6.5 200 Area Soil Vapor: Residential (Noncancer) Hazard Index (VISLs)

Constituent	Maximum Concentration (µg/m³)	VISL[2] (µg/m³)	Hazard Quotient[1]
Benzene	8.00E+01	1.04E+03	7.69E-02
Carbon disulfide	6.40E+01	2.43E+04	2.63E-03
Freon-12 (Dichlorodifluoromethane)	1.20E+03	3.48E+03	3.45E-01
1,1-Dichloroethene	1.20E+04	6.95E+03	**1.73E+00**
PCE	5.70E+04	1.39E+03	**4.10E+01**
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	4.70E+05	1.04E+06	4.52E-01
TCE	4.10E+05	6.95E+01	**5.90E+03**
Freon-11 (Trichlorofluoromethane)	4.90E+02	2.43E+04	2.02E-02
Total 200 Area Residential Soil Vapor Hazard Index			**5.94E+03**

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Residential Vapor Intrusion Screening Levels (NMED, 2022c), unless otherwise noted.

Bold values indicate an exceedance of screening levels.

Table 6.6 200 Area Soil Vapor: Industrial (Noncancer) Hazard Index (VISLs)

Constituent	Maximum Concentration ($\mu g/m^3$)	VISL[2] ($\mu g/m^3$)	Hazard Quotient[1]
Benzene	8.00E+01	4.92E+03	1.63E-02
Carbon disulfide	6.40E+01	1.15E+05	5.57E-04
Freon-12 (Dichlorodifluoromethane)	1.20E+03	1.64E+04	7.32E-02
1,1-Dichloroethene	1.20E+04	3.28E+04	3.66E-01
PCE	5.70E+04	6.55E+03	**8.70E+00**
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	4.70E+05	4.92E+06	9.55E-02
TCE	4.10E+05	3.28E+02	**1.25E+03**
Freon-11 (Trichlorofluoromethane)	4.90E+02	1.15E+05	4.26E-03
Total 200 Area Industrial Soil Vapor Hazard Index			**1.26E+03**

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Industrial Vapor Intrusion Screening Levels (NMED, 2022c), unless otherwise noted.

Bold values indicate an exceedance of screening levels.

Table 6.7 200 Area Soil Vapor: Residential (Noncancer) Hazard Index (RBCs)

Constituent	Maximum Concentration (µg/m^3)	Depth Maximum Detected (ft bgs)	RBC[2] (µg/m^3)	RBC Depth Used (ft bgs)	Hazard Quotient[1]
Benzene	8.00E+01	19	2.90E+04	10	2.76E-03
Carbon disulfide	6.40E+01	19	6.10E+05	10	1.05E-04
Freon-12 (Dichlorodifluoromethane)	1.20E+03	34	2.20E+05	25	5.45E-03
1,1-Dichloroethene	1.20E+04	34	4.00E+05	25	3.00E-02
PCE	5.70E+04	34	1.30E+05	25	4.38E-01
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	4.70E+05	34	1.20E+08	25	3.92E-03
TCE	4.10E+05	34	4.90E+03	25	**8.37E+01**
Freon-11 (Trichlorofluoromethane)	4.90E+02	9	5.30E+05	5	9.25E-04
Total 200 Area Residential Soil Vapor Hazard Index					**8.42E+01**

Notes:
[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.[2] Table 2a, Derivation of Vapor Risk-Based Concentrations: Resident (NASA, 2022).
Bold values indicate an exceedance of NMED screening levels or target hazard.
RBC – WSTF Risk Based Concentration

Table 6.8 200 Area Soil Vapor: Industrial (Noncancer) Hazard Index (RBCs)

Constituent	Maximum Concentration (µg/m^3)	Depth Maximum Detected (ft bgs)	RBC[2] (µg/m^3)	RBC Depth Used (ft bgs)	Hazard Quotient[1]
Benzene	8.00E+01	19	4.00E+05	10	2.00E-04
Carbon disulfide	6.40E+01	19	8.10E+06	10	7.90E-06
Freon-12 (Dichlorodifluoromethane)	1.20E+03	34	3.80E+06	25	3.16E-04
1,1-Dichloroethene	1.20E+04	34	6.70E+06	25	1.79E-03
PCE	5.70E+04	34	2.30E+06	25	2.48E-02
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	4.70E+05	34	2.30E+09	25	2.04E-04
TCE	4.10E+05	34	8.40E+04	25	**4.88E+00**
Freon-11 (Trichlorofluoromethane)	4.90E+02	9	6.40E+06	5	7.66E-05
Total 200 Area Industrial Soil Vapor Hazard Index					**4.91E+00**

Notes:
[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.
[2] Table 3a, Derivation of Vapor Risk-Based Concentrations: Commercial Worker (NASA, 2022).
Bold values indicate an exceedance of screening levels.
RBC – WSTF Risk Based Concentration

Table 6.9 200 Area Indoor Air: Residential Cancer Risk (VISLs)

Constituent	Maximum Concentration (µg/m^3)	Indoor Air VISL[2] (µg/m^3)	Cancer Risk[1]
Benzene	1.60E+00	3.60E+00	4.44E-06
Carbon tetrachloride	4.50E-01	4.68E+00	9.62E-07
Chloroform	3.90E-01	1.22E+00	3.20E-06
Chloromethane	6.00E-01	1.56E+01	3.85E-07
Ethylbenzene	4.70E-01	1.12E+01	4.20E-07
Methylene chloride	1.60E+00	1.01E+03	1.58E-08
PCE	2.80E-01	1.08E+02	2.59E-08
TCE	1.30E+00	4.42E+00	2.94E-06
Total 200 Area Residential Indoor Air Cancer Risk			1.24E-05 or 1E-05

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Residential Indoor Air Screening Levels (NMED, 2022c).

Table 6.10 200 Area Indoor Air: Industrial Cancer Risk

Constituent	Maximum Concentration (µg/m^3)	Indoor Air VISLs[2] (µg/m^3)	Cancer Risk[1]
Benzene	1.60E+00	1.76E+01	9.09E-07
Carbon tetrachloride	4.50E-01	2.29E+01	1.97E-07
Chloroform	3.90E-01	5.98E+00	6.52E-07
Chloromethane	6.00E-01	7.65E+01	7.84E-08
Ethylbenzene	4.70E-01	5.51E+01	8.53E-08
Methylene chloride	1.60E+00	1.38E+04	1.16E-09
PCE	2.80E-01	5.29E+02	5.29E-09
TCE	1.30E+00	3.36E+01	3.87E-07
Total 200 Area Industrial Indoor Air Cancer Risk			2.31E-06

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Industrial Indoor Air Screening Levels (NMED, 2022c).

Table 6.11 200 Area Indoor Air: Residential (Noncancer) Hazard Index (VISLs)

Constituent	Max. Concentration Or UCL95 (µg/m^3)	Indoor AirVISLs[2] (µg/m^3)	Hazard Quotient[1]
Acetone[3]	1.21E+01	3.23E+04	3.76E-04
Benzene[3]	7.05E-01	3.13E+01	2.25E-02
2-Butanone (Methyl ethyl ketone)[3]	2.75E+00	5.21E+03	5.28E-04
Carbon disulfide	4.70E-01	7.30E+02	6.44E-04
Carbon tetrachloride[3]	4.11E-01	1.04E+02	3.95E-03
Chloroform	3.90E-01	1.02E+02	3.82E-03
Chloromethane[3]	5.27E-01	9.39E+01	5.61E-03
Ethylbenzene	4.70E-01	1.04E+03	4.52E-04
Freon-12 (Dichlorodifluoromethane)[3]	2.50E+00	1.04E+02	2.41E-02
trans-1,2-Dichloroethene	2.20E+00	4.17E+01	5.28E-02
n-Hexane[3]	6.24E-01	7.30E+02	8.55E-04
4-Methyl-2-pentanone (Methyl isobutyl ketone)	2.40E+01	3.13E+03	7.67E-03
Methylene chloride[3]	5.84E-01	6.26E+02	9.33E-04
Styrene	1.90E+00	1.04E+03	1.83E-03
PCE	2.80E-01	4.17E+01	6.71E-03
Toluene[3]	2.68E+00	5.21E+03	5.14E-04
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)[3]	6.19E+02	3.13E+04	1.98E-02
TCE[3]	5.21E-01	2.09E+00	2.49E-01
Freon-11 (Trichlorofluoromethane)[3]	7.57E+00	7.30E+02	1.04E-02
m,p-Xylene	1.50E+00	1.04E+02	1.44E-02
o-Xylene	6.00E-01	1.04E+02	5.75E-03
1,2,4-Trimethylbenzene[4]	9.20E-01	6.30E+01	1.46E-02
2,2,4-Trimethylpentane	3.90E-01	NE	NA
2-Hexanone[4]	1.10E+00	3.10E+01	3.55E-02
2-Propanol (Isopropanol)[3,4]	2.63E+01	2.10E+02	1.25E-01
Ethanol[3]	8.64E+00	NE	NA
Freon-21 (Dichlorofluoromethane)	3.50E+00	NE	NA
Heptane[4]	3.30E-01	4.20E+02	7.86E-04
Tetrahydrofuran[4]	2.90E-01	2.10E+03	1.38E-04
Total 200 Area Residential Indoor Air Hazard Index			6.09E-01

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Residential Indoor Air Screening Levels (NMED, 2022c), unless otherwise noted.

[3] These entries are UCL95 values calculated using ProUCL software.
[4] EPA Regional Screening Level Residential Air (EPA, 2022) used when NMED screening levels are unavailable.
NA – Not Applicable
NE – Not Established

Table 6.12 200 Area Indoor Air: Industrial (Noncancer) Hazard Index (VISLs)

Constituent	Maximum Concentration Or UCL95 (µg/m^3)	Indoor Air VISLs[2] (µg/m^3)	Hazard Quotient[1]
Acetone[3]	1.21E+01	1.52E+05	7.99E-05
Benzene[3]	7.05E-01	1.76E+01	4.01E-02
2-Butanone (Methyl ethyl ketone)[3]	2.75E+00	2.46E+04	1.12E-04
Carbon disulfide	4.70E-01	3.44E+03	1.37E-04
Carbon Tetrachloride[3]	4.11E-01	2.29E+01	1.79E-02
Chloroform	3.90E-01	5.98E+00	6.52E-02
Chloromethane[3]	5.27E-01	7.65E+01	6.89E-03
Ethylbenzene	4.70E-01	5.51E+01	8.53E-03
Freon-12 (Dichlorodifluoromethane)[3]	2.50E+00	4.92E+02	5.09E-03
trans-1,2-Dichloroethene	2.20E+00	1.97E+02	1.12E-02
n-Hexane[3]	6.24E-01	3.44E+03	1.81E-04
4-Methyl-2-pentanone (Methyl isobutyl ketone)	2.40E+01	1.47E+04	1.63E-03
Methylene chloride[3]	5.84E-01	2.95E+03	1.98E-04
Styrene	1.90E+00	4.92E+03	3.86E-04
PCE	2.80E-01	1.97E+02	1.42E-03
Toluene[3]	2.68E+00	2.46E+04	1.09E-04
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)[3]	6.19E+02	1.47E+05	4.21E-03
TCE[3]	5.21E-01	9.83E+00	5.30E-02
Freon-11 (Trichlorofluoromethane)[3]	7.57E+00	7.30E+02	1.04E-02
m,p-Xylene	1.50E+00	4.92E+02	3.05E-03
o-Xylene	6.00E-01	4.92E+02	1.22E-03
1,2,4-Trimethylbenzene[4]	9.20E-01	2.60E+02	3.54E-03
2,2,4-Trimethylpentane	3.90E-01	NE	NA
2-Hexanone[4]	1.10E+00	1.30E+02	8.46E-03
2-Propanol (Isopropanol)[3,4]	2.63E+01	8.80E+02	2.99E-02
Ethanol[3]	8.64E+00	NE	NA
Freon-21 (Dichlorofluoromethane)	3.50E+00	NE	NA
Heptane[4]	3.30E-01	1.80E+03	1.83E-04
Tetrahydrofuran[4]	2.90E-01	8.80E+03	3.30E-05
Total 200 Area Industrial Indoor Air Hazard Index			2.73E-01

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Industrial Indoor Air Screening Levels (NMED, 2022c), unless otherwise noted.

[3] These entries are UCL95 values calculated using ProUCL software.
[4] EPA Regional Screening Level Industrial Air (EPA, 2022) used when NMED screening levels are unavailable.
NA – Not Applicable
NE – Not Established

Table 6.13 200 Area Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	200 Area Max. Detected Concentration (mg/kg)	Soil Background Area 2 BTV (95% UTL) 8-12 ft (mg/kg)	Conclusion
Aluminum, Total	8-10	6,460	12,577	Below background
Antimony, Total	8-10	1.2	1.77	Below background
Arsenic, Total	8-10	13.7	14.2	Below background
Barium, Total	8-10	108	137	Below background
Beryllium, Total	8-10	0.49	0.609	Below background
Cadmium, Total	8-10	0.95	1.42	Below background
Chromium, Hex	8-10	0.04	3.78	Below background
Chromium, Total	8-10	9.26	9.41	Below background
Cobalt, Total	8-10	5.35	5.49	Below background
Copper, Total	8-10	8.21	8.29	Below background
Iron, Total	8-10	19,300	39,313	Below background
Lead, Total	8-10	13	21.6	Below background
Manganese, Total	8-10	321	404	Below background
Mercury, Total	8-10	0.003	NE	**Include as COPC**
Molybdenum, Total	8-10	1.8	3.65	Below background
Nickel, Total	8-10	11	17.1	Below background
NO_2/NO_3	8-10	7.4	3.1	**Compare populations**
Strontium, Total	8-10	250	896	Below background
Titanium, Total	8-10	111	273	Below background
Uranium, Total	8-10	1.76	3.26	Below background
Vanadium, Total	8-10	42.2	50.1	Below background
Zinc, Total	8-10	68	96.5	Below background

Notes:
NE = Not Established. Constituent was not detected in sufficient samples to establish a BTV.

Table 6.14 200 Area Essential Nutrient Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	200 Area Max. Detected Concentration (mg/kg)	Soil Background Area 2 BTV (95% UTL) 8-12 ft (mg/kg)	Conclusion
Calcium, Total	8-16[1]	108,000	109,364	Below background
Chloride	8-10	16	579	Below background
Magnesium, Total	8-10	28,400	47,233	Below background
Potassium, Total	8-10	1,870	2,942	Below background
Sodium, Total	8-10	200	796	Below background

Notes:

[1] No analytical samples were collected between 0-10 ft bgs for 200-SB-10, so the shallowest sample was used for that soil boring (16 ft bgs).

Table 6.15 Population Comparison of Background and 200 Area Soil Data

Constituent	Area 2	Conclusion
NO_2/NO_3	BG >= 200 Area	200 Area soil data is no more than Background data. Delete as COPC.

Table 6.16 200 Area Soil: Residential Cancer Risk

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Cancer Risk[1]
Dioxins/Furans	2.99E-07	4.90E-05[3]	6.10E-08
Total 200 Area Residential Soil Cancer Risk			6E-08

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-1, NMED Residential Soil Screening Levels (NMED, 2022c).

[3] Per NMED Guidance (November 2022), dioxin/furan concentrations were compared to 2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin).

Table 6.17 200 Area Soil: Industrial Cancer Risk

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Cancer Risk[1]
Dioxins/Furans	2.99E-07	2.38E-04[3]	1.26E-08
Total 200 Area Industrial Soil Cancer Risk			1E-08

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-1, NMED Industrial Soil Screening Levels (NMED, 2022c).

[3] Per NMED Guidance (November 2022), dioxin/furan concentrations were compared to 2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin).

Table 6.18 200 Area Soil: Residential (Noncancer) Hazard Index

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Hazard Quotient[1]
Mercury (elemental)	3.00E-03	2.38E+01	1.26E-04
Toluene	2.10E+00	5.23E+03	4.02E-04
Dioxins/Furans	3.11E-07	5.06E-05[3]	6.15E-03
Total 200 Area Residential Soil Hazard Index			6.7E-03

Notes:
[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.
[2] Table A-1, NMED Residential Soil Screening Levels (NMED, 2022c).
[3] Per NMED Guidance (November 2022), dioxin/furan concentrations were compared to 2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin).

Table 6.19 200 Area Soil: Industrial (Noncancer) Hazard Index

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Hazard Quotient[1]
Mercury (elemental)	3.00E-03	2.35E+01	1.28E-04
Toluene	2.10E+00	6.13E+04	3.43E-05
Dioxins/Furans	3.11E-07	8.08E-04[3]	3.85E-04
Total 200 Area Industrial Soil Hazard Index			5.47E-04

Notes:
[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.
[2] Table A-1, NMED Industrial Soil Screening Levels (NMED, 2022c).
[3] Per NMED Guidance (November 2022), dioxin/furan concentrations were compared to 2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin).

Table 6.20 200 Area Cumulative Residential Risk and Hazard; All Pathways

Pathway	Cancer Risk	Hazard	Source Risk / Hazard
Soil Vapor	**3.75E-04**	**8.42E+01**	Table 6.3 (RBCs) / Table 6.7 (RBCs)
Soil	6.35E-08	6.67E-03	Table 6.16 / Table 6.18
Total	**3.75E-04**	**8.42E+01**	

Notes:
Bold values indicate exceedance of NMED target.

Table 6.21 200 Area Cumulative Industrial Risk and Hazard; All Pathways

Pathway	Cancer Risk	Hazard	Source Risk / Hazard
Soil Vapor	**1.48E-05**	**4.91E+00**	Table 6.4 (RBCs) / Table 6.8 (RBCs)
Soil	1.31E-08	5.47E-04	Table 6.17 / Table 6.19
Total	**1.48E-05**	**4.91E+00**	

Notes:
Bold values indicate exceedance of NMED target.

Table 6.22 600 Area Soil Vapor: Residential Cancer Risk (VISLs)

Constituent	Maximum Concentration (µg/m³)	VISLs[2] (µg/m³)	Cancer Risk[1]
Benzene	3.20E+00	1.20E+02	2.67E-07
Bromodichloromethane	6.20E-01	2.53E+01	2.45E-07
Chloroform	4.10E+01	4.07E+01	**1.01E-05**
Chloromethane	1.50E+00	5.20E+02	2.88E-08
1,4-Dichlorobenzene	1.90E+00	8.51E+01	2.23E-07
1,1-Dichloroethane	5.70E+00	5.85E+02	9.74E-08
1,2-Dichloroethane	7.30E-01	3.60E+01	2.03E-07
Ethylbenzene	1.60E+00	3.74E+02	4.287E-08
Methylene chloride	2.40E+01	3.38E+04	7.10E-09
PCE	5.20E+00	3.60E+03	1.44E-08
TCE	7.40E+02	1.47E+02	**5.03E-05**
Total 600 Area Residential Soil Vapor Cancer Risk			**6.15E-05**

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Residential Vapor Intrusion Screening Levels (VISLs; NMED, 2022c).

Bold values indicate an exceedance of screening levels.

Table 6.23 600 Area Soil Vapor: Industrial Cancer Risk (VISLs)

Constituent	Maximum Concentration (µg/m³)	VISLs[2] (µg/m³)	Cancer Risk[1]
Benzene	3.20E+00	5.88E+02	5.44E-08
Bromodichloromethane	6.20E-01	1.24E+02	5.00E-08
Chloroform	4.10E+01	1.99E+02	2.06E-06
Chloromethane	1.50E+00	2.55E+03	5.88E-09
1,4-Dichlorobenzene	1.90E+00	4.17E+02	4.56E-08
1,1-Dichloroethane	5.70E+00	2.87E+03	1.99E-08
1,2-Dichloroethane	7.30E-01	1.76E+02	4.15E-08
Ethylbenzene	1.60E+00	1.84E+03	8.70E-09
Methylene chloride	2.40E+01	4.59E+05	5.23E-10
PCE	5.20E+00	1.76E+04	2.95E-09
TCE	7.40E+02	1.12E+03	6.61E-06
Total 600 Area Industrial Soil Vapor Cancer Risk			8.90E-06

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Industrial Vapor Intrusion Screening Levels (VISLs; NMED, 2022c).

Table 6.24 600 Area Soil Vapor: Residential Cancer Risk (RBCs)

Constituent	Maximum Concentration (µg/m^3)	Depth Maximum Detected (ft bgs)	RBC[2] (µg/m^3)	RBC Depth Used (ft bgs)	Cancer Risk[1]
Benzene	3.20E+00	12.5	3.40E+03	10	9.41E-09
Bromodichloromethane	6.20E-01	12.5	9.80E+02	10	6.33E-09
Chloroform	4.10E+01	12.5	1.20E+03	10	3.42E-07
Chloromethane	1.50E+00	12.5	1.20E+04	10	1.25E-09
1,4-Dichlorobenzene[3]	1.90E+00	12.5	8.51E+01	10	2.23E-07
1,1-Dichloroethane	5.70E+00	12.5	1.70E+04	10	3.35E-09
1,2-Dichloroethane[3]	7.30E-01	12.5	3.60E+01	10	2.03E-07
Ethylbenzene[3]	1.60E+00	12.5	3.74E+02	10	4.28E-08
Methylene chloride	2.40E+01	12.5	8.70E+05	10	2.76E-10
PCE	5.20E+00	12.5	1.50E+05	10	3.47E-10
TCE	7.40E+02	12.5	5.40E+03	10	1.37E-06
Total 600 Area Residential Soil Vapor Cancer Risk					2.20E-06

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table 2a, Derivation of Vapor Risk-Based Concentrations: Resident (NASA, 2022).

[3] NMED screening level (Table A-4 NMED VISLs; NMED 2022c) used when WSTF RBC screening levels are unavailable.

RBC - WSTF Risk Based Concentration

Table 6.25 600 Area Soil Vapor: Residential (Noncancer) Hazard Index (VISLs)

Constituent	Maximum Concentration ($\mu g/m^3$)	VISLs[2] ($\mu g/m^3$)	Hazard Quotient[1]
Acetone	2.70E+01	1.08E+06	2.50E-05
Benzene	3.20E+00	1.04E+03	3.08E-03
2-Butanone (Methyl ethyl ketone)	1.20E+01	1.74E+05	6.90E-05
Carbon disulfide	8.60E+01	2.43E+04	3.54E-03
Chloroform	4.10E+01	3.41E+03	1.20E-02
Chloromethane	1.50E+00	3.13E+03	4.79E-04
Cis-1,2-dichloroethene[3]	8.20E-01	4.20E+01	1.95E-02
1,2-Dichloroethane	7.30E-01	2.43E+02	3.00E-03
1,4-Dichlorobenzene	1.90E+00	2.78E+04	6.83E-05
Ethylbenzene	1.60E+00	3.48E+04	4.60E-05
Freon-12 (Dichlorodifluoromethane)	2.40E+00	3.48E+03	6.90E-04
Ethyl chloride (Chloroethane)	2.00E+00	3.48E+05	5.75E-06
n-Hexane	1.50E+00	2.43E+04	6.17E-05
Methylene chloride	2.40E+01	2.09E+04	1.15E-03
PCE	5.20E+00	1.39E+03	3.74E-03
Toluene	2.90E+00	1.74E+05	1.67E-05
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	8.20E+03	1.04E+06	7.88E-03
1,1,1-Trichloroethane	3.60E+00	1.74E+05	2.07E-05
TCE	7.40E+02	6.95E+01	**1.06E+01**
Freon-11 (Trichlorofluoromethane)	1.40E+03	2.43E+04	5.76E-02
m,p-Xylene	2.90E+00	3.48E+03	8.33E-04
o-Xylene	1.10E+00	3.48E+03	3.16E-04
1,2,4-Trimethylbenzene[3]	9.20E-01	6.30E+01	1.46E-02
2-Hexanone[3]	1.00E+00	3.10E+01	3.23E-02
2-Propanol (Isopropyl alcohol or Isopropanol)[3]	4.30E+00	2.10E+02	2.05E-02
Ethanol	9.60E+00	NE	NA
Freon 21 (Dichlorofluoromethane)	1.00E+01	NE	NA
Tetrahydrofuran[3]	8.50E-01	2.10E+03	4.05E-04
Total 600 Area Residential Soil Vapor Hazard Index			**1.08E+01**

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Residential Vapor Intrusion Screening Levels (VISLs; NMED, 2022c), unless otherwise noted.

[3] EPA Regional Screening Level Residential Air used when NMED screening levels are unavailable.

Bold values indicate an exceedance of screening levels.

NA = Not applicable

NE – Not Established

Table 6.26 600 Area Soil Vapor: Industrial (Noncancer) Hazard Index (VISLs)

Constituent	Maximum Concentration ($\mu g/m^3$)	VISLs[2] ($\mu g/m^3$)	Hazard Quotient[1]
Acetone	2.70E+01	5.08E+06	5.31E-06
Benzene	3.20E+00	4.92E+03	6.50E-04
2-Butanone (Methyl ethyl ketone)	1.20E+01	8.19E+05	1.47E-05
Carbon disulfide	8.60E+01	1.15E+05	7.48E-04
Chloroform	4.10E+01	1.61E+04	2.55E-03
Chloromethane	1.50E+00	1.47E+04	1.02E-04
cis-1,2-dichloroethene[3]	8.20E-01	1.80E+02	4.56E-03
1,2-Dichloroethane	7.30E-01	1.15E+03	6.35E-04
1,4-Dichlorobenzene	1.90E+00	1.31E+05	1.45E-05
Ethylbenzene	1.60E+00	1.64E+05	9.76E-06
Freon-12 (Dichlorodifluoromethane)	2.40E+00	1.64E+04	1.46E-04
Ethyl chloride (Chloroethane)	2.00E+00	1.64E+06	1.22E-06
n-Hexane	1.50E+00	1.15E+05	1.30E-05
Methylene chloride	2.40E+01	9.83E+04	2.44E-04
PCE	5.20E+00	6.55E+03	7.94E-04
Toluene	2.90E+00	8.19E+05	3.54E-06
Freon-113 (1,1,2-Trichloro-1,2,2-trifluorooethane)	8.20E+03	4.92E+06	1.67E-03
1,1,1-Trichloroethane	3.60E+00	8.19E+05	4.40E-06
TCE	7.40E+02	3.28E+02	**2.26E+00**
Freon-11 (Trichlorofluoromethane)	1.40E+03	1.15E+05	1.22E-02
m,p-Xylene	2.90E+00	1.64E+04	1.77E-04
o-Xylene	1.10E+00	1.64E+04	6.71E-05
1,2,4-Trimethylbenzene[3]	9.20E-01	2.60E+02	3.54E-03
2-Hexanone[3]	1.00E+00	1.30E+02	7.69E-03
2-Propanol (Isopropyl alcohol or Isopropanol)[3]	4.30E+00	8.80E+02	4.89E-03
Ethanol	9.60E+00	NE	NA
Freon 21 (Dichlorofluoromethane)	1.00E+01	NE	NA
Tetrahydrofuran[3]	8.50E-01	8.80E+03	9.66E-05
Total 600 Area Industrial Soil Vapor Hazard Index			**2.30E+00**

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Industrial Vapor Intrusion Screening Levels (VISLs; NMED, 2022c), unless otherwise noted.

[3] EPA Regional Screening Level Industrial Air used when NMED screening levels are unavailable.

Bold values indicate an exceedance of screening levels.

NA - Not Applicable

NE - Not Established

Table 6.27 600 Area Soil Vapor: Residential (Noncancer) Hazard Index (RBCs)

Constituent	Maximum Concentration (µg/m³)	Depth Maximum Detected (ft bgs)	RBC² (µg/m³)	RBC Depth Used (ft bgs)	Hazard Quotient¹
Acetone	2.70E+01	7.5	1.90E+07	5	1.42E-06
Benzene	3.20E+00	12.5	2.90E+04	10	1.10E-04
2-Butanone (Methyl ethyl ketone)	1.20E+01	12.5	4.80E+06	10	2.50E-06
Carbon disulfide	8.60E+01	12.5	6.10E+05	10	1.41E-04
Chloroform	4.10E+01	12.5	1.00E+05	10	4.10E-04
Chloromethane	1.50E+00	12.5	7.20E+04	10	2.08E-05
Cis-1,2-dichloroethene⁴	8.20E-01	12.5	4.20E+01	10	1.95E-02
1,2-Dichloroethane³	7.30E-01	12.5	2.43E+02	10	3.00E-03
1,4-Dichlorobenzene³	1.90E+00	12.5	2.78E+04	10	6.83E-05
Ethylbenzene³	1.60E+00	12.5	3.48E+04	10	4.60E-05
Freon-12 (Dichloro-difluoromethane)	2.40E+00	7.5	7.00E+04	5	3.43E-05
Ethyl chloride (Chloroethane)	2.00E+00	12.5	8.90E+06	10	2.25E-07
n-Hexane	1.50E+00	12.5	7.80E+05	10	1.92E-06
Methylene chloride	2.40E+01	12.5	5.50E+05	10	4.36E-05
PCE	5.20E+00	12.5	5.80E+04	10	8.97E-05
Toluene³	2.90E+00	12.5	1.74E+05	10	1.67E-05
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	8.20E+03	12.5	5.50E+07	10	1.49E-04
1,1,1-Trichloroethane	3.60E+00	12.5	6.10E+06	10	5.90E-07
TCE	7.40E+02	12.5	2.30E+03	10	3.22E-01
Freon-11 (Trichlorofluoromethane)	1.40E+03	12.5	8.40E+05	10	1.67E-03
m,p-Xylene³	2.90E+00	12.5	3.48E+03	10	8.33E-04
o-Xylene³	1.10E+00	12.5	3.48E+03	10	3.16E-04
1,2,4-Trimethylbenzene⁴	9.20E-01	12.5	6.30E+01	10	1.46E-02
2-Hexanone	1.00E+00	7.5	2.20E+04	5	4.55E-05
2-Propanol (Isopropyl alcohol)	4.30E+00	12.5	1.80E+05	10	2.39E-05
Ethanol	9.60E+00	12.5	1.50E+07	10	6.40E-07
Freon 21 (Dichlorofluoromethane)	1.00E+01	12.5	1.20E+05	10	8.33E-05
Tetrahydrofuran	8.50E-01	12.5	1.80E+06	10	4.72E-07
Total 600 Area Residential Soil Vapor Hazard Index					3.63E-01

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table 2a, Derivation of Vapor Risk-Based Concentrations: Resident (NASA, 2022).

[3] NMED screening level (Table A-4 VISLs; NMED, 2022c) used when WSTF RBC screening levels are unavailable.
[4] EPA screening level used when WSTF RBC and NMED screening level are unavailable.
RBC – WSTF Risk Based Concentration

Table 6.28 600 Area Soil Vapor: Industrial (Noncancer) Hazard Index (RBCs)

Constituent	Maximum Concentration (µg/m^3)	Depth Maximum Detected (ft bgs)	RBC[2] (µg/m^3)	RBC Depth Used (ft bgs)	Hazard Quotient[1]
Acetone	2.70E+01	7.5	2.00E+08	5	1.35E-07
Benzene	3.20E+00	12.5	4.00E+05	10	8.00E-06
2-Butanone (Methyl ethyl ketone)	1.20E+01	12.5	6.60E+07	10	1.82E-07
Carbon disulfide	8.60E+01	12.5	8.10E+06	10	1.06E-05
Chloroform	4.10E+01	12.5	1.50E+06	10	2.73E-05
Chloromethane	1.50E+00	12.5	9.00E+05	10	1.67E-06
cis-1,2-dichloroethene[4]	8.20E-01	12.5	1.80E+02	10	4.56E-03
1,2-Dichloroethane[3]	7.30E-01	12.5	1.15E+03	10	6.35E-04
1,4-Dichlorobenzene[3]	1.90E+00	12.5	1.31E+05	10	1.45E-05
Ethylbenzene[3]	1.60E+00	12.5	1.64E+05	10	9.76E-06
Freon-12 (Dichlorodifluoromethane)	2.40E+00	7.5	8.10E+05	5	2.96E-06
Ethyl chloride (Chloroethane)	2.00E+00	12.5	1.20E+08	10	1.67E-08
n-Hexane	1.50E+00	12.5	1.10E+07	10	1.36E-07
Methylene chloride	2.40E+01	12.5	7.40E+06	10	3.24E-06
PCE	5.20E+00	12.5	9.10E+05	10	5.71E-06
Toluene[3]	2.90E+00	12.5	8.19E+05	10	3.54E-06
Freon-113 (1,1,2-Trichloro-1,2,2-trifluorooethane)	8.20E+03	12.5	9.00E+08	10	9.11E-06
1,1,1-Trichloroethane	3.60E+00	12.5	9.00E+07	10	4.00E-08
TCE	7.40E+02	12.5	3.40E+04	10	2.18E-02
Freon-11 (Trichlorofluoromethane)	1.40E+03	12.5	8.40E+05	10	1.67E-03
m,p-Xylene[3]	2.90E+00	12.5	1.64E+04	10	1.77E-04
o-Xylene[3]	1.10E+00	12.5	1.64E+04	10	6.71E-05
1,2,4-Trimethylbenzene[4]	9.20E-01	12.5	2.60E+02	10	3.54E-03
2-Hexanone	1.00E+00	7.5	2.50E+05	5	4.00E-06
2-Propanol (Isopropyl alcohol)	4.30E+00	12.5	2.40E+06	10	1.79E-06
Ethanol	9.60E+00	12.5	1.70E+08	10	5.65E-08
Freon 21 (Dichlorofluoromethane)	1.00E+01	12.5	1.80E+06	10	5.56E-06
Tetrahydrofuran	8.50E-01	12.5	2.40E+07	10	3.54E-08
Total 600 Area Industrial Soil Vapor Hazard Index					3.25E-02

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.
[2] Table 3a, Derivation of Vapor Risk-Based Concentrations: Commercial Worker (NASA, 2022).
[3] NMED screening level (Table A-4 VISLs; NMED, 2022c) used when WSTF RBC screening levels are unavailable.
[4] EPA screening level used when WSTF RBC and NMED screening level are unavailable.
RBC – WSTF Risk Based Concentration

Table 6.29 600 Area Indoor Air: Residential Cancer Risk (VISLs)

Constituent	Maximum Concentration ($\mu g/m^3$)	VISLs[2] ($\mu g/m^3$)	Cancer Risk[1]
Benzene	4.00E-01	3.60E+00	1.11E-06
Carbon tetrachloride	4.50E-01	4.68E+00	9.62E-07
Chloromethane	6.50E-01	1.56E+01	4.17E-07
Methylene chloride	5.50E-01	1.01E+03	5.45E-09
Total 600 Area Residential Indoor Air Cancer Risk			2.49E-06

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Residential Indoor Air Screening Levels (NMED, 2022c).

Table 6.30 600 Area Indoor Air: Industrial Cancer Risk (VISLs)

Constituent	Maximum Concentration ($\mu g/m^3$)	VISLs[2] ($\mu g/m^3$)	Cancer Risk[1]
Benzene	4.00E-01	1.76E+01	2.27E-07
Carbon tetrachloride	4.50E-01	2.29E+01	1.97E-07
Chloromethane	6.50E-01	7.65E+01	8.50E-08
Methylene chloride	5.50E-01	1.38E+04	3.99E-10
Total 600 Area Industrial Indoor Air Cancer Risk			5.09E-07

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Industrial Indoor Air Screening Levels (NMED, 2022c).

Table 6.31 600 Area Indoor Air: Residential (Noncancer) Hazard Index(VISLs)

Constituent	Maximum Concentration (µg/m³)	VISLs[2] (µg/m³)	Hazard Quotient[1]
Acetone	2.80E+01	3.23E+04	8.67E-04
Benzene	4.00E-01	3.13E+01	1.28E-02
2-Butanone (Methyl ethyl ketone)	5.30E+00	5.21E+03	1.02E-03
Carbon tetrachloride	4.50E-01	1.04E+02	4.33E-03
Chloromethane	6.50E-01	9.39E+01	6.92E-03
Freon-12 (Dichlorodifluoromethane)	2.30E+00	1.04E+02	2.21E-02
n-Hexane	7.90E-01	7.30E+02	1.08E-03
4-Methyl-2-pentanone (Methyl isobutyl ketone)	5.00E-01	3.13E+03	1.60E-04
Methylene chloride	5.50E-01	6.26E+02	8.79E-04
Toluene	6.00E-01	5.21E+03	1.15E-04
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	5.90E-01	3.13E+04	1.88E-05
Freon-11 (Trichlorofluoromethane)	1.40E+00	7.30E+02	1.92E-03
2-Hexanone[3]	1.10E+00	3.10E+01	3.55E-02
2-Propanol[3]	3.40E+00	2.10E+02	1.62E-02
Ethanol[4]	2.00E+01	NE	NA
Heptane[3]	3.00E-01	4.20E+02	7.14E-04
Total 600 Area Residential Indoor Air Hazard Index			1.05E-01

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Residential Indoor Air Screening Levels (NMED, 2022c), unless otherwise noted.

[3] EPA Regional Screening Level (EPA, 2022) used when NMED screening levels and WSTF RBCs are unavailable.

NA – Not Applicable

NE – Not Established

Table 6.32 600 Area Indoor Air: Industrial (Noncancer) Hazard Index (VISLs)

Constituent	Maximum Concentration (µg/m^3)	VISLs[2] (µg/m^3)	Hazard Quotient[1]
Acetone	2.80E+01	1.52E+05	1.84E-04
Benzene	4.00E-01	1.76E+01	2.27E-02
2-Butanone (Methyl ethyl ketone)	5.30E+00	2.46E+04	2.15E-04
Carbon tetrachloride	4.50E-01	2.29E+01	1.97E-02
Chloromethane	6.50E-01	7.65E+01	8.50E-03
Freon-12 (Dichlorodifluoromethane)	2.30E+00	4.92E+02	4.67E-03
n-Hexane	7.90E-01	3.44E+03	2.30E-04
4-Methyl-2pentanone (Methyl isobutyl ketone)	5.00E-01	1.47E+04	3.40E-05
Methylene chloride	5.50E-01	2.95E+03	1.86E-04
Toluene	6.00E-01	2.46E+04	2.44E-05
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	5.90E-01	1.47E+05	4.01E-06
Freon-11 (Trichlorofluoroethane)	1.40E+00	3.44E+03	4.07E-04
2-Hexanone[3]	1.10E+00	3.10E+02	3.55E-03
2-Propanol[3]	3.40E+00	8.80E+02	3.86E-03
Ethanol	2.00E+01	NE	NA
Heptane[3]	3.00E-01	1.80E+03	1.67E-04
Total 600 Area Industrial Indoor Air Hazard Index			6.44E-02

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Industrial Indoor Air Screening Levels (NMED, 2022c), unless otherwise noted.

[3] EPA Regional Screening Level (EPA, 2022) used when NMED screening levels and WSTF RBCs are unavailable.

NA – Not Applicable
NE - Not Established

Table 6.33 600 Area Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	600 Area Max. Detected Concentration (mg/kg)	Soil Background Area 4 BTV (95% UTL) (mg/kg)	Conclusion
Aluminum, Total	0-4	9,480	17,681	Below background
	4-8	11,600	12,154	
	8-10	4,650	13,653	
Antimony, Total	0-4	<0.5[1]	NE[2]	**Include as COPC**
	4-8	<0.5[1]	NE[2]	
	8-10	**0.4**	NE[2]	
Arsenic, Total	0-4	8.3	11.1	Below background
	4-8	10.1	12.6	
	8-10	6.76	11.9	
Barium, Total	0-4	191	215	**Compare Populations**
	4-8	240	398	
	8-10	**338**	310	
Beryllium, Total	0-4	0.56	1.1	**Compare Populations**
	4-8	**0.72**	0.713	
	8-10	0.37	0.814	
Boron, Total	0-4	**3**	NE[2]	**Include as COPC**
	4-8	<2[1]	NE[2]	
	8-10	**4**	NE[2]	
Cadmium, Total	0-4	0.2	0.696	**Include as COPC**
	4-8	**0.36**	NE[2]	
	8-10	**0.27**	NE[2]	
Chromium, Hex	0-4	0.4	1.2	Below background
	4-8	0.21	6.94	
	8-10	<0.2[1]	1.23	
Chromium, Total	0-4	**16.7**	11.1	**Compare Populations**
	4-8	**15.4**	11.7	
	8-10	7.2	11.3	
Cobalt, Total	0-4	**6.8**	5.35	**Compare Populations**
	4-8	**5.4**	5.35	
	8-10	2.2	5.28	
Copper, Total	0-4	7.7	11.7	**Compare Populations**
	4-8	**10.4**	9.2	
	8-10	6.8	13.5	
Iron, Total	0-4	13,800	39,911	Below background
	4-8	12,600	15,794	
	8-10	8,140	18,759	
Lead, Total	0-4	8.8	15.9	Below background
	4-8	9.5	10.3	
	8-10	5.7	15.6	
Manganese, Total	0-4	187	444	**Compare Populations**
	4-8	**325**	296	
	8-10	253	393	

Table 6.33 600 Area Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	600 Area Max. Detected Concentration (mg/kg)	Soil Background Area 4 BTV (95% UTL) (mg/kg)	Conclusion
Mercury, Total	0-4	0.012	0.0709	**Compare Populations**
	4-8	**0.099**	0.0576	
	8-10	0.005	0.0302	
Molybdenum, Total	0-4	**3.2**	1.33	**Compare Populations**
	4-8	1.8	2.85	
	8-10	1.4	1.98	
Nickel, Total	0-4	14.9	15.4	Below background
	4-8	11.4	12.3	
	8-10	7.2	14.1	
NO_2/NO_3	0-4	**54.6**	6.39	**Compare Populations**
	4-8	55.4	2.84	
	8-10	14.9	4.82	
Perchlorate	0-4	0.00086	0.0112	**Include as COPC**
	4-8	<0.0005[1]	0.00495	
	8-10	**0.03**	0.00337	
Selenium, Total	0-4	0.4	1.96	Below background
	4-8	<0.4[1]	1.7	
	8-10	0.5	2.45	
Thallium, Total	0-4	5.9	NE[2]	**Include as COPC**
	4-8	7.1	NE[2]	
	8-10	7.6	NE[2]	
Tin, Total	0-4	7	NE[2]	**Include as COPC**
	4-8	10	NE[2]	
	8-10	6	NE[2]	
Titanium, Total	0-4	211	359	Below background
	4-8	213	352	
	8-10	130	330	
Vanadium, Total	0-4	26	33.9	Below background
	4-8	32.6	56.3	
	8-10	19.7	42.4	
Zinc, Total	0-4	38.6	59.7	**Compare Populations**
	4-8	**43.7**	40.8	
	8-10	23.2	52.9	

Notes:[1] Not Detected above laboratory detection limit

[2] Not Established

Bold font indicates concentration exceeds BTV.

Table 6.34 600 Area Essential Nutrients Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	600 Area Max. Detected Concentration (mg/kg)	Soil Background Area 4 BTV (95% UTL) (mg/kg)	Conclusion
Calcium, Total	0-4	177,000	302,460	Below background
	4-8	200,000	214,770	
	8-10	145,000	332,558	
Magnesium, Total	0-4	**19,800**	14,149	**Compare Populations**
	4-8	21,800	31,298	
	8-10	15,600	33,658	
Potassium, Total	0-4	2,020	4,151	**Compare Populations**
	4-8	**3,130**	3,038	
	8-10	1,090	3,125	
Sodium	0-4	280	643	**Compare Populations**
	4-8	**12,900**	1,242	
	8-10	1,260	1,297	

Notes:
Bold font indicates maximum concentration exceeds BTV.

Table 6.35 Population Comparison of Background and 600 Area Soil Data

Constituent	Area 4	Conclusion
Barium	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Beryllium	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Chromium	**BG < 600 Area**	**600 Area soil data exceeds Background data. Retain as COPC.**
Cobalt	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Copper	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Manganese	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Mercury	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Molybdenum	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
NO_2/NO_3	**BG < 600 Area**	**600 Area soil data exceeds Background data. Retain as COPC.**
Zinc	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Essential Nutrients		
Magnesium	BG >= 600 Area	600 Area soil data is no more than Background data. Delete nutrient.
Potassium	BG >= 600 Area	600 Area soil data is no more than Background data. Delete nutrient.
Sodium	**BG < 600 Area**	**600 Area soil data may exceed Background data. Retain nutrient.**

Table 6.36 600 Area Soil: Residential Cancer Risk

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Cancer Risk[1]
Benzo(a)anthracene	4.80E-03	1.53E+00	3.14E-08
Bis(2-ethylhexyl)phthalate	1.40E+00	3.80E+02	3.68E-08
Cadmium	3.60E-01	8.59E+04	4.19E-11
Chromium (Total)	1.67E+01	9.66E+01	1.73E-06
Chrysene	4.40E-03	1.53E+02	2.88E-10
Trichloroethylene	4.90E-04	1.55E+01	3.16E-10
Total 600 Area Residential Soil Cancer Risk			1.80E-06

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-1, NMED Residential Soil Screening Levels (NMED, 2022c).

Table 6.37 600 Area Soil: Industrial Cancer Risk

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Cancer Risk[1]
Benzo(a)anthracene	4.80E-03	3.23E+01	1.49E-09
Bis(2-ethylhexyl)phthalate	1.40E+00	1.83E+03	7.65E-09
Cadmium	3.60E-01	4.17E+05	8.63E-12
Chromium (Total)	1.67E+01	5.05E+02	3.31E-07
Chrysene	4.40E-03	3.23E+03	1.36E-11
Trichloroethylene	4.90E-04	1.12E+02	4.38E-11
Total 600 Area Industrial Soil Cancer Risk			3.40E-07

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-1, NMED Industrial Soil Screening Levels (NMED, 2022c).

Table 6.38 600 Area Soil: Residential (Noncancer) Hazard Index

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Hazard Quotient[1]
Acetone	8.70E-02	6.63E+04	1.31E-06
Antimony	4.00E-01	3.13E+01	1.28E-02
Benzyl Alcohol[3]	3.20E-01	6.30E+03[3]	5.08E-05
Bis(2-ethylhexyl)phthalate	1.40E+00	1.23E+03	1.14E-03
Boron	4.00E+00	1.56E+04	2.56E-04
2-Butanone (Methyl ethyl ketone)	7.00E-03	3.74E+04	1.87E-07
Cadmium	3.60E-01	7.05E+01	5.11E-03
Carbon disulfide	8.10E-04	1.55E+03	5.23E-07
Chromium (Total)	1.67E+01	4.52E+04	3.69E-04
Methyl isobutyl ketone	1.10E-03	5.81E+03	1.89E-07
Nitrite	5.54E+01	7.82E+03	7.08E-03
Perchlorate	3.00E-02	5.48E+01	5.47E-04
Thallium[4]	5.19E+00	7.82E-01	**6.63E+00**
Toluene	6.00E-04	5.23E+03	1.15E-07
Freon-113	1.40E-01	5.08E+04	2.76E-06
TCE	4.90E-04	6.77E+00	7.24E-05
Tetrahydrofuran[3]	1.70E-03	1.80E+04	9.44E-08
Tin, Total[3,4]	1.00E+01	4.70E+04	2.13E-04
2-Propanol[3]	1.80E-02	5.60E+03	3.21E-06
Total 600 Area Residential Soil Hazard Index			**6.66E+00**
Essential Nutrients			
Sodium	1.29E+04	7.82E+06	

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-1, NMED Residential Soil Screening Levels (NMED, 2022c), unless otherwise noted.

[3] EPA screening level (EPA, 2022) used when NMED screening levels are unavailable.

[4] These entries are UCL95 values calculated using ProUCL software.

Bold values indicate an exceedance of screening levels.

Table 6.39 600 Area Soil: Industrial (Noncancer) Hazard Index

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Hazard Quotient[1]
Acetone	8.70E-02	9.60E+05	9.06E-08
Antimony	4.00E-01	5.19E+02	7.71E-04
Benzyl Alcohol[3]	3.20E-01	8.20E+04	3.90E-06
Bis(2-ethylhexyl)phthalate	1.40E+00	1.83E+04	7.65E-05
Boron	4.00E+00	2.59E+05	1.54E-05
2-Butanone (Methyl ethyl ketone)	7.00E-03	4.11E+05	1.70E-08
Cadmium	3.60E-01	1.11E+03	3.24E-04
Carbon disulfide	8.10E-04	8.54E+03	9.48E-08
Chromium (Total)	1.67E+01	3.14E+05	5.32E-05
Methyl isobutyl ketone	1.10E-03	8.16E+04	1.35E-08
Nitrite	5.54E+01	1.30E+05	4.26E-04
Perchlorate	3.00E-02	9.08E+02	3.30E-05
Thallium[4]	5.19E+00	1.30E+01	3.99E-01
Toluene	6.00E-04	6.13E+04	9.79E-09
Freon-113	1.40E-01	2.43E+05	5.76E-07
TCE	4.90E-04	3.65E+01	1.34E-05
Tetrahydrofuran[3]	1.70E-03	9.50E+04	1.79E-08
Tin, Total[3]	1.00E+01	7.00E+05	1.43E-05
2-Propanol[3]	1.80E-02	2.40E+04	7.50E-07
Total 600 Area Industrial Soil Hazard Index			4.01E-01

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-1, NMED Industrial Soil Screening Levels (NMED, 2022c), unless otherwise noted.

[3] EPA screening level (EPA, 2022) used when NMED screening levels are unavailable.

[4] These entries are UCL95 values calculated using ProUCL software.

Table 6.40 600 Area Cumulative Residential Risk and Hazard; All Pathways

Pathway	Cancer Risk	Hazard	Source Risk / Hazard
Soil Vapor	2.20E-06	3.63E-01	Table 6.24 (RBCs) / Table 6.27 (RBCs)
Soil	1.80E-06	**6.66E+00**	Table 6.36 / Table 6.38
Total	4.00E-06	**7.02E+00**	

Notes:
Bold value indicates exceedance of NMED target.

Table 6.41 600 Area Cumulative Industrial Risk and Hazard; All Pathways

Pathway	Cancer Risk	Hazard	Source Risk / Hazard
Soil Vapor	8.90E-06	3.25E-02	Table 6.23 (VISLs) / Table 6.28 (RBCs)
Soil	3.40E-07	4.01E-01	Table 6.37 / Table 6.39
Total	9.24E-06	4.34E-01	

Table 6.42 Summary of F113 and TCE Vertical Concentration Profiles for Select 200 and 600 Area Wells

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – 2018[#&] (µg/m^3)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
MSVGM Well 200-SG-2						
Freon 113	F113 in soil non-detect (<11.0 µg/kg) for soil sample at 80 ft bgs. Vadose zone soil porosity not reported (insufficient sample for geotechnical analysis[@]).	Increasing F113 in soil vapor with depth by one order of magnitude from shallow port (30 ft) to middle port (60 ft). Deep port submerged in aquifer. Significant concentration increase with depth by one order of magnitude.	Steadily decreasing trend for F113 in deep soil vapor port over time for historical sampling events from 169,000 µg/m^3 to 110,000 µg/m^3.	Latest equivalent soil vapor in equilibrium with groundwater is 2,592,000 µg/m^3 on 10/22/14.	Soil vapor concentration in middle port (deep port submerged) at 110,000 µg/m^3 is one order of magnitude below equivalent soil vapor in equilibrium with groundwater.	The increasing F113 in soil vapor with depth is coincident with proximity to the local confined groundwater aquifer. The deep port is located 23 ft above groundwater Decreasing F113 soil vapor concentrations over time are coincident with declining F113 groundwater concentrations (Appendix E and NASA, 2019b).*
TCE	TCE in soil non-detect (<5.3 µg/kg) for soil sample at 80 ft bgs. Vadose zone porosity not reported (insufficient sample for geotechnical analyses[@]).	Generally increasing TCE in soil vapor with depth (within the same order of magnitude) from shallow (30 ft) to middle (60 ft) port located. Deep port submerged in aquifer.	Irregular TCE trend in deep soil vapor port over time for relatively low concentrations within the same order of magnitude for historical sampling events.	Latest equivalent soil vapor in equilibrium with groundwater is 485 µg/m^3 on 10/22/14.	Soil vapor concentration in middle port at 800 µg/m^3 is within the same order of magnitude as equivalent soil vapor in equilibrium with groundwater.	The increasing TCE in soil vapor with port depth is coincident with proximity to groundwater. The deep port is located 23 ft above groundwater. Fluctuating TCE soil vapor concentrations over time are within the same order of magnitude and are consistent with the relatively stable low level groundwater concentrations of between 1.2 µg/L and 1.6 µg/L

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – 2018#& (µg/m³)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
						(Appendix E and NASA, 2019b).*
			MSVGM Well 200-SG-3			
Freon 113	F113 in soil non-detect (<11.0 µg/kg) for soil samples at 30 ft, 50 ft, and 60 ft bgs. Vadose zone soil porosity reported as between 24% and 46% at the same sampling intervals.@	Increasing F113 in soil vapor with port depth by one order of magnitude for the upper 3 ports located at 30 ft, 60 ft, and 90 ft within vadose zone alluvium and shallow bedrock. Concentrations subsequently decline within the deep bedrock port at 154 ft.	Steadily decreasing trend for F113 in soil vapor ports over time for historical sampling events.	Equivalent soil vapor in equilibrium with groundwater is 1,922,400 µg/m³ on 10/21/14.	Soil vapor for the deep port (110,000 µg/m³) is one order of magnitude lower than equivalent soil vapor in equilibrium with groundwater.	Increasing F113 in soil vapor with depth for the ports at 30 ft, 60 ft, & 90 ft located within either permeable alluvium or shallow bedrock. Decreasing F113 soil vapor concentrations occur within the port at depth (154 ft) located 10 ft above groundwater within a sedimentary bedrock sequence with irregular permeability. Decreasing F113 trend in soil vapor over time is coincident with declining groundwater concentrations in the local 200 Area aquifer (Appendix E and NASA, 2019b).*

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – 2018#& (µg/m^3)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
TCE	TCE in soil non-detect (<5.3 µg/kg) for soil samples at 30 ft, 50 ft, and 60 ft bgs. Vadose zone soil porosity reported as between 24% to 46% at the same sampling intervals.@	Increasing TCE in soil vapor with port depth within the same order of magnitude for the upper 3 ports located at 30 ft, 60 ft, and 90 ft within vadose zone alluvium and shallow bedrock. Concentrations subsequently decline within deep port at 154 ft.	Decreasing TCE in soil vapor ports over time for historical sampling events.	Equivalent soil vapor in equilibrium with groundwater is 1,697 µg/m^3 on 10/21/14.	Soil vapor for the deep port (4,200 µg/m^3) is within the same order of magnitude as equivalent soil vapor in equilibrium with groundwater.	Increasing TCE in soil vapor with depth for the ports at 30 ft, 60 ft, & 90 ft) located within relatively permeable alluvium or shallow bedrock. Decreasing TCE soil vapor concentrations within the accessible port at depth (154 ft) located 10 ft above groundwater within a sedimentary bedrock sequence with irregular permeability. Decreasing TCE trend in soil vapor over time is consistent with declining groundwater concentrations in the local 200 Area aquifer (Appendix E and NASA, 2019b).*
MSVM Well 600-SGW-1						
F113	F113 in soil 140 and non-detect (<0.76 µg/kg) at 10 - 12 ft, and non-detect (<0.79 µg/kg) for the soil sample at	Steadily increasing F113 in soil vapor with depth in ports located at 12.5 ft, 57.5 ft, and 117.5 ft. Concentrations remain within the	Steadily decreasing F113 in soil vapor ports over time for all historical sampling events 2010 - 2014. The shallow port at 12.5 ft sampled for the	No groundwater sample available for this well.	No direct comparison performed.	The increasing F113 trend in soil vapor with port depth is coincident with proximity to the projected fractured bedrock depth at 160 ft) and projected groundwater aquifer depth at 170 ft. Although no groundwater

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – 2018$^{\#\&}$ (µg/m^3)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
	72.5 - 75 ft. vadose zone soil porosity reported as 32% at 10 – 12 ft and 47% at 72.5 – 75 ft.[#]	same order of magnitude.	vapor intrusion assessment display continuation of this declining trend.			sample is available for this well, decreasing F113 soil vapor concentrations over time correspond to declining F113 concentrations in the local 600 Area groundwater aquifer (Appendix E and NASA, 2019b).*
TCE	TCE in soil 0.49 and non-detect (<0.41 µg/kg) at 10 – 12 ft, and non-detect (<0.43 µg/kg) for the soil sample at 72.5 – 75 ft. Vadose zone soil porosity reported as 32% at 10 – 12 ft and 47% at 72.5 – 75 ft.[#]	Steadily increasing TCE in soil vapor with depth in ports located at 12.5 ft, 57.5 ft, and 117.5 ft. Concentrations remain within the same order of magnitude.	Steadily decreasing TCE in all soil vapor ports over time for all historical sampling events 2010 - 2014. Shallow port at 12.5 ft sampled for VI assessment events continued the declining vapor concentration trend.	No groundwater sample available for this well.	No direct comparison performed.	Increasing TCE trend in soil vapor with port depth coincident with proximity to projected fractured bedrock (depth 160 ft) and projected groundwater aquifer (depth 170 ft). Although no groundwater sample is available for this well, decreasing TCE soil vapor concentrations over time are coincident with declines for TCE concentrations in local 600 Area groundwater aquifer (Appendix E and NASA, 2019b).*
MSVM Well 600-SGW-5 (Twinned with Monitoring Well 600-G-138)						
Freon 113	F113 in soil non-detect for the soil	Increasing F113 in soil vapor with port depth by two orders	Decreasing F113 in all soil vapor ports over time for	Latest equivalent soil vapor concentration in	Soil vapor concentration in the lower port	Increasing F113 in soil vapor with depth and significant increase in deep port at

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – 2018[#&] (µg/m^3)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
	samples at 4 ft (<0.71 µg/kg) and 77 (<0.65 µg/kg) ft. Vadose zone soil porosity reported as 34% at 4 – 6 ft.[#]	of magnitude. Significant increase in deep port at 137.5 ft.	historical sampling events 2010 – 2014.	equilibrium with groundwater from twinned well 600-G-138 is 280,800 µg/m^3 on 11/20/14.	(280,000 µg/m^3 on 10/9/14) is within the same order of magnitude and has excellent correlation to the equivalent soil vapor in equilibrium with groundwater.	137.5 ft located 7 ft above perched groundwater on top of bedrock. Irregular F113 soil vapor concentrations over time within the deep port are associated with irregularly fluctuating F113 concentrations in perched groundwater at 600 Area well 600-G-136 (Appendix E and NASA, 2019b).*
TCE	TCE in soil non-detect for soil samples at 4 ft (<0.39 µg/kg) and 77 (<0.35 µg/kg) ft. Vadose zone soil porosity reported as 34% at 4 – 6 ft.[#]	Increasing TCE in soil vapor with port depth by two orders of magnitude. Significant increase in deep port at 137.5 ft.	Decreasing TCE in upper 3 soil vapor ports over time for historical sampling events. Deep port relatively consistent at between 13,800 and 16,000 µg/m^3.	Latest equivalent soil vapor concentration in equilibrium with groundwater from twinned well 600-G-138 is 26,260 µg/m^3 on 11/20/14.	Soil vapor concentration in the lower port (15,000 µg/m^3 on 10/9/14) is within the same order of magnitude and has strong correlation to the equivalent soil vapor in equilibrium with groundwater.	Increasing TCE in soil vapor with depth and significant increase in deep port at 137.5 ft located 7 ft above perched groundwater on top of bedrock. Irregular TCE soil vapor concentrations over time within the deep port are associated with irregularly fluctuating TCE concentrations in perched groundwater at twinned 600 Area well 600-G-136 (Appendix E and NASA, 2019b).*

Notes:

[@] = Soil analytical data from NASA, 2004.

= Soil and soil vapor analytical data (August 2010) from NASA, 2010.

& = Soil vapor data sets: March 2013 (NASA, 2013c); October 2014 (NASA, 2015c); and the VI assessment (August 2017 and February 2018).

* = Vertical concentration profiles (Appendix E) and Periodic Monitoring Report Time-Concentration maps and table (Appendix E of NASA, 2019b).

Appendix A
Pre-Sampling Building Inspection Forms

Complete This Form For Each Building Involved In Indoor Air Testing/Sampling 200 AREA B.200

Preparer's Name: GEOFF GILES

Date/Time Prepared: 6/21/17 1200 HRS

Preparer's Affiliation: NAVARRO RESEARCH & ENGINEERING

Work Phone: 575-524-5352

Purpose of Investigation: COMPONENT OF 200 AREA AND 600 AREA VAPOR INTRUSION ASSESSMENT WORK PLAN

1. **OCCUPANT:**

Interviewed: [✓ **Yes**] **or No**

Last Name: PINA ARPIN

First Name: CHRISTINA

Address: 12600 NASA ROAD, B.200, LAS CRUCES, NM 88012

County: DOÑA ANA

Work Phone: 575-524-5195

Alternate Phone:

Number of occupants at location: ≃20

Age of occupants: 20-60 YEARS

2. **OWNER OR LANDLORD:** (Check if same as occupant) ✓

Interviewed: [✓ **Y**]/**N**

Last Name:

First Name:

Address:

County:

Work Phone:

Alternate Phone:

3. **BUILDING CHARACTERISTICS:**

Type of Building: (Circle appropriate response)

Residential

[✓ Industrial]

School

Church

Commercial/Multi-use

Other: WSTF B.200 AREA

If the property is residential, type? (Circle appropriate response)

Ranch

Raised Ranch

Cape Cod

Duplex

Modular

2-Family

Split Level

Contemporary

Apartment House

Log Home

3-Family

Colonial

Mobile Home

Townhouse/Condos

Other:

NOTE: JIM MCCULLOUGH @ 575-524-5287 (200 AREA ENGINEER) PROVIDED ASSISTANCE WITH THE COMPLETION OF THIS FORM

If multiple units, how many? —

If the property is commercial, type?

Business Type(s) LABORATORY - PHOTOLAB, MACHINE SHOPS, TECHNICAL FACILITY

Does it include residences (i.e., multi-use)? Yes or [✓ No] If yes, how many?

Other characteristics:

Number of floors: 1 Building Age: 53 YEARS

Is the building insulated? [✓ Yes] or No How air tight? Tight / [✓ Average] / Not Tight

4. **AIRFLOW**

Use air current tubes or tracer smoke to evaluate airflow patterns & qualitatively describe:

Airflow between floors:

SINGLE FLOOR

Airflow near source:

FORCED REFRIDGERATED AIR (USING WATER-FILLED COOLING COILS)

Outdoor air infiltration:

THROUGH DOOR THRESHOLDS, CRACKS, OPEN DOORS ETC.

Infiltration into air ducts:

DUCT LEAKAGE THROUGH AIR DUCTS IN ROOF

5. **BASEMENT & CONSTRUCTION CHARACTERISTICS (Circle all that apply)**

Above grade construction: wood frame [✓ concrete] stone brick (SOME METAL SHEET PANELING IN THE NORTH HIGHBAY).

Basement type: full crawlspace slab other:

Basement floor: concrete dirt stone other:

Basement floor: unsealed sealed

Covered with:

Concrete floor: unsealed [✓ sealed]

Sealed with: CONCRETE SEALANT COVERED WITH 9"x9" VINYL TILE.

Foundation walls: [✓ poured block] stone other: POURED CONCRETE FOOTING

Foundation walls: unsealed [✓ sealed]

Sealed with: CONCRETE SEALANT COVERED WITH PAINT

The basement is: wet damp dry moldy [✓ N/A]

The basement is: finished unfinished partially finished [✓ N/A]

Sump present? Yes or No

Basement/Lowest level depth below grade: ____________________ feet

Water in sump? Yes No Not Applicable

Identify potential soil vapor entry points & approximate size (e.g., cracks, utility ports, drains).

____

6. HEATING, VENTING & AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

[✓ Hot air circulation] Heat pump Hot water baseboard

Space heaters Steam radiation Radiant floor

Electric baseboard Wood stove Outdoor wood boiler

Other: ____

The primary type of fuel used is:

[✓ Natural gas] Fuel oil Kerosene

Electric Propane Solar

Wood Coal

Domestic hot water tank fueled by: NATURAL GAS BOILER

Boiler/furnace located in: Basement Outdoors [✓ Main Floor] (NORTH HIGHBAY)

Other: ____

Air conditioning: [✓ Central air] Window units Open windows (LOCALIZED EXCEPTIONS 1) SMALL REFRIGERATED UNIT @ PHOTOLAB ROOMS 203 AND 204. 2) SMALL REFRIGERATED UNIT FOR ROOM 206B*)

Are there air distribution ducts present? [✓ Yes] or No

[✓ Heat Pump] None

Describe the supply & cold air return ductwork & its condition where visible, including whether there is a cold air return & tightness of duct joints. Indicate the locations on the floor plan diagram.

HVAC SYSTEM RUNS 24 e 7 DUE TO LABORATORY ENVIRONMENT

*NOTE: ROOM 206B WAS BUILT OVER THE FENCED-IN YARD THAT WAS THE LOCATION FOR THE CLEAN ROOM TANKS IN THE 1960'S.

7. OCCUPANCY

Is basement/lowest lever occupied?

Full-time [✓ Occasionally] Seldom Almost never

Level General use of each floor (e.g., family room, bedroom, laundry, workshop, storage)

Basement: N/A

1st Floor: PHOTOGRAPHY LAB, MACHINE SHOPS, EQUIPMENT /MATERIAL STORAGE, GARAGE, UTILITY ROOMS.

2nd Floor: N/A

3rd Floor: N/A

4th Floor: N/A

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

Is there an attached garage? Yes or [✓ No]

Does the garage have a separate heating unit? Yes , No or [✓ Not Applicable]

Are petroleum-powered machines or vehicles stored in the garage? (e.g., lawnmower, ATV, car)

Yes or No. Please specify:

Has the building ever had a fire? Yes or [✓ No] When?

Is a kerosene or unvented gas space heater present? Yes or [✓ No]

Where & Type?

Is there a workshop or hobby/craft area? [✓ Yes] or No

Where & Type? MACHINE SHOP WITH DRILL, LATHE, LUBRICATING OILS

Is there smoking in the building? Yes or [✓ No] Frequency?

Have cleaning products been used recently? [✓ Yes] or No

When and What Type? JANITOR CLEANS BUILDING AS REQUIRED (DAILY), CLEANING ROOM OPERATIONS.

Have cosmetic products been used recently? [✓ Yes] or No

When and What Type? COSMETIC PRODUCTS USED DAILY BY PERSONNEL

Has painting/staining been done in the last 6 months? Yes or [✓ No]

Where and When?

Is there new carpet, drapes or other textiles? Yes or [✓ No]

Where and When?

Have air fresheners been used recently? [✓ Yes] or No

When and What Type? FEBREEZE IN BATHROOMS

Is there a kitchen exhaust fan? [✓ Yes] or No

If yes, where vented? SEVERAL FLUME HOODS VENTED ON ADJACENT WALL TO OUTSIDE

Is there a bathroom exhaust fan? [✓ Yes] or No

If yes, where vented? ADJACENT WALL TO ROOF AREA.

Is there a clothes dryer? [✓ Yes] or No If yes, is it vented outside? [✓ Yes] or No (VALVE SHOP AREA)

Has there been a pesticide application? [✓ Yes] or No

When and Type? ON A QUARTERLY SCHEDULE - POTENTIALLY TODAY (6/21/17).

Are there odors in the building? [✓ Yes] or No

If yes, please describe: BUILDING PART OF CHEMISTRY LAB - EACH ROOM HAS A DIFFERENT ODOR RELATED TO SUPPLIES.

Do any of the building occupants use solvents or volatile chemicals at work? [✓ Yes] or No (e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)

If yes, what type of solvents are used? CHEMICAL MANUFACTURING, LABORATORY SOLVENTS, OILS & LUBRICANTS IN MACHINE SHOP, PAINTS, ADHESIVES, ETC.

If yes, are their clothes washed at work? [✓ Yes] or No

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle one)

Yes, use dry-cleaning regularly (weekly) [✓ Yes, use dry-cleaning infrequently (monthly or less)]

Yes, work at a dry-cleaning service No

Unknown

Is there a radon mitigation system for the building/structure? Yes or [✓ No]

Date of Installation: ____________________

Is the system active or passive? Active or Passive

9. WATER & SEWAGE

Water Supply: Public water [✓ Drilled well] Driven well Dug well

Other: WATER SUPPLIED FROM DRILLED WELLS LOCATED 5 MILES TO THE WEST

Sewage Disposal: [✓ Public sewer] Septic tank Leach field Dry well

Other: CITY OF LAS CRUCES PUBLIC SANITARY SYSTEM

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. **Provide reasons why relocation is recommended:**

____

b. **Residents choose to:** remain in home relocate to friends/family relocate to hotel/motel

c. **Responsibility for costs associated with reimbursement explained?** Yes or No

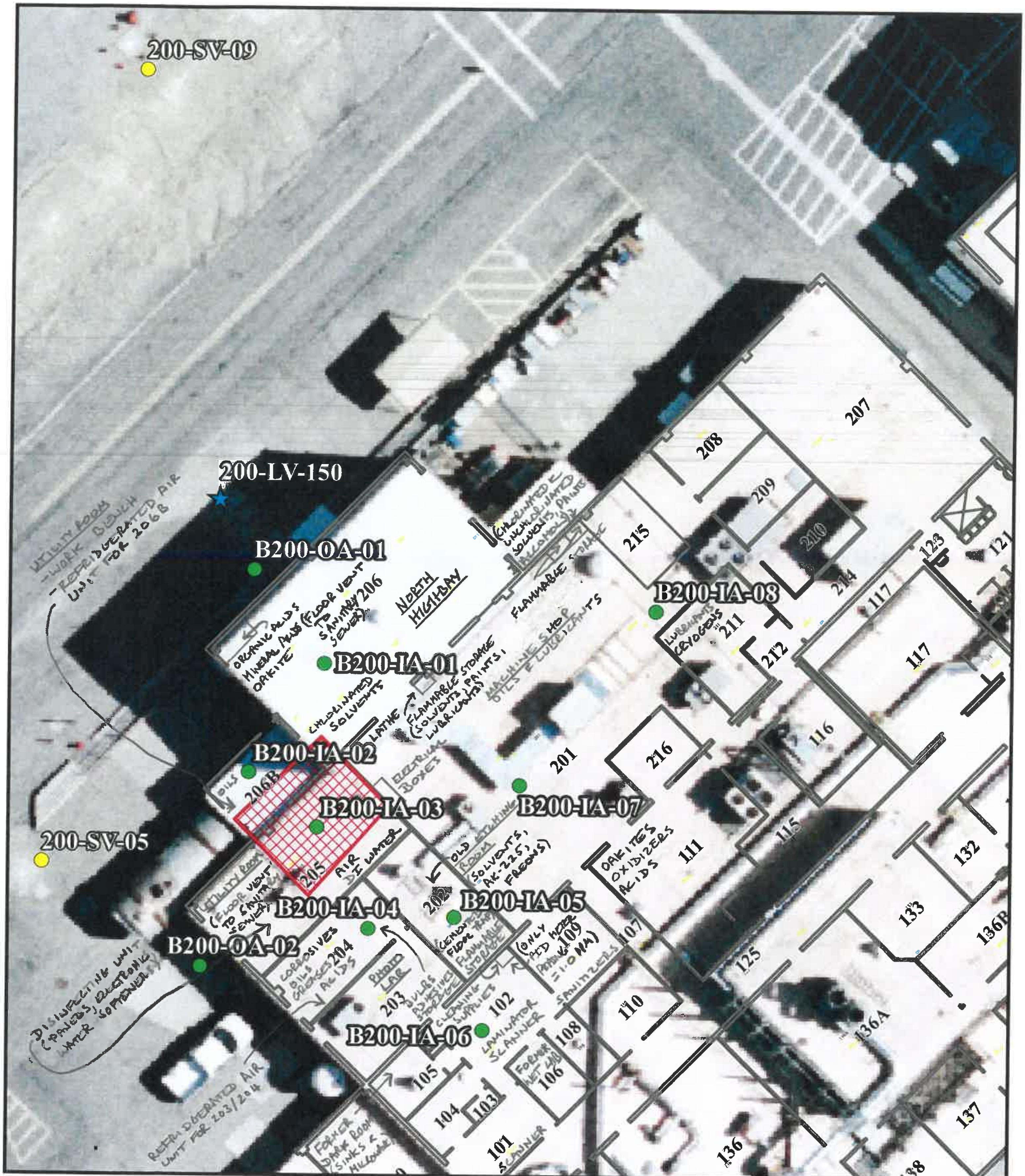
d. Relocation package provided & explained to residents? Yes or No

11. FLOOR PLANS

Draw a plan view sketch of the basement & first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement: N/A

First Floor: SEE ATTACHED SHEET (WEST BUILDING 200)



West Building 200 Soil Vapor and Air Sampling Locations

● Air Sample Location

★ MSVGM Well Sample

🟥 HWMU

● MSVM Sample

N
W E
S

0 10 20 40 Feet

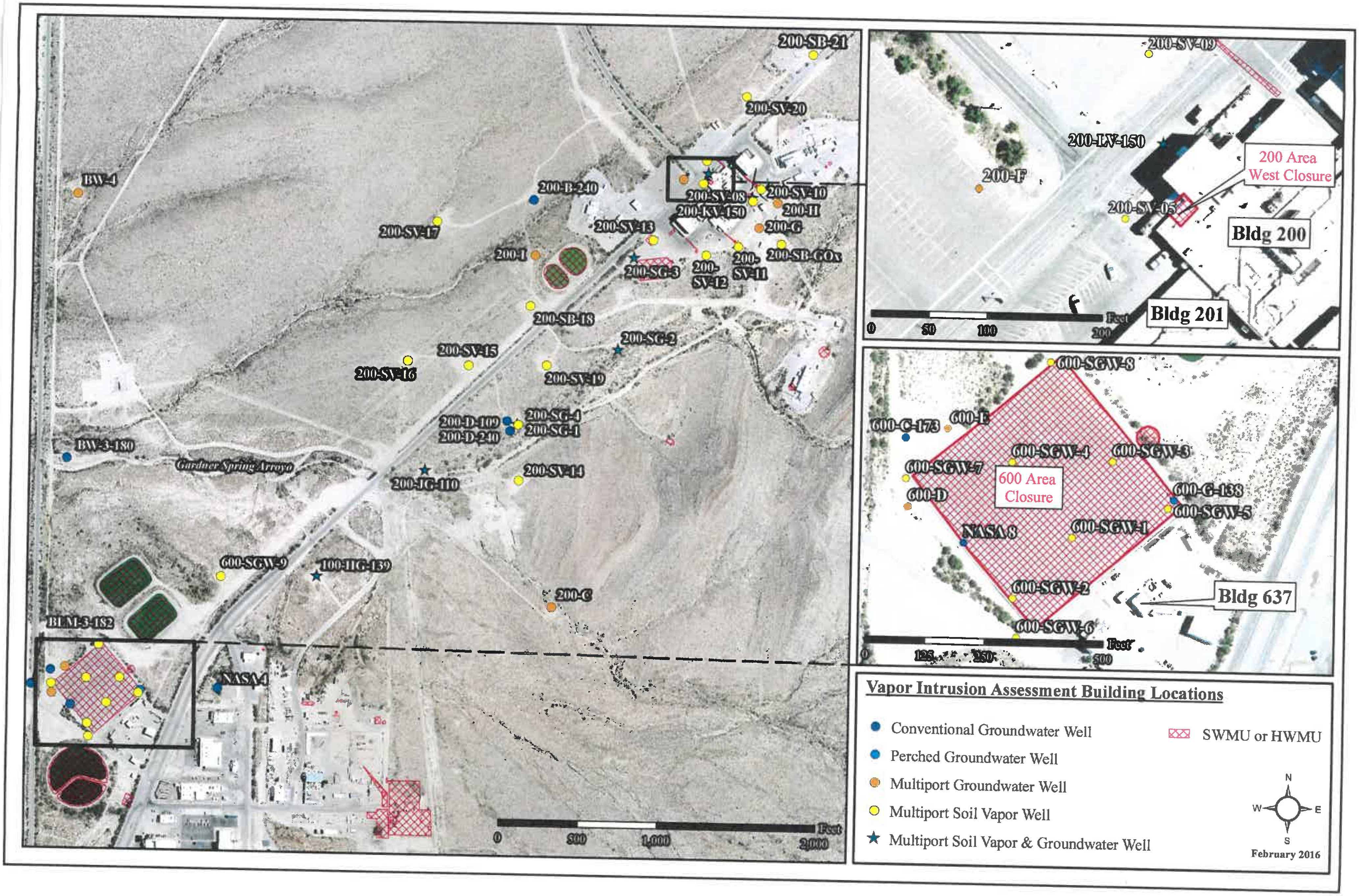
February 2016

Second Floor: N/A

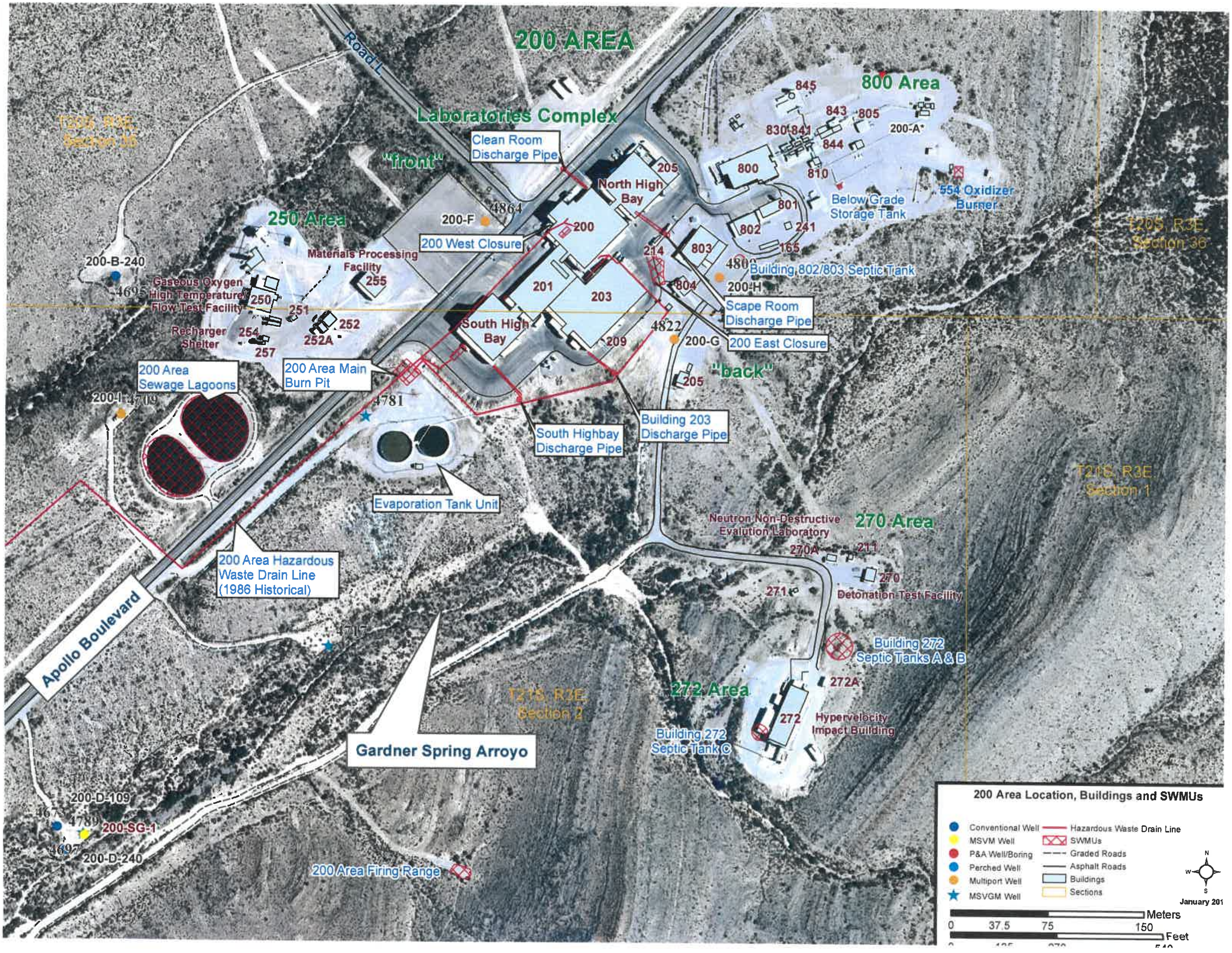
12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc), outdoor air sampling location(s) & PID meter readings.

Also indicate compass direction, wind direction & speed during sampling, the locations of the well & septic system, if applicable, & a qualifying statement to help locate the site on a topographic map.



Vapor Intrusion Assessment Building Locations



200 AREA
Road L
Laboratories Complex
"front"
"back"
800 Area
250 Area
270 Area
272 Area
T20S, R3E, Section 35
T20S, R3E, Section 36
T21S, R3E, Section 1
T21S, R3E, Section 2
Clean Room Discharge Pipe
North High Bay
205
200
201
203
209
214
South High Bay
200 West Closure
200 East Closure
Scape Room Discharge Pipe
South Highbay Discharge Pipe
Building 203 Discharge Pipe
200 Area Main Burn Pit
200 Area Sewage Lagoons
Evaporation Tank Unit
200 Area Hazardous Waste Drain Line (1986 Historical)
Apollo Boulevard
Gardner Spring Arroyo
200 Area Firing Range
4864
200-F
4822
200-G
4800
200-H
4781
4709
200-I
4717
200-B-240
4695
200-D-109
4673
4789
200-SG-1
4697
200-D-240
Materials Processing Facility
255
Gaseous Oxygen High Temperature Flow Test Facility
250
251
252
252A
Recharger Shelter
254
257
845
843
805
830
841
844
200-A*
800
810
801
802
241
165
803
804
554 Oxidizer Burner
Below Grade Storage Tank
Building 802/803 Septic Tank
205
Neutron Non-Destructive Evalution Laboratory
270A
211
270
271
Detonation Test Facility
Building 272 Septic Tanks A & B
272A
272
Hypervelocity Impact Building
Building 272 Septic Tank C
200 Area Location, Buildings and SWMUs
Conventional Well
MSVM Well
P&A Well/Boring
Perched Well
Multiport Well
MSVGM Well
Hazardous Waste Drain Line
SWMUs
Graded Roads
Asphalt Roads
Buildings
Sections
N
W
S
January 201
Meters
0
37.5
75
150
Feet

13. PRODUCT INVENTORY FORM

Preliminary walk-through conducted on 6/21/2017
P. Egan and G. Giles, Navarro

Make & Model of field instrument used: MSA Altair 5X PID

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (ppm)	Photo** Y / N
Photo Lab Rm 102 B200-IA-06	Glue Paper		In Use	Heat-activated Adhesive	0	Y
	Flammables Cabinet	~3ft^3	In Use	Various chemicals	1	
	Fire Extinguisher		Unopened	Possible fluorocarbon propelling agent	0	
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
	Hand Sanitizer	2 liters	In Use	Ethyl Alcohol	0	
Photo Lab Room 203	Fire Extinguisher		Ready to Use	Possible fluorocarbon propelling agent	0	Y
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
	Gator Board		In Use	Adhesive Backing	0	
Photo Lab Room 204 (Storage (Shelves) B200-IA-04	Adhesive Tape	50' roll	Open & Unopened	Adhesive Backing	0	Y
	Dry Erase Markers		Unopened	Solvent (ethanol ?)	0	
	Kodak Lens Cleaner		Unopened		0	
Room 202 B200-IA-05	Sure Coat	5 gal buckets	Unopened & Used	Epoxy	0	Y
	Freon	Steel canisters	Unopened	Freon	0	
Room 201	FilterMate Vapor Extractor	machine	In Use	?	0	Y
	Hydraulic Drill Press	machine	In Use	Lubes/Oils	0	
Room 111	Cleaners	Open Vats	In Use	Oakite, oxidizers, sulfuric acids	0	Y
Room 201 B200-IA-08	drain to sanitary sewer (outside room 111)	Utility Sink	In Use	?	0	Y
B200-IA-07	Flammable Cabinets #2 & #3	1 large, 1 small	In Use	Alcohols, chlorinated solvents, Rustoleum spray paints, WD-40	0	
	Flammable Cabinet #1	small	In Use	Paints, solvents, lubes	0	

Room 216 Assembly Room	Krytox		In Use	?	0	Y
Room 206 (CSS HiBay) B200-IA-01	Several products		In Use	Oakite, IPA, Acids, Sat Accum Area, full of stuff!	0	Y
Room 206B Workbench Area B200-IA-02	Marker Pens Oils used for assembly	small	In Use	?	0	Y
Room 205 Utility Room B200-IA-03	Active Drain to Sewer Bags of water softening pellets		In Use	Citric acid anhydrous	0	Y
Room 204	Various		In Use	Full of petrochemicals, acids, corrosives, vacuum pump oils.	0	Y

***Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D)**
****Photographs of the front & back of the product containers can replace the hand written list of chemical ingredients. However, the photographs must be of good quality & ingredient labels must be legible.**

Complete This Form For Each Building Involved In Indoor Air Testing/Sampling 600 AREA B.637

Preparer's Name: GEOFF GILES Date/Time Prepared: 6/26/17 1400 HRS

Preparer's Affiliation: NAVARRO RESEARCH & ENGINEERING Work Phone: 575-524-5352

Purpose of Investigation: COMPONENT OF 200 AREA AND 600 AREA VAPOR INTRUSION ASSESSMENT WORK PLAN

1. **OCCUPANT:**
Interviewed: [✓ **Yes**] **or No**

Last Name: DEL FERRARO First Name: CRAIG

Address: 12600 NASA ROAD, B.637, LAS CRUCES, NM 88012

County: DOÑA ANA

Work Phone: 575-524-5699 Alternate Phone:

Number of occupants at location: ≃ 8

Age of occupants: ≃ 20-60 YEARS

2. **OWNER OR LANDLORD:** (Check if same as occupant) ✓
Interviewed: Y/N

Last Name: First Name:

Address:

County:

Work Phone: Alternate Phone:

3. **BUILDING CHARACTERISTICS:**

Type of Building: (Circle appropriate response)

Residential
[✓ Industrial]
School
Church
Commercial/Multi-use
Other: WSTF B.637 AREA (1200 SQFT BUILDING)

If the property is residential, type? (Circle appropriate response)

Ranch
Raised Ranch
Cape Cod
Duplex
Modular
2-Family
Split Level
Contemporary
Apartment House
Log Home
3-Family
Colonial
Mobile Home
Townhouse/Condos
Other:

If multiple units, how many? —

If the property is commercial, type?

Business Type(s) GROUND WATER ASSESSMENT BUILDING - SAMPLING EQUIPMENT

Does it include residences (i.e., multi-use)? Yes or [✓ No] If yes, how many? ____

Other characteristics:

Number of floors: 1 Building Age: 26 YEARS

Is the building insulated? [✓ Yes] or No How air tight? Tight / [✓ Average] / Not Tight

4. **AIRFLOW**

Use air current tubes or tracer smoke to evaluate airflow patterns & qualitatively describe:

Airflow between floors:

SINGLE FLOOR

Airflow near source:

FORCED AIR THROUGH SWAMP COOLER

Outdoor air infiltration:

THROUGH DOOR THRESHOLDS, OPEN DOORS (NO WINDOWS)

Infiltration into air ducts:

VIA SWAMP COOLER LOCATED ON GROUND ON NORTH SIDE OF B. 637

5. **BASEMENT & CONSTRUCTION CHARACTERISTICS (Circle all that apply)**

Above grade construction: wood frame [✓ concrete] stone brick [✓ CORRUGATED METAL SIDING]

Basement type: full crawlspace slab other: ____

Basement floor: concrete dirt stone other: ____

Basement floor: unsealed sealed

Covered with: ____

Concrete floor: unsealed [✓ sealed]

Sealed with: CONCRETE SEALANT

Foundation walls: poured block stone other: POURED CONCRETE FOOTING CORRUGATED METAL SIDING

Foundation walls: unsealed [✓ sealed]

Sealed with: PAINT

The basement is: wet damp dry moldy [✓ N/A]

The basement is: finished unfinished partially finished [✓ N/A]

Sump present? Yes or No

Basement/Lowest level depth below grade: ________________ feet

Water in sump? Yes No Not Applicable

Identify potential soil vapor entry points & approximate size (e.g., cracks, utility ports, drains).

____

6. HEATING, VENTING & AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

[✓ Hot air circulation] Heat pump Hot water baseboard

Space heaters Steam radiation Radiant floor

Electric baseboard Wood stove Outdoor wood boiler

Other: ____

The primary type of fuel used is:

[✓ Natural gas] Fuel oil Kerosene

Electric Propane Solar

Wood Coal

Domestic hot water tank fueled by: N/A

Boiler/furnace located in: Basement Outdoors Main Floor

Other: ____

Air conditioning: [✓ Central air] Window units Open windows

Are there air distribution ducts present? [✓ Yes] or No

Heat Pump None

Describe the supply & cold air return ductwork & its condition where visible, including whether there is a cold air return & tightness of duct joints. Indicate the locations on the floor plan diagram.

SWAMP COOLER USUALLY SHUT DOWN AT WEEKEND WHEN BUILDING IS UNOCCUPIED

7. OCCUPANCY

Is basement/lowest lever occupied?

Full-time [✓ Occasionally] Seldom Almost never

Level General use of each floor (e.g., family room, bedroom, laundry, workshop, storage)

Basement: N/A

1st Floor: SAMPLE EQUIPMENT STORAGE AND SAMPLE MANAGEMENT IN SINGLE ROOM WAREHOUSE.

2nd Floor: N/A

3rd Floor: N/A

4th Floor: N/A

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

Is there an attached garage? Yes or [✓ No] NEARBY (10 FT) MORGAN BUILDING (T-637A) ON SOUTHWEST CORNER, CONTAINS GENERATORS, STEAM CLEANERS, FLAMMABLES – SILICONE SPRAY, ISOPROPYL ALCOHOL, GASOLINE, CORROSIVES – SODIUM HYDROXIDE, OILS.

Does the garage have a separate heating unit? Yes , No or [✓ Not Applicable]

Are petroleum-powered machines or vehicles stored in the garage? (e.g., lawnmower, ATV, car)

Yes or No. Please specify:

Has the building ever had a fire? Yes or [✓ No] When?

Is a kerosene or unvented gas space heater present? Yes or [✓ No]

Where & Type?

Is there a workshop or hobby/craft area? [✓ Yes] or No

Where & Type? WORKBENCH WITH TOOLS & LUBRICANTS IN SOUTHWEST CORNER OF BUILDING.

Is there smoking in the building? Yes or [✓ No]? Frequency?

Have cleaning products been used recently? [✓ Yes] or No

When and What Type? TECHNICIANS CLEAN WORK SURFACES W/CHLORINATED WIPES WHEN REQUIRED.

Have cosmetic products been used recently? Yes or [✓ No]

When and What Type?

Has painting/staining been done in the last 6 months? Yes or [✓ No]

Where and When?

Is there new carpet, drapes or other textiles? Yes or [✓ No]

Where and When?

Have air fresheners been used recently? Yes or [✓ No]

When and What Type?

Is there a kitchen exhaust fan? Yes or [✓ No]

If yes, where vented? ______________________________

Is there a bathroom exhaust fan? Yes or [✓ No]

If yes, where vented? ______________________________

Is there a clothes dryer? Yes or [✓ No] If yes, is it vented outside? Yes or No

Has there been a pesticide application? [✓ Yes] or No

When and Type? WITHIN LAST MONTH FOR INSECTS & RODENTS.

Are there odors in the building? [✓ Yes] or No

If yes, please describe: CHEMICAL PRESERVATIVES FOR WATER SAMPLES (DILUTE ACIDS)

Do any of the building occupants use solvents or volatile chemicals at work? [✓ Yes] or No (e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)

If yes, what type of solvents are used? LABORATORY PRESERVATIVES, CLEANING FLUIDS.

If yes, are their clothes washed at work? Yes or [✓ No]

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle one)

Yes, use dry-cleaning regularly (weekly) Yes, use dry-cleaning infrequently (monthly or less)

Yes, work at a dry-cleaning service [✓ No]

Unknown

Is there a radon mitigation system for the building/structure? Yes or [✓ No]

Date of Installation: ______________________________

Is the system active or passive? Active or Passive

9. WATER & SEWAGE

Water Supply: Public water [✓ Drilled well] Driven well Dug well

Other: WATER SUPPLIED FROM DRILLED WELLS LOCATED 4 MILES TO THE WEST

Sewage Disposal: [✓ Public sewer] Septic tank Leach field Dry well

Other: ______________________________

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended:

____

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? Yes or No

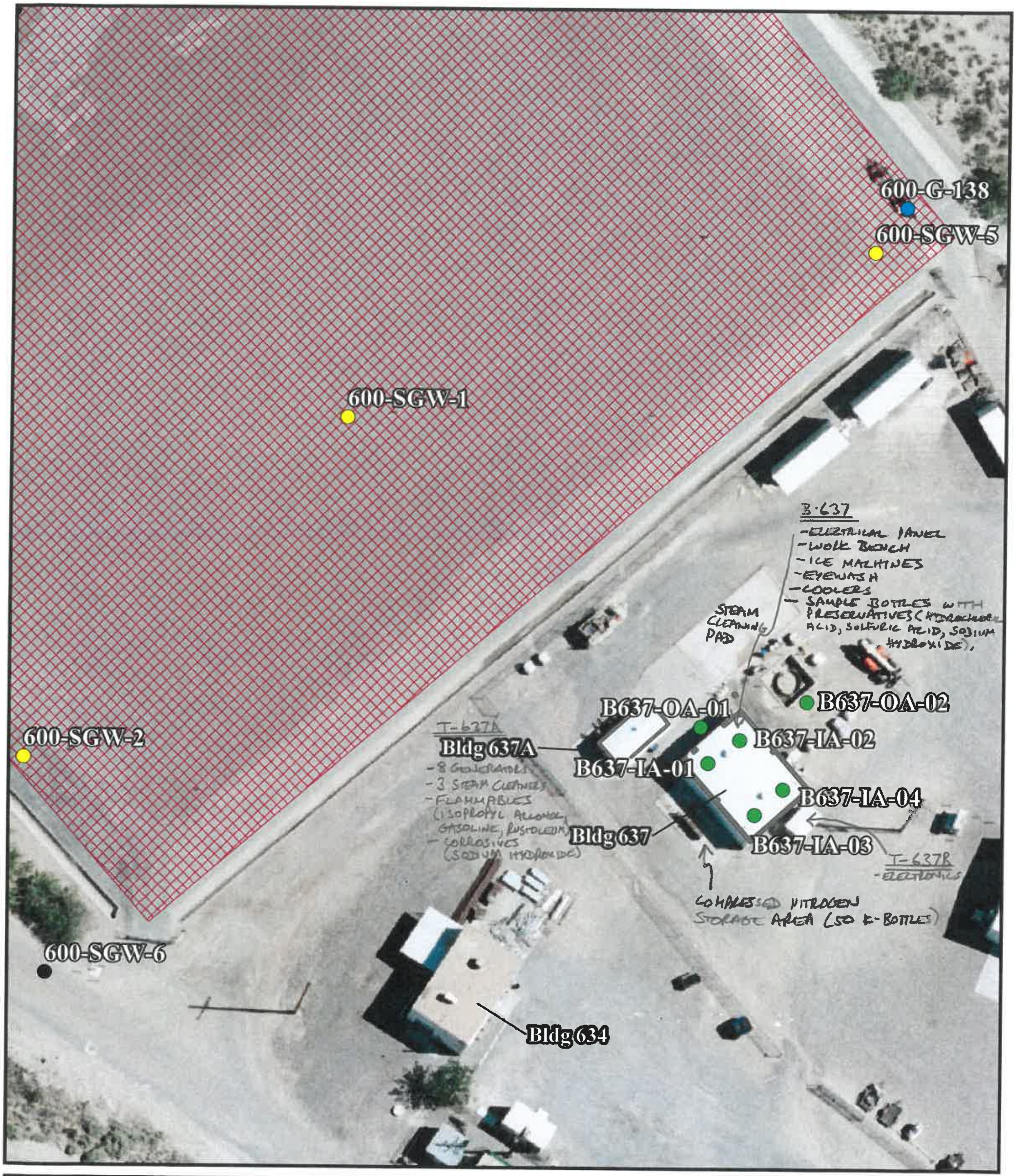
d. Relocation package provided & explained to residents? Yes or No

11. FLOOR PLANS

Draw a plan view sketch of the basement & first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement: N/A

First Floor: SEE ATTACHED SHEET (BUILDING 637)



Building 637 Soil Vapor and Air Sampling Locations

● Air Sample Location
● MGMV Well Sample
● MGVM Well
● Perched GW Monitoring Well
▨ SWMU

0 15 30 60 Feet

N
W E
S

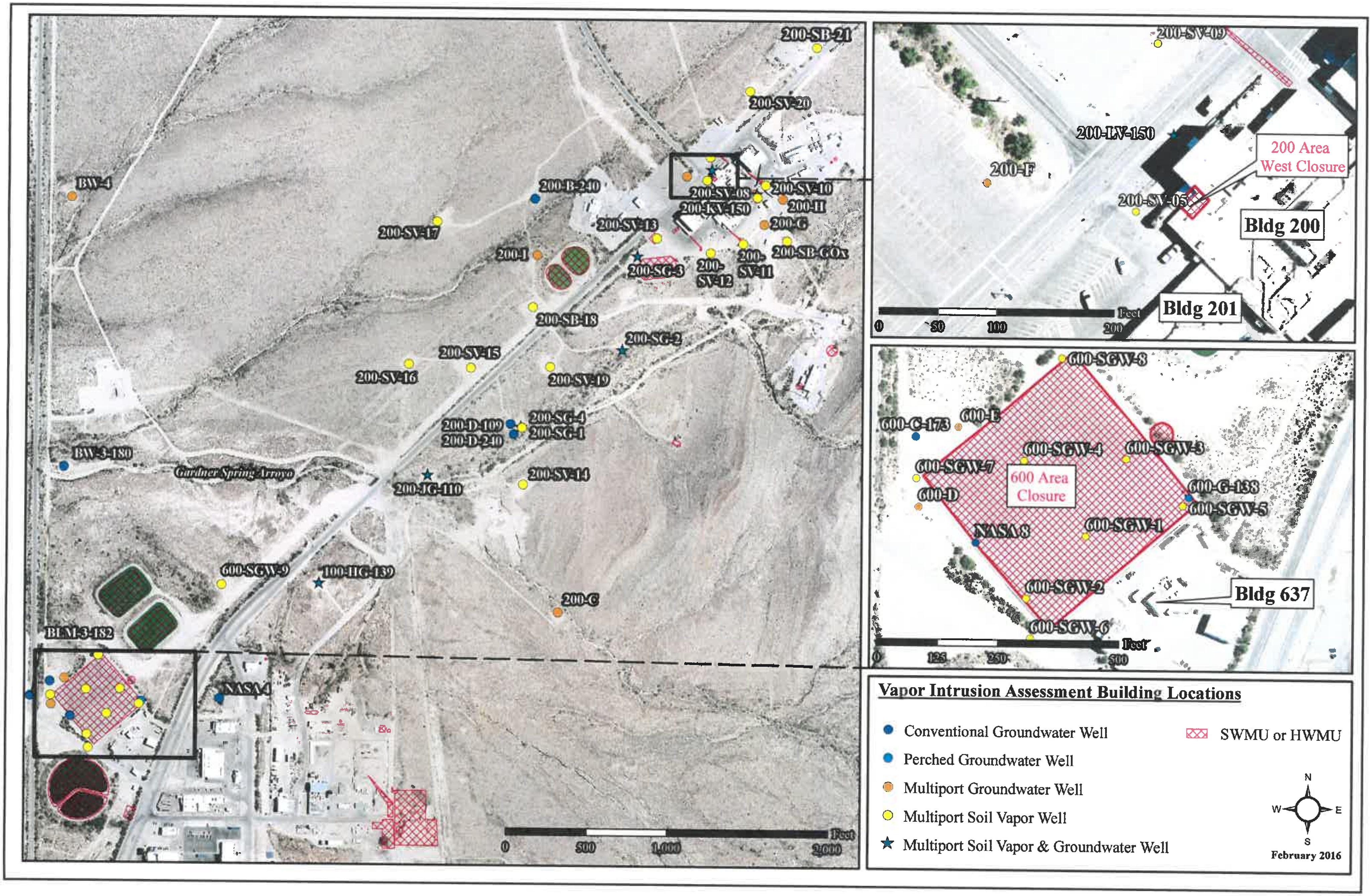
February 2016

Second Floor: N/A

12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc), outdoor air sampling location(s) & PID meter readings.

Also indicate compass direction, wind direction & speed during sampling, the locations of the well & septic system, if applicable, & a qualifying statement to help locate the site on a topographic map.


200-SB-21
200-SV-20
BW-4
200-B-240
200-SV-17
200-SV-08
200-KV-150
200-SV-10
200-H
200-SV-13
200-G
200-I
200-SG-3
200-SV-12
200-SV-11
200-SB-GOx
200-SB-18
200-SG-2
200-SV-15
200-SV-16
200-SV-19
200-D-109
200-D-240
200-SG-4
200-SG-1
BW-3-180
Gardner Spring Arroyo
200-JG-110
200-SV-14
600-SGW-9
100-HG-139
200-C
BLM-3-182
NASA-4
0
500
1,000
2,000
Feet
200-SV-09
200-LV-150
200-F
200 Area West Closure
200-SV-05
Bldg 200
Bldg 201
0
50
100
200
Feet
600-SGW-8
600-C-173
600-E
600-SGW-4
600-SGW-3
600-SGW-7
600 Area Closure
600-D
600-G-138
600-SGW-5
NASA 8
600-SGW-1
600-SGW-2
Bldg 637
600-SGW-6
0
125
250
500
Feet
Vapor Intrusion Assessment Building Locations
● Conventional Groundwater Well
● Perched Groundwater Well
● Multiport Groundwater Well
○ Multiport Soil Vapor Well
★ Multiport Soil Vapor & Groundwater Well
▨ SWMU or HWMU
N
W
E
S
February 2016

13. PRODUCT INVENTORY FORM

Preliminary walk-through conducted on 6/26/2017
G. Giles, Navarro

Make & Model of field instrument used: MSA Altair 5X PID

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (ppm)	Photo** Y / N
Building 637	Sample Bottles (with Preservative)	40 mL – 1 Liter	Unopened	Dilute hydrochloric acid, sulfuric acid, sodium hydrozide	0	Y
	Fire Extinguisher	0.5 cuft	Unopened	Possible fluorocarbon propelling agent	0	
	Hand Sanitizer	1 Liter	In Use	Ethyl Alcohol	0	
Building T-637A	Flammables Cabinet	0.25L – 1 Liter	In Use	Silicone spray, isopropyl alcohol, gasoline, Rustoleum products	0	Y
	Corrosives Cabinet	14 oz	In Use	Sodium hydroxide	0	
	Generators	8 cuft	In Use	Gasoline and oil	0	
	Steam Cleaners	8 cuft	In Use	Gasoline and oil	0	
	Oils/Lubricants	1 Liter	Unopened	Various motor oils and lubricants (WD40)	0	
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
Building T-637B	Groundwater Sampling Equipment Electronics	50’ – 500’ reels	In Use		0	Y
Compressed Nitrogen Storage Area Adjacent to B. 637	Compressed Gas Cylinders	1.5 cuft	In Use	Nitrogen	0	N

***Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D)**
****Photographs of the front & back of the product containers can replace the hand written list of chemical ingredients. However, the photographs must be of good quality & ingredient labels must be legible.**

Appendix B
Pre-Sampling Building Walkthrough Photographs

Photograph 1 **Building 200, Room 102 (Photographic Laboratory) – 06/28/2017**

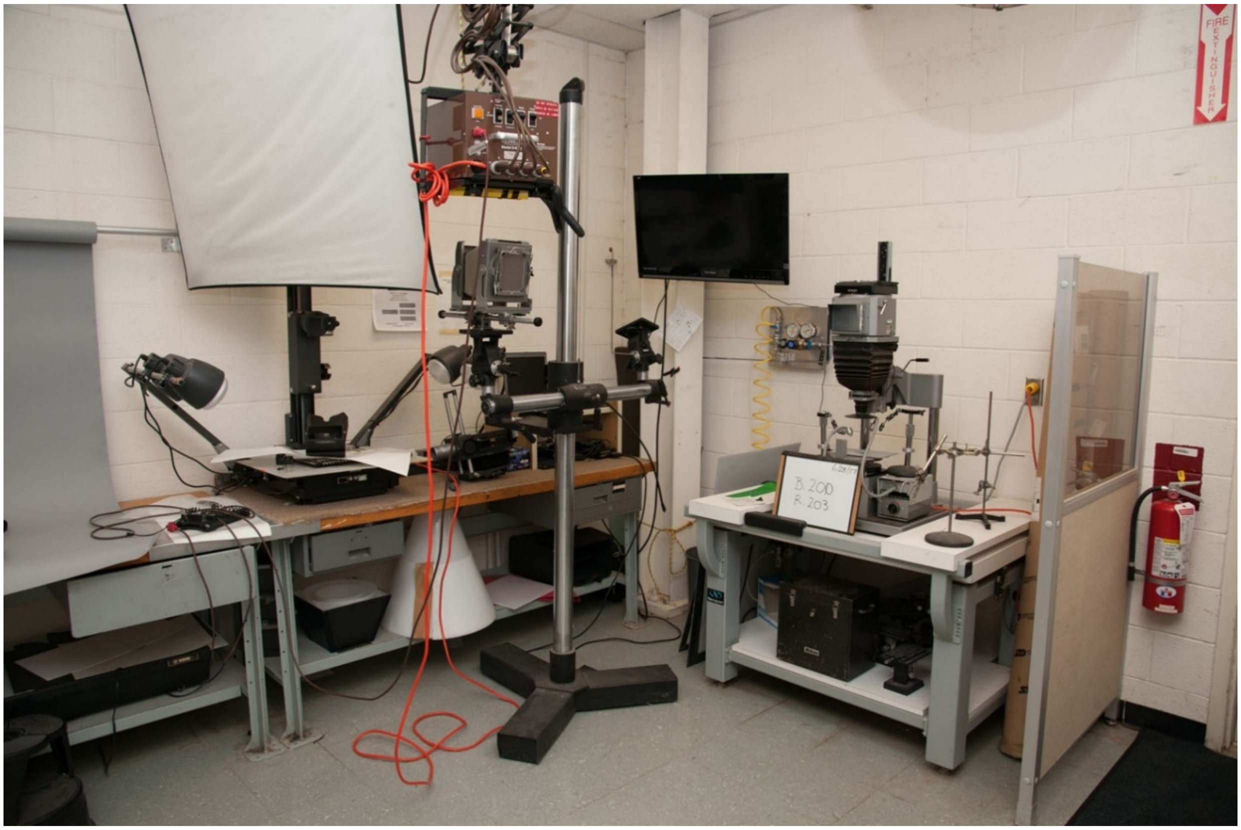
Photograph 2 **Building 200, Room 102 (Photographic Laboratory) – 06/28/2017**

Photograph 3 Building 200, Room 106 (Photographic Laboratory Office) – 06/28/2017

Photograph 4 Building 200, Room 108 (Photographic Laboratory Office) – 06/28/2017

Photograph 5 **Building 200, Room 105 (Photographic Laboratory Store Room) – 06/28/2017**

Photograph 6 **Building 200, Room 203 (Photographic Laboratory) – 06/28/2017**



Photograph 7 **Building 200, Room 204 (Photographic Laboratory Store Room) – 06/28/2017**

Photograph 8 **Building 200, Room 201 (Technical Facility Store Room) – 06/28/2017**

Photograph 9 **Building 200, Room 201 (Machine Shop) – 06/28/2017**

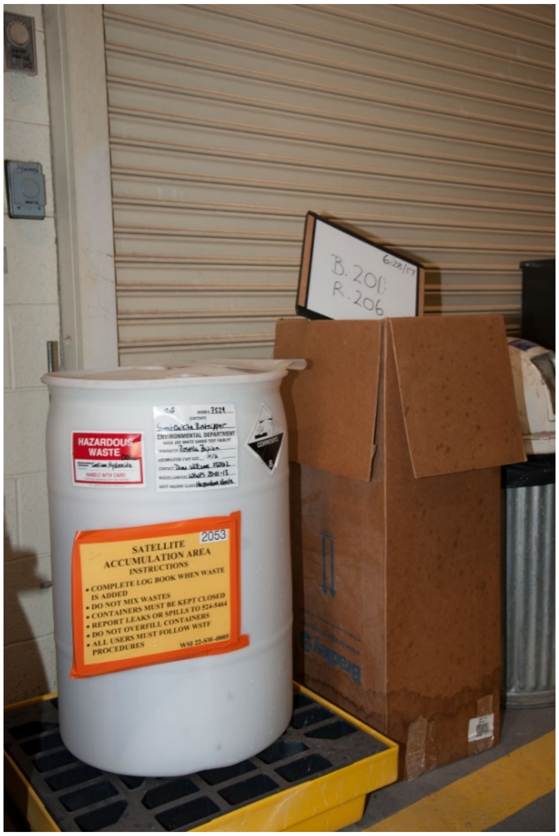
Photograph 10 **Building 200, Room 201 (Machine Shop) – 06/28/2017**

Photograph 11 Building 200, Room 206 (Technical Facility Chemical Storage) – 06/28/2017

Photograph 12 Building 200, Room 206 (Technical Facility Chemical Storage) – 06/28/2017

Photograph 13 **Building 200, Room 206 (Technical Facility Chemical Storage) – 06/28/2017**

Photograph 14 **Building 200, Room 206 (Technical Facility Chemical Storage) – 06/28/2017**



Photograph 15 **Building 200, Room 206B (Workshop) – 06/28/2017**

Photograph 16 **Building 200, Room 205 (Equipment Room) – 06/28/2017**

Photograph 17 **Building 200, Room 205 (Equipment Room Storage) – 06/28/2017**

Photograph 18 **Building 200, Room 204 (Equipment Room Storage) – 06/28/2017**

Photograph 19 Building 637 Northeast Corner (Groundwater Assessment Building) – 06/28/2017

Photograph 20 Building 637 Northwest Corner (Groundwater Assessment Building) – 06/28/2017

Photograph 21 **Building 637 Southwest Corner (Groundwater Assessment Building) – 06/28/2017**

Photograph 22 **Building 637 Southeast Corner (Groundwater Assessment Building) – 06/28/2017**

Photograph 23 Building T-637A (Morgan Building for Flammable Storage) – 06/28/2017

Photograph 24 Building T-637A (Morgan Building for Flammable Storage) – 06/28/2017

Photograph 25 Building T-637B (Morgan Building for Miscellaneous Equipment Storage) – 06/28/2017

Photograph 26 Building T-637B (Morgan Building for Miscellaneous Equipment Storage) – 06/28/2017

Photograph 27 **Outside, South West Side of Building 200 (1L Soil Vapor Sample with Duplicate) – 02/25/2018**

Photograph 28 **Building 200, Room 102 (6L Indoor Air Sample) – 02/25/2018**

Photograph 29 **Outside on South Side of Building 200 (6L Outdoor Air Sample) – 02/25/2018**

Appendix C
Quality Assurance Reports

National Aeronautics and Space Administration

Quality Assurance Report for White Sands Test Facility 200 and 600 Area Vapor Intrusion Assessment Report Soils Analytical Data

April 2023

NM 8800019434

Report Submitted:
Report Prepared by: Will Teas
Navarro Research and Engineering, Inc.

1.0 Introduction

The 200 and 600 Area Vapor Intrusion Assessment Work Plan requires the preparation of an investigation report that includes soil analytical data reported. The Quality Assurance Report (QAR) prepared and reviewed by responsible environmental contractor data management personnel provides the following information:

- A summary of notable anomalies.
- A summary of notable data quality issues by analytical method, if any.
- A list of the sample events for which soil samples were collected in April and October 2017.
- The quantity and type of quality control samples collected or prepared in April and October 2017.
- Definitions of data qualifiers used in WSTF analytical data reporting.
- The quantity and type of data qualifiers applied to individual analytical results.
- A list of duplicate samples and their relative percent differences (RPD)
- A summary table of blank sample detections.

2.0 Data Quality

2.1 Notable Anomalies

Soil analytical data from samples collected for the 200 Area Phase II Investigation Report and the 600 Area Closure Investigation Report were used to perform a cumulative risk screening assessment. The soil data includes equipment blanks, field blanks, duplicates, trip blanks, in accordance with the approved work plan.

3.0 Data Tables

Table 1 summarizes the soil sample events in September 2009, November 2009, December 2009, January 2010, June 2014, and July 2014. This report is based on data quality issues related to the sample events listed in Table 1.

Table 2 through Table 5 contain information related to the sample events identified in Table 1. As specified by the Vapor Intrusion Assessment Work Plan, Section 5.4, specific quality control samples are utilized to assess the quality of analytical data. Table 2 presents the quantity of quality control samples collected for each analytical method. Table 3 compares the quality control sample percentages collected to the requirements in the respective investigation work plan. When data quality criteria are not met, data qualifiers are applied to the data. Definitions of data qualifiers used for WSTF chemical analytical data are listed in Table 4. Table 5 presents the total number of individual result records and summarize the quantity of field and laboratory data qualifiers assigned to individual analyte result records in the WSTF analytical database. Table 6 provides the RPD between duplicate samples. Samples associated with qualified data are identified by bold text in Table 6. Table 7 provides all detections found in trip blank and field blank samples. All data affected by blank sample detections are appropriately qualified.

4.0 Usability Assessment

The goal of the usability assessment is to determine the quality of each data point and to identify data that are not acceptable to support project quality objectives. This QAR qualifies as the completed assessment for the soil data from samples collected for the 200 Area Phase II Investigation Report and the 600 Area Closure Investigation Report in addition to the August 2017 and February 2018 sample events performed for the 200 and 600 Area Vapor Intrusion Assessment Report. No data was rejected (R) based on established quality review protocols.

Table 1 – Soil Sample Events

Location Sample ID	Sample Matrix	Event Date
200-SB-5 (8 ft bgs)	Soil	6/15/2014
200-SB-6 (8 ft bgs)	Soil	6/14/2014
200-SB-7 (8 ft bgs)	Soil	6/11/2014
200-SB-7 (18 ft bgs)	Soil	6/11/2014
200-SB-7 (38 ft bgs)	Soil	6/12/2014
200-SB-8 (8 ft bgs)	Soil	7/13/2014
200-SB-8 (28 ft bgs)	Soil	6/13/2014
200-SB-8 (43 ft bgs)	Soil	6/13/2014
200-SB-9 (8 ft bgs)	Soil	6/30/2014
200-SB-10 (16 ft bgs)	Soil	6/28/2014
200-SB-10 (26 ft bgs)	Soil	6/28/2014
200-SB-10 (36 ft bgs)	Soil	6/28/2014
200-SB-11 (8 ft bgs)	Soil	7/1/2014
200-SB-11 (28 ft bgs)	Soil	7/1/2014
200-SB-13 (8 ft bgs)	Soil	6/16/2014
200-SB-13 (28 ft bgs)	Soil	6/16/2014
600-SB-01 (6 ft bgs)	Soil	11/13/2009
600-SB-01 (72 ft bgs)	Soil	11/16/2009
600-SB-02 (3 ft bgs)	Soil	1/26/2010
600-SB-02 (8 ft bgs)	Soil	1/26/2010
600-SB-02 (75 ft bgs)	Soil	1/27/2010
600-SB-02A (3 ft bgs)	Soil	11/19/2009
600-SB-02A (8 ft bgs)	Soil	11/19/2009
600-SB-03 (6 ft bgs)	Soil	11/19/2009
600-SB-03 (10 ft bgs)	Soil	11/19/2009
600-SB-03 (75 ft bgs)	Soil	1/13/2010
600-SB-04 (6 ft bgs)	Soil	11/20/2009
600-SB-04 (10 ft bgs)	Soil	11/20/2009
600-SB-04 (75 ft bgs)	Soil	1/20/2010
600-SB-05 (4 ft bgs)	Soil	11/23/2009
600-SB-05 (77 ft bgs)	Soil	12/17/2009
600-SB-05 (144 ft bgs)	Soil	12/21/2009
600-SB-06 (4 ft bgs)	Soil	11/23/2009
600-SB-06 (75 ft bgs)	Soil	1/6/2010
600-SB-07 (6 ft bgs)	Soil	11/20/2009
600-SB-07 (78 ft bgs)	Soil	12/2/2009
600-SB-07 (158 ft bgs)	Soil	12/2/2009
600-SB-08 (6 ft bgs)	Soil	11/20/2009
600-SB-08 (85 ft bgs)	Soil	12/10/2009
600-SB-08 (150 ft bgs)	Soil	12/14/2009
600-SB-10 (01 ft bgs)	Soil	9/18/2009
600-SB-10 (10 ft bgs)	Soil	9/21/2009
600-SB-10 (20 ft bgs)	Soil	9/22/2009

Table 2 Quantity of Quality Control Samples

Matrix	Method	Total Samples	Non-QA Samples	Equipment Blanks	Field Blanks	Duplicates	Trip Blanks
Soil	353.2M	44	23	16		5	
Soil	607M	72	41	25		6	
Soil	6010	3	3				
Soil	6010B	46	23	17	1	5	
Soil	6010C	26	16	8		2	
Soil	6011C		0				
Soil	6020A		0				
Soil	6056A		0				
Soil	6850	47	35	8		4	
Soil	7196a	10	1	8		1	
Soil	7199	37	21	13		3	
Soil	8260B	65	26	20	1	5	13
Soil	8260C	34	16	8		2	8
Soil	8270C	44	23	16		5	
Soil	8270D	25	15	8		2	
Soil	8290A	26	16	8		2	
Total		**479**	**259**	**155**	**2**	**42**	**21**

Table 3 – Quality Control Sample Percentages (Soil)

Method	Quality Control Requirement	Sample Quantity	QC Quantity	QC %
353.2M	Equipment Blanks	60	16	27
	Field Blanks	44	0	0
	Duplicates	49	5	10
	Trip Blanks	44	0	0
607M	Equipment Blanks	97	25	26
	Field Blanks	72	0	0
	Duplicates	78	6	8
	Trip Blanks	72	0	0
6010	Equipment Blanks	3	0	0
	Field Blanks	3	0	0
	Duplicates	3	0	0
	Trip Blanks	3	0	0
6010B	Equipment Blanks	63	17	27
	Field Blanks	47	1	2
	Duplicates	51	5	10
	Trip Blanks	46	0	0
6010C	Equipment Blanks	34	8	24
	Field Blanks	26	0	0
	Duplicates	28	2	7
	Trip Blanks	26	0	0
6850	Equipment Blanks	55	8	15
	Field Blanks	47	0	0
	Duplicates	51	4	8
	Trip Blanks	47	0	0
7196a	Equipment Blanks	18	8	44
	Field Blanks	10	0	0
	Duplicates	11	1	9
	Trip Blanks	10	0	0

Method	Quality Control Requirement	Sample Quantity	QC Quantity	QC %
7199	Equipment Blanks	50	13	26
	Field Blanks	37	0	0
	Duplicates	40	3	8
	Trip Blanks	37	0	0
8260B	Equipment Blanks	85	20	24
	Field Blanks	66	1	2
	Duplicates	70	5	7
	Trip Blanks	78	13	17
8260C	Equipment Blanks	42	8	19
	Field Blanks	34	0	0
	Duplicates	36	2	6
	Trip Blanks	42	8	19
8270C	Equipment Blanks	60	16	27
	Field Blanks	44	0	0
	Duplicates	49	5	10
	Trip Blanks	44	0	0
8270D	Equipment Blanks	33	8	24
	Field Blanks	25	0	0
	Duplicates	27	2	7
	Trip Blanks	25	0	0
8290D	Equipment Blanks	34	8	24
	Field Blanks	26	0	0
	Duplicates	28	2	7
	Trip Blanks	26	0	0

Table 4 – Definitions of Data Qualifiers

Qualifier	Definition
*	User defined qualifier. See quality assurance narrative.
A	The result of an analyte for a laboratory control sample (LCS), initial calibration verification (ICV) or continuing calibration verification (CCV) was outside standard limits.
AD	Relative percent difference for analyst (laboratory) duplicates was outside standard limits.
D	The reported result is from a dilution.
EB	The analyte was detected in the equipment blank.
FB	The analyte was detected in the field blank.
G	The result is an estimated value greater than the upper calibration limit.
i	The result, quantitation limit, and/or detection limit may have been affected by matrix interference.
J	The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA	The value/result was either not analyzed for or not applicable.
ND	The analyte was not detected above the detection limit.
Q	The result for a blind control sample was outside standard limits.
QD	The relative percent difference for a field duplicate was outside standard limits.
R	The result is rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
RB	The analyte was detected in the method blank.
S	The result was determined by the method of standard addition.
SP	The matrix spike recovery and/or the relative percent difference for matrix spike duplicates was outside standard limits.
T	The sample was analyzed outside the specified holding time or temperature.
TB	The analyte was detected in the trip blank.
TIC	The analyte was tentatively identified by a GC/MS library search and the amount reported is an estimated value.

Table 5 – Quantity of Field Based Data Qualifiers Assigned to Individual Result Records (Soil)

COPC	FB	EB	TB	Q	QD	SP	R	*	A	AD	G	RB	T	D	i	J	TIC
2-Butanone (Methyl ethyl ketone)												2				19	
2-Propanol		1														2	
Acetone		9	1									13				16	
Antimony						1						18				19	
Benzo(a)anthracene																	
Benzyl Alcohol												12				14	
Bis(2-ethylhexyl)phthalate									2								
Boron																3	
Cadmium																38	
Carbon disulfide						1										2	
Chromium (Total)					2	1											
Chrysene																1	
Cobalt						1										18	
Freon-113																	
Manganese					2	3											
Mercury												2				22	
Methyl isobutyl ketone																1	
Molybdenum									8			3				31	
Nitrate+Nitrite as Nitrogen					5							3				27	
Tetrahydrofuran												8				11	
Thallium																1	
Tin, Total																19	
Toluene									3							10	
Trichloroethylene																4	
Zinc					2												

Table 6 – Duplicate Sample Relative Percent Difference

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
200-SB-5-8	**6/15/2014**	**Antimony**	**10.5**		**J RB**
200-SB-5-8	**6/15/2014**	**Cadmium**	**31.6**		**J**
200-SB-5-8	6/15/2014	Chromium	8.0		
200-SB-5-8	6/15/2014	Cobalt	1.3		
200-SB-5-8	6/15/2014	Manganese	10.3		
200-SB-5-8	**6/15/2014**	**Molybdenum**	**11.8**		**J**
200-SB-5-8	**6/15/2014**	**Nitrate+Nitrite as Nitrogen**	**13.3**		**J**
200-SB-5-8	6/15/2014	Zinc	0.3		
200-SB-8-8	**7/13/2014**	**Antimony**	**18.2**		**J RB**
200-SB-8-8	**7/13/2014**	**Cadmium**	**18.2**		**J**
200-SB-8-8	7/13/2014	Chromium	5.6		
200-SB-8-8	7/13/2014	Cobalt	20.8		
200-SB-8-8	7/13/2014	Manganese	8.8		
200-SB-8-8	**7/13/2014**	**Molybdenum**	**24.0**		**J**
200-SB-8-8	**7/13/2014**	**Nitrate+Nitrite as Nitrogen**	**0.0**		**J**
200-SB-8-8	7/13/2014	Zinc	14.7		
600-SB-01-006	11/13/2009	Freon 113	24.0		

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
600-SB-01-006	**11/13/2009**	**2-Butanone (MEK)**	**33.3**		**J**
600-SB-01-006	11/13/2009	Acetone	27.6		
600-SB-01-006	11/13/2009	Benz(a)anthracene	NA*		
600-SB-01-006	**11/13/2009**	**Bis(2-ethylhexyl) Phthalate**	**17.6**		**A**
600-SB-01-006	**11/13/2009**	**Cadmium**	**2.8**		**J**
600-SB-01-006	**11/13/2009**	**Carbon Disulfide**	**NA***		**J**
600-SB-01-006	11/13/2009	Chromium	3.6		
600-SB-01-006	11/13/2009	Chrysene	NA*		
600-SB-01-006	**11/13/2009**	**Cobalt**	**16.0**		**J**
600-SB-01-006	11/13/2009	Manganese	17.0		
600-SB-01-006	**11/13/2009**	**Mercury**	**11.1**		**J**
600-SB-01-006	**11/13/2009**	**Nitrate+Nitrite as Nitrogen**	**15.4**		**J**
600-SB-01-006	11/13/2009	Thallium	70.0		
600-SB-01-006	**11/13/2009**	**Tin, Total**	**22.2**		**J**
600-SB-01-006	**11/13/2009**	**Trichloroethene (TCE)**	**4.2**		**J**
600-SB-01-006	11/13/2009	Zinc	11.6		
600-SB-02A-003	**11/19/2009**	**2-Butanone (MEK)**	**24.0**		**J**
600-SB-02A-003	**11/19/2009**	**Benzyl Alcohol**	**32.7**		**J RB**
600-SB-02A-003	**11/19/2009**	**Cadmium**	**0.0**	**25**	**J**
600-SB-02A-003	**11/19/2009**	**Chromium**	**25.7**	**25**	**QD**
600-SB-02A-003	11/19/2009	Cobalt	34.5	**25**	
600-SB-02A-003	11/19/2009	Manganese	13.3	**25**	
600-SB-02A-003	**11/19/2009**	**Mercury**	**18.2**	**25**	**J**
600-SB-02A-003	**11/19/2009**	**Molybdenum**	**37.0**	**25**	**A**
600-SB-02A-003	**11/19/2009**	**Nitrate+Nitrite as Nitrogen**	**93.2**	**25**	**QD**
600-SB-02A-003	**11/19/2009**	**Thallium**	**56.0**	**25**	**J**
600-SB-02A-003	**11/19/2009**	**Zinc**	**35.4**	**25**	**QD**
600-SB-05-004	**11/23/2009**	**2-Butanone (MEK)**	**11.6**	**25**	**J**
600-SB-05-004	**11/23/2009**	**2-Propanol**	**NA***	**25**	**J EB**
600-SB-05-004	**11/23/2009**	**Acetone**	**14.1**	**25**	**J RB**
600-SB-05-004	**11/23/2009**	**Benzyl Alcohol**	**33.3**	**25**	**J RB**
600-SB-05-004	**11/23/2009**	**Cadmium**	**66.7**	**25**	**J**
600-SB-05-004	11/23/2009	Chromium	17.1	**25**	
600-SB-05-004	**11/23/2009**	**Cobalt**	**27.5**	**25**	**J**
600-SB-05-004	**11/23/2009**	**Manganese**	**50.3**	**25**	**QD**
600-SB-05-004	**11/23/2009**	**Mercury**	**28.6**	**25**	**J**
600-SB-05-004	**11/23/2009**	**Nitrate+Nitrite as Nitrogen**	**85.9**	**25**	**QD**
600-SB-05-004	11/23/2009	Tetrahydrofuran	NA*	**25**	
600-SB-05-004	11/23/2009	Thallium	18.5	**25**	
600-SB-05-004	**11/23/2009**	**Tin**	**0.0**	**25**	**J**
600-SB-05-004	11/23/2009	Zinc	20.8	**25**	

[1] RPD could not be calculated due to one of the duplicate samples being non-detect

Table 7 – Blank Sample Detections

Sample Location*	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
200-SB-11-8	7/1/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	9.40E-01	µg/L	J EB
200-SB-11-8	7/1/2014	Equipment Blank	Chromium, Total	2.00E-03	mg/L	J EB
200-SB-11-8	7/1/2014	Equipment Blank	Manganese	3.00E-03	mg/L	J EB
200-SB-11-8	7/1/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	3.00E-02	mg/L	J EB
200-SB-11-8	7/1/2014	Equipment Blank	Zinc	8.00E-03	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Chromium, Total	2.00E-03	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Manganese	5.00E-03	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Mercury	1.00E-04	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.90E-02	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Zinc	6.00E-03	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Acetone	2.60E+00	µg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.30E+00	µg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Chromium, Total	3.00E-03	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Manganese	6.00E-03	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Molybdenum	2.00E-03	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	2.90E-02	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Zinc	6.00E-03	mg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Acetone	2.00E+00	µg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Antimony	3.00E-04	mg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.50E+01	µg/L	EB
200-SB-6-8	6/14/2014	Equipment Blank	Chromium, Total	1.10E-02	mg/L	EB
200-SB-6-8	6/14/2014	Equipment Blank	Manganese	1.70E-02	mg/L	EB
200-SB-6-8	6/14/2014	Equipment Blank	Molybdenum	5.00E-03	mg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.40E-02	mg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Zinc	1.40E-02	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Acetone	1.60E+00	µg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Antimony	2.00E-04	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Carbon Disulfide	6.80E-01	µg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Chromium, Total	3.00E-03	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Manganese	6.00E-03	mg/L	J RB EB
200-SB-7-8	6/11/2014	Equipment Blank	Molybdenum	2.00E-03	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	4.30E-02	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Zinc	9.00E-03	mg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Acetone	1.50E+00	µg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Antimony	2.00E-04	mg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.10E+01	µg/L	EB
200-SB-8-8	7/13/2014	Equipment Blank	Chromium, Total	1.00E-02	mg/L	EB
200-SB-8-8	7/13/2014	Equipment Blank	Manganese	1.70E-02	mg/L	EB

Sample Location*	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
200-SB-8-8	7/13/2014	Equipment Blank	Molybdenum	7.00E-03	mg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.10E-02	mg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Zinc	1.00E-02	mg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Acetone	1.60E+00	µg/L	J RB EB A
200-SB-9-8	6/30/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	3.80E+00	µg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Chromium, Total	3.00E-03	mg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Manganese	7.00E-03	mg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Molybdenum	2.00E-03	mg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.90E-02	mg/L	J EB
600-SB-01-072	11/16/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.40E+00	µg/L	J RB EB
600-SB-01-072	11/16/2009	Equipment Blank	Thallium	5.00E-04	mg/L	J EB
600-SB-02-003	1/26/2010	Equipment Blank	Bis(2-ethylhexyl) Phthalate	2.00E+00	µg/L	J EB
600-SB-02-003	1/26/2010	Equipment Blank	Boron	6.00E-02	mg/L	J EB
600-SB-02-003	1/26/2010	Equipment Blank	Mercury	2.00E-05	mg/L	J EB
600-SB-02-003	1/26/2010	Equipment Blank	Zinc	4.00E-03	mg/L	J EB
600-SB-02-075	1/27/2010	Equipment Blank	Bis(2-ethylhexyl) Phthalate	6.70E-01	µg/L	J
600-SB-02-075	1/27/2010	Equipment Blank	Chromium, Total	5.00E-03	mg/L	J EB
600-SB-02-075	1/27/2010	Equipment Blank	Manganese	1.60E-02	mg/L	EB
600-SB-02-075	1/27/2010	Equipment Blank	Zinc	1.00E-02	mg/L	J EB
600-SB-02A-003	11/19/2009	Equipment Blank	Mercury	2.00E-05	mg/L	J EB
600-SB-03-006	11/19/2009	Equipment Blank	Acetone	3.40E+00	µg/L	J EB
600-SB-03-006	11/19/2009	Equipment Blank	Chromium, Total	3.00E-03	mg/L	J EB
600-SB-03-006	11/19/2009	Equipment Blank	Manganese	5.00E-03	mg/L	J EB
600-SB-03-006	11/19/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.00E-02	mg/L	J EB
600-SB-03-075	1/13/2010	Equipment Blank	Acetone	1.70E+00	µg/L	J EB
600-SB-03-075	1/13/2010	Equipment Blank	Manganese	1.00E-03	mg/L	J EB
600-SB-03-075	1/13/2010	Equipment Blank	Nitrate+Nitrite as Nitrogen	7.00E-03	mg/L	J RB EB
600-SB-03-075	1/13/2010	Equipment Blank	Zinc	4.00E-03	mg/L	J EB
600-SB-04-006	11/20/2009	Equipment Blank	Acetone	2.40E+00	µg/L	J EB
600-SB-04-006	11/20/2009	Equipment Blank	Manganese	2.00E-03	mg/L	J EB
600-SB-04-006	11/20/2009	Equipment Blank	Mercury	2.00E-05	mg/L	J EB
600-SB-04-006	11/20/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	9.00E-03	mg/L	J EB
600-SB-04-075	1/20/2010	Equipment Blank	Acetone	1.90E+00	µg/L	J TB EB
600-SB-05-004	11/23/2009	Equipment Blank	2-Propanol	1.40E+01	µg/L	J EB
600-SB-05-004	11/23/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	2.10E+00	µg/L	J EB
600-SB-05-004	11/23/2009	Equipment Blank	Manganese	4.00E-03	mg/L	J EB
600-SB-05-004	11/23/2009	Equipment Blank	Molybdenum	4.00E-03	mg/L	J EB
600-SB-05-004	11/23/2009	Equipment Blank	Thallium	1.30E-03	mg/L	J EB

Sample Location*	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
600-SB-05-077	12/17/2009	Equipment Blank	Acetone	2.80E+00	µg/L	J TB EB
600-SB-06-075	1/6/2010	Equipment Blank	Acetone	2.90E+00	µg/L	J TB EB
600-SB-07-006	11/20/2009	Equipment Blank	Acetone	2.80E+00	µg/L	J EB
600-SB-07-006	11/20/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	2.50E-01	µg/L	J RB EB
600-SB-07-006	11/20/2009	Equipment Blank	Manganese	3.00E-03	mg/L	J EB
600-SB-07-006	11/20/2009	Equipment Blank	Mercury	2.00E-05	mg/L	J EB
600-SB-07-006	11/20/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	3.00E-03	mg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	2-Propanol	3.60E+01	µg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	Acetone	5.50E+00	µg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	3.30E-01	µg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	Manganese	7.00E-03	mg/L	J RB EB
600-SB-07-078	12/2/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.40E-02	mg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	Zinc	5.00E-03	mg/L	J EB
600-SB-07-158	12/2/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	3.00E-01	µg/L	J EB
600-SB-07-158	12/2/2009	Equipment Blank	Manganese	3.00E-03	mg/L	J RB EB
600-SB-07-158	12/2/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.70E-02	mg/L	J RB EB
600-SB-07-158	12/2/2009	Equipment Blank	Zinc	3.00E-03	mg/L	J EB
600-SB-08-006	11/20/2009	Equipment Blank	Acetone	3.30E+00	µg/L	J EB
600-SB-08-006	11/20/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	4.30E-01	µg/L	J EB RB
600-SB-08-006	11/20/2009	Equipment Blank	Manganese	2.00E-03	mg/L	J EB
600-SB-08-006	11/20/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	5.00E-03	mg/L	J EB
600-SB-08-085	12/10/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	4.60E+00	µg/L	J EB
600-SB-08-085	12/10/2009	Equipment Blank	Manganese	2.00E-03	mg/L	J EB
600-SB-08-085	12/10/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.80E-02	mg/L	J RB EB
600-SB-08-085	12/10/2009	Equipment Blank	Zinc	4.00E-03	mg/L	J EB
600-SB-10-001	9/18/2009	Equipment Blank	Acetone	2.20E+00	µg/L	J EB
600-SB-10-001	9/18/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.30E+00	µg/L	J EB
600-SB-10-001	9/18/2009	Equipment Blank	Manganese	2.20E-02	mg/L	EB
600-SB-10-001	9/18/2009	Equipment Blank	Zinc	1.30E-02	mg/L	J RB EB
600-SB-10-010	9/21/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.60E+00	µg/L	J EB
600-SB-10-010	9/21/2009	Equipment Blank	Manganese	5.00E-03	mg/L	J EB FB
600-SB-10-010	9/21/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	6.00E-03	mg/L	J EB
600-SB-10-010	9/21/2009	Equipment Blank	Zinc	4.00E-03	mg/L	J EB FB
600-SB-10-020	9/22/2009	Equipment Blank	Acetone	2.70E+01	µg/L	J EB
600-SB-10-020	9/22/2009	Equipment Blank	Antimony	9.00E-04	mg/L	J RB EB
600-SB-10-020	9/22/2009	Equipment Blank	Cadmium	3.00E-04	mg/L	J EB
600-SB-10-020	9/22/2009	Equipment Blank	Chromium, Total	2.68E-01	mg/L	EB

Sample Location*	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
600-SB-10-020	9/22/2009	Equipment Blank	Cobalt	5.00E-03	mg/L	J EB
600-SB-10-020	9/22/2009	Equipment Blank	Manganese	3.68E-01	mg/L	EB
600-SB-10-020	9/22/2009	Equipment Blank	Molybdenum	6.00E-03	mg/L	J EB
600-SB-10-020	9/22/2009	Equipment Blank	Zinc	1.21E-01	mg/L	EB
600-SB-10-010	9/21/2009	Field Blank	Antimony	4.00E-04	mg/L	J RB FB
600-SB-10-010	9/21/2009	Field Blank	Chromium, Total	2.60E-02	mg/L	FB
600-SB-10-010	9/21/2009	Field Blank	Manganese	4.00E-02	mg/L	EB FB
600-SB-10-010	9/21/2009	Field Blank	Zinc	1.45E-01	mg/L	FB
600-SB-01-072	11/16/2009	Trip Blank	Acetone	1.90E+00	µg/L	J TB
600-SB-04-006	11/20/2009	Trip Blank	Carbon Disulfide	1.20E+00	µg/L	TB
600-SB-04-075	1/20/2010	Trip Blank	2-Propanol	2.30E+01	µg/L	J TB
600-SB-04-075	1/20/2010	Trip Blank	Acetone	3.60E+00	µg/L	J TB EB
600-SB-05-077	12/17/2009	Trip Blank	Acetone	5.30E+00	µg/L	J TB EB
600-SB-06-075	1/6/2010	Trip Blank	Acetone	2.00E+00	µg/L	J TB EB
600-SB-10-001	9/18/2009	Trip Blank	Carbon Disulfide	1.80E+00	µg/L	TB
600-SB-10-010	9/21/2009	Trip Blank	Acetone	1.80E+00	µg/L	J TB

National Aeronautics and Space Administration

Quality Assurance Report for White Sands Test Facility 200 and 600 Area Vapor Intrusion Assessment Report Vapor Analytical Data

April 2023

NM 8800019434

Report Submitted:
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1.0 Introduction

The 200 and 600 Area Vapor Intrusion Assessment Work Plan requires the preparation of an investigation report that includes soil analytical data reported. The Quality Assurance Report (QAR) prepared and reviewed by responsible environmental contractor data management personnel provides the following information:

- A summary of notable anomalies.
- A summary of notable data quality issues by analytical method, if any.
- A list of the sample events for which soil samples were collected in April and October 2017.
- The quantity and type of quality control samples collected or prepared in April and October 2017.
- Definitions of data qualifiers used in WSTF analytical data reporting.
- The quantity and type of data qualifiers applied to individual analytical results.
- A list of duplicate samples and their relative percent differences (RPD)
- A summary table of blank sample detections.

2.0 Data Quality

2.1 Notable Anomalies

In the 200 and 600 areas, samples collected during this investigation include soil vapor samples, indoor air samples, and outdoor air samples. These sample sets include field blanks, duplicates, trip blanks, and matrix spikes in accordance with the approved work plan.

3.0 Data Tables

Table 1 summarizes the soil vapor, indoor air, and outdoor air sample events in August 2017 and February 2018. This report is based on data quality issues related to the sample events listed in Table 1.

Table 2 through Table 6 contain information related to the sample events identified in Table 1. As specified by the Vapor Intrusion Assessment Work Plan Section 5.4, specific quality control samples are utilized to assess the quality of analytical data. Table 2 presents the quantity of quality control samples collected for each analytical method. Table 3 compares the quality control sample percentages collected to the requirements in the respective investigation work plan. When data quality criteria are not met, data qualifiers are applied to the data. Definitions of data qualifiers used for WSTF chemical analytical data are listed in Table 4. Table 5 presents the total number of individual result records and summarize the quantity of field and laboratory data qualifiers assigned to individual analyte result records in the WSTF analytical database. Table 6 provides the RPD between duplicate samples. Samples associated with qualified data are identified by bold text in Table 6. Table 7 provides all detections found in trip blank and field blank samples. All data affected by blank sample detections are appropriately qualified.

4.0 Usability Assessment

The goal of the usability assessment is to determine the quality of each data point and to identify data that are not acceptable to support project quality objectives. This QAR qualifies as the completed assessment for the soil data from samples collected for the 200 Area Phase II Investigation Report and the 600 Area Closure Investigation Report in addition to the August 2017 and February 2018 sample events performed for the 200 and 600 Area Vapor Intrusion Assessment Report. There were ten Freon 123a soil vapor detections that included a tentatively identified compound (TIC) QA flag which were excluded from the dataset. No data was rejected (R) based on established quality review protocols.

5.0 References

Table 1 – Soil Vapor, Indoor Air, and Outdoor Air Sample Events

Location Sample ID	Sample Matrix	Event Date
200-IA-1	Air	8/27/2017
		2/25/2018
200-IA-2	Air	8/27/2017
		2/25/2018
200-IA-3	Air	8/27/2017
		2/25/2018
200-IA-4	Air	8/27/2017
		2/25/2018
200-IA-5	Air	8/27/2017
		2/25/2018
200-IA-6	Air	8/27/2017
		2/25/2018
200-IA-7	Air	8/27/2017
		2/25/2018
200-IA-8	Air	8/27/2017
		2/25/2018
200-OA-1	Air	8/27/2017
		2/25/2018
200-OA-2	Air	8/27/2017
		2/25/2018
600-IA-1	Air	8/26/2017
		2/24/2018
600-IA-2	Air	8/26/2017
		2/24/2018
600-IA-3	Air	8/26/2017
		2/24/2018
600-IA-4	Air	8/26/2017
		2/24/2018
600-OA-1	Air	8/26/2017
		2/24/2018
600-OA-2	Air	8/26/2017
		2/24/2018
200-LV-150 (34 ft bgs)	Soil Vapor	8/27/2017
		2/25/2018
200-SV-05 (9 ft bgs)	Soil Vapor	8/27/2017
		2/25/2018
200-SV-09 (19 ft bgs)	Soil Vapor	8/27/2017
		2/25/2018
600-SGW-1 (12.5 ft bgs)	Soil Vapor	8/26/2017
		2/24/2018
600-SGW-2 (12.5 ft bgs)	Soil Vapor	8/26/2017
		2/24/2018

Location Sample ID	Sample Matrix	Event Date
600-SGW-5 (7.5 ft bgs)	Soil Vapor	8/26/2017
		2/24/2018

Table 2 – Quantity of Quality Control Samples (Soil Vapor, Indoor Air, and Outdoor Air)

Matrix	Method	Total Samples	Non-QA Samples	Field Blanks	Duplicates	Trip Blanks	Matrix Spikes
Indoor/Outdoor Air	TO-15	74	32	4	4	2	32
Soil Vapor	TO-15	32	12	4	4	0	12
Total		106	44	8	8	2	44

Table 3 – Quality Control Sample Percentages (Soil Vapor, Indoor Air, and Outdoor Air)

Quality Control Requirement	IWP Requirement	Sample Quantity	QC Quantity	QC %
Air, Field Blanks	4	40	8	20
Air, Trip Blanks	1 per shipment	34	2	6
Air, Duplicates	10%	40	8	20
Air, Matrix Spikes		64	32	50
Soil Vapor, Field Blanks	4	12	4	33
Soil Vapor, Trip Blanks	1 per shipment	12		0
Soil Vapor, Duplicates	10%	12	4	33
Soil Vapor, Matrix Spikes		24	12	50

Table 4 – Definitions of Data Qualifiers

Qualifier	Definition
*	User defined qualifier. See quality assurance narrative.
A	The result of an analyte for a laboratory control sample (LCS), initial calibration verification (ICV) or continuing calibration verification (CCV) was outside standard limits.
AD	Relative percent difference for analyst (laboratory) duplicates was outside standard limits.
D	The reported result is from a dilution.
EB	The analyte was detected in the equipment blank.
FB	The analyte was detected in the field blank.
G	The result is an estimated value greater than the upper calibration limit.
i	The result, quantitation limit, and/or detection limit may have been affected by matrix interference.
J	The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA	The value/result was either not analyzed for or not applicable.
ND	The analyte was not detected above the detection limit.
Q	The result for a blind control sample was outside standard limits.
QD	The relative percent difference for a field duplicate was outside standard limits.
R	The result is rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
RB	The analyte was detected in the method blank.
S	The result was determined by the method of standard addition.
SP	The matrix spike recovery and/or the relative percent difference for matrix spike duplicates was outside standard limits.
T	The sample was analyzed outside the specified holding time or temperature.
TB	The analyte was detected in the trip blank.
TIC	The analyte was tentatively identified by a GC/MS library search and the amount reported is an estimated value.

Table 5 – Quantity of Field Based Data Qualifiers Assigned to Individual Result Records (Soil Vapor, Indoor Air, and Outdoor Air)

COPC	Method	Total Records	FB	EB	TB	Q	QD	SP	R	*	A	AD	G	RB	T	D	i	J	TIC
1,1,1-Trichloroethane	TO-15	52																2	
1,1-Dichloroethene	TO-15	52																	
1,2,4-Trimethylbenzene	TO-15	52																4	
1,2-Dichloroethane	TO-15	52																1	
1,4-Dichlorobenzene	TO-15	52																1	
2,2,4-Trimethylpentane	TO-15	52																2	
2-Butanone (Methyl Ethyl Ketone)	TO-15	52	9		2													39	
2-Hexanone	TO-15	52	2															7	
2-Propanol	TO-15	52	2		1		2											7	
4-Methyl-2-pentanone	TO-15	52					2											4	
Acetone	TO-15	52	12		2		4			1								23	
Benzene	TO-15	52	2															22	
Bromodichloromethane	TO-15	52																2	
Carbon Disulfide	TO-15	52	2		1						6							7	
Carbon Tetrachloride	TO-15	52	2															36	
Chloroethane	TO-15	52																2	
Chloroform	TO-15	52	4															10	
Chloromethane	TO-15	52	8		2													37	
cis-1,2-Dichloroethene	TO-15	52																1	
Ethanol	TO-15	52	7		1		2											21	
Ethyl Benzene	TO-15	52																4	
Freon 11	TO-15	52	9				2				22								
Freon 113	TO-15	52	7		2		4									4		21	
Freon 12	TO-15	52	12		2														
Freon 123a	TO-15	52	4							26									10
Freon 21	TO-15	52																1	
Heptane	TO-15	52																4	
Hexane	TO-15	52	1		1													14	
m,p-Xylene	TO-15	52	1															4	
Methylene Chloride	TO-15	52	4		1													21	
o-Xylene	TO-15	52																4	
Styrene	TO-15	52																	
Tetrachloroethene	TO-15	52	1															2	
Tetrahydrofuran	TO-15	52																3	
Toluene	TO-15	52	5		1													17	
trans-1,2-Dichloroethene	TO-15	52	2															4	
Trichloroethene	TO-15	52	4													4		7	

Table 6 – Duplicate Sample Relative Percent Difference

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
200-IA-3	8/27/2017	1,2,4-Trimethylbenzene	104.1	25	
200-IA-3	8/27/2017	2,2,4-Trimethylpentane	NA[1]	25	
200-IA-3	8/27/2017	2-Butanone (Methyl Ethyl Ketone)	43.4	25	
200-IA-3	**8/27/2017**	**2-Hexanone**	**89.5**	**25**	**J**
200-IA-3	**8/27/2017**	**2-Propanol**	**120.0**	**25**	**QD**
200-IA-3	**8/27/2017**	**4-Methyl-2-pentanone**	**193.1**	**25**	**QD**
200-IA-3	**8/27/2017**	**Acetone**	**63.6**	**25**	**QD**
200-IA-3	**8/27/2017**	**Benzene**	**20.2**	**25**	**J**
200-IA-3	**8/27/2017**	**Carbon Tetrachloride**	**2.4**	**25**	**J**
200-IA-3	**8/27/2017**	**Chloroform**	**NA[1]**	**25**	**J**
200-IA-3	**8/27/2017**	**Chloromethane**	**8.7**	**25**	**J**
200-IA-3	**8/27/2017**	**Ethanol**	**48.6**	**25**	**QD**
200-IA-3	**8/27/2017**	**Ethyl Benzene**	**NA[1]**	**25**	**J**
200-IA-3	**8/27/2017**	**Freon 11**	**58.8**	**25**	**A QD**
200-IA-3	**8/27/2017**	**Freon 113**	**33.0**	**25**	**QD**
200-IA-3	8/27/2017	Freon 12	4.1	25	
200-IA-3	8/27/2017	Freon 21	74.5	25	
200-IA-3	**8/27/2017**	**Heptane**	**NA[1]**	**25**	**J**
200-IA-3	8/27/2017	Hexane	23.3	25	
200-IA-3	8/27/2017	m,p-Xylene	69.1	25	
200-IA-3	**8/27/2017**	**Methylene Chloride**	**NA[1]**	**25**	**J**
200-IA-3	**8/27/2017**	**o-Xylene**	**55.3**	**25**	**J**
200-IA-3	8/27/2017	Styrene	NA[1]	25	
200-IA-3	**8/27/2017**	**Tetrahydrofuran**	**NA[1]**	**25**	**J**
200-IA-3	8/27/2017	Toluene	26.7	25	
200-IA-3	**8/27/2017**	**trans-1,2-Dichloroethene**	**24.8**	**25**	**J**
200-IA-3	**8/27/2017**	**Trichloroethene**	**2.5**	**25**	**J**
200-SV-05-9	8/27/2017	1,1-Dichloroethene	2.3	25	
200-SV-05-9	**8/27/2017**	**Freon 11**	**NA[1]**	**25**	**A**
200-SV-05-9	8/27/2017	Freon 113	0.0	25	

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
200-SV-05-9	8/27/2017	Tetrachloroethene	3.2	25	
200-SV-05-9	8/27/2017	Trichloroethene	2.5	25	
600-IA-4	**8/26/2017**	**2-Butanone (Methyl Ethyl Ketone)**	**33.0**	**25**	**J**
600-IA-4	8/26/2017	2-Hexanone	11.5	25	
600-IA-4	8/26/2017	2-Propanol	30.5	25	
600-IA-4	**8/26/2017**	**4-Methyl-2-pentanone**	**0.0**	**25**	**J**
600-IA-4	**8/26/2017**	**Acetone**	**43.5**	**25**	**QD**
600-IA-4	**8/26/2017**	**Benzene**	**NA[1]**	**25**	**J**
600-IA-4	**8/26/2017**	**Carbon Tetrachloride**	**15.8**	**25**	**J**
600-IA-4	**8/26/2017**	**Chloromethane**	**3.1**	**25**	**J**
600-IA-4	**8/26/2017**	**Ethanol**	**121.3**	**25**	**J**
600-IA-4	**8/26/2017**	**Freon 11**	**0.0**	**25**	**A**
600-IA-4	**8/26/2017**	**Freon 113**	**4.3**	**25**	**J**
600-IA-4	8/26/2017	Freon 12	4.4	25	
600-IA-4	**8/26/2017**	**Heptane**	**NA[1]**	**25**	**J**
600-IA-4	**8/26/2017**	**Hexane**	**5.2**	**25**	**J**
600-IA-4	**8/26/2017**	**Toluene**	**47.4**	**25**	**J**
600-SGW-5-7.5	**8/26/2017**	**2-Butanone (Methyl Ethyl Ketone)**	**51.9**	**25**	**J FB**
600-SGW-5-7.5	**8/26/2017**	**Acetone**	**31.6**	**25**	**J FB**
600-SGW-5-7.5	**8/26/2017**	**Carbon Disulfide**	**NA[1]**	**25**	**J A FB**
600-SGW-5-7.5	**8/26/2017**	**Chloroform**	**12.5**	**25**	**J FB**
600-SGW-5-7.5	8/26/2017	Ethanol	NA[1]	25	
600-SGW-5-7.5	**8/26/2017**	**Freon 11**	**177.7**	**25**	**A FB**
600-SGW-5-7.5	**8/26/2017**	**Freon 113**	**26.5**	**25**	**QD FB**
600-SGW-5-7.5	**8/26/2017**	**Freon 12**	**4.3**	**25**	**FB**
600-SGW-5-7.5	8/26/2017	Methylene Chloride	NA[1]	25	
600-SGW-5-7.5	8/26/2017	Toluene	NA[1]	25	
600-SGW-5-7.5	**8/26/2017**	**Trichloroethene**	**9.5**	**25**	**FB**
200-IA-3	**2/25/2018**	**2-Butanone (Methyl Ethyl Ketone)**	**106.0**	**25**	**J**
200-IA-3	2/25/2018	2-Propanol	13.3	25	

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
200-IA-3	**2/25/2018**	**Acetone**	**61.5**	**25**	**J**
200-IA-3	**2/25/2018**	**Benzene**	**2.7**	**25**	**J**
200-IA-3	**2/25/2018**	**Carbon Tetrachloride**	**7.6**	**25**	**J**
200-IA-3	**2/25/2018**	**Chloroform**	**13.7**	**25**	**J**
200-IA-3	**2/25/2018**	**Chloromethane**	**5.1**	**25**	**J**
200-IA-3	**2/25/2018**	**Ethanol**	**7.4**	**25**	**J**
200-IA-3	2/25/2018	Freon 11	2.3	25	
200-IA-3	2/25/2018	Freon 113	13.3	25	
200-IA-3	2/25/2018	Freon 12	7.7	25	
200-IA-3	2/25/2018	Hexane	9.5	25	
200-IA-3	**2/25/2018**	**Methylene Chloride**	**4.8**	**25**	**J**
200-IA-3	2/25/2018	Toluene	0.0	25	
200-IA-3	**2/25/2018**	**Trichloroethene**	**20.7**	**25**	**J**
200-SV-05-9	2/25/2018	1,1-Dichloroethene	3.8	25	
200-SV-05-9	2/25/2018	Freon 113	3.6	25	
200-SV-05-9	2/25/2018	Tetrachloroethene	1.9	25	
200-SV-05-9	2/25/2018	Trichloroethene	3.9	25	
600-IA-1	**2/24/2018**	**2-Butanone (Methyl Ethyl Ketone)**	**18.9**	**25**	**J FB**
600-IA-1	**2/24/2018**	**Acetone**	**13.6**	**25**	**J FB**
600-IA-1	**2/24/2018**	**Benzene**	**5.1**	**25**	**J**
600-IA-1	**2/24/2018**	**Carbon Tetrachloride**	**6.9**	**25**	**J**
600-IA-1	**2/24/2018**	**Chloromethane**	**12.2**	**25**	**J FB**
600-IA-1	**2/24/2018**	**Ethanol**	**54.5**	**25**	**J FB**
600-IA-1	**2/24/2018**	**Freon 11**	**7.4**	**25**	**FB**
600-IA-1	**2/24/2018**	**Freon 113**	**1.8**	**25**	**J**
600-IA-1	**2/24/2018**	**Freon 12**	**4.4**	**25**	**FB**
600-IA-1	**2/24/2018**	**Methylene Chloride**	**3.7**	**25**	**J FB**
600-IA-1	2/24/2018	Toluene	NA[1]	25	
600-SGW-5-7.5	**2/24/2018**	**2-Butanone (Methyl Ethyl Ketone)**	**77.8**	**25**	**J FB**
600-SGW-5-7.5	**2/24/2018**	**2-Hexanone**	**NA[1]**	**25**	**J FB**

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
600-SGW-5-7.5	**2/24/2018**	**Acetone**	**34.8**	**25**	**FB**
600-SGW-5-7.5	**2/24/2018**	**Chloroform**	**0.0**	**25**	**J FB**
600-SGW-5-7.5	**2/24/2018**	**Freon 11**	**3.8**	**25**	**FB**
600-SGW-5-7.5	**2/24/2018**	**Freon 113**	**0.0**	**25**	**FB**
600-SGW-5-7.5	**2/24/2018**	**Freon 12**	**0.0**	**25**	**FB**
600-SGW-5-7.5	**2/24/2018**	**Tetrachloroethene**	**NA[1]**	**25**	**J FB**
600-SGW-5-7.5	**2/24/2018**	**Trichloroethene**	**2.4**	**25**	**FB**

[1]RPD could not be calculated due to one of the duplicate samples being non-detect

Table 7 – Blank Sample Detections

Sample Location[1]	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
200-IA-7	8/27/2017	Field Blank	2-Butanone (Methyl Ethyl Ketone)	1.9	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	2-Propanol	14.0	UG/M3	FB
200-IA-7	8/27/2017	Field Blank	Acetone	17.0	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Chloromethane	0.6	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Ethanol	15.0	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Freon 11	3.9	UG/M3	A FB
200-IA-7	8/27/2017	Field Blank	Freon 113	25.0	UG/M3	FB
200-IA-7	8/27/2017	Field Blank	Freon 12	2.8	UG/M3	FB
200-IA-7	8/27/2017	Field Blank	Tetrachloroethene	0.6	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Tetrahydrofuran	45.0	UG/M3	FB
200-IA-7	8/27/2017	Field Blank	Toluene	1.0	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Trichloroethene	2.7	UG/M3	FB
200-SV-09-19	8/27/2017	Field Blank	2-Butanone (Methyl Ethyl Ketone)	2.3	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	2-Propanol	0.8	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Acetone	12.0	UG/M3	FB
200-SV-09-19	8/27/2017	Field Blank	Benzene	0.4	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Carbon Tetrachloride	0.4	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Ethanol	1.6	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Freon 11	1.0	UG/M3	A FB
200-SV-09-19	8/27/2017	Field Blank	Freon 113	0.5	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Freon 12	2.0	UG/M3	FB
200-SV-09-19	8/27/2017	Field Blank	Hexane	0.4	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Tetrahydrofuran	3.9	UG/M3	FB
600-IA-1	8/26/2017	Field Blank	1,4-Dioxane	1.5	UG/M3	J FB
600-IA-1	8/26/2017	Field Blank	2-Butanone (Methyl Ethyl Ketone)	5.9	UG/M3	J FB
600-IA-1	8/26/2017	Field Blank	2-Hexanone	0.9	UG/M3	J FB

Sample Location[1]	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
600-IA-1	8/26/2017	Field Blank	Acetone	62.0	UG/M3	FB
600-IA-1	8/26/2017	Field Blank	Carbon Disulfide	130.0	UG/M3	A FB
600-IA-1	8/26/2017	Field Blank	Chloromethane	0.8	UG/M3	J FB
600-IA-1	8/26/2017	Field Blank	Ethanol	9.1	UG/M3	J FB
600-IA-1	8/26/2017	Field Blank	Freon 11	1.2	UG/M3	J A FB
600-IA-1	8/26/2017	Field Blank	Freon 12	2.3	UG/M3	FB
600-IA-1	8/26/2017	Field Blank	Tetrahydrofuran	0.9	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	2-Butanone (Methyl Ethyl Ketone)	4.2	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Acetone	23.0	UG/M3	FB
600-SGW-1-12.5	8/26/2017	Field Blank	Benzene	1.0	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Carbon Disulfide	13.0	UG/M3	J A FB
600-SGW-1-12.5	8/26/2017	Field Blank	Chloromethane	0.7	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Cyclohexane	2.1	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Ethanol	4.6	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Freon 11	1.2	UG/M3	J A FB
600-SGW-1-12.5	8/26/2017	Field Blank	Freon 113	0.8	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Freon 12	2.3	UG/M3	FB
600-SGW-1-12.5	8/26/2017	Field Blank	Hexane	1.4	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	m,p-Xylene	1.9	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Styrene	0.8	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Toluene	6.2	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	2-Propanol	2.7	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Acetone	5.9	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Carbon Tetrachloride	0.4	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Chloromethane	0.6	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Ethanol	1.8	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Freon 11	1.9	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Freon 113	12.0	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Freon 12	2.4	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Methylene Chloride	0.4	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Toluene	0.5	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	trans-1,2-Dichloroethene	1.6	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Trichloroethene	0.4	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Acetone	8.1	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Chloromethane	1.1	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Freon 11	1.2	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Freon 113	6.9	UG/M3	FB
200-SV-09-19	2/25/2018	Field Blank	Freon 12	2.4	UG/M3	FB
200-SV-09-19	2/25/2018	Field Blank	Methylene Chloride	0.7	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Tetrachloroethene	2.7	UG/M3	FB
200-SV-09-19	2/25/2018	Field Blank	Trichloroethene	15.0	UG/M3	FB

Sample Location[1]	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
600-IA-1	2/24/2018	Field Blank	2-Butanone (Methyl Ethyl Ketone)	0.9	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Acetone	14.0	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Carbon Disulfide	2.6	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Chloromethane	1.1	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Ethanol	5.1	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Freon 11	1.4	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Freon 12	2.3	UG/M3	FB
600-IA-1	2/24/2018	Field Blank	Methylene Chloride	0.9	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	2-Butanone (Methyl Ethyl Ketone)	3.6	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	2-Propanol	9.1	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Acetone	14.0	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Benzene	2.6	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Carbon Disulfide	6.3	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Chloromethane	1.0	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Cyclohexane	9.5	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Ethanol	9.1	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Freon 11	1.2	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Freon 113	0.9	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Freon 12	2.3	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Heptane	2.1	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Hexane	5.9	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Methylene Chloride	1.3	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Toluene	20.0	UG/M3	FB
200-OA-1	2/25/2018	Trip Blank	2-Propanol	15.0	UG/M3	TB
200-OA-1	2/25/2018	Trip Blank	Freon 113	2.4	UG/M3	J TB
200-OA-1	2/25/2018	Trip Blank	Freon 12	2.4	UG/M3	J TB
200-OA-1	2/25/2018	Trip Blank	o-Xylene	1.4	UG/M3	J TB

[1] There were no detections in the Trip Blank (200-IA-7) collected on August 27, 2017.

Appendix D
UCL95 Results for Cumulative Risk Assessment

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 4/2/2023 10:03:59 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	0.95

200_Soil_NO2/NO3

Raw Statistics

Number of Valid Observations	8
Number of Distinct Observations	8
Minimum	0.6
Maximum	7.4
Mean of Raw Data	2.9
Standard Deviation of Raw Data	2.479
Khat	1.594
Theta hat	1.82
Kstar	1.079
Theta star	2.687
Mean of Log Transformed Data	0.719
Standard Deviation of Log Transformed Data	0.909

Normal GOF Test Results

Correlation Coefficient R	0.925
Shapiro Wilk Test Statistic	0.847
Shapiro Wilk Critical (0.05) Value	0.818
Approximate Shapiro Wilk P Value	0.11
Lilliefors Test Statistic	0.296
Lilliefors Critical (0.05) Value	0.283

Data appear Approximate Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.972
A-D Test Statistic	0.421
A-D Critical (0.05) Value	0.728
K-S Test Statistic	0.236
K-S Critical(0.05) Value	0.299

Data appear Gamma Distributed at (0.05) Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
44	**Lognormal GOF Test Results**											
45												
46	Correlation Coefficient R					0.974						
47	Shapiro Wilk Test Statistic					0.932						
48	Shapiro Wilk Critical (0.05) Value					0.818						
49	Approximate Shapiro Wilk P Value					0.677						
50	Lilliefors Test Statistic					0.194						
51	Lilliefors Critical (0.05) Value					0.283						
52	**Data appear Lognormal at (0.05) Significance Level**											
53												
54	200_BG2_NO2/NO3											
55												
56	**Raw Statistics**											
57	Number of Valid Observations					36						
58	Number of Distinct Observations					15						
59	Minimum					0.5						
60	Maximum					3.1						
61	Mean of Raw Data					1.225						
62	Standard Deviation of Raw Data					0.533						
63	Khat					7.222						
64	Theta hat					0.17						
65	Kstar					6.638						
66	Theta star					0.185						
67	Mean of Log Transformed Data					0.132						
68	Standard Deviation of Log Transformed Data					0.364						
69												
70	**Normal GOF Test Results**											
71												
72	Correlation Coefficient R					0.882						
73	Shapiro Wilk Test Statistic					0.792						
74	Shapiro Wilk Critical (0.05) Value					0.935						
75	Approximate Shapiro Wilk P Value					2.2301E-6						
76	Lilliefors Test Statistic					0.191						
77	Lilliefors Critical (0.05) Value					0.145						
78	**Data not Normal at (0.05) Significance Level**											
79												
80	**Gamma GOF Test Results**											
81												
82	Correlation Coefficient R					0.938						
83	A-D Test Statistic					1.244						
84	A-D Critical (0.05) Value					0.749						
85	K-S Test Statistic					0.184						
86	K-S Critical(0.05) Value					0.147						
87	**Data not Gamma Distributed at (0.05) Significance Level**											
88												

	A	B	C	D	E	F	G	H	I	J	K	L
89	**Lognormal GOF Test Results**											
90												
91	Correlation Coefficient R					0.964						
92	Shapiro Wilk Test Statistic					0.941						
93	Shapiro Wilk Critical (0.05) Value					0.935						
94	Approximate Shapiro Wilk P Value					0.0699						
95	Lilliefors Test Statistic					0.169						
96	Lilliefors Critical (0.05) Value					0.145						
97	**Data appear Approximate_Lognormal at (0.05) Significance Level**											

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 1:49:38 AM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Selected Null Hypothesis			Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)								
9	Alternative Hypothesis			Sample 1 Mean/Median > Sample 2 Mean/Median								
10												
11												
12	**Sample 1 Data: 200_Soil_NO2/NO3**											
13	**Sample 2 Data: 200_BG2_NO2/NO3**											
14												
15	**Raw Statistics**											
16					Sample 1	Sample 2						
17	Number of Valid Data				8	36						
18	Number of Non-Detects				1	0						
19	Number of Detect Data				7	36						
20	Minimum Non-Detect				0.6	N/A						
21	Maximum Non-Detect				0.6	N/A						
22	Percent Non-detects				12.50%	0.00%						
23	Minimum Detect				0.8	0.5						
24	Maximum Detect				7.4	3.1						
25	Mean of Detects				3.229	1.225						
26	Median of Detects				1.8	1						
27	SD of Detects				2.482	0.533						
28	KM Mean				2.9	1.225						
29	KM SD				2.319	0.533						
30												
31	**Sample 1 vs Sample 2 Gehan Test**											
32												
33	**H0: Mean/Median of Sample 1 <= Mean/Median of background**											
34												
35	Gehan z Test Value				1.628							
36	Critical z (0.05)				1.645							
37	P-Value				0.0518							
38												
39	**Conclusion with Alpha = 0.05**											
40	**Do Not Reject H0, Conclude Sample 1 <= Sample 2**											
41	**P-Value >= alpha (0.05)**											
42												

Tarone-Ware Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:50:46 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 200_Soil_NO2/NO3

Sample 2 Data: 200_BG2_NO2/NO3

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	8	36
Number of Non-Detects	1	0
Number of Detects	7	36
Minimum Non-Detect	0.6	N/A
Maximum Non-Detect	0.6	N/A
Percent Non-detects	12.50%	0.00%
Minimum Detect	0.8	0.5
Maximum Detect	7.4	3.1
Mean of Detects	3.229	1.225
Median of Detects	1.8	1
SD of Detects	2.482	0.533
KM Mean	2.9	1.225
KM SD	2.319	0.533

Sample 1 vs Sample 2 Tarone-Ware Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

TW Statistic	1.539
TW Critical Value (0.05)	1.645
P-Value	0.0619

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:18:04 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean <= Sample 2 Mean (Form 1)
Alternative Hypothesis	Sample 1 Mean > the Sample 2 Mean

Sample 1 Data: 600 Barium 0-10

Sample 2 Data: 600 BG4 Barium 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	15	33
Minimum	36.4	42.2
Maximum	338	383
Mean	142.4	114.1
Median	151	94.85
SD	77.81	67.71
SE of Mean	20.09	11.28

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 - Mean of Sample 2 <= 0

Method	DF	t-Test Value	Critical t (0.05)	P-Value
Pooled (Equal Variance)	49	1.299	1.677	0.100
Welch-Satterthwaite (Unequal Varian	23.3	1.226	1.714	0.116

Pooled SD 70.743

Conclusion with Alpha = 0.050

Student t (Pooled) Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Welch-Satterthwaite Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

	A	B	C	D	E	F	G	H	I	J	K	L
41	**Test of Equality of Variances**											
42												
43	Variance of Sample 1				6055							
44	Variance of Sample 2				4584							
45												
46	Numerator DF		Denominator DF		F-Test Value		P-Value					
47	14		35		1.321		0.490					
48	Conclusion with Alpha = 0.05											
49	Two variances appear to be equal											
50												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 12:21:18 AM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Substantial Difference			0.000								
9	Selected Null Hypothesis			Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)								
10	Alternative Hypothesis			Sample 1 Mean/Median > Sample 2 Mean/Median								
11												
12												
13	**Sample 1 Data: 600 Barium 0-10**											
14	**Sample 2 Data: 600 BG4 Barium 0-12**											
15												
16				**Raw Statistics**								
17					Sample 1	Sample 2						
18	Number of Valid Observations				15	36						
19	Number of Distinct Observations				15	33						
20	Minimum				36.4	42.2						
21	Maximum				338	383						
22	Mean				142.4	114.1						
23	Median				151	94.85						
24	SD				77.81	67.71						
25	SE of Mean				20.09	11.28						
26												
27			**Wilcoxon-Mann-Whitney (WMW) Test**									
28												
29	**H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2**											
30												
31	Sample 1 Rank Sum W-Stat				457							
32	Standardized WMW U-Stat				1.375							
33	Mean (U)				270							
34	SD(U) - Adj ties				48.37							
35	Approximate U-Stat Critical Value (0.05)				1.645							
36	P-Value (Adjusted for Ties)				0.0846							
37												
38	**Conclusion with Alpha = 0.05**											
39	**Do Not Reject H0, Conclude Sample 1 <= Sample 2**											
40	**P-Value >= alpha (0.05)**											
41												

	A	B	C	D	E	F	G	H	I	J	K	L
1				**Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects**								
2	**User Selected Options**											
3	Date/Time of Computation			ProUCL 5.2 3/6/2023 12:09:56 AM								
4	From File			UCL95_input_Revised.xls								
5	Full Precision			OFF								
6	Confidence Coefficient			0.95								
7												
8												
9	**600 Barium 0-10**											
10												
11	**Raw Statistics**											
12	Number of Valid Observations					15						
13	Number of Distinct Observations					15						
14	Minimum					36.4						
15	Maximum					338						
16	Mean of Raw Data					142.4						
17	Standard Deviation of Raw Data					77.81						
18	Khat					3.575						
19	Theta hat					39.82						
20	Kstar					2.904						
21	Theta star					49.01						
22	Mean of Log Transformed Data					4.812						
23	Standard Deviation of Log Transformed Data					0.582						
24												
25	**Normal GOF Test Results**											
26												
27	Correlation Coefficient R					0.951						
28	Shapiro Wilk Test Statistic					0.914						
29	Shapiro Wilk Critical (0.05) Value					0.881						
30	Approximate Shapiro Wilk P Value					0.14						
31	Lilliefors Test Statistic					0.166						
32	Lilliefors Critical (0.05) Value					0.22						
33	**Data appear Normal at (0.05) Significance Level**											
34												
35	**Gamma GOF Test Results**											
36												
37	Correlation Coefficient R					0.979						
38	A-D Test Statistic					0.366						
39	A-D Critical (0.05) Value					0.742						
40	K-S Test Statistic					0.184						
41	K-S Critical(0.05) Value					0.223						
42	**Data appear Gamma Distributed at (0.05) Significance Level**											
43												

44	**Lognormal GOF Test Results**	
45		
46	Correlation Coefficient R	0.976
47	Shapiro Wilk Test Statistic	0.957
48	Shapiro Wilk Critical (0.05) Value	0.881
49	Approximate Shapiro Wilk P Value	0.597
50	Lilliefors Test Statistic	0.211
51	Lilliefors Critical (0.05) Value	0.22
52	**Data appear Lognormal at (0.05) Significance Level**	
53		
54	**600 BG4 Barium 0-12**	
55		
56	**Raw Statistics**	
57	Number of Valid Observations	36
58	Number of Distinct Observations	33
59	Minimum	42.2
60	Maximum	383
61	Mean of Raw Data	114.1
62	Standard Deviation of Raw Data	67.71
63	Khat	4.383
64	Theta hat	26.04
65	Kstar	4.036
66	Theta star	28.27
67	Mean of Log Transformed Data	4.619
68	Standard Deviation of Log Transformed Data	0.465
69		
70	**Normal GOF Test Results**	
71		
72	Correlation Coefficient R	0.847
73	Shapiro Wilk Test Statistic	0.736
74	Shapiro Wilk Critical (0.05) Value	0.935
75	Approximate Shapiro Wilk P Value	8.1232E-8
76	Lilliefors Test Statistic	0.219
77	Lilliefors Critical (0.05) Value	0.145
78	**Data not Normal at (0.05) Significance Level**	
79		
80	**Gamma GOF Test Results**	
81		
82	Correlation Coefficient R	0.924
83	A-D Test Statistic	1.012
84	A-D Critical (0.05) Value	0.752
85	K-S Test Statistic	0.143
86	K-S Critical(0.05) Value	0.147
87	**Data follow Appr. Gamma Distribution at (0.05) Significance Level**	
88		

Lognormal GOF Test Results

Correlation Coefficient R	0.973
Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical (0.05) Value	0.935
Approximate Shapiro Wilk P Value	0.159
Lilliefors Test Statistic	0.108
Lilliefors Critical (0.05) Value	0.145

Data appear Lognormal at (0.05) Significance Level

600 Beryllium 0-10

Raw Statistics

Number of Valid Observations	15
Number of Distinct Observations	13
Minimum	0.34
Maximum	0.72
Mean of Raw Data	0.45
Standard Deviation of Raw Data	0.103
Khat	23.3
Theta hat	0.0193
Kstar	18.69
Theta star	0.0241
Mean of Log Transformed Data	-0.82
Standard Deviation of Log Transformed Data	0.21

Normal GOF Test Results

Correlation Coefficient R	0.937
Shapiro Wilk Test Statistic	0.882
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	0.0495
Lilliefors Test Statistic	0.167
Lilliefors Critical (0.05) Value	0.22

Data appear Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.962
A-D Test Statistic	0.382
A-D Critical (0.05) Value	0.735
K-S Test Statistic	0.139
K-S Critical(0.05) Value	0.221

Data appear Gamma Distributed at (0.05) Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
134	**Lognormal GOF Test Results**											
135												
136	Correlation Coefficient R					0.969						
137	Shapiro Wilk Test Statistic					0.937						
138	Shapiro Wilk Critical (0.05) Value					0.881						
139	Approximate Shapiro Wilk P Value					0.36						
140	Lilliefors Test Statistic					0.126						
141	Lilliefors Critical (0.05) Value					0.22						
142	**Data appear Lognormal at (0.05) Significance Level**											
143												
144	**600 BG4 Beryllium 0-12**											
145												
146	**Raw Statistics**											
147	Number of Valid Observations					36						
148	Number of Distinct Observations					27						
149	Minimum					0.17						
150	Maximum					0.72						
151	Mean of Raw Data					0.471						
152	Standard Deviation of Raw Data					0.119						
153	Khat					13.66						
154	Theta hat					0.0345						
155	Kstar					12.54						
156	Theta star					0.0376						
157	Mean of Log Transformed Data					-0.789						
158	Standard Deviation of Log Transformed Data					0.292						
159												
160	**Normal GOF Test Results**											
161												
162	Correlation Coefficient R					0.992						
163	Shapiro Wilk Test Statistic					0.986						
164	Shapiro Wilk Critical (0.05) Value					0.935						
165	Approximate Shapiro Wilk P Value					0.943						
166	Lilliefors Test Statistic					0.106						
167	Lilliefors Critical (0.05) Value					0.145						
168	**Data appear Normal at (0.05) Significance Level**											
169												
170	**Gamma GOF Test Results**											
171												
172	Correlation Coefficient R					0.975						
173	A-D Test Statistic					0.529						
174	A-D Critical (0.05) Value					0.748						
175	K-S Test Statistic					0.116						
176	K-S Critical(0.05) Value					0.147						
177	**Data appear Gamma Distributed at (0.05) Significance Level**											
178												

Lognormal GOF Test Results

Correlation Coefficient R	0.953
Shapiro Wilk Test Statistic	0.919
Shapiro Wilk Critical (0.05) Value	0.935
Approximate Shapiro Wilk P Value	0.0138
Lilliefors Test Statistic	0.112
Lilliefors Critical (0.05) Value	0.145

Data appear Approximate_Lognormal at (0.05) Significance Level

600 Cadmium 0-10

Raw Statistics

Number of Valid Observations	15
Number of Distinct Observations	13
Minimum	0.09
Maximum	0.36
Mean of Raw Data	0.187
Standard Deviation of Raw Data	0.0727
Khat	7.519
Theta hat	0.0248
Kstar	6.059
Theta star	0.0308
Mean of Log Transformed Data	-1.746
Standard Deviation of Log Transformed Data	0.381

Normal GOF Test Results

Correlation Coefficient R	0.968
Shapiro Wilk Test Statistic	0.939
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	0.363
Lilliefors Test Statistic	0.124
Lilliefors Critical (0.05) Value	0.22

Data appear Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.991
A-D Test Statistic	0.187
A-D Critical (0.05) Value	0.738
K-S Test Statistic	0.124
K-S Critical(0.05) Value	0.222

Data appear Gamma Distributed at (0.05) Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
224	**Lognormal GOF Test Results**											
225												
226	Correlation Coefficient R					0.994						
227	Shapiro Wilk Test Statistic					0.985						
228	Shapiro Wilk Critical (0.05) Value					0.881						
229	Approximate Shapiro Wilk P Value					0.989						
230	Lilliefors Test Statistic					0.113						
231	Lilliefors Critical (0.05) Value					0.22						
232	**Data appear Lognormal at (0.05) Significance Level**											
233												
234	**600 BG4 Cadmium 0-12**											
235												
236	**Raw Statistics**											
237	Number of Valid Observations					36						
238	Number of Distinct Observations					10						
239	Minimum					0.06						
240	Maximum					0.21						
241	Mean of Raw Data					0.0847						
242	Standard Deviation of Raw Data					0.0365						
243	Khat					8.066						
244	Theta hat					0.0105						
245	Kstar					7.413						
246	Theta star					0.0114						
247	Mean of Log Transformed Data					-2.532						
248	Standard Deviation of Log Transformed Data					0.331						
249												
250	**Normal GOF Test Results**											
251												
252	Correlation Coefficient R					0.779						
253	Shapiro Wilk Test Statistic					0.615						
254	Shapiro Wilk Critical (0.05) Value					0.935						
255	Approximate Shapiro Wilk P Value					1.578E-10						
256	Lilliefors Test Statistic					0.434						
257	Lilliefors Critical (0.05) Value					0.145						
258	**Data not Normal at (0.05) Significance Level**											
259												
260	**Gamma GOF Test Results**											
261												
262	Correlation Coefficient R					0.855						
263	A-D Test Statistic					5.712						
264	A-D Critical (0.05) Value					0.749						
265	K-S Test Statistic					0.435						
266	K-S Critical(0.05) Value					0.147						
267	**Data not Gamma Distributed at (0.05) Significance Level**											
268												

	A	B	C	D	E	F	G	H	I	J	K	L
269	**Lognormal GOF Test Results**											
270												
271	Correlation Coefficient R					0.824						
272	Shapiro Wilk Test Statistic					0.679						
273	Shapiro Wilk Critical (0.05) Value					0.935						
274	Approximate Shapiro Wilk P Value					3.7477E-9						
275	Lilliefors Test Statistic					0.428						
276	Lilliefors Critical (0.05) Value					0.145						
277	**Data not Lognormal at (0.05) Significance Level**											
278												
279	**Non-parametric GOF Test Results**											
280												
281	**Data do not follow a discernible distribution at (0.05) Level of Significanc**											
282												
283	**600 Chromium 0-10**											
284												
285	**Raw Statistics**											
286	Number of Valid Observations					15						
287	Number of Distinct Observations					14						
288	Minimum					4.88						
289	Maximum					16.7						
290	Mean of Raw Data					8.633						
291	Standard Deviation of Raw Data					3.716						
292	Khat					7.17						
293	Theta hat					1.204						
294	Kstar					5.78						
295	Theta star					1.493						
296	Mean of Log Transformed Data					2.084						
297	Standard Deviation of Log Transformed Data					0.373						
298												
299	**Normal GOF Test Results**											
300												
301	Correlation Coefficient R					0.884						
302	Shapiro Wilk Test Statistic					0.779						
303	Shapiro Wilk Critical (0.05) Value					0.881						
304	Approximate Shapiro Wilk P Value					0.00173						
305	Lilliefors Test Statistic					0.28						
306	Lilliefors Critical (0.05) Value					0.22						
307	**Data not Normal at (0.05) Significance Level**											
308												

	A	B	C	D	E	F	G	H	I	J	K	L
309	**Gamma GOF Test Results**											
310												
311					Correlation Coefficient R	0.93						
312					A-D Test Statistic	1.101						
313					A-D Critical (0.05) Value	0.738						
314					K-S Test Statistic	0.238						
315					K-S Critical(0.05) Value	0.222						
316	**Data not Gamma Distributed at (0.05) Significance Level**											
317												
318	**Lognormal GOF Test Results**											
319												
320					Correlation Coefficient R	0.937						
321					Shapiro Wilk Test Statistic	0.873						
322					Shapiro Wilk Critical (0.05) Value	0.881						
323					Approximate Shapiro Wilk P Value	0.0408						
324					Lilliefors Test Statistic	0.212						
325					Lilliefors Critical (0.05) Value	0.22						
326	**Data appear Approximate_Lognormal at (0.05) Significance Level**											
327												
328	**600 BG4 Chromium 0-12**											
329												
330	**Raw Statistics**											
331					Number of Valid Observations	36						
332					Number of Distinct Observations	36						
333					Minimum	3.44						
334					Maximum	9.8						
335					Mean of Raw Data	6.296						
336					Standard Deviation of Raw Data	1.607						
337					Khat	15.1						
338					Theta hat	0.417						
339					Kstar	13.86						
340					Theta star	0.454						
341					Mean of Log Transformed Data	1.806						
342					Standard Deviation of Log Transformed Data	0.267						
343												
344	**Normal GOF Test Results**											
345												
346					Correlation Coefficient R	0.986						
347					Shapiro Wilk Test Statistic	0.962						
348					Shapiro Wilk Critical (0.05) Value	0.935						
349					Approximate Shapiro Wilk P Value	0.315						
350					Lilliefors Test Statistic	0.113						
351					Lilliefors Critical (0.05) Value	0.145						
352	**Data appear Normal at (0.05) Significance Level**											
353												

	A	B	C	D	E	F	G	H	I	J	K	L
354	**Gamma GOF Test Results**											
355												
356	Correlation Coefficient R					0.983						
357	A-D Test Statistic					0.614						
358	A-D Critical (0.05) Value					0.747						
359	K-S Test Statistic					0.129						
360	K-S Critical(0.05) Value					0.147						
361	**Data appear Gamma Distributed at (0.05) Significance Level**											
362												
363	**Lognormal GOF Test Results**											
364												
365	Correlation Coefficient R					0.981						
366	Shapiro Wilk Test Statistic					0.952						
367	Shapiro Wilk Critical (0.05) Value					0.935						
368	Approximate Shapiro Wilk P Value					0.161						
369	Lilliefors Test Statistic					0.143						
370	Lilliefors Critical (0.05) Value					0.145						
371	**Data appear Lognormal at (0.05) Significance Level**											
372												
373	**600 Cobalt 0-10**											
374												
375	**Raw Statistics**											
376	Number of Valid Observations					15						
377	Number of Distinct Observations					14						
378	Minimum					1.8						
379	Maximum					6.8						
380	Mean of Raw Data					3.58						
381	Standard Deviation of Raw Data					1.472						
382	Khat					6.759						
383	Theta hat					0.53						
384	Kstar					5.451						
385	Theta star					0.657						
386	Mean of Log Transformed Data					1.2						
387	Standard Deviation of Log Transformed Data					0.401						
388												
389	**Normal GOF Test Results**											
390												
391	Correlation Coefficient R					0.962						
392	Shapiro Wilk Test Statistic					0.92						
393	Shapiro Wilk Critical (0.05) Value					0.881						
394	Approximate Shapiro Wilk P Value					0.215						
395	Lilliefors Test Statistic					0.174						
396	Lilliefors Critical (0.05) Value					0.22						
397	**Data appear Normal at (0.05) Significance Level**											
398												

Gamma GOF Test Results

Correlation Coefficient R	0.987
A-D Test Statistic	0.306
A-D Critical (0.05) Value	0.738
K-S Test Statistic	0.121
K-S Critical(0.05) Value	0.222

Data appear Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.986
Shapiro Wilk Test Statistic	0.96
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	0.757
Lilliefors Test Statistic	0.114
Lilliefors Critical (0.05) Value	0.22

Data appear Lognormal at (0.05) Significance Level

600 BG4 Cobalt 0-12

Raw Statistics

Number of Valid Observations	37
Number of Distinct Observations	34
Minimum	2.12
Maximum	4.6
Mean of Raw Data	3.329
Standard Deviation of Raw Data	0.727
Khat	20.88
Theta hat	0.159
Kstar	19.2
Theta star	0.173
Mean of Log Transformed Data	1.179
Standard Deviation of Log Transformed Data	0.225

Normal GOF Test Results

Correlation Coefficient R	0.978
Shapiro Wilk Test Statistic	0.935
Shapiro Wilk Critical (0.05) Value	0.936
Approximate Shapiro Wilk P Value	0.0428
Lilliefors Test Statistic	0.106
Lilliefors Critical (0.05) Value	0.144

Data appear Approximate Normal at (0.05) Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
444	**Gamma GOF Test Results**											
445												
446	Correlation Coefficient R					0.971						
447	A-D Test Statistic					0.736						
448	A-D Critical (0.05) Value					0.747						
449	K-S Test Statistic					0.117						
450	K-S Critical(0.05) Value					0.145						
451	**Data appear Gamma Distributed at (0.05) Significance Level**											
452												
453	**Lognormal GOF Test Results**											
454												
455	Correlation Coefficient R					0.976						
456	Shapiro Wilk Test Statistic					0.932						
457	Shapiro Wilk Critical (0.05) Value					0.936						
458	Approximate Shapiro Wilk P Value					0.0338						
459	Lilliefors Test Statistic					0.128						
460	Lilliefors Critical (0.05) Value					0.144						
461	**Data appear Approximate_Lognormal at (0.05) Significance Level**											
462												
463	**600 Copper 0-10**											
464												
465	**Raw Statistics**											
466	Number of Valid Observations					15						
467	Number of Distinct Observations					15						
468	Minimum					2.2						
469	Maximum					10.4						
470	Mean of Raw Data					4.84						
471	Standard Deviation of Raw Data					2.546						
472	Khat					4.258						
473	Theta hat					1.137						
474	Kstar					3.451						
475	Theta star					1.402						
476	Mean of Log Transformed Data					1.455						
477	Standard Deviation of Log Transformed Data					0.505						
478												
479	**Normal GOF Test Results**											
480												
481	Correlation Coefficient R					0.939						
482	Shapiro Wilk Test Statistic					0.872						
483	Shapiro Wilk Critical (0.05) Value					0.881						
484	Approximate Shapiro Wilk P Value					0.0422						
485	Lilliefors Test Statistic					0.22						
486	Lilliefors Critical (0.05) Value					0.22						
487	**Data not Normal at (0.05) Significance Level**											
488												

	A	B	C	D	E	F	G	H	I	J	K	L
489	**Gamma GOF Test Results**											
490												
491	Correlation Coefficient R					0.974						
492	A-D Test Statistic					0.585						
493	A-D Critical (0.05) Value					0.74						
494	K-S Test Statistic					0.167						
495	K-S Critical(0.05) Value					0.222						
496	**Data appear Gamma Distributed at (0.05) Significance Level**											
497												
498	**Lognormal GOF Test Results**											
499												
500	Correlation Coefficient R					0.97						
501	Shapiro Wilk Test Statistic					0.924						
502	Shapiro Wilk Critical (0.05) Value					0.881						
503	Approximate Shapiro Wilk P Value					0.283						
504	Lilliefors Test Statistic					0.153						
505	Lilliefors Critical (0.05) Value					0.22						
506	**Data appear Lognormal at (0.05) Significance Level**											
507												
508	**600 BG4 Copper 0-12**											
509												
510	**Raw Statistics**											
511	Number of Valid Observations					36						
512	Number of Distinct Observations					35						
513	Minimum					3.73						
514	Maximum					9.53						
515	Mean of Raw Data					5.859						
516	Standard Deviation of Raw Data					1.641						
517	Khat					13.9						
518	Theta hat					0.422						
519	Kstar					12.76						
520	Theta star					0.459						
521	Mean of Log Transformed Data					1.732						
522	Standard Deviation of Log Transformed Data					0.271						
523												
524	**Normal GOF Test Results**											
525												
526	Correlation Coefficient R					0.964						
527	Shapiro Wilk Test Statistic					0.913						
528	Shapiro Wilk Critical (0.05) Value					0.935						
529	Approximate Shapiro Wilk P Value					0.00897						
530	Lilliefors Test Statistic					0.133						
531	Lilliefors Critical (0.05) Value					0.145						
532	**Data appear Approximate Normal at (0.05) Significance Level**											
533												

	A	B	C	D	E	F	G	H	I	J	K	L
534	**Gamma GOF Test Results**											
535												
536	Correlation Coefficient R					0.98						
537	A-D Test Statistic					0.712						
538	A-D Critical (0.05) Value					0.748						
539	K-S Test Statistic					0.123						
540	K-S Critical(0.05) Value					0.147						
541	**Data appear Gamma Distributed at (0.05) Significance Level**											
542												
543	**Lognormal GOF Test Results**											
544												
545	Correlation Coefficient R					0.979						
546	Shapiro Wilk Test Statistic					0.939						
547	Shapiro Wilk Critical (0.05) Value					0.935						
548	Approximate Shapiro Wilk P Value					0.062						
549	Lilliefors Test Statistic					0.112						
550	Lilliefors Critical (0.05) Value					0.145						
551	**Data appear Lognormal at (0.05) Significance Level**											
552												
553	**600 Manganese 0-10**											
554												
555	**Raw Statistics**											
556	Number of Valid Observations					15						
557	Number of Distinct Observations					13						
558	Minimum					102						
559	Maximum					325						
560	Mean of Raw Data					175.9						
561	Standard Deviation of Raw Data					65.42						
562	Khat					8.6						
563	Theta hat					20.45						
564	Kstar					6.924						
565	Theta star					25.4						
566	Mean of Log Transformed Data					5.11						
567	Standard Deviation of Log Transformed Data					0.35						
568												
569	**Normal GOF Test Results**											
570												
571	Correlation Coefficient R					0.943						
572	Shapiro Wilk Test Statistic					0.884						
573	Shapiro Wilk Critical (0.05) Value					0.881						
574	Approximate Shapiro Wilk P Value					0.0611						
575	Lilliefors Test Statistic					0.231						
576	Lilliefors Critical (0.05) Value					0.22						
577	**Data appear Approximate Normal at (0.05) Significance Level**											
578												

Gamma GOF Test Results

Correlation Coefficient R	0.973
A-D Test Statistic	0.579
A-D Critical (0.05) Value	0.738
K-S Test Statistic	0.221
K-S Critical(0.05) Value	0.222

Data appear Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.969
Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	0.312
Lilliefors Test Statistic	0.204
Lilliefors Critical (0.05) Value	0.22

Data appear Lognormal at (0.05) Significance Level

600 BG4 Manganese 0-12

Raw Statistics

Number of Valid Observations	36
Number of Distinct Observations	33
Minimum	74
Maximum	320
Mean of Raw Data	178.2
Standard Deviation of Raw Data	61.62
Khat	8.503
Theta hat	20.96
Kstar	7.813
Theta star	22.81
Mean of Log Transformed Data	5.123
Standard Deviation of Log Transformed Data	0.358

Normal GOF Test Results

Correlation Coefficient R	0.98
Shapiro Wilk Test Statistic	0.951
Shapiro Wilk Critical (0.05) Value	0.935
Approximate Shapiro Wilk P Value	0.148
Lilliefors Test Statistic	0.166
Lilliefors Critical (0.05) Value	0.145

Data appear Approximate Normal at (0.05) Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
624	**Gamma GOF Test Results**											
625												
626	Correlation Coefficient R					0.988						
627	A-D Test Statistic					0.425						
628	A-D Critical (0.05) Value					0.749						
629	K-S Test Statistic					0.125						
630	K-S Critical(0.05) Value					0.147						
631	**Data appear Gamma Distributed at (0.05) Significance Level**											
632												
633	**Lognormal GOF Test Results**											
634												
635	Correlation Coefficient R					0.985						
636	Shapiro Wilk Test Statistic					0.962						
637	Shapiro Wilk Critical (0.05) Value					0.935						
638	Approximate Shapiro Wilk P Value					0.326						
639	Lilliefors Test Statistic					0.102						
640	Lilliefors Critical (0.05) Value					0.145						
641	**Data appear Lognormal at (0.05) Significance Level**											
642												
643	**600 Mercury 0-10**											
644												
645	**Raw Statistics**											
646	Number of Valid Observations					15						
647	Number of Distinct Observations					11						
648	Minimum					0.001						
649	Maximum					0.099						
650	Mean of Raw Data					0.0155						
651	Standard Deviation of Raw Data					0.0268						
652	Khat					0.764						
653	Theta hat					0.0202						
654	Kstar					0.656						
655	Theta star					0.0236						
656	Mean of Log Transformed Data					-4.951						
657	Standard Deviation of Log Transformed Data					1.152						
658												
659	**Normal GOF Test Results**											
660												
661	Correlation Coefficient R					0.71						
662	Shapiro Wilk Test Statistic					0.527						
663	Shapiro Wilk Critical (0.05) Value					0.881						
664	Approximate Shapiro Wilk P Value					1.4244E-6						
665	Lilliefors Test Statistic					0.418						
666	Lilliefors Critical (0.05) Value					0.22						
667	**Data not Normal at (0.05) Significance Level**											
668												

669	**Gamma GOF Test Results**	
670		
671	Correlation Coefficient R	0.92
672	A-D Test Statistic	1.576
673	A-D Critical (0.05) Value	0.774
674	K-S Test Statistic	0.314
675	K-S Critical(0.05) Value	0.23
676	**Data not Gamma Distributed at (0.05) Significance Level**	
677		
678	**Lognormal GOF Test Results**	
679		
680	Correlation Coefficient R	0.944
681	Shapiro Wilk Test Statistic	0.904
682	Shapiro Wilk Critical (0.05) Value	0.881
683	Approximate Shapiro Wilk P Value	0.0914
684	Lilliefors Test Statistic	0.217
685	Lilliefors Critical (0.05) Value	0.22
686	**Data appear Lognormal at (0.05) Significance Level**	
687		
688	**600 BG4 Mercury 0-12**	
689		
690	**Raw Statistics**	
691	Number of Valid Observations	36
692	Number of Distinct Observations	11
693	Minimum	0.006
694	Maximum	0.025
695	Mean of Raw Data	0.00897
696	Standard Deviation of Raw Data	0.00517
697	Khat	4.787
698	Theta hat	0.00187
699	Kstar	4.406
700	Theta star	0.00204
701	Mean of Log Transformed Data	-4.822
702	Standard Deviation of Log Transformed Data	0.427
703		
704	**Normal GOF Test Results**	
705		
706	Correlation Coefficient R	0.792
707	Shapiro Wilk Test Statistic	0.628
708	Shapiro Wilk Critical (0.05) Value	0.935
709	Approximate Shapiro Wilk P Value	2.947E-10
710	Lilliefors Test Statistic	0.303
711	Lilliefors Critical (0.05) Value	0.145
712	**Data not Normal at (0.05) Significance Level**	
713		

	A	B	C	D	E	F	G	H	I	J	K	L
714	**Gamma GOF Test Results**											
715												
716					Correlation Coefficient R	0.887						
717					A-D Test Statistic	4.493						
718					A-D Critical (0.05) Value	0.751						
719					K-S Test Statistic	0.259						
720					K-S Critical(0.05) Value	0.147						
721	**Data not Gamma Distributed at (0.05) Significance Level**											
722												
723	**Lognormal GOF Test Results**											
724												
725					Correlation Coefficient R	0.851						
726					Shapiro Wilk Test Statistic	0.716						
727					Shapiro Wilk Critical (0.05) Value	0.935						
728					Approximate Shapiro Wilk P Value	2.7161E-8						
729					Lilliefors Test Statistic	0.245						
730					Lilliefors Critical (0.05) Value	0.145						
731	**Data not Lognormal at (0.05) Significance Level**											
732												
733	**Non-parametric GOF Test Results**											
734												
735	**Data do not follow a discernible distribution at (0.05) Level of Significanc**											
736												
737	**600 Molybdenum 0-10**											
738												
739	**Raw Statistics**											
740					Number of Valid Observations	15						
741					Number of Distinct Observations	7						
742					Minimum	0.4						
743					Maximum	3.2						
744					Mean of Raw Data	0.887						
745					Standard Deviation of Raw Data	0.784						
746					Khat	2.054						
747					Theta hat	0.432						
748					Kstar	1.688						
749					Theta star	0.525						
750					Mean of Log Transformed Data	-0.383						
751					Standard Deviation of Log Transformed Data	0.698						
752												
753	**Normal GOF Test Results**											
754												
755					Correlation Coefficient R	0.824						
756					Shapiro Wilk Test Statistic	0.691						
757					Shapiro Wilk Critical (0.05) Value	0.881						
758					Approximate Shapiro Wilk P Value	1.1009E-4						
759					Lilliefors Test Statistic	0.289						
760					Lilliefors Critical (0.05) Value	0.22						
761	**Data not Normal at (0.05) Significance Level**											
762												

763	**Gamma GOF Test Results**	
764		
765	Correlation Coefficient R	0.947
766	A-D Test Statistic	1.573
767	A-D Critical (0.05) Value	0.747
768	K-S Test Statistic	0.31
769	K-S Critical(0.05) Value	0.224
770	**Data not Gamma Distributed at (0.05) Significance Level**	
771		
772	**Lognormal GOF Test Results**	
773		
774	Correlation Coefficient R	0.885
775	Shapiro Wilk Test Statistic	0.774
776	Shapiro Wilk Critical (0.05) Value	0.881
777	Approximate Shapiro Wilk P Value	0.00163
778	Lilliefors Test Statistic	0.311
779	Lilliefors Critical (0.05) Value	0.22
780	**Data not Lognormal at (0.05) Significance Level**	
781		
782	**Non-parametric GOF Test Results**	
783		
784	**Data do not follow a discernible distribution at (0.05) Level of Significance**	
785		
786	**600 BG4 Molybdenum 0-12**	
787		
788	**Raw Statistics**	
789	Number of Valid Observations	36
790	Number of Distinct Observations	11
791	Minimum	0.2
792	Maximum	1.9
793	Mean of Raw Data	0.661
794	Standard Deviation of Raw Data	0.428
795	Khat	2.862
796	Theta hat	0.231
797	Kstar	2.642
798	Theta star	0.25
799	Mean of Log Transformed Data	-0.599
800	Standard Deviation of Log Transformed Data	0.614
801		
802	**Normal GOF Test Results**	
803		
804	Correlation Coefficient R	0.926
805	Shapiro Wilk Test Statistic	0.853
806	Shapiro Wilk Critical (0.05) Value	0.935
807	Approximate Shapiro Wilk P Value	1.1553E-4
808	Lilliefors Test Statistic	0.178
809	Lilliefors Critical (0.05) Value	0.145
810	**Data not Normal at (0.05) Significance Level**	
811		

	A	B	C	D	E	F	G	H	I	J	K	L
812	**Gamma GOF Test Results**											
813												
814	Correlation Coefficient R					0.983						
815	A-D Test Statistic					0.675						
816	A-D Critical (0.05) Value					0.755						
817	K-S Test Statistic					0.14						
818	K-S Critical(0.05) Value					0.148						
819	**Data appear Gamma Distributed at (0.05) Significance Level**											
820												
821	**Lognormal GOF Test Results**											
822												
823	Correlation Coefficient R					0.983						
824	Shapiro Wilk Test Statistic					0.95						
825	Shapiro Wilk Critical (0.05) Value					0.935						
826	Approximate Shapiro Wilk P Value					0.135						
827	Lilliefors Test Statistic					0.143						
828	Lilliefors Critical (0.05) Value					0.145						
829	**Data appear Lognormal at (0.05) Significance Level**											
830												
831	**600 NO2/NO3 0-10**											
832												
833	**Raw Statistics**											
834	Number of Valid Observations					15						
835	Number of Distinct Observations					15						
836	Minimum					0.7						
837	Maximum					55.4						
838	Mean of Raw Data					16.21						
839	Standard Deviation of Raw Data					20.26						
840	Khat					0.72						
841	Theta hat					22.53						
842	Kstar					0.62						
843	Theta star					26.14						
844	Mean of Log Transformed Data					1.949						
845	Standard Deviation of Log Transformed Data					1.407						
846												
847	**Normal GOF Test Results**											
848												
849	Correlation Coefficient R					0.856						
850	Shapiro Wilk Test Statistic					0.721						
851	Shapiro Wilk Critical (0.05) Value					0.881						
852	Approximate Shapiro Wilk P Value					3.3924E-4						
853	Lilliefors Test Statistic					0.342						
854	Lilliefors Critical (0.05) Value					0.22						
855	**Data not Normal at (0.05) Significance Level**											
856												

	A	B	C	D	E	F	G	H	I	J	K	L
857	**Gamma GOF Test Results**											
858												
859	Correlation Coefficient R					0.933						
860	A-D Test Statistic					0.819						
861	A-D Critical (0.05) Value					0.777						
862	K-S Test Statistic					0.25						
863	K-S Critical(0.05) Value					0.231						
864	**Data not Gamma Distributed at (0.05) Significance Level**											
865												
866	**Lognormal GOF Test Results**											
867												
868	Correlation Coefficient R					0.973						
869	Shapiro Wilk Test Statistic					0.932						
870	Shapiro Wilk Critical (0.05) Value					0.881						
871	Approximate Shapiro Wilk P Value					0.356						
872	Lilliefors Test Statistic					0.168						
873	Lilliefors Critical (0.05) Value					0.22						
874	**Data appear Lognormal at (0.05) Significance Level**											
875												
876	**600 BG4 NO2/NO3 0-12**											
877												
878	**Raw Statistics**											
879	Number of Valid Observations					40						
880	Number of Distinct Observations					18						
881	Minimum					0.3						
882	Maximum					3.3						
883	Mean of Raw Data					0.95						
884	Standard Deviation of Raw Data					0.784						
885	Khat					1.891						
886	Theta hat					0.502						
887	Kstar					1.766						
888	Theta star					0.538						
889	Mean of Log Transformed Data					-0.338						
890	Standard Deviation of Log Transformed Data					0.75						
891												
892	**Normal GOF Test Results**											
893												
894	Correlation Coefficient R					0.897						
895	Shapiro Wilk Test Statistic					0.799						
896	Shapiro Wilk Critical (0.05) Value					0.94						
897	Approximate Shapiro Wilk P Value					6.9488E-7						
898	Lilliefors Test Statistic					0.204						
899	Lilliefors Critical (0.05) Value					0.139						
900	**Data not Normal at (0.05) Significance Level**											
901												

902	**Gamma GOF Test Results**	
903		
904	Correlation Coefficient R	0.982
905	A-D Test Statistic	1.429
906	A-D Critical (0.05) Value	0.76
907	K-S Test Statistic	0.156
908	K-S Critical(0.05) Value	0.141
909	**Data not Gamma Distributed at (0.05) Significance Level**	
910		
911	**Lognormal GOF Test Results**	
912		
913	Correlation Coefficient R	0.961
914	Shapiro Wilk Test Statistic	0.899
915	Shapiro Wilk Critical (0.05) Value	0.94
916	Approximate Shapiro Wilk P Value	0.00153
917	Lilliefors Test Statistic	0.151
918	Lilliefors Critical (0.05) Value	0.139
919	**Data not Lognormal at (0.05) Significance Level**	
920		
921	**Non-parametric GOF Test Results**	
922		
923	**Data do not follow a discernible distribution at (0.05) Level of Significanc**	
924		
925	**600 Zinc 0-10**	
926		
927	**Raw Statistics**	
928	Number of Valid Observations	15
929	Number of Distinct Observations	15
930	Minimum	15.8
931	Maximum	43.7
932	Mean of Raw Data	23.89
933	Standard Deviation of Raw Data	8.72
934	Khat	9.577
935	Theta hat	2.494
936	Kstar	7.706
937	Theta star	3.1
938	Mean of Log Transformed Data	3.12
939	Standard Deviation of Log Transformed Data	0.325
940		
941	**Normal GOF Test Results**	
942		
943	Correlation Coefficient R	0.907
944	Shapiro Wilk Test Statistic	0.817
945	Shapiro Wilk Critical (0.05) Value	0.881
946	Approximate Shapiro Wilk P Value	0.00615
947	Lilliefors Test Statistic	0.265
948	Lilliefors Critical (0.05) Value	0.22
949	**Data not Normal at (0.05) Significance Level**	
950		

	A	B	C	D	E	F	G	H	I	J	K	L
951	**Gamma GOF Test Results**											
952												
953	Correlation Coefficient R					0.948						
954	A-D Test Statistic					0.839						
955	A-D Critical (0.05) Value					0.737						
956	K-S Test Statistic					0.226						
957	K-S Critical(0.05) Value					0.222						
958	**Data not Gamma Distributed at (0.05) Significance Level**											
959												
960	**Lognormal GOF Test Results**											
961												
962	Correlation Coefficient R					0.945						
963	Shapiro Wilk Test Statistic					0.882						
964	Shapiro Wilk Critical (0.05) Value					0.881						
965	Approximate Shapiro Wilk P Value					0.0613						
966	Lilliefors Test Statistic					0.204						
967	Lilliefors Critical (0.05) Value					0.22						
968	**Data appear Lognormal at (0.05) Significance Level**											
969												
970	**600 BG4 Zinc 0-12**											
971												
972	**Raw Statistics**											
973	Number of Valid Observations					36						
974	Number of Distinct Observations					32						
975	Minimum					12.7						
976	Maximum					44.8						
977	Mean of Raw Data					27.5						
978	Standard Deviation of Raw Data					7.299						
979	Khat					13.57						
980	Theta hat					2.027						
981	Kstar					12.46						
982	Theta star					2.208						
983	Mean of Log Transformed Data					3.277						
984	Standard Deviation of Log Transformed Data					0.285						
985												
986	**Normal GOF Test Results**											
987												
988	Correlation Coefficient R					0.992						
989	Shapiro Wilk Test Statistic					0.981						
990	Shapiro Wilk Critical (0.05) Value					0.935						
991	Approximate Shapiro Wilk P Value					0.834						
992	Lilliefors Test Statistic					0.0865						
993	Lilliefors Critical (0.05) Value					0.145						
994	**Data appear Normal at (0.05) Significance Level**											
995												

	A	B	C	D	E	F	G	H	I	J	K	L
996	**Gamma GOF Test Results**											
997												
998	Correlation Coefficient R					0.987						
999	A-D Test Statistic					0.346						
1000	A-D Critical (0.05) Value					0.748						
1001	K-S Test Statistic					0.0982						
1002	K-S Critical(0.05) Value					0.147						
1003	**Data appear Gamma Distributed at (0.05) Significance Level**											
1004												
1005	**Lognormal GOF Test Results**											
1006												
1007	Correlation Coefficient R					0.979						
1008	Shapiro Wilk Test Statistic					0.956						
1009	Shapiro Wilk Critical (0.05) Value					0.935						
1010	Approximate Shapiro Wilk P Value					0.219						
1011	Lilliefors Test Statistic					0.0973						
1012	Lilliefors Critical (0.05) Value					0.145						
1013	**Data appear Lognormal at (0.05) Significance Level**											
1014												
1015	**600 Magnesium 0-10**											
1016												
1017	**Raw Statistics**											
1018	Number of Valid Observations					15						
1019	Number of Distinct Observations					15						
1020	Minimum					3460						
1021	Maximum					21800						
1022	Mean of Raw Data					11429						
1023	Standard Deviation of Raw Data					5270						
1024	Khat					4.567						
1025	Theta hat					2503						
1026	Kstar					3.698						
1027	Theta star					3091						
1028	Mean of Log Transformed Data					9.23						
1029	Standard Deviation of Log Transformed Data					0.519						
1030												
1031	**Normal GOF Test Results**											
1032												
1033	Correlation Coefficient R					0.985						
1034	Shapiro Wilk Test Statistic					0.964						
1035	Shapiro Wilk Critical (0.05) Value					0.881						
1036	Approximate Shapiro Wilk P Value					0.78						
1037	Lilliefors Test Statistic					0.124						
1038	Lilliefors Critical (0.05) Value					0.22						
1039	**Data appear Normal at (0.05) Significance Level**											
1040												

	A	B	C	D	E	F	G	H	I	J	K	L
1041	**Gamma GOF Test Results**											
1042												
1043	Correlation Coefficient R					0.988						
1044	A-D Test Statistic					0.207						
1045	A-D Critical (0.05) Value					0.739						
1046	K-S Test Statistic					0.116						
1047	K-S Critical(0.05) Value					0.222						
1048	**Data appear Gamma Distributed at (0.05) Significance Level**											
1049												
1050	**Lognormal GOF Test Results**											
1051												
1052	Correlation Coefficient R					0.978						
1053	Shapiro Wilk Test Statistic					0.954						
1054	Shapiro Wilk Critical (0.05) Value					0.881						
1055	Approximate Shapiro Wilk P Value					0.585						
1056	Lilliefors Test Statistic					0.149						
1057	Lilliefors Critical (0.05) Value					0.22						
1058	**Data appear Lognormal at (0.05) Significance Level**											
1059												
1060	**600 BG4 Magnesium 0-12**											
1061												
1062	**Raw Statistics**											
1063	Number of Valid Observations					36						
1064	Number of Distinct Observations					35						
1065	Minimum					4000						
1066	Maximum					18000						
1067	Mean of Raw Data					8765						
1068	Standard Deviation of Raw Data					4012						
1069	Khat					5.165						
1070	Theta hat					1697						
1071	Kstar					4.753						
1072	Theta star					1844						
1073	Mean of Log Transformed Data					8.979						
1074	Standard Deviation of Log Transformed Data					0.453						
1075												
1076	**Normal GOF Test Results**											
1077												
1078	Correlation Coefficient R					0.954						
1079	Shapiro Wilk Test Statistic					0.894						
1080	Shapiro Wilk Critical (0.05) Value					0.935						
1081	Approximate Shapiro Wilk P Value					0.00218						
1082	Lilliefors Test Statistic					0.2						
1083	Lilliefors Critical (0.05) Value					0.145						
1084	**Data not Normal at (0.05) Significance Level**											
1085												

	A	B	C	D	E	F	G	H	I	J	K	L
1086	**Gamma GOF Test Results**											
1087												
1088					Correlation Coefficient R	0.978						
1089					A-D Test Statistic	1.012						
1090					A-D Critical (0.05) Value	0.75						
1091					K-S Test Statistic	0.181						
1092					K-S Critical(0.05) Value	0.147						
1093	**Data not Gamma Distributed at (0.05) Significance Level**											
1094												
1095	**Lognormal GOF Test Results**											
1096												
1097					Correlation Coefficient R	0.973						
1098					Shapiro Wilk Test Statistic	0.925						
1099					Shapiro Wilk Critical (0.05) Value	0.935						
1100					Approximate Shapiro Wilk P Value	0.0213						
1101					Lilliefors Test Statistic	0.163						
1102					Lilliefors Critical (0.05) Value	0.145						
1103	**Data not Lognormal at (0.05) Significance Level**											
1104												
1105	**Non-parametric GOF Test Results**											
1106												
1107	**Data do not follow a discernible distribution at (0.05) Level of Significance**											
1108												
1109	**600 Potassium 0-10**											
1110												
1111	**Raw Statistics**											
1112					Number of Valid Observations	15						
1113					Number of Distinct Observations	14						
1114					Minimum	830						
1115					Maximum	3130						
1116					Mean of Raw Data	1371						
1117					Standard Deviation of Raw Data	614.5						
1118					Khat	7.247						
1119					Theta hat	189.1						
1120					Kstar	5.842						
1121					Theta star	234.6						
1122					Mean of Log Transformed Data	7.152						
1123					Standard Deviation of Log Transformed Data	0.364						
1124												
1125	**Normal GOF Test Results**											
1126												
1127					Correlation Coefficient R	0.858						
1128					Shapiro Wilk Test Statistic	0.75						
1129					Shapiro Wilk Critical (0.05) Value	0.881						
1130					Approximate Shapiro Wilk P Value	5.9501E-4						
1131					Lilliefors Test Statistic	0.282						
1132					Lilliefors Critical (0.05) Value	0.22						
1133	**Data not Normal at (0.05) Significance Level**											
1134												

	A	B	C	D	E	F	G	H	I	J	K	L
1135	**Gamma GOF Test Results**											
1136												
1137	Correlation Coefficient R					0.925						
1138	A-D Test Statistic					1.094						
1139	A-D Critical (0.05) Value					0.738						
1140	K-S Test Statistic					0.264						
1141	K-S Critical(0.05) Value					0.222						
1142	**Data not Gamma Distributed at (0.05) Significance Level**											
1143												
1144	**Lognormal GOF Test Results**											
1145												
1146	Correlation Coefficient R					0.926						
1147	Shapiro Wilk Test Statistic					0.862						
1148	Shapiro Wilk Critical (0.05) Value					0.881						
1149	Approximate Shapiro Wilk P Value					0.0242						
1150	Lilliefors Test Statistic					0.244						
1151	Lilliefors Critical (0.05) Value					0.22						
1152	**Data not Lognormal at (0.05) Significance Level**											
1153												
1154	**Non-parametric GOF Test Results**											
1155												
1156	**Data do not follow a discernible distribution at (0.05) Level of Significanc**											
1157												
1158	**600 BG4 Potassium 0-12**											
1159												
1160	**Raw Statistics**											
1161	Number of Valid Observations					36						
1162	Number of Distinct Observations					34						
1163	Minimum					920						
1164	Maximum					2770						
1165	Mean of Raw Data					1801						
1166	Standard Deviation of Raw Data					539.8						
1167	Khat					10.73						
1168	Theta hat					167.9						
1169	Kstar					9.854						
1170	Theta star					182.8						
1171	Mean of Log Transformed Data					7.449						
1172	Standard Deviation of Log Transformed Data					0.32						
1173												
1174	**Normal GOF Test Results**											
1175												
1176	Correlation Coefficient R					0.988						
1177	Shapiro Wilk Test Statistic					0.955						
1178	Shapiro Wilk Critical (0.05) Value					0.935						
1179	Approximate Shapiro Wilk P Value					0.198						
1180	Lilliefors Test Statistic					0.109						
1181	Lilliefors Critical (0.05) Value					0.145						
1182	**Data appear Normal at (0.05) Significance Level**											
1183												

Gamma GOF Test Results

Correlation Coefficient R	0.979
A-D Test Statistic	0.409
A-D Critical (0.05) Value	0.748
K-S Test Statistic	0.0904
K-S Critical(0.05) Value	0.147

Data appear Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.981
Shapiro Wilk Test Statistic	0.943
Shapiro Wilk Critical (0.05) Value	0.935
Approximate Shapiro Wilk P Value	0.0833
Lilliefors Test Statistic	0.0996
Lilliefors Critical (0.05) Value	0.145

Data appear Lognormal at (0.05) Significance Level

600 Sodium 0-10

Raw Statistics

Number of Valid Observations	15
Number of Distinct Observations	14
Minimum	140
Maximum	12900
Mean of Raw Data	1615
Standard Deviation of Raw Data	3352
Khat	0.585
Theta hat	2761
Kstar	0.512
Theta star	3152
Mean of Log Transformed Data	6.327
Standard Deviation of Log Transformed Data	1.309

Normal GOF Test Results

Correlation Coefficient R	0.677
Shapiro Wilk Test Statistic	0.484
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	5.1804E-7
Lilliefors Test Statistic	0.409
Lilliefors Critical (0.05) Value	0.22

Data not Normal at (0.05) Significance Level

1229	**Gamma GOF Test Results**	
1230		
1231	Correlation Coefficient R	0.924
1232	A-D Test Statistic	1.538
1233	A-D Critical (0.05) Value	0.787
1234	K-S Test Statistic	0.276
1235	K-S Critical(0.05) Value	0.233
1236	**Data not Gamma Distributed at (0.05) Significance Level**	
1237		
1238	**Lognormal GOF Test Results**	
1239		
1240	Correlation Coefficient R	0.938
1241	Shapiro Wilk Test Statistic	0.878
1242	Shapiro Wilk Critical (0.05) Value	0.881
1243	Approximate Shapiro Wilk P Value	0.0461
1244	Lilliefors Test Statistic	0.152
1245	Lilliefors Critical (0.05) Value	0.22
1246	**Data appear Approximate_Lognormal at (0.05) Significance Level**	
1247		
1248	**600 BG4 Sodium 0-12**	
1249		
1250	**Raw Statistics**	
1251	Number of Valid Observations	36
1252	Number of Distinct Observations	32
1253	Minimum	30
1254	Maximum	800
1255	Mean of Raw Data	286.6
1256	Standard Deviation of Raw Data	210.5
1257	Khat	1.732
1258	Theta hat	165.4
1259	Kstar	1.606
1260	Theta star	178.4
1261	Mean of Log Transformed Data	5.342
1262	Standard Deviation of Log Transformed Data	0.875
1263		
1264	**Normal GOF Test Results**	
1265		
1266	Correlation Coefficient R	0.959
1267	Shapiro Wilk Test Statistic	0.907
1268	Shapiro Wilk Critical (0.05) Value	0.935
1269	Approximate Shapiro Wilk P Value	0.00554
1270	Lilliefors Test Statistic	0.155
1271	Lilliefors Critical (0.05) Value	0.145
1272	**Data not Normal at (0.05) Significance Level**	
1273		

	A	B	C	D	E	F	G	H	I	J	K	L
1274	**Gamma GOF Test Results**											
1275												
1276	Correlation Coefficient R					0.985						
1277	A-D Test Statistic					0.252						
1278	A-D Critical (0.05) Value					0.763						
1279	K-S Test Statistic					0.0893						
1280	K-S Critical(0.05) Value					0.149						
1281	**Data appear Gamma Distributed at (0.05) Significance Level**											
1282												
1283	**Lognormal GOF Test Results**											
1284												
1285	Correlation Coefficient R					0.983						
1286	Shapiro Wilk Test Statistic					0.953						
1287	Shapiro Wilk Critical (0.05) Value					0.935						
1288	Approximate Shapiro Wilk P Value					0.172						
1289	Lilliefors Test Statistic					0.093						
1290	Lilliefors Critical (0.05) Value					0.145						
1291	**Data appear Lognormal at (0.05) Significance Level**											

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:28:23 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean <= Sample 2 Mean (Form 1)
Alternative Hypothesis	Sample 1 Mean > the Sample 2 Mean

Sample 1 Data: 600 Beryllium 0-10

Sample 2 Data: 600 BG4 Beryllium 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	13	27
Minimum	0.34	0.17
Maximum	0.72	0.72
Mean	0.45	0.471
Median	0.43	0.48
SD	0.103	0.119
SE of Mean	0.0265	0.0199

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 - Mean of Sample 2 <= 0

Method	DF	t-Test Value	Critical t (0.05)	P-Value
Pooled (Equal Variance)	49	-0.607	1.677	0.727
Welch-Satterthwaite (Unequal Varian	30.3	-0.646	1.697	0.738

Pooled SD 0.115

Conclusion with Alpha = 0.050

Student t (Pooled) Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Welch-Satterthwaite Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Test of Equality of Variances

Variance of Sample 1	0.0105
Variance of Sample 2	0.0142

Numerator DF	Denominator DF	F-Test Value	P-Value
35	14	1.350	0.559

Conclusion with Alpha = 0.05

Two variances appear to be equal

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:14:02 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean <= Sample 2 Mean (Form 1)
Alternative Hypothesis	Sample 1 Mean > the Sample 2 Mean

Sample 1 Data: 600 Cobalt 0-10

Sample 2 Data: 600 BG4 Cobalt 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	37
Number of Distinct Observations	14	34
Minimum	1.8	2.12
Maximum	6.8	4.6
Mean	3.58	3.329
Median	3.5	3.47
SD	1.472	0.727
SE of Mean	0.38	0.12

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 - Mean of Sample 2 <= 0

Method	DF	t-Test Value	Critical t (0.05)	P-Value
Pooled (Equal Variance)	50	0.825	1.676	0.207
Welch-Satterthwaite (Unequal Varian	16.8	0.629	1.740	0.269

Pooled SD 0.994

Conclusion with Alpha = 0.050

Student t (Pooled) Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Welch-Satterthwaite Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Test of Equality of Variances

Variance of Sample 1	2.167
Variance of Sample 2	0.529

Numerator DF	Denominator DF	F-Test Value	P-Value
14	36	4.101	0.001

Conclusion with Alpha = 0.05

Two variances are not equal

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:15:08 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Cobalt 0-10

Sample 2 Data: 600 BG4 Cobalt 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	37
Number of Distinct Observations	14	34
Minimum	1.8	2.12
Maximum	6.8	4.6
Mean	3.58	3.329
Median	3.5	3.47
SD	1.472	0.727
SE of Mean	0.38	0.12

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	398.5
Standardized WMW U-Stat	0.0101
Mean (U)	277.5
SD(U) - Adj ties	49.5
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.496

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Cr_BG4_pop2pop_Wil-Mann-Whit

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 12:33:49 AM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Substantial Difference			0.000								
9	Selected Null Hypothesis			Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)								
10	Alternative Hypothesis			Sample 1 Mean/Median > Sample 2 Mean/Median								
11												
12												
13	**Sample 1 Data: 600 Chromium 0-10**											
14	**Sample 2 Data: 600 BG4 Chromium 0-12**											
15												
16	**Raw Statistics**											
17					Sample 1	Sample 2						
18	Number of Valid Observations				15	36						
19	Number of Distinct Observations				14	36						
20	Minimum				4.88	3.44						
21	Maximum				16.7	9.8						
22	Mean				8.633	6.296						
23	Median				7.2	6.6						
24	SD				3.716	1.607						
25	SE of Mean				0.959	0.268						
26												
27	**Wilcoxon-Mann-Whitney (WMW) Test**											
28												
29	**H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2**											
30												
31	Sample 1 Rank Sum W-Stat				492							
32	Standardized WMW U-Stat				2.098							
33	Mean (U)				270							
34	SD(U) - Adj ties				48.37							
35	Approximate U-Stat Critical Value (0.05)				1.645							
36	P-Value (Adjusted for Ties)				0.0179							
37												
38	**Conclusion with Alpha = 0.05**											
39	**Reject H0, Conclude Sample 1 > Sample 2**											
40	**P-Value < alpha (0.05)**											
41												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs**											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.2 3/6/2023 12:35:27 AM								
5			From File	UCL95_input_Revised.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Substantial Difference	0.000								
9			Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)								
10			Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median								
11												
12												
13	**Sample 1 Data: 600 Copper 0-10**											
14	**Sample 2 Data: 600 BG4 Copper 0-12**											
15												
16				**Raw Statistics**								
17					Sample 1	Sample 2						
18				Number of Valid Observations	15	36						
19				Number of Distinct Observations	15	35						
20				Minimum	2.2	3.73						
21				Maximum	10.4	9.53						
22				Mean	4.84	5.859						
23				Median	4	5.675						
24				SD	2.546	1.641						
25				SE of Mean	0.657	0.274						
26												
27				**Wilcoxon-Mann-Whitney (WMW) Test**								
28												
29	**H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2**											
30												
31				Sample 1 Rank Sum W-Stat	287							
32				Standardized WMW U-Stat	-2.14							
33				Mean (U)	270							
34				SD(U) - Adj ties	48.37							
35				Approximate U-Stat Critical Value (0.05)	1.645							
36				P-Value (Adjusted for Ties)	0.984							
37												
38	**Conclusion with Alpha = 0.05**											
39	**Do Not Reject H0, Conclude Sample 1 <= Sample 2**											
40	**P-Value >= alpha (0.05)**											
41												

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:38:15 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Mercury 0-10

Sample 2 Data: 600 BG4 Mercury 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	1	17
Number of Detect Data	14	19
Minimum Non-Detect	0.001	0.006
Maximum Non-Detect	0.001	0.006
Percent Non-detects	6.67%	47.22%
Minimum Detect	0.002	0.007
Maximum Detect	0.099	0.025
Mean of Detects	0.0165	0.0116
Median of Detects	0.007	0.009
SD of Detects	0.0274	0.00602
KM Mean	0.0155	0.00897
KM SD	0.0258	0.0051

Sample 1 vs Sample 2 Gehan Test

H0: Mean/Median of Sample 1 <= Mean/Median of background

Gehan z Test Value	0.0109
Critical z (0.05)	1.645
P-Value	0.496

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Tarone-Ware Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:00:42 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Mercury 0-10

Sample 2 Data: 600 BG4 Mercury 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	1	17
Number of Detects	14	19
Minimum Non-Detect	0.001	0.006
Maximum Non-Detect	0.001	0.006
Percent Non-detects	6.67%	47.22%
Minimum Detect	0.002	0.007
Maximum Detect	0.099	0.025
Mean of Detects	0.0165	0.0116
Median of Detects	0.007	0.009
SD of Detects	0.0274	0.00602
KM Mean	0.0155	0.00897
KM SD	0.0258	0.0051

Sample 1 vs Sample 2 Tarone-Ware Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

TW Statistic	0.148
TW Critical Value (0.05)	1.645
P-Value	0.441

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:48:02 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Potassium 0-10

Sample 2 Data: 600 BG4 Potassium 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	14	34
Minimum	830	920
Maximum	3130	2770
Mean	1371	1801
Median	1110	1795
SD	614.5	539.8
SE of Mean	158.7	89.96

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	259
Standardized WMW U-Stat	-2.719
Mean (U)	270
SD(U) - Adj ties	48.37
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.997

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:46:32 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Magnesium 0-10

Sample 2 Data: 600 BG4 Magnesium 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	15	35
Minimum	3460	4000
Maximum	21800	18000
Mean	11429	8765
Median	11000	7160
SD	5270	4012
SE of Mean	1361	668.6

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	469.5
Standardized WMW U-Stat	1.633
Mean (U)	270
SD(U) - Adj ties	48.37
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.0512

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:36:55 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean <= Sample 2 Mean (Form 1)
Alternative Hypothesis	Sample 1 Mean > the Sample 2 Mean

Sample 1 Data: 600 Manganese 0-10

Sample 2 Data: 600 BG4 Manganese 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	13	33
Minimum	102	74
Maximum	325	320
Mean	175.9	178.2
Median	142	156.5
SD	65.42	61.62
SE of Mean	16.89	10.27

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 - Mean of Sample 2 <= 0

Method	DF	t-Test Value	Critical t (0.05)	P-Value
Pooled (Equal Variance)	49	-0.122	1.677	0.548
Welch-Satterthwaite (Unequal Varian	24.9	-0.119	1.708	0.547

Pooled SD 62.728

Conclusion with Alpha = 0.050

Student t (Pooled) Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Welch-Satterthwaite Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Test of Equality of Variances

Variance of Sample 1	4280
Variance of Sample 2	3797

Numerator DF	Denominator DF	F-Test Value	P-Value
14	35	1.127	0.740

Conclusion with Alpha = 0.05

Two variances appear to be equal

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:37:34 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Manganese 0-10

Sample 2 Data: 600 BG4 Manganese 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	13	33
Minimum	102	74
Maximum	325	320
Mean	175.9	178.2
Median	142	156.5
SD	65.42	61.62
SE of Mean	16.89	10.27

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	366.5
Standardized WMW U-Stat	-0.496
Mean (U)	270
SD(U) - Adj ties	48.37
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.69

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:39:50 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Molybdenum 0-10

Sample 2 Data: 600 BG4 Molybdenum 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	7	0
Number of Detect Data	8	36
Minimum Non-Detect	0.4	N/A
Maximum Non-Detect	0.4	N/A
Percent Non-detects	46.67%	0.00%
Minimum Detect	0.4	0.2
Maximum Detect	3.2	1.9
Mean of Detects	1.313	0.661
Median of Detects	1.1	0.55
SD of Detects	0.885	0.428
KM Mean	0.887	0.661
KM SD	0.757	0.428

Sample 1 vs Sample 2 Gehan Test

H0: Mean/Median of Sample 1 <= Mean/Median of background

Gehan z Test Value	-0.242
Critical z (0.05)	1.645
P-Value	0.596

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Tarone-Ware Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:08:42 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Molybdenum 0-10

Sample 2 Data: 600 BG4 Molybdenum 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	7	0
Number of Detects	8	36
Minimum Non-Detect	0.4	N/A
Maximum Non-Detect	0.4	N/A
Percent Non-detects	46.67%	0.00%
Minimum Detect	0.4	0.2
Maximum Detect	3.2	1.9
Mean of Detects	1.313	0.661
Median of Detects	1.1	0.55
SD of Detects	0.885	0.428
KM Mean	0.887	0.661
KM SD	0.757	0.428

Sample 1 vs Sample 2 Tarone-Ware Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

TW Statistic	-0.375
TW Critical Value (0.05)	1.645
P-Value	0.646

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:40:28 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Molybdenum 0-10

Sample 2 Data: 600 BG4 Molybdenum 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	7	0
Number of Detect Data	8	36
Minimum Non-Detect	0.4	N/A
Maximum Non-Detect	0.4	N/A
Percent Non-detects	46.67%	0.00%
Minimum Detect	0.4	0.2
Maximum Detect	3.2	1.9
Mean of Detects	1.313	0.661
Median of Detects	1.1	0.55
SD of Detects	0.885	0.428

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	388.5
Standardized WMW U-Stat	-0.0432
Mean (U)	270
SD(U) - Adj ties	48.3
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.517

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:49:32 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Sodium 0-10

Sample 2 Data: 600 BG4 Sodium 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	14	32
Minimum	140	30
Maximum	12900	800
Mean	1615	286.6
Median	580	217.5
SD	3352	210.5
SE of Mean	865.5	35.09

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	510.5
Standardized WMW U-Stat	2.482
Mean (U)	270
SD(U) - Adj ties	48.36
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.00654

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 > Sample 2

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:42:41 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 NO2/NO3 0-10

Sample 2 Data: 600 BG4 NO2/NO3 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	40
Number of Non-Detects	0	7
Number of Detect Data	15	33
Minimum Non-Detect	N/A	0.3
Maximum Non-Detect	N/A	0.3
Percent Non-detects	0.00%	17.50%
Minimum Detect	0.7	0.3
Maximum Detect	55.4	3.3
Mean of Detects	16.21	1.088
Median of Detects	5.5	0.8
SD of Detects	20.26	0.799

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	683
Standardized WMW U-Stat	4.984
Mean (U)	300
SD(U) - Adj ties	52.88
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	3.1107E-7

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 > Sample 2

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:44:58 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Zinc 0-10

Sample 2 Data: 600 BG4 Zinc 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	15	32
Minimum	15.8	12.7
Maximum	43.7	44.8
Mean	23.89	27.5
Median	22.7	27.05
SD	8.72	7.299
SE of Mean	2.251	1.217

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	300
Standardized WMW U-Stat	-1.871
Mean (U)	270
SD(U) - Adj ties	48.37
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.969

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:43:03 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200 IA Trans-1,2-Dichloroethene**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	14
14	Number of Detects	5	Number of Non-Detects	11
15	Number of Distinct Detects	5	Number of Distinct Non-Detects	9
16	Minimum Detect	0.51	Minimum Non-Detect	0.27
17	Maximum Detect	2.2	Maximum Non-Detect	7.3
18	Variance Detects	0.592	Percent Non-Detects	68.75%
19	Mean Detects	1.18	SD Detects	0.769
20	Median Detects	0.8	CV Detects	0.652
21	Skewness Detects	0.676	Kurtosis Detects	-2.378
22	Mean of Logged Detects	-0.00958	SD of Logged Detects	0.661
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.846	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.686	Detected Data appear Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.289	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.396	Detected Data appear Normal at 1% Significance Level	
29	**Detected Data appear Normal at 1% Significance Level**			
30	**Note GOF tests may be unreliable for small sample sizes**			
31				
32	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
33	KM Mean	0.573	KM Standard Error of Mean	0.169
34	90KM SD	0.585	95% KM (BCA) UCL	0.869
35	95% KM (t) UCL	0.869	95% KM (Percentile Bootstrap) UCL	0.849
36	95% KM (z) UCL	0.851	95% KM Bootstrap t UCL	1.046
37	90% KM Chebyshev UCL	1.08	95% KM Chebyshev UCL	1.309
38	97.5% KM Chebyshev UCL	1.627	99% KM Chebyshev UCL	2.252
39				
40	**Gamma GOF Tests on Detected Observations Only**			
41	A-D Test Statistic	0.45	**Anderson-Darling GOF Test**	
42	5% A-D Critical Value	0.683	Detected data appear Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.268	**Kolmogorov-Smirnov GOF**	
44	5% K-S Critical Value	0.359	Detected data appear Gamma Distributed at 5% Significance Level	
45	**Detected data appear Gamma Distributed at 5% Significance Level**			
46	**Note GOF tests may be unreliable for small sample sizes**			
47				

Calculation of Toxicity Equivalents (TEQ)[1] for Dioxins/Furans

Boring Number	Depth bgs (ft)	Sample Number	Analyte	Result	Original Units	Concentration (mg/kg)	TEF	Concentration x TEF	TEQ
200-SB-05	8	1406151129	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.0729	ng/Kg	7.29E-08	0.1	7.29E-09	
			Octachlorodibenzo-p-dioxin (OCDD)	0.643	ng/Kg	6.43E-07	0.0003	1.93E-10	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.159	ng/Kg	1.59E-07	0.01	1.59E-09	9.07E-09
		1406151145	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.157	ng/Kg	1.57E-07	0.1	1.57E-08	
			1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	2.35	ng/Kg	2.35E-06	0.01	2.35E-08	
			Octachlorodibenzo-p-dioxin (OCDD)	23.7	ng/Kg	2.37E-05	0.0003	7.11E-09	
			1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.133	ng/Kg	1.33E-07	0.1	1.33E-08	
			1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.123	ng/Kg	1.23E-07	0.1	1.23E-08	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.309	ng/Kg	3.09E-07	0.01	3.09E-09	
			Octachlorodibenzofuran (OCDF)	0.534	ng/Kg	5.34E-07	0.0003	1.60E-10	7.52E-08
200-SB-6	8	1406141704	Octachlorodibenzo-p-dioxin (OCDD)	0.8	ng/Kg	8.00E-07	0.0003	2.40E-10	
			1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.182	ng/Kg	1.82E-07	0.01	1.82E-09	2.06E-09
200-SB-7	8	1406111503	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	1.37	ng/Kg	1.37E-06	0.01	1.37E-08	
			Octachlorodibenzo-p-dioxin (OCDD)	17.1	ng/Kg	1.71E-05	0.0003	5.13E-09	1.88E-08
200-SB-8	8	1406130804	Octachlorodibenzo-p-dioxin (OCDD)	1.46	ng/Kg	1.46E-06	0.0003	4.38E-10	4.38E-10
		1406130814	Octachlorodibenzo-p-dioxin (OCDD)	1.24	ng/Kg	1.24E-06	0.0003	3.72E-10	3.72E-10
200-SB-09	8	1406301549	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.0476	ng/Kg	4.76E-08	0.1	4.76E-09	
			1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.0653	ng/Kg	6.53E-08	0.01	6.53E-10	
			Octachlorodibenzo-p-dioxin (OCDD)	0.475	ng/Kg	4.75E-07	0.0003	1.43E-10	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.0413	ng/Kg	4.13E-08	0.01	4.13E-10	5.97E-09
200-SB-10	16	1406281022	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxins (HpCDD)	0.263	ng/Kg	2.63E-07	0.01	2.63E-09	
			Octachlorodibenzo-p-dioxin (OCDD)	1.75	ng/Kg	1.75E-06	0.0003	5.25E-10	3.16E-09
200-SB-11	8	1407011414	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	0.282	ng/Kg	2.82E-07	1	2.82E-07	
			1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.192	ng/Kg	1.92E-07	0.01	1.92E-09	
			Octachlorodibenzo-p-dioxin (OCDD)	0.843	ng/Kg	8.43E-07	0.0003	2.53E-10	
			1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.0392	ng/Kg	3.92E-08	0.1	3.92E-09	
			1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.0418	ng/Kg	4.18E-08	0.1	4.18E-09	
			1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.0479	ng/Kg	4.79E-08	0.1	4.79E-09	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.201	ng/Kg	2.01E-07	0.01	2.01E-09	
			Octachlorodibenzofuran (OCDF)	0.23	ng/Kg	2.30E-07	0.0003	6.90E-11	2.99E-07
200-SB-13	8	1406161404	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.105	ng/Kg	1.05E-07	0.1	1.05E-08	
			1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.107	ng/Kg	1.07E-07	0.1	1.07E-08	
			1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.202	ng/Kg	2.02E-07	0.01	2.02E-09	
			Octachlorodibenzo-p-dioxin (OCDD)	10	ng/Kg	1.00E-05	0.0003	3.00E-09	
			1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.0506	ng/Kg	5.06E-08	0.1	5.06E-09	
			1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.0843	ng/Kg	8.43E-08	0.1	8.43E-09	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.0604	ng/Kg	6.04E-08	0.01	6.04E-10	
			1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.0664	ng/Kg	6.64E-08	0.01	6.64E-10	4.10E-08

Calculation of Toxicity Equivalents (TEQ)[1] for Dioxins/Furans

Boring Number	Depth bgs (ft)	Sample Number	Analyte	Result	Original Units	Concentration (mg/kg)	TEF	Concentration x TEF	TEQ

[1] = TEQs calculated per NMED RA Guidance (June 2019) Section 2.1. Dioxin and furan congeners were assessed using the 2005 World Health Organization's (WHO) toxicity equivalency factors (TEF) applied to the analytical results and summed for each sample location. The sum, or toxicity equivalent (TEQ), is compared to the NMED SSL for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) in the risk screening evaluation for carcinogens and noncarcinogens.

bgs = below ground surface

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Gamma Statistics on Detected Data Only**											
49	k hat (MLE)					3.012	k star (bias corrected MLE)					1.338
50	Theta hat (MLE)					0.392	Theta star (bias corrected MLE)					0.882
51	nu hat (MLE)					30.12	nu star (bias corrected)					13.38
52	Mean (detects)					1.18						
53												
54	**Gamma ROS Statistics using Imputed Non-Detects**											
55	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
56	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
57	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
58	This is especially true when the sample size is small.											
59	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
60	Minimum					0.01	Mean					0.376
61	Maximum					2.2	Median					0.01
62	SD					0.687	CV					1.828
63	k hat (MLE)					0.313	k star (bias corrected MLE)					0.296
64	Theta hat (MLE)					1.201	Theta star (bias corrected MLE)					1.27
65	nu hat (MLE)					10.01	nu star (bias corrected)					9.465
66	Adjusted Level of Significance (β)					0.0335						
67	Approximate Chi Square Value (9.46, α)					3.61	Adjusted Chi Square Value (9.46, β)					3.209
68	95% Gamma Approximate UCL					0.985	95% Gamma Adjusted UCL					1.108
69												
70	**Estimates of Gamma Parameters using KM Estimates**											
71	Mean (KM)					0.573	SD (KM)					0.585
72	Variance (KM)					0.342	SE of Mean (KM)					0.169
73	k hat (KM)					0.962	k star (KM)					0.823
74	nu hat (KM)					30.78	nu star (KM)					26.34
75	theta hat (KM)					0.596	theta star (KM)					0.697
76	80% gamma percentile (KM)					0.935	90% gamma percentile (KM)					1.385
77	95% gamma percentile (KM)					1.841	99% gamma percentile (KM)					2.916
78												
79	**Gamma Kaplan-Meier (KM) Statistics**											
80	Approximate Chi Square Value (26.34, α)					15.64	Adjusted Chi Square Value (26.34, β)					14.71
81	95% KM Approximate Gamma UCL					0.965	95% KM Adjusted Gamma UCL					1.027
82												
83	**Lognormal GOF Test on Detected Observations Only**											
84	Shapiro Wilk Test Statistic					0.88	**Shapiro Wilk GOF Test**					
85	10% Shapiro Wilk Critical Value					0.806	Detected Data appear Lognormal at 10% Significance Level					
86	Lilliefors Test Statistic					0.227	**Lilliefors GOF Test**					
87	10% Lilliefors Critical Value					0.319	Detected Data appear Lognormal at 10% Significance Level					
88	**Detected Data appear Lognormal at 10% Significance Level**											
89	**Note GOF tests may be unreliable for small sample sizes**											
90												

	A	B	C	D	E	F	G	H	I	J	K	L
91	**Lognormal ROS Statistics Using Imputed Non-Detects**											
92	Mean in Original Scale					0.441	Mean in Log Scale					-1.597
93	SD in Original Scale					0.651	SD in Log Scale					1.199
94	95% t UCL (assumes normality of ROS data)					0.726	95% Percentile Bootstrap UCL					0.731
95	95% BCA Bootstrap UCL					0.808	95% Bootstrap t UCL					1.147
96	95% H-UCL (Log ROS)					1.059						
97												
98	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
99	KM Mean (logged)					-0.876	KM Geo Mean					0.416
100	KM SD (logged)					0.701	95% Critical H Value (KM-Log)					2.282
101	KM Standard Error of Mean (logged)					0.202	95% H-UCL (KM -Log)					0.805
102	KM SD (logged)					0.701	95% Critical H Value (KM-Log)					2.282
103	KM Standard Error of Mean (logged)					0.202						
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107	Mean in Original Scale					0.698	Mean in Log Scale					-1.068
108	SD in Original Scale					1.004	SD in Log Scale					1.124
109	95% t UCL (Assumes normality)					1.138	95% H-Stat UCL					1.498
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Detected Data appear Normal Distributed at 1% Significance Level**											
114												
115	**Suggested UCL to Use**											
116	95% KM (t) UCL					0.869						
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:33:24 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA 2-Butanone (MEK)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	13
Number of Detects	15	Number of Non-Detects	1
Number of Distinct Detects	12	Number of Distinct Non-Detects	1
Minimum Detect	0.36	Minimum Non-Detect	8.1
Maximum Detect	8.7	Maximum Non-Detect	8.1
Variance Detects	4.008	Percent Non-Detects	6.25%
Mean Detects	1.921	SD Detects	2.002
Median Detects	1.8	CV Detects	1.042
Skewness Detects	3.048	Kurtosis Detects	10.84
Mean of Logged Detects	0.292	SD of Logged Detects	0.892

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.589	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.398	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.89	KM Standard Error of Mean	0.49
90KM SD	1.884	95% KM (BCA) UCL	2.848
95% KM (t) UCL	2.749	95% KM (Percentile Bootstrap) UCL	2.727
95% KM (z) UCL	2.696	95% KM Bootstrap t UCL	3.549
90% KM Chebyshev UCL	3.36	95% KM Chebyshev UCL	4.026
97.5% KM Chebyshev UCL	4.95	99% KM Chebyshev UCL	6.765

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.236	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.284	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.225	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

46	**Gamma Statistics on Detected Data Only**			
47	k hat (MLE)	1.531	k star (bias corrected MLE)	1.269
48	Theta hat (MLE)	1.254	Theta star (bias corrected MLE)	1.513
49	nu hat (MLE)	45.93	nu star (bias corrected)	38.08
50	Mean (detects)	1.921		
51				
52	**Gamma ROS Statistics using Imputed Non-Detects**			
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
56	This is especially true when the sample size is small.			
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
58	Minimum	0.36	Mean	1.886
59	Maximum	8.7	Median	1.75
60	SD	1.939	CV	1.028
61	k hat (MLE)	1.611	k star (bias corrected MLE)	1.351
62	Theta hat (MLE)	1.171	Theta star (bias corrected MLE)	1.396
63	nu hat (MLE)	51.55	nu star (bias corrected)	43.22
64	Adjusted Level of Significance (β)	0.0335		
65	Approximate Chi Square Value (43.22, α)	29.15	Adjusted Chi Square Value (43.22, β)	27.83
66	95% Gamma Approximate UCL	2.796	95% Gamma Adjusted UCL	2.928
67				
68	**Estimates of Gamma Parameters using KM Estimates**			
69	Mean (KM)	1.89	SD (KM)	1.884
70	Variance (KM)	3.551	SE of Mean (KM)	0.49
71	k hat (KM)	1.006	k star (KM)	0.859
72	nu hat (KM)	32.2	nu star (KM)	27.5
73	theta hat (KM)	1.878	theta star (KM)	2.2
74	80% gamma percentile (KM)	3.076	90% gamma percentile (KM)	4.518
75	95% gamma percentile (KM)	5.977	99% gamma percentile (KM)	9.404
76				
77	**Gamma Kaplan-Meier (KM) Statistics**			
78	Approximate Chi Square Value (27.50, α)	16.54	Adjusted Chi Square Value (27.50, β)	15.58
79	95% KM Approximate Gamma UCL	3.143	95% KM Adjusted Gamma UCL	3.338
80				
81	**Lognormal GOF Test on Detected Observations Only**			
82	Shapiro Wilk Test Statistic	0.825	**Shapiro Wilk GOF Test**	
83	10% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 10% Significance Level	
84	Lilliefors Test Statistic	0.253	**Lilliefors GOF Test**	
85	10% Lilliefors Critical Value	0.202	Detected Data Not Lognormal at 10% Significance Level	
86	**Detected Data Not Lognormal at 10% Significance Level**			
87				

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89	Mean in Original Scale					1.877	Mean in Log Scale					0.286
90	SD in Original Scale					1.942	SD in Log Scale					0.862
91	95% t UCL (assumes normality of ROS data)					2.728	95% Percentile Bootstrap UCL					2.698
92	95% BCA Bootstrap UCL					3.249	95% Bootstrap t UCL					3.585
93	95% H-UCL (Log ROS)					3.367						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96	KM Mean (logged)					0.284	KM Geo Mean					1.328
97	KM SD (logged)					0.855	95% Critical H Value (KM-Log)					2.488
98	KM Standard Error of Mean (logged)					0.226	95% H-UCL (KM -Log)					3.312
99	KM SD (logged)					0.855	95% Critical H Value (KM-Log)					2.488
100	KM Standard Error of Mean (logged)					0.226						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104	Mean in Original Scale					2.054	Mean in Log Scale					0.361
105	SD in Original Scale					2.006	SD in Log Scale					0.905
106	95% t UCL (Assumes normality)					2.933	95% H-Stat UCL					3.932
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Data do not follow a Discernible Distribution**											
111												
112	**Suggested UCL to Use**											
113	95% KM (t) UCL					2.749						
114												
115	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
116	**Please verify the data were collected from random locations.**											
117	**If the data were collected using judgmental or other non-random methods,**											
118	**then contact a statistician to correctly calculate UCLs.**											
119												
120	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
121	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
122	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
123												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Uncensored Full Data Sets**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 1:30:01 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	**200 IA 2-Propanol**											
12												
13	**General Statistics**											
14	Total Number of Observations					16	Number of Distinct Observations					15
15							Number of Missing Observations					0
16	Minimum					0.95	Mean					17.48
17	Maximum					68	Median					7.65
18	SD					20.08	Std. Error of Mean					5.021
19	Coefficient of Variation					1.149	Skewness					1.292
20												
21	**Normal GOF Test**											
22	Shapiro Wilk Test Statistic					0.813	**Shapiro Wilk GOF Test**					
23	1% Shapiro Wilk Critical Value					0.844	Data Not Normal at 1% Significance Level					
24	Lilliefors Test Statistic					0.244	**Lilliefors GOF Test**					
25	1% Lilliefors Critical Value					0.248	Data appear Normal at 1% Significance Level					
26	**Data appear Approximate Normal at 1% Significance Level**											
27												
28	**Assuming Normal Distribution**											
29	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
30	95% Student's-t UCL					26.28	95% Adjusted-CLT UCL (Chen-1995)					27.47
31							95% Modified-t UCL (Johnson-1978)					26.55
32												
33	**Gamma GOF Test**											
34	A-D Test Statistic					0.685	**Anderson-Darling Gamma GOF Test**					
35	5% A-D Critical Value					0.776	Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic					0.221	**Kolmogorov-Smirnov Gamma GOF Test**					
37	5% K-S Critical Value					0.224	Detected data appear Gamma Distributed at 5% Significance Level					
38	**Detected data appear Gamma Distributed at 5% Significance Level**											
39												
40	**Gamma Statistics**											
41	k hat (MLE)					0.732	k star (bias corrected MLE)					0.637
42	Theta hat (MLE)					23.87	Theta star (bias corrected MLE)					27.45
43	nu hat (MLE)					23.43	nu star (bias corrected)					20.37
44	MLE Mean (bias corrected)					17.48	MLE Sd (bias corrected)					21.91
45							Approximate Chi Square Value (0.05)					11.13
46	Adjusted Level of Significance					0.0335	Adjusted Chi Square Value					10.35
47												

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Assuming Gamma Distribution**											
49	95% Approximate Gamma UCL					32	95% Adjusted Gamma UCL					34.39
50												
51	**Lognormal GOF Test**											
52	Shapiro Wilk Test Statistic					0.911	**Shapiro Wilk Lognormal GOF Test**					
53	10% Shapiro Wilk Critical Value					0.906	Data appear Lognormal at 10% Significance Level					
54	Lilliefors Test Statistic					0.196	**Lilliefors Lognormal GOF Test**					
55	10% Lilliefors Critical Value					0.196	Data Not Lognormal at 10% Significance Level					
56	**Data appear Approximate Lognormal at 10% Significance Level**											
57												
58	**Lognormal Statistics**											
59	Minimum of Logged Data					-0.0513	Mean of logged Data					2.041
60	Maximum of Logged Data					4.22	SD of logged Data					1.442
61												
62	**Assuming Lognormal Distribution**											
63	95% H-UCL					78.32	90% Chebyshev (MVUE) UCL					43.53
64	95% Chebyshev (MVUE) UCL					54.46	97.5% Chebyshev (MVUE) UCL					69.62
65	99% Chebyshev (MVUE) UCL					99.41						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution**											
69												
70	**Nonparametric Distribution Free UCLs**											
71	95% CLT UCL					25.74	95% BCA Bootstrap UCL					26.85
72	95% Standard Bootstrap UCL					25.4	95% Bootstrap-t UCL					30.33
73	95% Hall's Bootstrap UCL					29.27	95% Percentile Bootstrap UCL					25.42
74	90% Chebyshev(Mean, Sd) UCL					32.54	95% Chebyshev(Mean, Sd) UCL					39.36
75	97.5% Chebyshev(Mean, Sd) UCL					48.84	99% Chebyshev(Mean, Sd) UCL					67.44
76												
77	**Suggested UCL to Use**											
78	95% Student's-t UCL					26.28						
79												
80	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
81	**Please verify the data were collected from random locations.**											
82	**If the data were collected using judgmental or other non-random methods,**											
83	**then contact a statistician to correctly calculate UCLs.**											
84												
85	When a data set follows an approximate distribution passing only one of the GOF tests,											
86	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
87												
88	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
89	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
90	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
91												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:32:42 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA Acetone

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	2.4	Mean	10.48
Maximum	30	Median	9.35
SD	8.196	Std. Error of Mean	2.049
Coefficient of Variation	0.782	Skewness	1.652

Normal GOF Test

Shapiro Wilk Test Statistic	0.785	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.844	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.254	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.248	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	14.07	95% Adjusted-CLT UCL (Chen-1995)	14.75
		95% Modified-t UCL (Johnson-1978)	14.21

Gamma GOF Test

A-D Test Statistic	0.477	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.165	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.218	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.104	k star (bias corrected MLE)	1.751
Theta hat (MLE)	4.979	Theta star (bias corrected MLE)	5.982
nu hat (MLE)	67.33	nu star (bias corrected)	56.04
MLE Mean (bias corrected)	10.48	MLE Sd (bias corrected)	7.916
		Approximate Chi Square Value (0.05)	39.83
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	38.28

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Assuming Gamma Distribution**											
49	95% Approximate Gamma UCL					14.74	95% Adjusted Gamma UCL					15.33
50												
51	**Lognormal GOF Test**											
52	Shapiro Wilk Test Statistic					0.944	**Shapiro Wilk Lognormal GOF Test**					
53	10% Shapiro Wilk Critical Value					0.906	Data appear Lognormal at 10% Significance Level					
54	Lilliefors Test Statistic					0.138	**Lilliefors Lognormal GOF Test**					
55	10% Lilliefors Critical Value					0.196	Data appear Lognormal at 10% Significance Level					
56	**Data appear Lognormal at 10% Significance Level**											
57												
58	**Lognormal Statistics**											
59	Minimum of Logged Data					0.875	Mean of logged Data					2.093
60	Maximum of Logged Data					3.401	SD of logged Data					0.746
61												
62	**Assuming Lognormal Distribution**											
63	95% H-UCL					16.79	90% Chebyshev (MVUE) UCL					16.71
64	95% Chebyshev (MVUE) UCL					19.54	97.5% Chebyshev (MVUE) UCL					23.46
65	99% Chebyshev (MVUE) UCL					31.15						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution**											
69												
70	**Nonparametric Distribution Free UCLs**											
71	95% CLT UCL					13.85	95% BCA Bootstrap UCL					14.63
72	95% Standard Bootstrap UCL					13.73	95% Bootstrap-t UCL					17.39
73	95% Hall's Bootstrap UCL					36.36	95% Percentile Bootstrap UCL					13.89
74	90% Chebyshev(Mean, Sd) UCL					16.62	95% Chebyshev(Mean, Sd) UCL					19.41
75	97.5% Chebyshev(Mean, Sd) UCL					23.27	99% Chebyshev(Mean, Sd) UCL					30.86
76												
77	**Suggested UCL to Use**											
78	95% Adjusted Gamma UCL					15.33						
79												
80	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
81	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
82	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
83												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:34:36 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA Acetone

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14
Number of Detects	15	Number of Non-Detects	1
Number of Distinct Detects	13	Number of Distinct Non-Detects	1
Minimum Detect	2.4	Minimum Non-Detect	30
Maximum Detect	29	Maximum Non-Detect	30
Variance Detects	42.93	Percent Non-Detects	6.25%
Mean Detects	9.173	SD Detects	6.552
Median Detects	8.7	CV Detects	0.714
Skewness Detects	2.015	Kurtosis Detects	5.829
Mean of Logged Detects	2.006	SD of Logged Detects	0.682

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.796	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.213	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level

Detected Data appear Approximate Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	9.173	KM Standard Error of Mean	1.692
90KM SD	6.33	95% KM (BCA) UCL	12.21
95% KM (t) UCL	12.14	95% KM (Percentile Bootstrap) UCL	11.99
95% KM (z) UCL	11.96	95% KM Bootstrap t UCL	13.62
90% KM Chebyshev UCL	14.25	95% KM Chebyshev UCL	16.55
97.5% KM Chebyshev UCL	19.74	99% KM Chebyshev UCL	26.01

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.411	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.147	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47					k hat (MLE)	2.528					k star (bias corrected MLE)	2.067
48					Theta hat (MLE)	3.628					Theta star (bias corrected MLE)	4.438
49					nu hat (MLE)	75.85					nu star (bias corrected)	62.01
50					Mean (detects)	9.173						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	2.4					Mean	9.108
59					Maximum	29					Median	8.413
60					SD	6.335					CV	0.696
61					k hat (MLE)	2.682					k star (bias corrected MLE)	2.221
62					Theta hat (MLE)	3.396					Theta star (bias corrected MLE)	4.101
63					nu hat (MLE)	85.82					nu star (bias corrected)	71.06
64					Adjusted Level of Significance (β)	0.0335						
65					Approximate Chi Square Value (71.06, α)	52.65					Adjusted Chi Square Value (71.06, β)	50.85
66					95% Gamma Approximate UCL	12.29					95% Gamma Adjusted UCL	12.73
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	9.173					SD (KM)	6.33
70					Variance (KM)	40.07					SE of Mean (KM)	1.692
71					k hat (KM)	2.1					k star (KM)	1.748
72					nu hat (KM)	67.2					nu star (KM)	55.94
73					theta hat (KM)	4.368					theta star (KM)	5.248
74					80% gamma percentile (KM)	13.95					90% gamma percentile (KM)	18.42
75					95% gamma percentile (KM)	22.72					99% gamma percentile (KM)	32.33
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (55.94, α)	39.75					Adjusted Chi Square Value (55.94, β)	38.2
79					95% KM Approximate Gamma UCL	12.91					95% KM Adjusted Gamma UCL	13.43
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk GOF Test**					
83					10% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 10% Significance Level					
84					Lilliefors Test Statistic	0.139	**Lilliefors GOF Test**					
85					10% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 10% Significance Level					
86	**Detected Data appear Lognormal at 10% Significance Level**											
87												

88	**Lognormal ROS Statistics Using Imputed Non-Detects**			
89	Mean in Original Scale	9.064	Mean in Log Scale	2.006
90	SD in Original Scale	6.345	SD in Log Scale	0.659
91	95% t UCL (assumes normality of ROS data)	11.85	95% Percentile Bootstrap UCL	11.86
92	95% BCA Bootstrap UCL	12.63	95% Bootstrap t UCL	13.26
93	95% H-UCL (Log ROS)	13.49		
94				
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
96	KM Mean (logged)	2.006	KM Geo Mean	7.431
97	KM SD (logged)	0.659	95% Critical H Value (KM-Log)	2.229
98	KM Standard Error of Mean (logged)	0.176	95% H-UCL (KM -Log)	13.49
99	KM SD (logged)	0.659	95% Critical H Value (KM-Log)	2.229
100	KM Standard Error of Mean (logged)	0.176		
101				
102	**DL/2 Statistics**			
103	**DL/2 Normal**		**DL/2 Log-Transformed**	
104	Mean in Original Scale	9.538	Mean in Log Scale	2.05
105	SD in Original Scale	6.495	SD in Log Scale	0.682
106	95% t UCL (Assumes normality)	12.38	95% H-Stat UCL	14.58
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**			
108				
109	**Nonparametric Distribution Free UCL Statistics**			
110	**Detected Data appear Approximate Normal Distributed at 1% Significance Level**			
111				
112	**Suggested UCL to Use**			
113	95% KM (t) UCL	12.14		
114				
115	When a data set follows an approximate distribution passing only one of the GOF tests,			
116	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL			
117				
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.			
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
121				

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 1:35:23 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10	**200 IA Benzene**											
11												
12	**General Statistics**											
13	Total Number of Observations					16	Number of Distinct Observations					12
14	Number of Detects					9	Number of Non-Detects					7
15	Number of Distinct Detects					8	Number of Distinct Non-Detects					6
16	Minimum Detect					0.23	Minimum Non-Detect					0.25
17	Maximum Detect					1.6	Maximum Non-Detect					6.2
18	Variance Detects					0.227	Percent Non-Detects					43.75%
19	Mean Detects					0.55	SD Detects					0.477
20	Median Detects					0.31	CV Detects					0.867
21	Skewness Detects					1.796	Kurtosis Detects					2.368
22	Mean of Logged Detects					-0.844	SD of Logged Detects					0.684
23												
24	**Normal GOF Test on Detects Only**											
25	Shapiro Wilk Test Statistic					0.703	**Shapiro Wilk GOF Test**					
26	1% Shapiro Wilk Critical Value					0.764	Detected Data Not Normal at 1% Significance Level					
27	Lilliefors Test Statistic					0.328	**Lilliefors GOF Test**					
28	1% Lilliefors Critical Value					0.316	Detected Data Not Normal at 1% Significance Level					
29	**Detected Data Not Normal at 1% Significance Level**											
30												
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
32	KM Mean					0.427	KM Standard Error of Mean					0.104
33	90KM SD					0.38	95% KM (BCA) UCL					0.605
34	95% KM (t) UCL					0.609	95% KM (Percentile Bootstrap) UCL					0.604
35	95% KM (z) UCL					0.598	95% KM Bootstrap t UCL					1.224
36	90% KM Chebyshev UCL					0.739	95% KM Chebyshev UCL					0.88
37	97.5% KM Chebyshev UCL					1.077	99% KM Chebyshev UCL					1.462
38												
39	**Gamma GOF Tests on Detected Observations Only**											
40	A-D Test Statistic					0.966	**Anderson-Darling GOF Test**					
41	5% A-D Critical Value					0.729	Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic					0.278	**Kolmogorov-Smirnov GOF**					
43	5% K-S Critical Value					0.282	Detected data appear Gamma Distributed at 5% Significance Level					
44	**Detected data follow Appr. Gamma Distribution at 5% Significance Level**											
45	**Note GOF tests may be unreliable for small sample sizes**											
46												

47	**Gamma Statistics on Detected Data Only**			
48	k hat (MLE)	2.187	k star (bias corrected MLE)	1.532
49	Theta hat (MLE)	0.251	Theta star (bias corrected MLE)	0.359
50	nu hat (MLE)	39.37	nu star (bias corrected)	27.58
51	Mean (detects)	0.55		
52				
53	**Gamma ROS Statistics using Imputed Non-Detects**			
54	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
55	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
56	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
57	This is especially true when the sample size is small.			
58	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
59	Minimum	0.01	Mean	0.353
60	Maximum	1.6	Median	0.255
61	SD	0.422	CV	1.196
62	k hat (MLE)	0.909	k star (bias corrected MLE)	0.781
63	Theta hat (MLE)	0.388	Theta star (bias corrected MLE)	0.452
64	nu hat (MLE)	29.1	nu star (bias corrected)	24.98
65	Adjusted Level of Significance (β)	0.0335		
66	Approximate Chi Square Value (24.98, α)	14.6	Adjusted Chi Square Value (24.98, β)	13.7
67	95% Gamma Approximate UCL	0.604	95% Gamma Adjusted UCL	0.643
68				
69	**Estimates of Gamma Parameters using KM Estimates**			
70	Mean (KM)	0.427	SD (KM)	0.38
71	Variance (KM)	0.144	SE of Mean (KM)	0.104
72	k hat (KM)	1.261	k star (KM)	1.066
73	nu hat (KM)	40.36	nu star (KM)	34.13
74	theta hat (KM)	0.338	theta star (KM)	0.4
75	80% gamma percentile (KM)	0.683	90% gamma percentile (KM)	0.967
76	95% gamma percentile (KM)	1.249	99% gamma percentile (KM)	1.902
77				
78	**Gamma Kaplan-Meier (KM) Statistics**			
79	Approximate Chi Square Value (34.13, α)	21.77	Adjusted Chi Square Value (34.13, β)	20.65
80	95% KM Approximate Gamma UCL	0.669	95% KM Adjusted Gamma UCL	0.705
81				
82	**Lognormal GOF Test on Detected Observations Only**			
83	Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**	
84	10% Shapiro Wilk Critical Value	0.859	Detected Data Not Lognormal at 10% Significance Level	
85	Lilliefors Test Statistic	0.24	**Lilliefors GOF Test**	
86	10% Lilliefors Critical Value	0.252	Detected Data appear Lognormal at 10% Significance Level	
87	**Detected Data appear Approximate Lognormal at 10% Significance Level**			
88	**Note GOF tests may be unreliable for small sample sizes**			
89				

	A	B	C	D	E	F	G	H	I	J	K	L
90	**Lognormal ROS Statistics Using Imputed Non-Detects**											
91	Mean in Original Scale					0.405	Mean in Log Scale					-1.15
92	SD in Original Scale					0.389	SD in Log Scale					0.631
93	95% t UCL (assumes normality of ROS data)					0.575	95% Percentile Bootstrap UCL					0.581
94	95% BCA Bootstrap UCL					0.639	95% Bootstrap t UCL					1.08
95	95% H-UCL (Log ROS)					0.553						
96												
97	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
98	KM Mean (logged)					-1.076	KM Geo Mean					0.341
99	KM SD (logged)					0.577	95% Critical H Value (KM-Log)					2.133
100	KM Standard Error of Mean (logged)					0.159	95% H-UCL (KM -Log)					0.553
101	KM SD (logged)					0.577	95% Critical H Value (KM-Log)					2.133
102	KM Standard Error of Mean (logged)					0.159						
103	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107	Mean in Original Scale					0.558	Mean in Log Scale					-1.131
108	SD in Original Scale					0.788	SD in Log Scale					0.952
109	95% t UCL (Assumes normality)					0.903	95% H-Stat UCL					0.97
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Detected Data appear Approximate Gamma Distributed at 5% Significance Level**											
114												
115	**Suggested UCL to Use**											
116	95% KM Adjusted Gamma UCL					0.705	95% GROS Adjusted Gamma UCL					0.643
117												
118	When a data set follows an approximate distribution passing only one of the GOF tests,											
119	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
120												
121	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
122	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
123	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
124												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.2 3/6/2023 1:36:19 PM								
5			From File	UCL95_input_Revised.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Number of Bootstrap Operations	2000								
9												
10	**200 IA Carbon Tetrachloride**											
11												
12	**General Statistics**											
13					Total Number of Observations	16					Number of Distinct Observations	8
14					Number of Detects	15					Number of Non-Detects	1
15					Number of Distinct Detects	7					Number of Distinct Non-Detects	1
16					Minimum Detect	0.37					Minimum Non-Detect	5.8
17					Maximum Detect	0.45					Maximum Non-Detect	5.8
18					Variance Detects	6.2857E-4					Percent Non-Detects	6.25%
19					Mean Detects	0.4					SD Detects	0.0251
20					Median Detects	0.39					CV Detects	0.0627
21					Skewness Detects	0.628					Kurtosis Detects	-0.587
22					Mean of Logged Detects	-0.918					SD of Logged Detects	0.0618
23												
24	**Normal GOF Test on Detects Only**											
25					Shapiro Wilk Test Statistic	0.908	**Shapiro Wilk GOF Test**					
26					1% Shapiro Wilk Critical Value	0.835	Detected Data appear Normal at 1% Significance Level					
27					Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**					
28					1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level					
29	**Detected Data appear Normal at 1% Significance Level**											
30												
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
32					KM Mean	0.4					KM Standard Error of Mean	0.00647
33					90KM SD	0.0242					95% KM (BCA) UCL	0.411
34					95% KM (t) UCL	0.411					95% KM (Percentile Bootstrap) UCL	0.41
35					95% KM (z) UCL	0.411					95% KM Bootstrap t UCL	0.413
36					90% KM Chebyshev UCL	0.419					95% KM Chebyshev UCL	0.428
37					97.5% KM Chebyshev UCL	0.44					99% KM Chebyshev UCL	0.464
38	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
39												
40	**Gamma GOF Tests on Detected Observations Only**											
41					A-D Test Statistic	0.581	**Anderson-Darling GOF Test**					
42					5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level					
43					K-S Test Statistic	0.196	**Kolmogorov-Smirnov GOF**					
44					5% K-S Critical Value	0.221	Detected data appear Gamma Distributed at 5% Significance Level					
45	**Detected data appear Gamma Distributed at 5% Significance Level**											
46												

	A	B	C	D	E	F	G	H	I	J	K	L
47	**Gamma Statistics on Detected Data Only**											
48					k hat (MLE)	278.1					k star (bias corrected MLE)	222.6
49					Theta hat (MLE)	0.00144					Theta star (bias corrected MLE)	0.0018
50					nu hat (MLE)	8344					nu star (bias corrected)	6677
51					Mean (detects)	0.4						
52												
53	**Gamma ROS Statistics using Imputed Non-Detects**											
54	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
55	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
56	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
57	This is especially true when the sample size is small.											
58	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
59					Minimum	0.37					Mean	0.4
60					Maximum	0.45					Median	0.395
61					SD	0.0242					CV	0.0606
62					k hat (MLE)	296.7					k star (bias corrected MLE)	241.1
63					Theta hat (MLE)	0.00135					Theta star (bias corrected MLE)	0.00166
64					nu hat (MLE)	9494					nu star (bias corrected)	7715
65					Adjusted Level of Significance (β)	0.0335						
66					Approximate Chi Square Value (N/A, α)	7512					Adjusted Chi Square Value (N/A, β)	7489
67					95% Gamma Approximate UCL	0.411					95% Gamma Adjusted UCL	0.412
68												
69	**Estimates of Gamma Parameters using KM Estimates**											
70					Mean (KM)	0.4					SD (KM)	0.0242
71					Variance (KM)	5.8667E-4					SE of Mean (KM)	0.00647
72					k hat (KM)	272.7					k star (KM)	221.6
73					nu hat (KM)	8727					nu star (KM)	7092
74					theta hat (KM)	0.00147					theta star (KM)	0.0018
75					80% gamma percentile (KM)	0.422					90% gamma percentile (KM)	0.435
76					95% gamma percentile (KM)	0.445					99% gamma percentile (KM)	0.465
77												
78	**Gamma Kaplan-Meier (KM) Statistics**											
79					Approximate Chi Square Value (N/A, α)	6897					Adjusted Chi Square Value (N/A, β)	6876
80					95% KM Approximate Gamma UCL	0.411					95% KM Adjusted Gamma UCL	0.413
81	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
82												
83	**Lognormal GOF Test on Detected Observations Only**											
84					Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**					
85					10% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 10% Significance Level					
86					Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**					
87					10% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 10% Significance Level					
88	**Detected Data appear Lognormal at 10% Significance Level**											
89												

	A	B	C	D	E	F	G	H	I	J	K	L
90	**Lognormal ROS Statistics Using Imputed Non-Detects**											
91	Mean in Original Scale					0.4	Mean in Log Scale					-0.918
92	SD in Original Scale					0.0242	SD in Log Scale					0.0597
93	95% t UCL (assumes normality of ROS data)					0.411	95% Percentile Bootstrap UCL					0.41
94	95% BCA Bootstrap UCL					0.411	95% Bootstrap t UCL					0.412
95	95% H-UCL (Log ROS)					N/A						
96												
97	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
98	KM Mean (logged)					-0.918	KM Geo Mean					0.399
99	KM SD (logged)					0.0597	95% Critical H Value (KM-Log)					N/A
100	KM Standard Error of Mean (logged)					0.016	95% H-UCL (KM -Log)					N/A
101	KM SD (logged)					0.0597	95% Critical H Value (KM-Log)					N/A
102	KM Standard Error of Mean (logged)					0.016						
103												
104	**DL/2 Statistics**											
105	**DL/2 Normal**						**DL/2 Log-Transformed**					
106	Mean in Original Scale					0.556	Mean in Log Scale					-0.794
107	SD in Original Scale					0.625	SD in Log Scale					0.499
108	95% t UCL (Assumes normality)					0.83	95% H-Stat UCL					0.667
109	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
110												
111	**Nonparametric Distribution Free UCL Statistics**											
112	**Detected Data appear Normal Distributed at 1% Significance Level**											
113												
114	**Suggested UCL to Use**											
115	95% KM (t) UCL					0.411						
116												
117	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
118	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:37:22 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA Chloromethane

General Statistics

Total Number of Observations	16	Number of Distinct Observations	11
Number of Detects	15	Number of Non-Detects	1
Number of Distinct Detects	10	Number of Distinct Non-Detects	1
Minimum Detect	0.29	Minimum Non-Detect	5.8
Maximum Detect	0.6	Maximum Non-Detect	5.8
Variance Detects	0.0164	Percent Non-Detects	6.25%
Mean Detects	0.469	SD Detects	0.128
Median Detects	0.56	CV Detects	0.273
Skewness Detects	-0.213	Kurtosis Detects	-2.077
Mean of Logged Detects	-0.796	SD of Logged Detects	0.29

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.781	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.295	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.469	KM Standard Error of Mean	0.0331
90KM SD	0.124	95% KM (BCA) UCL	0.518
95% KM (t) UCL	0.527	95% KM (Percentile Bootstrap) UCL	0.519
95% KM (z) UCL	0.523	95% KM Bootstrap t UCL	0.524
90% KM Chebyshev UCL	0.568	95% KM Chebyshev UCL	0.613
97.5% KM Chebyshev UCL	0.675	99% KM Chebyshev UCL	0.798

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.547	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.736	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.31	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.221	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
47	**Gamma Statistics on Detected Data Only**											
48					k hat (MLE)	13.41					k star (bias corrected MLE)	10.78
49					Theta hat (MLE)	0.0349					Theta star (bias corrected MLE)	0.0435
50					nu hat (MLE)	402.4					nu star (bias corrected)	323.3
51					Mean (detects)	0.469						
52												
53	**Gamma ROS Statistics using Imputed Non-Detects**											
54	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
55	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
56	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
57	This is especially true when the sample size is small.											
58	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
59					Minimum	0.29					Mean	0.468
60					Maximum	0.6					Median	0.51
61					SD	0.124					CV	0.264
62					k hat (MLE)	14.29					k star (bias corrected MLE)	11.65
63					Theta hat (MLE)	0.0328					Theta star (bias corrected MLE)	0.0402
64					nu hat (MLE)	457.4					nu star (bias corrected)	372.9
65					Adjusted Level of Significance (β)	0.0335						
66					Approximate Chi Square Value (372.95, α)	329.2					Adjusted Chi Square Value (372.95, β)	324.5
67					95% Gamma Approximate UCL	0.53					95% Gamma Adjusted UCL	0.538
68												
69	**Estimates of Gamma Parameters using KM Estimates**											
70					Mean (KM)	0.469					SD (KM)	0.124
71					Variance (KM)	0.0153					SE of Mean (KM)	0.0331
72					k hat (KM)	14.34					k star (KM)	11.69
73					nu hat (KM)	458.8					nu star (KM)	374.1
74					theta hat (KM)	0.0327					theta star (KM)	0.0401
75					80% gamma percentile (KM)	0.578					90% gamma percentile (KM)	0.651
76					95% gamma percentile (KM)	0.715					99% gamma percentile (KM)	0.845
77												
78	**Gamma Kaplan-Meier (KM) Statistics**											
79					Approximate Chi Square Value (374.15, α)	330.3					Adjusted Chi Square Value (374.15, β)	325.6
80					95% KM Approximate Gamma UCL	0.531					95% KM Adjusted Gamma UCL	0.538
81	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
82												
83	**Lognormal GOF Test on Detected Observations Only**											
84					Shapiro Wilk Test Statistic	0.791	**Shapiro Wilk GOF Test**					
85					10% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 10% Significance Level					
86					Lilliefors Test Statistic	0.305	**Lilliefors GOF Test**					
87					10% Lilliefors Critical Value	0.202	Detected Data Not Lognormal at 10% Significance Level					
88	**Detected Data Not Lognormal at 10% Significance Level**											
89												

	A	B	C	D	E	F	G	H	I	J	K	L
90	**Lognormal ROS Statistics Using Imputed Non-Detects**											
91	Mean in Original Scale					0.468	Mean in Log Scale					-0.796
92	SD in Original Scale					0.124	SD in Log Scale					0.28
93	95% t UCL (assumes normality of ROS data)					0.522	95% Percentile Bootstrap UCL					0.517
94	95% BCA Bootstrap UCL					0.514	95% Bootstrap t UCL					0.523
95	95% H-UCL (Log ROS)					0.537						
96												
97	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
98	KM Mean (logged)					-0.796	KM Geo Mean					0.451
99	KM SD (logged)					0.28	95% Critical H Value (KM-Log)					1.855
100	KM Standard Error of Mean (logged)					0.0748	95% H-UCL (KM -Log)					0.537
101	KM SD (logged)					0.28	95% Critical H Value (KM-Log)					1.855
102	KM Standard Error of Mean (logged)					0.0748						
103	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107	Mean in Original Scale					0.621	Mean in Log Scale					-0.679
108	SD in Original Scale					0.62	SD in Log Scale					0.543
109	95% t UCL (Assumes normality)					0.892	95% H-Stat UCL					0.788
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Data do not follow a Discernible Distribution**											
114												
115	**Suggested UCL to Use**											
116	95% KM (t) UCL					0.527						
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:38:05 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA Ethanol

General Statistics

Total Number of Observations	16	Number of Distinct Observations	15
Number of Detects	12	Number of Non-Detects	4
Number of Distinct Detects	12	Number of Distinct Non-Detects	4
Minimum Detect	1.5	Minimum Non-Detect	1.4
Maximum Detect	23	Maximum Non-Detect	31
Variance Detects	33.14	Percent Non-Detects	25%
Mean Detects	7.225	SD Detects	5.756
Median Detects	6.1	CV Detects	0.797
Skewness Detects	2.025	Kurtosis Detects	5.237
Mean of Logged Detects	1.719	SD of Logged Detects	0.771

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.798	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.805	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.259	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.281	Detected Data appear Normal at 1% Significance Level

Detected Data appear Approximate Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	6.067	KM Standard Error of Mean	1.469
90KM SD	5.447	95% KM (BCA) UCL	8.65
95% KM (t) UCL	8.642	95% KM (Percentile Bootstrap) UCL	8.447
95% KM (z) UCL	8.483	95% KM Bootstrap t UCL	10.02
90% KM Chebyshev UCL	10.47	95% KM Chebyshev UCL	12.47
97.5% KM Chebyshev UCL	15.24	99% KM Chebyshev UCL	20.68

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.323	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.168	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.248	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47					k hat (MLE)	2.086					k star (bias corrected MLE)	1.62
48					Theta hat (MLE)	3.464					Theta star (bias corrected MLE)	4.461
49					nu hat (MLE)	50.05					nu star (bias corrected)	38.87
50					Mean (detects)	7.225						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01					Mean	5.694
59					Maximum	23					Median	5.15
60					SD	5.723					CV	1.005
61					k hat (MLE)	0.517					k star (bias corrected MLE)	0.462
62					Theta hat (MLE)	11.01					Theta star (bias corrected MLE)	12.33
63					nu hat (MLE)	16.55					nu star (bias corrected)	14.78
64					Adjusted Level of Significance (β)	0.0335						
65					Approximate Chi Square Value (14.78, α)	7.112					Adjusted Chi Square Value (14.78, β)	6.513
66					95% Gamma Approximate UCL	11.84					95% Gamma Adjusted UCL	12.92
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	6.067					SD (KM)	5.447
70					Variance (KM)	29.67					SE of Mean (KM)	1.469
71					k hat (KM)	1.241					k star (KM)	1.05
72					nu hat (KM)	39.7					nu star (KM)	33.59
73					theta hat (KM)	4.89					theta star (KM)	5.78
74					80% gamma percentile (KM)	9.725					90% gamma percentile (KM)	13.8
75					95% gamma percentile (KM)	17.87					99% gamma percentile (KM)	27.27
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (33.59, α)	21.33					Adjusted Chi Square Value (33.59, β)	20.23
79					95% KM Approximate Gamma UCL	9.551					95% KM Adjusted Gamma UCL	10.07
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk GOF Test**					
83					10% Shapiro Wilk Critical Value	0.883	Detected Data appear Lognormal at 10% Significance Level					
84					Lilliefors Test Statistic	0.169	**Lilliefors GOF Test**					
85					10% Lilliefors Critical Value	0.223	Detected Data appear Lognormal at 10% Significance Level					
86	**Detected Data appear Lognormal at 10% Significance Level**											
87												

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89					Mean in Original Scale	5.874					Mean in Log Scale	1.388
90					SD in Original Scale	5.53					SD in Log Scale	0.94
91					95% t UCL (assumes normality of ROS data)	8.298					95% Percentile Bootstrap UCL	8.325
92					95% BCA Bootstrap UCL	8.902					95% Bootstrap t UCL	9.72
93					95% H-UCL (Log ROS)	11.74						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96					KM Mean (logged)	1.447					KM Geo Mean	4.25
97					KM SD (logged)	0.856					95% Critical H Value (KM-Log)	2.49
98					KM Standard Error of Mean (logged)	0.231					95% H-UCL (KM -Log)	10.62
99					KM SD (logged)	0.856					95% Critical H Value (KM-Log)	2.49
100					KM Standard Error of Mean (logged)	0.231						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104					Mean in Original Scale	6.534					Mean in Log Scale	1.414
105					SD in Original Scale	6.054					SD in Log Scale	1.088
106					95% t UCL (Assumes normality)	9.188					95% H-Stat UCL	16.5
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Detected Data appear Approximate Normal Distributed at 1% Significance Level**											
111												
112	**Suggested UCL to Use**											
113					95% KM (t) UCL	8.642						
114												
115	When a data set follows an approximate distribution passing only one of the GOF tests,											
116	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 1:39:03 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10	**200 IA Freon 11**											
11												
12	**General Statistics**											
13	Total Number of Observations					16	Number of Distinct Observations					12
14	Number of Detects					15	Number of Non-Detects					1
15	Number of Distinct Detects					11	Number of Distinct Non-Detects					1
16	Minimum Detect					1.3	Minimum Non-Detect					6.6
17	Maximum Detect					22	Maximum Non-Detect					6.6
18	Variance Detects					45.44	Percent Non-Detects					6.25%
19	Mean Detects					4.84	SD Detects					6.741
20	Median Detects					1.6	CV Detects					1.393
21	Skewness Detects					2.199	Kurtosis Detects					3.725
22	Mean of Logged Detects					1.004	SD of Logged Detects					0.975
23												
24	**Normal GOF Test on Detects Only**											
25	Shapiro Wilk Test Statistic					0.578	**Shapiro Wilk GOF Test**					
26	1% Shapiro Wilk Critical Value					0.835	Detected Data Not Normal at 1% Significance Level					
27	Lilliefors Test Statistic					0.326	**Lilliefors GOF Test**					
28	1% Lilliefors Critical Value					0.255	Detected Data Not Normal at 1% Significance Level					
29	**Detected Data Not Normal at 1% Significance Level**											
30												
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
32	KM Mean					4.685	KM Standard Error of Mean					1.645
33	90KM SD					6.346	95% KM (BCA) UCL					7.475
34	95% KM (t) UCL					7.569	95% KM (Percentile Bootstrap) UCL					7.412
35	95% KM (z) UCL					7.391	95% KM Bootstrap t UCL					14.48
36	90% KM Chebyshev UCL					9.621	95% KM Chebyshev UCL					11.86
37	97.5% KM Chebyshev UCL					14.96	99% KM Chebyshev UCL					21.06
38												
39	**Gamma GOF Tests on Detected Observations Only**											
40	A-D Test Statistic					1.928	**Anderson-Darling GOF Test**					
41	5% A-D Critical Value					0.763	Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic					0.305	**Kolmogorov-Smirnov GOF**					
43	5% K-S Critical Value					0.228	Detected Data Not Gamma Distributed at 5% Significance Level					
44	**Detected Data Not Gamma Distributed at 5% Significance Level**											
45												

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47	k hat (MLE)					1.007	k star (bias corrected MLE)					0.85
48	Theta hat (MLE)					4.806	Theta star (bias corrected MLE)					5.693
49	nu hat (MLE)					30.21	nu star (bias corrected)					25.5
50	Mean (detects)					4.84						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58	Minimum					1.3	Mean					4.669
59	Maximum					22	Median					1.65
60	SD					6.548	CV					1.402
61	k hat (MLE)					1.039	k star (bias corrected MLE)					0.886
62	Theta hat (MLE)					4.493	Theta star (bias corrected MLE)					5.27
63	nu hat (MLE)					33.25	nu star (bias corrected)					28.35
64	Adjusted Level of Significance (β)					0.0335						
65	Approximate Chi Square Value (28.35, α)					17.2	Adjusted Chi Square Value (28.35, β)					16.22
66	95% Gamma Approximate UCL					7.695	95% Gamma Adjusted UCL					8.162
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69	Mean (KM)					4.685	SD (KM)					6.346
70	Variance (KM)					40.27	SE of Mean (KM)					1.645
71	k hat (KM)					0.545	k star (KM)					0.484
72	nu hat (KM)					17.44	nu star (KM)					15.5
73	theta hat (KM)					8.596	theta star (KM)					9.67
74	80% gamma percentile (KM)					7.682	90% gamma percentile (KM)					12.76
75	95% gamma percentile (KM)					18.2	99% gamma percentile (KM)					31.62
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78	Approximate Chi Square Value (15.50, α)					7.612	Adjusted Chi Square Value (15.50, β)					6.99
79	95% KM Approximate Gamma UCL					9.54	95% KM Adjusted Gamma UCL					10.39
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82	Shapiro Wilk Test Statistic					0.762	**Shapiro Wilk GOF Test**					
83	10% Shapiro Wilk Critical Value					0.901	Detected Data Not Lognormal at 10% Significance Level					
84	Lilliefors Test Statistic					0.286	**Lilliefors GOF Test**					
85	10% Lilliefors Critical Value					0.202	Detected Data Not Lognormal at 10% Significance Level					
86	**Detected Data Not Lognormal at 10% Significance Level**											
87												

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89					Mean in Original Scale	4.68					Mean in Log Scale	0.993
90					SD in Original Scale	6.543					SD in Log Scale	0.943
91					95% t UCL (assumes normality of ROS data)	7.548					95% Percentile Bootstrap UCL	7.397
92					95% BCA Bootstrap UCL	8.299					95% Bootstrap t UCL	15.21
93					95% H-UCL (Log ROS)	7.966						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96					KM Mean (logged)	0.985					KM Geo Mean	2.677
97					KM SD (logged)	0.925					95% Critical H Value (KM-Log)	2.591
98					KM Standard Error of Mean (logged)	0.242					95% H-UCL (KM -Log)	7.623
99					KM SD (logged)	0.925					95% Critical H Value (KM-Log)	2.591
100					KM Standard Error of Mean (logged)	0.242						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104					Mean in Original Scale	4.744					Mean in Log Scale	1.016
105					SD in Original Scale	6.523					SD in Log Scale	0.943
106					95% t UCL (Assumes normality)	7.603					95% H-Stat UCL	8.154
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Data do not follow a Discernible Distribution**											
111												
112	**Suggested UCL to Use**											
113					95% KM (t) UCL	7.569						
114												
115	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
116	**Please verify the data were collected from random locations.**											
117	**If the data were collected using judgmental or other non-random methods,**											
118	**then contact a statistician to correctly calculate UCLs.**											
119												
120	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
121	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
122	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
123												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.2 3/6/2023 1:40:06 PM								
5			From File	UCL95_input_Revised.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Number of Bootstrap Operations	2000								
9												
10	**200 IA Freon 12**											
11												
12	**General Statistics**											
13					Total Number of Observations	16					Number of Distinct Observations	5
14					Number of Detects	15					Number of Non-Detects	1
15					Number of Distinct Detects	4					Number of Distinct Non-Detects	1
16					Minimum Detect	2.3					Minimum Non-Detect	6.6
17					Maximum Detect	2.7					Maximum Non-Detect	6.6
18					Variance Detects	0.0155					Percent Non-Detects	6.25%
19					Mean Detects	2.447					SD Detects	0.125
20					Median Detects	2.4					CV Detects	0.0509
21					Skewness Detects	0.982					Kurtosis Detects	0.648
22					Mean of Logged Detects	0.894					SD of Logged Detects	0.05
23												
24	**Normal GOF Test on Detects Only**											
25					Shapiro Wilk Test Statistic	0.848	**Shapiro Wilk GOF Test**					
26					1% Shapiro Wilk Critical Value	0.835	Detected Data appear Normal at 1% Significance Level					
27					Lilliefors Test Statistic	0.246	**Lilliefors GOF Test**					
28					1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level					
29	**Detected Data appear Normal at 1% Significance Level**											
30												
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
32					KM Mean	2.447					KM Standard Error of Mean	0.0322
33					90KM SD	0.12					95% KM (BCA) UCL	N/A
34					95% KM (t) UCL	2.503					95% KM (Percentile Bootstrap) UCL	N/A
35					95% KM (z) UCL	2.5					95% KM Bootstrap t UCL	N/A
36					90% KM Chebyshev UCL	2.543					95% KM Chebyshev UCL	2.587
37					97.5% KM Chebyshev UCL	2.648					99% KM Chebyshev UCL	2.767
38												
39	**Gamma GOF Tests on Detected Observations Only**											
40					A-D Test Statistic	0.915	**Anderson-Darling GOF Test**					
41					5% A-D Critical Value	0.734	Detected Data Not Gamma Distributed at 5% Significance Level					
42					K-S Test Statistic	0.248	**Kolmogorov-Smirnov GOF**					
43					5% K-S Critical Value	0.221	Detected Data Not Gamma Distributed at 5% Significance Level					
44	**Detected Data Not Gamma Distributed at 5% Significance Level**											
45												

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47					k hat (MLE)	424.1					k star (bias corrected MLE)	339.3
48					Theta hat (MLE)	0.00577					Theta star (bias corrected MLE)	0.00721
49					nu hat (MLE)	12723					nu star (bias corrected)	10179
50					Mean (detects)	2.447						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	2.3					Mean	2.447
59					Maximum	2.7					Median	2.4
60					SD	0.12					CV	0.0492
61					k hat (MLE)	452.3					k star (bias corrected MLE)	367.6
62					Theta hat (MLE)	0.00541					Theta star (bias corrected MLE)	0.00666
63					nu hat (MLE)	14475					nu star (bias corrected)	11762
64					Adjusted Level of Significance (β)	0.0335						
65					Approximate Chi Square Value (N/A, α)	11511					Adjusted Chi Square Value (N/A, β)	11483
66					95% Gamma Approximate UCL	2.5					95% Gamma Adjusted UCL	2.506
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	2.447					SD (KM)	0.12
70					Variance (KM)	0.0145					SE of Mean (KM)	0.0322
71					k hat (KM)	413.2					k star (KM)	335.7
72					nu hat (KM)	13221					nu star (KM)	10743
73					theta hat (KM)	0.00592					theta star (KM)	0.00729
74					80% gamma percentile (KM)	2.558					90% gamma percentile (KM)	2.619
75					95% gamma percentile (KM)	2.67					99% gamma percentile (KM)	2.768
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (N/A, α)	10503					Adjusted Chi Square Value (N/A, β)	10476
79					95% KM Approximate Gamma UCL	2.503					95% KM Adjusted Gamma UCL	2.509
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk GOF Test**					
83					10% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 10% Significance Level					
84					Lilliefors Test Statistic	0.241	**Lilliefors GOF Test**					
85					10% Lilliefors Critical Value	0.202	Detected Data Not Lognormal at 10% Significance Level					
86	**Detected Data Not Lognormal at 10% Significance Level**											
87												

88	**Lognormal ROS Statistics Using Imputed Non-Detects**			
89	Mean in Original Scale	2.446	Mean in Log Scale	0.894
90	SD in Original Scale	0.12	SD in Log Scale	0.0483
91	95% t UCL (assumes normality of ROS data)	2.499	95% Percentile Bootstrap UCL	2.499
92	95% BCA Bootstrap UCL	2.505	95% Bootstrap t UCL	2.515
93	95% H-UCL (Log ROS)	N/A		
94				
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
96	KM Mean (logged)	0.894	KM Geo Mean	2.444
97	KM SD (logged)	0.0483	95% Critical H Value (KM-Log)	N/A
98	KM Standard Error of Mean (logged)	0.0129	95% H-UCL (KM -Log)	N/A
99	KM SD (logged)	0.0483	95% Critical H Value (KM-Log)	N/A
100	KM Standard Error of Mean (logged)	0.0129		
101				
102	**DL/2 Statistics**			
103	**DL/2 Normal**		**DL/2 Log-Transformed**	
104	Mean in Original Scale	2.5	Mean in Log Scale	0.912
105	SD in Original Scale	0.245	SD in Log Scale	0.0893
106	95% t UCL (Assumes normality)	2.607	95% H-Stat UCL	N/A
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**			
108				
109	**Nonparametric Distribution Free UCL Statistics**			
110	**Detected Data appear Normal Distributed at 1% Significance Level**			
111				
112	**Suggested UCL to Use**			
113	95% KM (t) UCL	2.503		
114				
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
116	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.			
117	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
118				

1	**UCL Statistics for Uncensored Full Data Sets**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:39:34 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	**200 IA Freon 113**			
12				
13	**General Statistics**			
14	Total Number of Observations	16	Number of Distinct Observations	15
15			Number of Missing Observations	0
16	Minimum	0.53	Mean	267.5
17	Maximum	3200	Median	17.5
18	SD	802.3	Std. Error of Mean	200.6
19	Coefficient of Variation	2.999	Skewness	3.704
20				
21	**Normal GOF Test**			
22	Shapiro Wilk Test Statistic	0.38	**Shapiro Wilk GOF Test**	
23	1% Shapiro Wilk Critical Value	0.844	Data Not Normal at 1% Significance Level	
24	Lilliefors Test Statistic	0.448	**Lilliefors GOF Test**	
25	1% Lilliefors Critical Value	0.248	Data Not Normal at 1% Significance Level	
26	**Data Not Normal at 1% Significance Level**			
27				
28	**Assuming Normal Distribution**			
29	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
30	95% Student's-t UCL	619.2	95% Adjusted-CLT UCL (Chen-1995)	795.9
31			95% Modified-t UCL (Johnson-1978)	650.1
32				
33	**Gamma GOF Test**			
34	A-D Test Statistic	1.49	**Anderson-Darling Gamma GOF Test**	
35	5% A-D Critical Value	0.866	Data Not Gamma Distributed at 5% Significance Level	
36	K-S Test Statistic	0.285	**Kolmogorov-Smirnov Gamma GOF Test**	
37	5% K-S Critical Value	0.236	Data Not Gamma Distributed at 5% Significance Level	
38	**Data Not Gamma Distributed at 5% Significance Level**			
39				
40	**Gamma Statistics**			
41	k hat (MLE)	0.238	k star (bias corrected MLE)	0.235
42	Theta hat (MLE)	1123	Theta star (bias corrected MLE)	1138
43	nu hat (MLE)	7.621	nu star (bias corrected)	7.525
44	MLE Mean (bias corrected)	267.5	MLE Sd (bias corrected)	551.7
45			Approximate Chi Square Value (0.05)	2.463
46	Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	2.146
47				

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Assuming Gamma Distribution**											
49					95% Approximate Gamma UCL	817.3					95% Adjusted Gamma UCL	938.1
50												
51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.922	**Shapiro Wilk Lognormal GOF Test**					
53					10% Shapiro Wilk Critical Value	0.906	Data appear Lognormal at 10% Significance Level					
54					Lilliefors Test Statistic	0.182	**Lilliefors Lognormal GOF Test**					
55					10% Lilliefors Critical Value	0.196	Data appear Lognormal at 10% Significance Level					
56	**Data appear Lognormal at 10% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	-0.635					Mean of logged Data	2.583
60					Maximum of Logged Data	8.071					SD of logged Data	2.591
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	16209					90% Chebyshev (MVUE) UCL	650.8
64					95% Chebyshev (MVUE) UCL	853.5					97.5% Chebyshev (MVUE) UCL	1135
65					99% Chebyshev (MVUE) UCL	1688						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	597.5					95% BCA Bootstrap UCL	900.9
72					95% Standard Bootstrap UCL	588.3					95% Bootstrap-t UCL	5866
73					95% Hall's Bootstrap UCL	4024					95% Percentile Bootstrap UCL	651
74					90% Chebyshev(Mean, Sd) UCL	869.3					95% Chebyshev(Mean, Sd) UCL	1142
75					97.5% Chebyshev(Mean, Sd) UCL	1520					99% Chebyshev(Mean, Sd) UCL	2263
76												
77	**Suggested UCL to Use**											
78					95% Student's-t UCL	619.2						
79												
80	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
81	**Please verify the data were collected from random locations.**											
82	**If the data were collected using judgmental or other non-random methods,**											
83	**then contact a statistician to correctly calculate UCLs.**											
84												
85	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
86	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
87	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
88												

	A B C D E	F	G H I J K	L
1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:41:03 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200 IA Hexane**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	14
14	Number of Detects	8	Number of Non-Detects	8
15	Number of Distinct Detects	7	Number of Distinct Non-Detects	7
16	Minimum Detect	0.3	Minimum Non-Detect	0.22
17	Maximum Detect	1.2	Maximum Non-Detect	5.8
18	Variance Detects	0.159	Percent Non-Detects	50%
19	Mean Detects	0.659	SD Detects	0.399
20	Median Detects	0.46	CV Detects	0.606
21	Skewness Detects	0.574	Kurtosis Detects	-2.107
22	Mean of Logged Detects	-0.58	SD of Logged Detects	0.607
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.777	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.749	Detected Data appear Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.28	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.333	Detected Data appear Normal at 1% Significance Level	
29	**Detected Data appear Normal at 1% Significance Level**			
30	**Note GOF tests may be unreliable for small sample sizes**			
31				
32	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
33	KM Mean	0.455	KM Standard Error of Mean	0.0964
34	90KM SD	0.349	95% KM (BCA) UCL	0.618
35	95% KM (t) UCL	0.624	95% KM (Percentile Bootstrap) UCL	0.617
36	95% KM (z) UCL	0.614	95% KM Bootstrap t UCL	0.662
37	90% KM Chebyshev UCL	0.745	95% KM Chebyshev UCL	0.875
38	97.5% KM Chebyshev UCL	1.057	99% KM Chebyshev UCL	1.414
39				
40	**Gamma GOF Tests on Detected Observations Only**			
41	A-D Test Statistic	0.789	**Anderson-Darling GOF Test**	
42	5% A-D Critical Value	0.721	Detected Data Not Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.257	**Kolmogorov-Smirnov GOF**	
44	5% K-S Critical Value	0.296	Detected data appear Gamma Distributed at 5% Significance Level	
45	**Detected data follow Appr. Gamma Distribution at 5% Significance Level**			
46	**Note GOF tests may be unreliable for small sample sizes**			
47				

48	**Gamma Statistics on Detected Data Only**			
49	k hat (MLE)	3.228	k star (bias corrected MLE)	2.101
50	Theta hat (MLE)	0.204	Theta star (bias corrected MLE)	0.314
51	nu hat (MLE)	51.65	nu star (bias corrected)	33.62
52	Mean (detects)	0.659		
53				
54	**Gamma ROS Statistics using Imputed Non-Detects**			
55	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
56	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
57	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
58	This is especially true when the sample size is small.			
59	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
60	Minimum	0.01	Mean	0.347
61	Maximum	1.2	Median	0.26
62	SD	0.425	CV	1.222
63	k hat (MLE)	0.477	k star (bias corrected MLE)	0.429
64	Theta hat (MLE)	0.729	Theta star (bias corrected MLE)	0.81
65	nu hat (MLE)	15.25	nu star (bias corrected)	13.73
66	Adjusted Level of Significance (β)	0.0335		
67	Approximate Chi Square Value (13.73, α)	6.384	Adjusted Chi Square Value (13.73, β)	5.822
68	95% Gamma Approximate UCL	0.747	95% Gamma Adjusted UCL	0.819
69				
70	**Estimates of Gamma Parameters using KM Estimates**			
71	Mean (KM)	0.455	SD (KM)	0.349
72	Variance (KM)	0.122	SE of Mean (KM)	0.0964
73	k hat (KM)	1.703	k star (KM)	1.425
74	nu hat (KM)	54.49	nu star (KM)	45.61
75	theta hat (KM)	0.267	theta star (KM)	0.32
76	80% gamma percentile (KM)	0.709	90% gamma percentile (KM)	0.961
77	95% gamma percentile (KM)	1.207	99% gamma percentile (KM)	1.764
78				
79	**Gamma Kaplan-Meier (KM) Statistics**			
80	Approximate Chi Square Value (45.61, α)	31.11	Adjusted Chi Square Value (45.61, β)	29.75
81	95% KM Approximate Gamma UCL	0.668	95% KM Adjusted Gamma UCL	0.698
82				
83	**Lognormal GOF Test on Detected Observations Only**			
84	Shapiro Wilk Test Statistic	0.821	**Shapiro Wilk GOF Test**	
85	10% Shapiro Wilk Critical Value	0.851	Detected Data Not Lognormal at 10% Significance Level	
86	Lilliefors Test Statistic	0.242	**Lilliefors GOF Test**	
87	10% Lilliefors Critical Value	0.265	Detected Data appear Lognormal at 10% Significance Level	
88	**Detected Data appear Approximate Lognormal at 10% Significance Level**			
89	**Note GOF tests may be unreliable for small sample sizes**			
90				

	A	B	C	D	E	F	G	H	I	J	K	L
91	**Lognormal ROS Statistics Using Imputed Non-Detects**											
92	Mean in Original Scale					0.401	Mean in Log Scale					-1.287
93	SD in Original Scale					0.383	SD in Log Scale					0.868
94	95% t UCL (assumes normality of ROS data)					0.569	95% Percentile Bootstrap UCL					0.564
95	95% BCA Bootstrap UCL					0.591	95% Bootstrap t UCL					0.621
96	95% H-UCL (Log ROS)					0.706						
97												
98	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
99	KM Mean (logged)					-1.011	KM Geo Mean					0.364
100	KM SD (logged)					0.621	95% Critical H Value (KM-Log)					2.184
101	KM Standard Error of Mean (logged)					0.172	95% H-UCL (KM -Log)					0.626
102	KM SD (logged)					0.621	95% Critical H Value (KM-Log)					2.184
103	KM Standard Error of Mean (logged)					0.172						
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107	Mean in Original Scale					0.565	Mean in Log Scale					-1.137
108	SD in Original Scale					0.73	SD in Log Scale					1.044
109	95% t UCL (Assumes normality)					0.885	95% H-Stat UCL					1.169
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Detected Data appear Normal Distributed at 1% Significance Level**											
114												
115	**Suggested UCL to Use**											
116	95% KM (t) UCL					0.624						
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:41:36 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA Methylene Chloride

General Statistics

Total Number of Observations	16	Number of Distinct Observations	12
Number of Detects	10	Number of Non-Detects	6
Number of Distinct Detects	7	Number of Distinct Non-Detects	5
Minimum Detect	0.26	Minimum Non-Detect	0.3
Maximum Detect	1.6	Maximum Non-Detect	6.6
Variance Detects	0.148	Percent Non-Detects	37.5%
Mean Detects	0.516	SD Detects	0.384
Median Detects	0.41	CV Detects	0.744
Skewness Detects	3.059	Kurtosis Detects	9.562
Mean of Logged Detects	-0.797	SD of Logged Detects	0.469

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.47	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.781	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.489	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.304	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.431	KM Standard Error of Mean	0.0874
90KM SD	0.321	95% KM (BCA) UCL	0.665
95% KM (t) UCL	0.584	95% KM (Percentile Bootstrap) UCL	0.597
95% KM (z) UCL	0.574	95% KM Bootstrap t UCL	0.87
90% KM Chebyshev UCL	0.693	95% KM Chebyshev UCL	0.812
97.5% KM Chebyshev UCL	0.976	99% KM Chebyshev UCL	1.3

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.232	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.73	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.469	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.268	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47					k hat (MLE)	3.866					k star (bias corrected MLE)	2.773
48					Theta hat (MLE)	0.133					Theta star (bias corrected MLE)	0.186
49					nu hat (MLE)	77.32					nu star (bias corrected)	55.46
50					Mean (detects)	0.516						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01					Mean	0.364
59					Maximum	1.6					Median	0.395
60					SD	0.365					CV	1.003
61					k hat (MLE)	1.196					k star (bias corrected MLE)	1.013
62					Theta hat (MLE)	0.305					Theta star (bias corrected MLE)	0.36
63					nu hat (MLE)	38.26					nu star (bias corrected)	32.42
64					Adjusted Level of Significance (β)	0.0335						
65					Approximate Chi Square Value (32.42, α)	20.4					Adjusted Chi Square Value (32.42, β)	19.32
66					95% Gamma Approximate UCL	0.579					95% Gamma Adjusted UCL	0.611
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	0.431					SD (KM)	0.321
70					Variance (KM)	0.103					SE of Mean (KM)	0.0874
71					k hat (KM)	1.799					k star (KM)	1.504
72					nu hat (KM)	57.58					nu star (KM)	48.12
73					theta hat (KM)	0.239					theta star (KM)	0.286
74					80% gamma percentile (KM)	0.666					90% gamma percentile (KM)	0.897
75					95% gamma percentile (KM)	1.121					99% gamma percentile (KM)	1.627
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (48.12, α)	33.2					Adjusted Chi Square Value (48.12, β)	31.79
79					95% KM Approximate Gamma UCL	0.624					95% KM Adjusted Gamma UCL	0.652
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.604	**Shapiro Wilk GOF Test**					
83					10% Shapiro Wilk Critical Value	0.869	Detected Data Not Lognormal at 10% Significance Level					
84					Lilliefors Test Statistic	0.44	**Lilliefors GOF Test**					
85					10% Lilliefors Critical Value	0.241	Detected Data Not Lognormal at 10% Significance Level					
86	**Detected Data Not Lognormal at 10% Significance Level**											
87												

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89	Mean in Original Scale					0.417	Mean in Log Scale					-1.022
90	SD in Original Scale					0.327	SD in Log Scale					0.485
91	95% t UCL (assumes normality of ROS data)					0.56	95% Percentile Bootstrap UCL					0.571
92	95% BCA Bootstrap UCL					0.652	95% Bootstrap t UCL					0.796
93	95% H-UCL (Log ROS)					0.522						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96	KM Mean (logged)					-0.98	KM Geo Mean					0.375
97	KM SD (logged)					0.446	95% Critical H Value (KM-Log)					1.997
98	KM Standard Error of Mean (logged)					0.122	95% H-UCL (KM -Log)					0.522
99	KM SD (logged)					0.446	95% Critical H Value (KM-Log)					1.997
100	KM Standard Error of Mean (logged)					0.122						
101	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
102												
103	**DL/2 Statistics**											
104	**DL/2 Normal**						**DL/2 Log-Transformed**					
105	Mean in Original Scale					0.58	Mean in Log Scale					-0.987
106	SD in Original Scale					0.801	SD in Log Scale					0.836
107	95% t UCL (Assumes normality)					0.931	95% H-Stat UCL					0.899
108	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
109												
110	**Nonparametric Distribution Free UCL Statistics**											
111	**Data do not follow a Discernible Distribution**											
112												
113	**Suggested UCL to Use**											
114	95% KM (t) UCL					0.584						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:44:08 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200_IA_TCE**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	13
14	Number of Detects	6	Number of Non-Detects	10
15	Number of Distinct Detects	6	Number of Distinct Non-Detects	7
16	Minimum Detect	0.33	Minimum Non-Detect	0.2
17	Maximum Detect	1.3	Maximum Non-Detect	5.4
18	Variance Detects	0.145	Percent Non-Detects	62.5%
19	Mean Detects	0.627	SD Detects	0.381
20	Median Detects	0.44	CV Detects	0.608
21	Skewness Detects	1.434	Kurtosis Detects	1.163
22	Mean of Logged Detects	-0.598	SD of Logged Detects	0.536
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.803	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.713	Detected Data appear Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.317	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.373	Detected Data appear Normal at 1% Significance Level	
29	**Detected Data appear Normal at 1% Significance Level**			
30	**Note GOF tests may be unreliable for small sample sizes**			
31				
32	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
33	KM Mean	0.371	KM Standard Error of Mean	0.0858
34	90KM SD	0.303	95% KM (BCA) UCL	0.548
35	95% KM (t) UCL	0.521	95% KM (Percentile Bootstrap) UCL	0.522
36	95% KM (z) UCL	0.512	95% KM Bootstrap t UCL	0.651
37	90% KM Chebyshev UCL	0.628	95% KM Chebyshev UCL	0.745
38	97.5% KM Chebyshev UCL	0.906	99% KM Chebyshev UCL	1.224
39				
40	**Gamma GOF Tests on Detected Observations Only**			
41	A-D Test Statistic	0.548	**Anderson-Darling GOF Test**	
42	5% A-D Critical Value	0.7	Detected data appear Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.299	**Kolmogorov-Smirnov GOF**	
44	5% K-S Critical Value	0.334	Detected data appear Gamma Distributed at 5% Significance Level	
45	**Detected data appear Gamma Distributed at 5% Significance Level**			
46	**Note GOF tests may be unreliable for small sample sizes**			
47				

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Gamma Statistics on Detected Data Only**											
49					k hat (MLE)	3.981					k star (bias corrected MLE)	2.102
50					Theta hat (MLE)	0.157					Theta star (bias corrected MLE)	0.298
51					nu hat (MLE)	47.77					nu star (bias corrected)	25.22
52					Mean (detects)	0.627						
53												
54	**Gamma ROS Statistics using Imputed Non-Detects**											
55	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
56	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
57	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
58	This is especially true when the sample size is small.											
59	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
60					Minimum	0.01					Mean	0.241
61					Maximum	1.3					Median	0.01
62					SD	0.379					CV	1.57
63					k hat (MLE)	0.393					k star (bias corrected MLE)	0.361
64					Theta hat (MLE)	0.614					Theta star (bias corrected MLE)	0.669
65					nu hat (MLE)	12.57					nu star (bias corrected)	11.54
66					Adjusted Level of Significance (β)	0.0335						
67					Approximate Chi Square Value (11.54, α)	4.928					Adjusted Chi Square Value (11.54, β)	4.445
68					95% Gamma Approximate UCL	0.565					95% Gamma Adjusted UCL	0.627
69												
70	**Estimates of Gamma Parameters using KM Estimates**											
71					Mean (KM)	0.371					SD (KM)	0.303
72					Variance (KM)	0.092					SE of Mean (KM)	0.0858
73					k hat (KM)	1.493					k star (KM)	1.255
74					nu hat (KM)	47.79					nu star (KM)	40.16
75					theta hat (KM)	0.248					theta star (KM)	0.295
76					80% gamma percentile (KM)	0.584					90% gamma percentile (KM)	0.807
77					95% gamma percentile (KM)	1.026					99% gamma percentile (KM)	1.526
78												
79	**Gamma Kaplan-Meier (KM) Statistics**											
80					Approximate Chi Square Value (40.16, α)	26.64					Adjusted Chi Square Value (40.16, β)	25.39
81					95% KM Approximate Gamma UCL	0.559					95% KM Adjusted Gamma UCL	0.586
82												
83	**Lognormal GOF Test on Detected Observations Only**											
84					Shapiro Wilk Test Statistic	0.871	**Shapiro Wilk GOF Test**					
85					10% Shapiro Wilk Critical Value	0.826	Detected Data appear Lognormal at 10% Significance Level					
86					Lilliefors Test Statistic	0.267	**Lilliefors GOF Test**					
87					10% Lilliefors Critical Value	0.298	Detected Data appear Lognormal at 10% Significance Level					
88	**Detected Data appear Lognormal at 10% Significance Level**											
89	**Note GOF tests may be unreliable for small sample sizes**											
90												

	A	B	C	D	E	F	G	H	I	J	K	L
91	**Lognormal ROS Statistics Using Imputed Non-Detects**											
92	Mean in Original Scale					0.303	Mean in Log Scale					-1.651
93	SD in Original Scale					0.341	SD in Log Scale					0.943
94	95% t UCL (assumes normality of ROS data)					0.452	95% Percentile Bootstrap UCL					0.455
95	95% BCA Bootstrap UCL					0.491	95% Bootstrap t UCL					0.601
96	95% H-UCL (Log ROS)					0.566						
97												
98	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
99	KM Mean (logged)					-1.205	KM Geo Mean					0.3
100	KM SD (logged)					0.584	95% Critical H Value (KM-Log)					2.142
101	KM Standard Error of Mean (logged)					0.165	95% H-UCL (KM -Log)					0.491
102	KM SD (logged)					0.584	95% Critical H Value (KM-Log)					2.142
103	KM Standard Error of Mean (logged)					0.165						
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107	Mean in Original Scale					0.473	Mean in Log Scale					-1.349
108	SD in Original Scale					0.68	SD in Log Scale					1.021
109	95% t UCL (Assumes normality)					0.771	95% H-Stat UCL					0.9
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Detected Data appear Normal Distributed at 1% Significance Level**											
114												
115	**Suggested UCL to Use**											
116	95% KM (t) UCL					0.521						
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:42:22 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA Toluene

General Statistics

Total Number of Observations	16	Number of Distinct Observations	15
Number of Detects	13	Number of Non-Detects	3
Number of Distinct Detects	13	Number of Distinct Non-Detects	3
Minimum Detect	0.25	Minimum Non-Detect	0.29
Maximum Detect	7.2	Maximum Non-Detect	0.38
Variance Detects	3.402	Percent Non-Detects	18.75%
Mean Detects	1.285	SD Detects	1.844
Median Detects	0.64	CV Detects	1.436
Skewness Detects	3.18	Kurtosis Detects	10.71
Mean of Logged Detects	-0.238	SD of Logged Detects	0.907

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.544	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.814	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.313	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.271	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.092	KM Standard Error of Mean	0.429
90KM SD	1.647	95% KM (BCA) UCL	1.935
95% KM (t) UCL	1.843	95% KM (Percentile Bootstrap) UCL	1.864
95% KM (z) UCL	1.797	95% KM Bootstrap t UCL	3.447
90% KM Chebyshev UCL	2.378	95% KM Chebyshev UCL	2.96
97.5% KM Chebyshev UCL	3.768	99% KM Chebyshev UCL	5.356

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.907	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.755	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.208	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.242	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47					k hat (MLE)	1.163					k star (bias corrected MLE)	0.946
48					Theta hat (MLE)	1.105					Theta star (bias corrected MLE)	1.358
49					nu hat (MLE)	30.23					nu star (bias corrected)	24.59
50					Mean (detects)	1.285						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01					Mean	1.046
59					Maximum	7.2					Median	0.615
60					SD	1.728					CV	1.652
61					k hat (MLE)	0.566					k star (bias corrected MLE)	0.502
62					Theta hat (MLE)	1.847					Theta star (bias corrected MLE)	2.085
63					nu hat (MLE)	18.11					nu star (bias corrected)	16.05
64					Adjusted Level of Significance (β)	0.0335						
65					Approximate Chi Square Value (16.05, α)	7.998					Adjusted Chi Square Value (16.05, β)	7.358
66					95% Gamma Approximate UCL	2.098					95% Gamma Adjusted UCL	2.281
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	1.092					SD (KM)	1.647
70					Variance (KM)	2.712					SE of Mean (KM)	0.429
71					k hat (KM)	0.44					k star (KM)	0.399
72					nu hat (KM)	14.07					nu star (KM)	12.76
73					theta hat (KM)	2.484					theta star (KM)	2.738
74					80% gamma percentile (KM)	1.762					90% gamma percentile (KM)	3.086
75					95% gamma percentile (KM)	4.542					99% gamma percentile (KM)	8.203
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (12.76, α)	5.734					Adjusted Chi Square Value (12.76, β)	5.207
79					95% KM Approximate Gamma UCL	2.431					95% KM Adjusted Gamma UCL	2.677
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.92	**Shapiro Wilk GOF Test**					
83					10% Shapiro Wilk Critical Value	0.889	Detected Data appear Lognormal at 10% Significance Level					
84					Lilliefors Test Statistic	0.129	**Lilliefors GOF Test**					
85					10% Lilliefors Critical Value	0.215	Detected Data appear Lognormal at 10% Significance Level					
86	**Detected Data appear Lognormal at 10% Significance Level**											
87												

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89					Mean in Original Scale	1.077					Mean in Log Scale	-0.522
90					SD in Original Scale	1.709					SD in Log Scale	1.019
91					95% t UCL (assumes normality of ROS data)	1.826					95% Percentile Bootstrap UCL	1.83
92					95% BCA Bootstrap UCL	2.296					95% Bootstrap t UCL	3.46
93					95% H-UCL (Log ROS)	2.046						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96					KM Mean (logged)	-0.448					KM Geo Mean	0.639
97					KM SD (logged)	0.9					95% Critical H Value (KM-Log)	2.554
98					KM Standard Error of Mean (logged)	0.234					95% H-UCL (KM -Log)	1.735
99					KM SD (logged)	0.9					95% Critical H Value (KM-Log)	2.554
100					KM Standard Error of Mean (logged)	0.234						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104					Mean in Original Scale	1.074					Mean in Log Scale	-0.536
105					SD in Original Scale	1.711					SD in Log Scale	1.036
106					95% t UCL (Assumes normality)	1.824					95% H-Stat UCL	2.094
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Detected Data appear Approximate Gamma Distributed at 5% Significance Level**											
111												
112	**Suggested UCL to Use**											
113					95% KM Adjusted Gamma UCL	2.677						
114												
115	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
116	**Please verify the data were collected from random locations.**											
117	**If the data were collected using judgmental or other non-random methods,**											
118	**then contact a statistician to correctly calculate UCLs.**											
119												
120	When a data set follows an approximate distribution passing only one of the GOF tests,											
121	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
122												
123	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
124	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
125	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
126												

1	**UCL Statistics for Uncensored Full Data Sets**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 2:22:15 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	**600 IA 2-Butanone (MEK)**			
12				
13	**General Statistics**			
14	Total Number of Observations	8	Number of Distinct Observations	7
15			Number of Missing Observations	0
16	Minimum	0.37	Mean	2.089
17	Maximum	5.3	Median	1.41
18	SD	1.985	Std. Error of Mean	0.702
19	Coefficient of Variation	0.95	Skewness	0.677
20				
21	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**			
22	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**			
23	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**			
24	**The Chebyshev UCL often results in gross overestimates of the mean.**			
25	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**			
26				
27	**Normal GOF Test**			
28	Shapiro Wilk Test Statistic	0.836	**Shapiro Wilk GOF Test**	
29	1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level	
30	Lilliefors Test Statistic	0.285	**Lilliefors GOF Test**	
31	1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level	
32	**Data appear Normal at 1% Significance Level**			
33	**Note GOF tests may be unreliable for small sample sizes**			
34				
35	**Assuming Normal Distribution**			
36	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
37	95% Student's-t UCL	3.418	95% Adjusted-CLT UCL (Chen-1995)	3.423
38			95% Modified-t UCL (Johnson-1978)	3.446
39				
40	**Gamma GOF Test**			
41	A-D Test Statistic	0.673	**Anderson-Darling Gamma GOF Test**	
42	5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.296	**Kolmogorov-Smirnov Gamma GOF Test**	
44	5% K-S Critical Value	0.301	Detected data appear Gamma Distributed at 5% Significance Level	
45	**Detected data appear Gamma Distributed at 5% Significance Level**			
46	**Note GOF tests may be unreliable for small sample sizes**			
47				

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Gamma Statistics**											
49					k hat (MLE)	1.077					k star (bias corrected MLE)	0.756
50					Theta hat (MLE)	1.94					Theta star (bias corrected MLE)	2.762
51					nu hat (MLE)	17.23					nu star (bias corrected)	12.1
52					MLE Mean (bias corrected)	2.089					MLE Sd (bias corrected)	2.402
53											Approximate Chi Square Value (0.05)	5.293
54					Adjusted Level of Significance	0.0195					Adjusted Chi Square Value	4.211
55												
56	**Assuming Gamma Distribution**											
57					95% Approximate Gamma UCL	4.775					95% Adjusted Gamma UCL	6.001
58												
59	**Lognormal GOF Test**											
60					Shapiro Wilk Test Statistic	0.823	**Shapiro Wilk Lognormal GOF Test**					
61					10% Shapiro Wilk Critical Value	0.851	Data Not Lognormal at 10% Significance Level					
62					Lilliefors Test Statistic	0.269	**Lilliefors Lognormal GOF Test**					
63					10% Lilliefors Critical Value	0.265	Data Not Lognormal at 10% Significance Level					
64	**Data Not Lognormal at 10% Significance Level**											
65												
66	**Lognormal Statistics**											
67					Minimum of Logged Data	-0.994					Mean of logged Data	0.205
68					Maximum of Logged Data	1.668					SD of logged Data	1.17
69												
70	**Assuming Lognormal Distribution**											
71					95% H-UCL	13.4					90% Chebyshev (MVUE) UCL	4.888
72					95% Chebyshev (MVUE) UCL	6.125					97.5% Chebyshev (MVUE) UCL	7.842
73					99% Chebyshev (MVUE) UCL	11.21						
74												
75	**Nonparametric Distribution Free UCL Statistics**											
76	**Data appear to follow a Discernible Distribution**											
77												
78	**Nonparametric Distribution Free UCLs**											
79					95% CLT UCL	3.243					95% BCA Bootstrap UCL	3.396
80					95% Standard Bootstrap UCL	3.187					95% Bootstrap-t UCL	3.727
81					95% Hall's Bootstrap UCL	3.332					95% Percentile Bootstrap UCL	3.236
82					90% Chebyshev(Mean, Sd) UCL	4.194					95% Chebyshev(Mean, Sd) UCL	5.148
83					97.5% Chebyshev(Mean, Sd) UCL	6.472					99% Chebyshev(Mean, Sd) UCL	9.072
84												
85	**Suggested UCL to Use**											
86					95% Student's-t UCL	3.418						
87												
88	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
89	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
90	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
91												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Uncensored Full Data Sets**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 2:26:35 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	**600 IA Acetone**											
12												
13	**General Statistics**											
14	Total Number of Observations					8	Number of Distinct Observations					7
15							Number of Missing Observations					0
16	Minimum					3.8	Mean					11.84
17	Maximum					28	Median					7.85
18	SD					9.555	Std. Error of Mean					3.378
19	Coefficient of Variation					0.807	Skewness					0.846
20												
21	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**											
22	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**											
23	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**											
24	**The Chebyshev UCL often results in gross overestimates of the mean.**											
25	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**											
26												
27	**Normal GOF Test**											
28	Shapiro Wilk Test Statistic					0.832	**Shapiro Wilk GOF Test**					
29	1% Shapiro Wilk Critical Value					0.749	Data appear Normal at 1% Significance Level					
30	Lilliefors Test Statistic					0.272	**Lilliefors GOF Test**					
31	1% Lilliefors Critical Value					0.333	Data appear Normal at 1% Significance Level					
32	**Data appear Normal at 1% Significance Level**											
33	**Note GOF tests may be unreliable for small sample sizes**											
34												
35	**Assuming Normal Distribution**											
36	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
37	95% Student's-t UCL					18.24	95% Adjusted-CLT UCL (Chen-1995)					18.47
38							95% Modified-t UCL (Johnson-1978)					18.41
39												
40	**Gamma GOF Test**											
41	A-D Test Statistic					0.626	**Anderson-Darling Gamma GOF Test**					
42	5% A-D Critical Value					0.726	Detected data appear Gamma Distributed at 5% Significance Level					
43	K-S Test Statistic					0.291	**Kolmogorov-Smirnov Gamma GOF Test**					
44	5% K-S Critical Value					0.298	Detected data appear Gamma Distributed at 5% Significance Level					
45	**Detected data appear Gamma Distributed at 5% Significance Level**											
46	**Note GOF tests may be unreliable for small sample sizes**											
47												

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Gamma Statistics**											
49					k hat (MLE)	1.796					k star (bias corrected MLE)	1.206
50					Theta hat (MLE)	6.589					Theta star (bias corrected MLE)	9.814
51					nu hat (MLE)	28.74					nu star (bias corrected)	19.3
52					MLE Mean (bias corrected)	11.84					MLE Sd (bias corrected)	10.78
53											Approximate Chi Square Value (0.05)	10.34
54					Adjusted Level of Significance	0.0195					Adjusted Chi Square Value	8.726
55												
56	**Assuming Gamma Distribution**											
57					95% Approximate Gamma UCL	22.1					95% Adjusted Gamma UCL	26.18
58												
59	**Lognormal GOF Test**											
60					Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk Lognormal GOF Test**					
61					10% Shapiro Wilk Critical Value	0.851	Data Not Lognormal at 10% Significance Level					
62					Lilliefors Test Statistic	0.27	**Lilliefors Lognormal GOF Test**					
63					10% Lilliefors Critical Value	0.265	Data Not Lognormal at 10% Significance Level					
64	**Data Not Lognormal at 10% Significance Level**											
65												
66	**Lognormal Statistics**											
67					Minimum of Logged Data	1.335					Mean of logged Data	2.168
68					Maximum of Logged Data	3.332					SD of logged Data	0.84
69												
70	**Assuming Lognormal Distribution**											
71					95% H-UCL	32.65					90% Chebyshev (MVUE) UCL	22.48
72					95% Chebyshev (MVUE) UCL	27.32					97.5% Chebyshev (MVUE) UCL	34.04
73					99% Chebyshev (MVUE) UCL	47.25						
74												
75	**Nonparametric Distribution Free UCL Statistics**											
76	**Data appear to follow a Discernible Distribution**											
77												
78	**Nonparametric Distribution Free UCLs**											
79					95% CLT UCL	17.39					95% BCA Bootstrap UCL	18.55
80					95% Standard Bootstrap UCL	17.13					95% Bootstrap-t UCL	20.09
81					95% Hall's Bootstrap UCL	18.15					95% Percentile Bootstrap UCL	17.39
82					90% Chebyshev(Mean, Sd) UCL	21.97					95% Chebyshev(Mean, Sd) UCL	26.56
83					97.5% Chebyshev(Mean, Sd) UCL	32.94					99% Chebyshev(Mean, Sd) UCL	45.45
84												
85	**Suggested UCL to Use**											
86					95% Student's-t UCL	18.24						
87												
88	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
89	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
90	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
91												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 2:27:19 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10	**600 IA Benzene**											
11												
12	**General Statistics**											
13	Total Number of Observations					8	Number of Distinct Observations					6
14	Number of Detects					7	Number of Non-Detects					1
15	Number of Distinct Detects					6	Number of Distinct Non-Detects					1
16	Minimum Detect					0.28	Minimum Non-Detect					0.28
17	Maximum Detect					0.4	Maximum Non-Detect					0.28
18	Variance Detects					0.00246	Percent Non-Detects					12.5%
19	Mean Detects					0.353	SD Detects					0.0496
20	Median Detects					0.37	CV Detects					0.14
21	Skewness Detects					-0.537	Kurtosis Detects					-1.68
22	Mean of Logged Detects					-1.051	SD of Logged Detects					0.146
23												
24	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**											
25	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**											
26	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**											
27	**The Chebyshev UCL often results in gross overestimates of the mean.**											
28	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**											
29												
30	**Normal GOF Test on Detects Only**											
31	Shapiro Wilk Test Statistic					0.874	**Shapiro Wilk GOF Test**					
32	1% Shapiro Wilk Critical Value					0.73	Detected Data appear Normal at 1% Significance Level					
33	Lilliefors Test Statistic					0.207	**Lilliefors GOF Test**					
34	1% Lilliefors Critical Value					0.35	Detected Data appear Normal at 1% Significance Level					
35	**Detected Data appear Normal at 1% Significance Level**											
36	**Note GOF tests may be unreliable for small sample sizes**											
37												
38	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
39	KM Mean					0.344	KM Standard Error of Mean					0.0188
40	90KM SD					0.0492	95% KM (BCA) UCL					0.373
41	95% KM (t) UCL					0.379	95% KM (Percentile Bootstrap) UCL					0.373
42	95% KM (z) UCL					0.375	95% KM Bootstrap t UCL					0.377
43	90% KM Chebyshev UCL					0.4	95% KM Chebyshev UCL					0.426
44	97.5% KM Chebyshev UCL					0.461	99% KM Chebyshev UCL					0.531
45												

46	**Gamma GOF Tests on Detected Observations Only**			
47	A-D Test Statistic	0.48	**Anderson-Darling GOF Test**	
48	5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level	
49	K-S Test Statistic	0.228	**Kolmogorov-Smirnov GOF**	
50	5% K-S Critical Value	0.311	Detected data appear Gamma Distributed at 5% Significance Level	
51	**Detected data appear Gamma Distributed at 5% Significance Level**			
52	**Note GOF tests may be unreliable for small sample sizes**			
53				
54	**Gamma Statistics on Detected Data Only**			
55	k hat (MLE)	56.44	k star (bias corrected MLE)	32.34
56	Theta hat (MLE)	0.00625	Theta star (bias corrected MLE)	0.0109
57	nu hat (MLE)	790.1	nu star (bias corrected)	452.8
58	Mean (detects)	0.353		
59				
60	**Gamma ROS Statistics using Imputed Non-Detects**			
61	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
62	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
63	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
64	This is especially true when the sample size is small.			
65	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
66	Minimum	0.243	Mean	0.339
67	Maximum	0.4	Median	0.35
68	SD	0.0601	CV	0.177
69	k hat (MLE)	34.25	k star (bias corrected MLE)	21.49
70	Theta hat (MLE)	0.0099	Theta star (bias corrected MLE)	0.0158
71	nu hat (MLE)	547.9	nu star (bias corrected)	343.8
72	Adjusted Level of Significance (β)	0.0195		
73	Approximate Chi Square Value (343.80, α)	301.8	Adjusted Chi Square Value (343.80, β)	291.9
74	95% Gamma Approximate UCL	0.386	95% Gamma Adjusted UCL	0.4
75				
76	**Estimates of Gamma Parameters using KM Estimates**			
77	Mean (KM)	0.344	SD (KM)	0.0492
78	Variance (KM)	0.00242	SE of Mean (KM)	0.0188
79	k hat (KM)	48.76	k star (KM)	30.56
80	nu hat (KM)	780.1	nu star (KM)	488.9
81	theta hat (KM)	0.00705	theta star (KM)	0.0112
82	80% gamma percentile (KM)	0.395	90% gamma percentile (KM)	0.425
83	95% gamma percentile (KM)	0.452	99% gamma percentile (KM)	0.505
84				
85	**Gamma Kaplan-Meier (KM) Statistics**			
86	Approximate Chi Square Value (488.92, α)	438.6	Adjusted Chi Square Value (488.92, β)	426.5
87	95% KM Approximate Gamma UCL	0.383	95% KM Adjusted Gamma UCL	0.394
88				

	A	B	C	D	E	F	G	H	I	J	K	L
89	**Lognormal GOF Test on Detected Observations Only**											
90	Shapiro Wilk Test Statistic					0.869	**Shapiro Wilk GOF Test**					
91	10% Shapiro Wilk Critical Value					0.838	Detected Data appear Lognormal at 10% Significance Level					
92	Lilliefors Test Statistic					0.222	**Lilliefors GOF Test**					
93	10% Lilliefors Critical Value					0.28	Detected Data appear Lognormal at 10% Significance Level					
94	**Detected Data appear Lognormal at 10% Significance Level**											
95	**Note GOF tests may be unreliable for small sample sizes**											
96												
97	**Lognormal ROS Statistics Using Imputed Non-Detects**											
98	Mean in Original Scale					0.34	Mean in Log Scale					-1.094
99	SD in Original Scale					0.0592	SD in Log Scale					0.182
100	95% t UCL (assumes normality of ROS data)					0.379	95% Percentile Bootstrap UCL					0.371
101	95% BCA Bootstrap UCL					0.369	95% Bootstrap t UCL					0.378
102	95% H-UCL (Log ROS)					0.389						
103												
104	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
105	KM Mean (logged)					-1.078	KM Geo Mean					0.34
106	KM SD (logged)					0.146	95% Critical H Value (KM-Log)					1.89
107	KM Standard Error of Mean (logged)					0.0558	95% H-UCL (KM -Log)					0.382
108	KM SD (logged)					0.146	95% Critical H Value (KM-Log)					1.89
109	KM Standard Error of Mean (logged)					0.0558						
110												
111	**DL/2 Statistics**											
112	**DL/2 Normal**						**DL/2 Log-Transformed**					
113	Mean in Original Scale					0.326	Mean in Log Scale					-1.165
114	SD in Original Scale					0.0881	SD in Log Scale					0.351
115	95% t UCL (Assumes normality)					0.385	95% H-Stat UCL					0.44
116	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
117												
118	**Nonparametric Distribution Free UCL Statistics**											
119	**Detected Data appear Normal Distributed at 1% Significance Level**											
120												
121	**Suggested UCL to Use**											
122	95% KM (t) UCL					0.379						
123												
124	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
125	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
126	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
127												

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Uncensored Full Data Sets											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 2:25:47 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	600 IA Carbon Tetrachloride											
12												
13	General Statistics											
14	Total Number of Observations					8	Number of Distinct Observations					5
15							Number of Missing Observations					0
16	Minimum					0.37	Mean					0.419
17	Maximum					0.45	Median					0.42
18	SD					0.0247	Std. Error of Mean					0.00875
19	Coefficient of Variation					0.0591	Skewness					-0.941
20												
21	Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,											
22	refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,											
23	but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).											
24	The Chebyshev UCL often results in gross overestimates of the mean.											
25	Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.											
26												
27	Normal GOF Test											
28	Shapiro Wilk Test Statistic					0.912	Shapiro Wilk GOF Test					
29	1% Shapiro Wilk Critical Value					0.749	Data appear Normal at 1% Significance Level					
30	Lilliefors Test Statistic					0.237	Lilliefors GOF Test					
31	1% Lilliefors Critical Value					0.333	Data appear Normal at 1% Significance Level					
32	Data appear Normal at 1% Significance Level											
33	Note GOF tests may be unreliable for small sample sizes											
34												
35	Assuming Normal Distribution											
36	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
37	95% Student's-t UCL					0.435	95% Adjusted-CLT UCL (Chen-1995)					0.43
38							95% Modified-t UCL (Johnson-1978)					0.435
39												
40	Gamma GOF Test											
41	A-D Test Statistic					0.433	Anderson-Darling Gamma GOF Test					
42	5% A-D Critical Value					0.715	Detected data appear Gamma Distributed at 5% Significance Level					
43	K-S Test Statistic					0.236	Kolmogorov-Smirnov Gamma GOF Test					
44	5% K-S Critical Value					0.294	Detected data appear Gamma Distributed at 5% Significance Level					
45	Detected data appear Gamma Distributed at 5% Significance Level											
46	Note GOF tests may be unreliable for small sample sizes											
47												

48	**Gamma Statistics**			
49	k hat (MLE)	317	k star (bias corrected MLE)	198.2
50	Theta hat (MLE)	0.00132	Theta star (bias corrected MLE)	0.00211
51	nu hat (MLE)	5072	nu star (bias corrected)	3171
52	MLE Mean (bias corrected)	0.419	MLE Sd (bias corrected)	0.0297
53			Approximate Chi Square Value (0.05)	3041
54	Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	3009
55				
56	**Assuming Gamma Distribution**			
57	95% Approximate Gamma UCL	0.437	95% Adjusted Gamma UCL	0.441
58				
59	**Lognormal GOF Test**			
60	Shapiro Wilk Test Statistic	0.897	**Shapiro Wilk Lognormal GOF Test**	
61	10% Shapiro Wilk Critical Value	0.851	Data appear Lognormal at 10% Significance Level	
62	Lilliefors Test Statistic	0.248	**Lilliefors Lognormal GOF Test**	
63	10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level	
64	**Data appear Lognormal at 10% Significance Level**			
65	**Note GOF tests may be unreliable for small sample sizes**			
66				
67	**Lognormal Statistics**			
68	Minimum of Logged Data	-0.994	Mean of logged Data	-0.872
69	Maximum of Logged Data	-0.799	SD of logged Data	0.0606
70				
71	**Assuming Lognormal Distribution**			
72	95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	0.446
73	95% Chebyshev (MVUE) UCL	0.458	97.5% Chebyshev (MVUE) UCL	0.475
74	99% Chebyshev (MVUE) UCL	0.508		
75				
76	**Nonparametric Distribution Free UCL Statistics**			
77	**Data appear to follow a Discernible Distribution**			
78				
79	**Nonparametric Distribution Free UCLs**			
80	95% CLT UCL	0.433	95% BCA Bootstrap UCL	0.429
81	95% Standard Bootstrap UCL	0.432	95% Bootstrap-t UCL	0.432
82	95% Hall's Bootstrap UCL	0.431	95% Percentile Bootstrap UCL	0.431
83	90% Chebyshev(Mean, Sd) UCL	0.445	95% Chebyshev(Mean, Sd) UCL	0.457
84	97.5% Chebyshev(Mean, Sd) UCL	0.473	99% Chebyshev(Mean, Sd) UCL	0.506
85				
86	**Suggested UCL to Use**			
87	95% Student's-t UCL	0.435		
88				
89	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
90	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.			
91	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
92				
93	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
94	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
95				

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:28:07 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

600 IA Chloromethane

General Statistics

Total Number of Observations	8	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	0.31	Mean	0.471
Maximum	0.65	Median	0.465
SD	0.162	Std. Error of Mean	0.0574
Coefficient of Variation	0.345	Skewness	0.0261

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,

refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,

but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).

The Chebyshev UCL often results in gross overestimates of the mean.

Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.739	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.308	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.58	95% Adjusted-CLT UCL (Chen-1995)	0.566
		95% Modified-t UCL (Johnson-1978)	0.58

Gamma GOF Test

A-D Test Statistic	1.134	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.716	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.319	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
47	**Gamma Statistics**											
48					k hat (MLE)	9.302					k star (bias corrected MLE)	5.897
49					Theta hat (MLE)	0.0507					Theta star (bias corrected MLE)	0.0799
50					nu hat (MLE)	148.8					nu star (bias corrected)	94.35
51					MLE Mean (bias corrected)	0.471					MLE Sd (bias corrected)	0.194
52											Approximate Chi Square Value (0.05)	72.95
53					Adjusted Level of Significance	0.0195					Adjusted Chi Square Value	68.2
54												
55	**Assuming Gamma Distribution**											
56					95% Approximate Gamma UCL	0.61					95% Adjusted Gamma UCL	0.652
57												
58	**Lognormal GOF Test**											
59					Shapiro Wilk Test Statistic	0.734	**Shapiro Wilk Lognormal GOF Test**					
60					10% Shapiro Wilk Critical Value	0.851	Data Not Lognormal at 10% Significance Level					
61					Lilliefors Test Statistic	0.301	**Lilliefors Lognormal GOF Test**					
62					10% Lilliefors Critical Value	0.265	Data Not Lognormal at 10% Significance Level					
63	**Data Not Lognormal at 10% Significance Level**											
64												
65	**Lognormal Statistics**											
66					Minimum of Logged Data	-1.171					Mean of logged Data	-0.807
67					Maximum of Logged Data	-0.431					SD of logged Data	0.357
68												
69	**Assuming Lognormal Distribution**											
70					95% H-UCL	0.634					90% Chebyshev (MVUE) UCL	0.651
71					95% Chebyshev (MVUE) UCL	0.732					97.5% Chebyshev (MVUE) UCL	0.845
72					99% Chebyshev (MVUE) UCL	1.067						
73												
74	**Nonparametric Distribution Free UCL Statistics**											
75	**Data appear to follow a Discernible Distribution**											
76												
77	**Nonparametric Distribution Free UCLs**											
78					95% CLT UCL	0.566					95% BCA Bootstrap UCL	0.553
79					95% Standard Bootstrap UCL	0.56					95% Bootstrap-t UCL	0.57
80					95% Hall's Bootstrap UCL	0.535					95% Percentile Bootstrap UCL	0.554
81					90% Chebyshev(Mean, Sd) UCL	0.644					95% Chebyshev(Mean, Sd) UCL	0.722
82					97.5% Chebyshev(Mean, Sd) UCL	0.83					99% Chebyshev(Mean, Sd) UCL	1.043
83												
84	**Suggested UCL to Use**											
85					95% Student's-t UCL	0.58						
86												
87	When a data set follows an approximate distribution passing only one of the GOF tests,											
88	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
89												
90	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
91	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
92	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
93												

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 2:29:00 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**600 IA Ethanol**			
11				
12	**General Statistics**			
13	Total Number of Observations	8	Number of Distinct Observations	8
14	Number of Detects	7	Number of Non-Detects	1
15	Number of Distinct Detects	7	Number of Distinct Non-Detects	1
16	Minimum Detect	1.6	Minimum Non-Detect	1.4
17	Maximum Detect	20	Maximum Non-Detect	1.4
18	Variance Detects	40.81	Percent Non-Detects	12.5%
19	Mean Detects	6.271	SD Detects	6.388
20	Median Detects	3.8	CV Detects	1.019
21	Skewness Detects	2.145	Kurtosis Detects	4.773
22	Mean of Logged Detects	1.507	SD of Logged Detects	0.822
23				
24	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**			
25	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**			
26	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**			
27	**The Chebyshev UCL often results in gross overestimates of the mean.**			
28	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**			
29				
30	**Normal GOF Test on Detects Only**			
31	Shapiro Wilk Test Statistic	0.715	**Shapiro Wilk GOF Test**	
32	1% Shapiro Wilk Critical Value	0.73	Detected Data Not Normal at 1% Significance Level	
33	Lilliefors Test Statistic	0.341	**Lilliefors GOF Test**	
34	1% Lilliefors Critical Value	0.35	Detected Data appear Normal at 1% Significance Level	
35	**Detected Data appear Approximate Normal at 1% Significance Level**			
36	**Note GOF tests may be unreliable for small sample sizes**			
37				
38	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
39	KM Mean	5.663	KM Standard Error of Mean	2.201
40	90KM SD	5.762	95% KM (BCA) UCL	9.538
41	95% KM (t) UCL	9.832	95% KM (Percentile Bootstrap) UCL	9.55
42	95% KM (z) UCL	9.282	95% KM Bootstrap t UCL	21.17
43	90% KM Chebyshev UCL	12.26	95% KM Chebyshev UCL	15.25
44	97.5% KM Chebyshev UCL	19.4	99% KM Chebyshev UCL	27.56
45				

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma GOF Tests on Detected Observations Only**											
47	A-D Test Statistic					0.52	**Anderson-Darling GOF Test**					
48	5% A-D Critical Value					0.719	Detected data appear Gamma Distributed at 5% Significance Level					
49	K-S Test Statistic					0.3	**Kolmogorov-Smirnov GOF**					
50	5% K-S Critical Value					0.316	Detected data appear Gamma Distributed at 5% Significance Level					
51	**Detected data appear Gamma Distributed at 5% Significance Level**											
52	**Note GOF tests may be unreliable for small sample sizes**											
53												
54	**Gamma Statistics on Detected Data Only**											
55	k hat (MLE)					1.669	k star (bias corrected MLE)					1.049
56	Theta hat (MLE)					3.757	Theta star (bias corrected MLE)					5.978
57	nu hat (MLE)					23.37	nu star (bias corrected)					14.69
58	Mean (detects)					6.271						
59												
60	**Gamma ROS Statistics using Imputed Non-Detects**											
61	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
62	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
63	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
64	This is especially true when the sample size is small.											
65	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
66	Minimum					0.01	Mean					5.489
67	Maximum					20	Median					3.75
68	SD					6.315	CV					1.151
69	k hat (MLE)					0.638	k star (bias corrected MLE)					0.482
70	Theta hat (MLE)					8.599	Theta star (bias corrected MLE)					11.38
71	nu hat (MLE)					10.21	nu star (bias corrected)					7.716
72	Adjusted Level of Significance (β)					0.0195						
73	Approximate Chi Square Value (7.72, α)					2.572	Adjusted Chi Square Value (7.72, β)					1.885
74	95% Gamma Approximate UCL					16.47	95% Gamma Adjusted UCL					22.47
75												
76	**Estimates of Gamma Parameters using KM Estimates**											
77	Mean (KM)					5.663	SD (KM)					5.762
78	Variance (KM)					33.2	SE of Mean (KM)					2.201
79	k hat (KM)					0.966	k star (KM)					0.687
80	nu hat (KM)					15.45	nu star (KM)					10.99
81	theta hat (KM)					5.864	theta star (KM)					8.244
82	80% gamma percentile (KM)					9.313	90% gamma percentile (KM)					14.28
83	95% gamma percentile (KM)					19.41	99% gamma percentile (KM)					31.67
84												
85	**Gamma Kaplan-Meier (KM) Statistics**											
86	Approximate Chi Square Value (10.99, α)					4.569	Adjusted Chi Square Value (10.99, β)					3.581
87	95% KM Approximate Gamma UCL					13.62	95% KM Adjusted Gamma UCL					17.38
88												

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.936	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.838	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.249	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.562	Mean in Log Scale	1.255
SD in Original Scale	6.245	SD in Log Scale	1.044
95% t UCL (assumes normality of ROS data)	9.746	95% Percentile Bootstrap UCL	9.462
95% BCA Bootstrap UCL	10.99	95% Bootstrap t UCL	19.63
95% H-UCL (Log ROS)	24.37		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.361	KM Geo Mean	3.9
KM SD (logged)	0.811	95% Critical H Value (KM-Log)	2.976
KM Standard Error of Mean (logged)	0.31	95% H-UCL (KM -Log)	13.48
KM SD (logged)	0.811	95% Critical H Value (KM-Log)	2.976
KM Standard Error of Mean (logged)	0.31		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	5.575	Mean in Log Scale	1.274
SD in Original Scale	6.234	SD in Log Scale	1.007
95% t UCL (Assumes normality)	9.751	95% H-Stat UCL	22.02

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL	9.832

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.

Please verify the data were collected from random locations.

If the data were collected using judgmental or other non-random methods,

then contact a statistician to correctly calculate UCLs.

When a data set follows an approximate distribution passing only one of the GOF tests,

it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

1	**UCL Statistics for Uncensored Full Data Sets**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 2:29:41 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	**600 IA Freon 11**			
12				
13	**General Statistics**			
14	Total Number of Observations	8	Number of Distinct Observations	3
15			Number of Missing Observations	0
16	Minimum	1.2	Mean	1.288
17	Maximum	1.4	Median	1.25
18	SD	0.0991	Std. Error of Mean	0.035
19	Coefficient of Variation	0.077	Skewness	0.312
20				
21	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**			
22	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**			
23	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**			
24	**The Chebyshev UCL often results in gross overestimates of the mean.**			
25	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**			
26				
27	**Normal GOF Test**			
28	Shapiro Wilk Test Statistic	0.735	**Shapiro Wilk GOF Test**	
29	1% Shapiro Wilk Critical Value	0.749	Data Not Normal at 1% Significance Level	
30	Lilliefors Test Statistic	0.311	**Lilliefors GOF Test**	
31	1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level	
32	**Data appear Approximate Normal at 1% Significance Level**			
33	**Note GOF tests may be unreliable for small sample sizes**			
34				
35	**Assuming Normal Distribution**			
36	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
37	95% Student's-t UCL	1.354	95% Adjusted-CLT UCL (Chen-1995)	1.349
38			95% Modified-t UCL (Johnson-1978)	1.355
39				
40	**Gamma GOF Test**			
41	A-D Test Statistic	1.061	**Anderson-Darling Gamma GOF Test**	
42	5% A-D Critical Value	0.715	Data Not Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.328	**Kolmogorov-Smirnov Gamma GOF Test**	
44	5% K-S Critical Value	0.294	Data Not Gamma Distributed at 5% Significance Level	
45	**Data Not Gamma Distributed at 5% Significance Level**			
46				

	A	B	C	D	E	F	G	H	I	J	K	L
47	**Gamma Statistics**											
48					k hat (MLE)	194.8					k star (bias corrected MLE)	121.8
49					Theta hat (MLE)	0.00661					Theta star (bias corrected MLE)	0.0106
50					nu hat (MLE)	3117					nu star (bias corrected)	1949
51					MLE Mean (bias corrected)	1.288					MLE Sd (bias corrected)	0.117
52											Approximate Chi Square Value (0.05)	1848
53					Adjusted Level of Significance	0.0195					Adjusted Chi Square Value	1823
54												
55	**Assuming Gamma Distribution**											
56					95% Approximate Gamma UCL	1.358					95% Adjusted Gamma UCL	1.377
57												
58	**Lognormal GOF Test**											
59					Shapiro Wilk Test Statistic	0.735	**Shapiro Wilk Lognormal GOF Test**					
60					10% Shapiro Wilk Critical Value	0.851	Data Not Lognormal at 10% Significance Level					
61					Lilliefors Test Statistic	0.312	**Lilliefors Lognormal GOF Test**					
62					10% Lilliefors Critical Value	0.265	Data Not Lognormal at 10% Significance Level					
63	**Data Not Lognormal at 10% Significance Level**											
64												
65	**Lognormal Statistics**											
66					Minimum of Logged Data	0.182					Mean of logged Data	0.25
67					Maximum of Logged Data	0.336					SD of logged Data	0.0764
68												
69	**Assuming Lognormal Distribution**											
70					95% H-UCL	N/A					90% Chebyshev (MVUE) UCL	1.392
71					95% Chebyshev (MVUE) UCL	1.439					97.5% Chebyshev (MVUE) UCL	1.505
72					99% Chebyshev (MVUE) UCL	1.634						
73												
74	**Nonparametric Distribution Free UCL Statistics**											
75	**Data appear to follow a Discernible Distribution**											
76												
77	**Nonparametric Distribution Free UCLs**											
78					95% CLT UCL	1.345					95% BCA Bootstrap UCL	N/A
79					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A
80					95% Hall's Bootstrap UCL	N/A					95% Percentile Bootstrap UCL	N/A
81					90% Chebyshev(Mean, Sd) UCL	1.393					95% Chebyshev(Mean, Sd) UCL	1.44
82					97.5% Chebyshev(Mean, Sd) UCL	1.506					99% Chebyshev(Mean, Sd) UCL	1.636
83												
84	**Suggested UCL to Use**											
85					95% Student's-t UCL	1.354						
86												
87	When a data set follows an approximate distribution passing only one of the GOF tests,											
88	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
89												
90	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
91	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
92	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
93												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:30:52 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

600 IA Freon 12

General Statistics

Total Number of Observations	8	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	2.2	Mean	2.288
Maximum	2.3	Median	2.3
SD	0.0354	Std. Error of Mean	0.0125
Coefficient of Variation	0.0155	Skewness	-2.828

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.419	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.513	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.311	95% Adjusted-CLT UCL (Chen-1995)	2.295
		95% Modified-t UCL (Johnson-1978)	2.309

Gamma GOF Test

A-D Test Statistic	2.504	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.522	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics**											
47					k hat (MLE)	4679					k star (bias corrected MLE)	2924
48					Theta hat (MLE)	4.8889E-4					Theta star (bias corrected MLE)	7.8221E-4
49					nu hat (MLE)	74863					nu star (bias corrected)	46791
50					MLE Mean (bias corrected)	2.288					MLE Sd (bias corrected)	0.0423
51											Approximate Chi Square Value (0.05)	46289
52					Adjusted Level of Significance	0.0195					Adjusted Chi Square Value	46161
53												
54	**Assuming Gamma Distribution**											
55					95% Approximate Gamma UCL	2.312					95% Adjusted Gamma UCL	2.319
56												
57	**Lognormal GOF Test**											
58					Shapiro Wilk Test Statistic	0.419	**Shapiro Wilk Lognormal GOF Test**					
59					10% Shapiro Wilk Critical Value	0.851	Data Not Lognormal at 10% Significance Level					
60					Lilliefors Test Statistic	0.513	**Lilliefors Lognormal GOF Test**					
61					10% Lilliefors Critical Value	0.265	Data Not Lognormal at 10% Significance Level					
62	**Data Not Lognormal at 10% Significance Level**											
63												
64	**Lognormal Statistics**											
65					Minimum of Logged Data	0.788					Mean of logged Data	0.827
66					Maximum of Logged Data	0.833					SD of logged Data	0.0157
67												
68	**Assuming Lognormal Distribution**											
69					95% H-UCL	N/A					90% Chebyshev (MVUE) UCL	2.326
70					95% Chebyshev (MVUE) UCL	2.343					97.5% Chebyshev (MVUE) UCL	2.367
71					99% Chebyshev (MVUE) UCL	2.414						
72												
73	**Nonparametric Distribution Free UCL Statistics**											
74	**Data do not follow a Discernible Distribution**											
75												
76	**Nonparametric Distribution Free UCLs**											
77					95% CLT UCL	2.308					95% BCA Bootstrap UCL	N/A
78					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A
79					95% Hall's Bootstrap UCL	N/A					95% Percentile Bootstrap UCL	N/A
80					90% Chebyshev(Mean, Sd) UCL	2.325					95% Chebyshev(Mean, Sd) UCL	2.342
81					97.5% Chebyshev(Mean, Sd) UCL	2.366					99% Chebyshev(Mean, Sd) UCL	2.412
82												
83	**Suggested UCL to Use**											
84					Recommendation cannot be provided							
85												
86	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
87	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
88	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
89												
90	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**											
91	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**											
92												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:30:17 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

600 IA Freon 113

General Statistics

Total Number of Observations	8	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	0.47	Mean	0.524
Maximum	0.59	Median	0.52
SD	0.0484	Std. Error of Mean	0.0171
Coefficient of Variation	0.0924	Skewness	0.158

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,

refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,

but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).

The Chebyshev UCL often results in gross overestimates of the mean.

Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.856	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.257	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.556	95% Adjusted-CLT UCL (Chen-1995)	0.553
		95% Modified-t UCL (Johnson-1978)	0.556

Gamma GOF Test

A-D Test Statistic	0.654	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.269	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Gamma Statistics**											
49					k hat (MLE)	134.4					k star (bias corrected MLE)	84.1
50					Theta hat (MLE)	0.0039					Theta star (bias corrected MLE)	0.00623
51					nu hat (MLE)	2151					nu star (bias corrected)	1346
52					MLE Mean (bias corrected)	0.524					MLE Sd (bias corrected)	0.0571
53											Approximate Chi Square Value (0.05)	1261
54					Adjusted Level of Significance	0.0195					Adjusted Chi Square Value	1241
55												
56	**Assuming Gamma Distribution**											
57					95% Approximate Gamma UCL	0.559					95% Adjusted Gamma UCL	0.568
58												
59	**Lognormal GOF Test**											
60					Shapiro Wilk Test Statistic	0.854	**Shapiro Wilk Lognormal GOF Test**					
61					10% Shapiro Wilk Critical Value	0.851	Data appear Lognormal at 10% Significance Level					
62					Lilliefors Test Statistic	0.252	**Lilliefors Lognormal GOF Test**					
63					10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level					
64	**Data appear Lognormal at 10% Significance Level**											
65	**Note GOF tests may be unreliable for small sample sizes**											
66												
67	**Lognormal Statistics**											
68					Minimum of Logged Data	-0.755					Mean of logged Data	-0.65
69					Maximum of Logged Data	-0.528					SD of logged Data	0.0922
70												
71	**Assuming Lognormal Distribution**											
72					95% H-UCL	N/A					90% Chebyshev (MVUE) UCL	0.575
73					95% Chebyshev (MVUE) UCL	0.598					97.5% Chebyshev (MVUE) UCL	0.63
74					99% Chebyshev (MVUE) UCL	0.694						
75												
76	**Nonparametric Distribution Free UCL Statistics**											
77	**Data appear to follow a Discernible Distribution**											
78												
79	**Nonparametric Distribution Free UCLs**											
80					95% CLT UCL	0.552					95% BCA Bootstrap UCL	0.549
81					95% Standard Bootstrap UCL	0.55					95% Bootstrap-t UCL	0.558
82					95% Hall's Bootstrap UCL	0.545					95% Percentile Bootstrap UCL	0.55
83					90% Chebyshev(Mean, Sd) UCL	0.575					95% Chebyshev(Mean, Sd) UCL	0.598
84					97.5% Chebyshev(Mean, Sd) UCL	0.631					99% Chebyshev(Mean, Sd) UCL	0.694
85												
86	**Suggested UCL to Use**											
87					95% Student's-t UCL	0.556						
88												
89	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
90	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
91	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
92												

1	**UCL Statistics for Uncensored Full Data Sets**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 2:31:55 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	**600 ResSoil Thallium**			
12				
13	**General Statistics**			
14	Total Number of Observations	15	Number of Distinct Observations	15
15			Number of Missing Observations	0
16	Minimum	0.2	Mean	4.18
17	Maximum	7.6	Median	4.6
18	SD	2.215	Std. Error of Mean	0.572
19	Coefficient of Variation	0.53	Skewness	-0.132
20				
21	**Normal GOF Test**			
22	Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk GOF Test**	
23	1% Shapiro Wilk Critical Value	0.835	Data appear Normal at 1% Significance Level	
24	Lilliefors Test Statistic	0.148	**Lilliefors GOF Test**	
25	1% Lilliefors Critical Value	0.255	Data appear Normal at 1% Significance Level	
26	**Data appear Normal at 1% Significance Level**			
27				
28	**Assuming Normal Distribution**			
29	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
30	95% Student's-t UCL	5.188	95% Adjusted-CLT UCL (Chen-1995)	5.1
31			95% Modified-t UCL (Johnson-1978)	5.184
32				
33	**Gamma GOF Test**			
34	A-D Test Statistic	0.594	**Anderson-Darling Gamma GOF Test**	
35	5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level	
36	K-S Test Statistic	0.193	**Kolmogorov-Smirnov Gamma GOF Test**	
37	5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance Level	
38	**Detected data appear Gamma Distributed at 5% Significance Level**			
39				
40	**Gamma Statistics**			
41	k hat (MLE)	2.193	k star (bias corrected MLE)	1.798
42	Theta hat (MLE)	1.906	Theta star (bias corrected MLE)	2.324
43	nu hat (MLE)	65.78	nu star (bias corrected)	53.95
44	MLE Mean (bias corrected)	4.18	MLE Sd (bias corrected)	3.117
45			Approximate Chi Square Value (0.05)	38.08
46	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	36.44
47				

<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>H</th><th>I</th><th>J</th><th>K</th><th>L</th></tr>
<tr><td>48</td><td colspan="12">Assuming Gamma Distribution</td></tr>
<tr><td>49</td><td colspan="5">95% Approximate Gamma UCL</td><td>5.923</td><td colspan="5">95% Adjusted Gamma UCL</td><td>6.189</td></tr>
<tr><td>50</td><td colspan="12"></td></tr>
<tr><td>51</td><td colspan="12">Lognormal GOF Test</td></tr>
<tr><td>52</td><td colspan="5">Shapiro Wilk Test Statistic</td><td>0.774</td><td colspan="6">Shapiro Wilk Lognormal GOF Test</td></tr>
<tr><td>53</td><td colspan="5">10% Shapiro Wilk Critical Value</td><td>0.901</td><td colspan="6">Data Not Lognormal at 10% Significance Level</td></tr>
<tr><td>54</td><td colspan="5">Lilliefors Test Statistic</td><td>0.207</td><td colspan="6">Lilliefors Lognormal GOF Test</td></tr>
<tr><td>55</td><td colspan="5">10% Lilliefors Critical Value</td><td>0.202</td><td colspan="6">Data Not Lognormal at 10% Significance Level</td></tr>
<tr><td>56</td><td colspan="12">Data Not Lognormal at 10% Significance Level</td></tr>
<tr><td>57</td><td colspan="12"></td></tr>
<tr><td>58</td><td colspan="12">Lognormal Statistics</td></tr>
<tr><td>59</td><td colspan="5">Minimum of Logged Data</td><td>-1.609</td><td colspan="5">Mean of logged Data</td><td>1.185</td></tr>
<tr><td>60</td><td colspan="5">Maximum of Logged Data</td><td>2.028</td><td colspan="5">SD of logged Data</td><td>0.919</td></tr>
<tr><td>61</td><td colspan="12"></td></tr>
<tr><td>62</td><td colspan="12">Assuming Lognormal Distribution</td></tr>
<tr><td>63</td><td colspan="5">95% H-UCL</td><td>9.483</td><td colspan="5">90% Chebyshev (MVUE) UCL</td><td>8.506</td></tr>
<tr><td>64</td><td colspan="5">95% Chebyshev (MVUE) UCL</td><td>10.18</td><td colspan="5">97.5% Chebyshev (MVUE) UCL</td><td>12.51</td></tr>
<tr><td>65</td><td colspan="5">99% Chebyshev (MVUE) UCL</td><td>17.08</td><td colspan="5"></td><td></td></tr>
<tr><td>66</td><td colspan="12"></td></tr>
<tr><td>67</td><td colspan="12">Nonparametric Distribution Free UCL Statistics</td></tr>
<tr><td>68</td><td colspan="12">Data appear to follow a Discernible Distribution</td></tr>
<tr><td>69</td><td colspan="12"></td></tr>
<tr><td>70</td><td colspan="12">Nonparametric Distribution Free UCLs</td></tr>
<tr><td>71</td><td colspan="5">95% CLT UCL</td><td>5.121</td><td colspan="5">95% BCA Bootstrap UCL</td><td>5.043</td></tr>
<tr><td>72</td><td colspan="5">95% Standard Bootstrap UCL</td><td>5.106</td><td colspan="5">95% Bootstrap-t UCL</td><td>5.144</td></tr>
<tr><td>73</td><td colspan="5">95% Hall's Bootstrap UCL</td><td>5.057</td><td colspan="5">95% Percentile Bootstrap UCL</td><td>5.113</td></tr>
<tr><td>74</td><td colspan="5">90% Chebyshev(Mean, Sd) UCL</td><td>5.896</td><td colspan="5">95% Chebyshev(Mean, Sd) UCL</td><td>6.673</td></tr>
<tr><td>75</td><td colspan="5">97.5% Chebyshev(Mean, Sd) UCL</td><td>7.752</td><td colspan="5">99% Chebyshev(Mean, Sd) UCL</td><td>9.872</td></tr>
<tr><td>76</td><td colspan="12"></td></tr>
<tr><td>77</td><td colspan="12">Suggested UCL to Use</td></tr>
<tr><td>78</td><td colspan="5">95% Student's-t UCL</td><td>5.188</td><td colspan="5"></td><td></td></tr>
<tr><td>79</td><td colspan="12"></td></tr>
<tr><td>80</td><td colspan="12">Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.</td></tr>
<tr><td>81</td><td colspan="12">Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.</td></tr>
<tr><td>82</td><td colspan="12">However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.</td></tr>
<tr><td>83</td><td colspan="12"></td></tr>
<tr><td>84</td><td colspan="12">Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be</td></tr>
<tr><td>85</td><td colspan="12">reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.</td></tr>
<tr><td>86</td><td colspan="12"></td></tr>
</table>

1	**UCL Statistics for Uncensored Full Data Sets**			
2				
3	User Selected Options			
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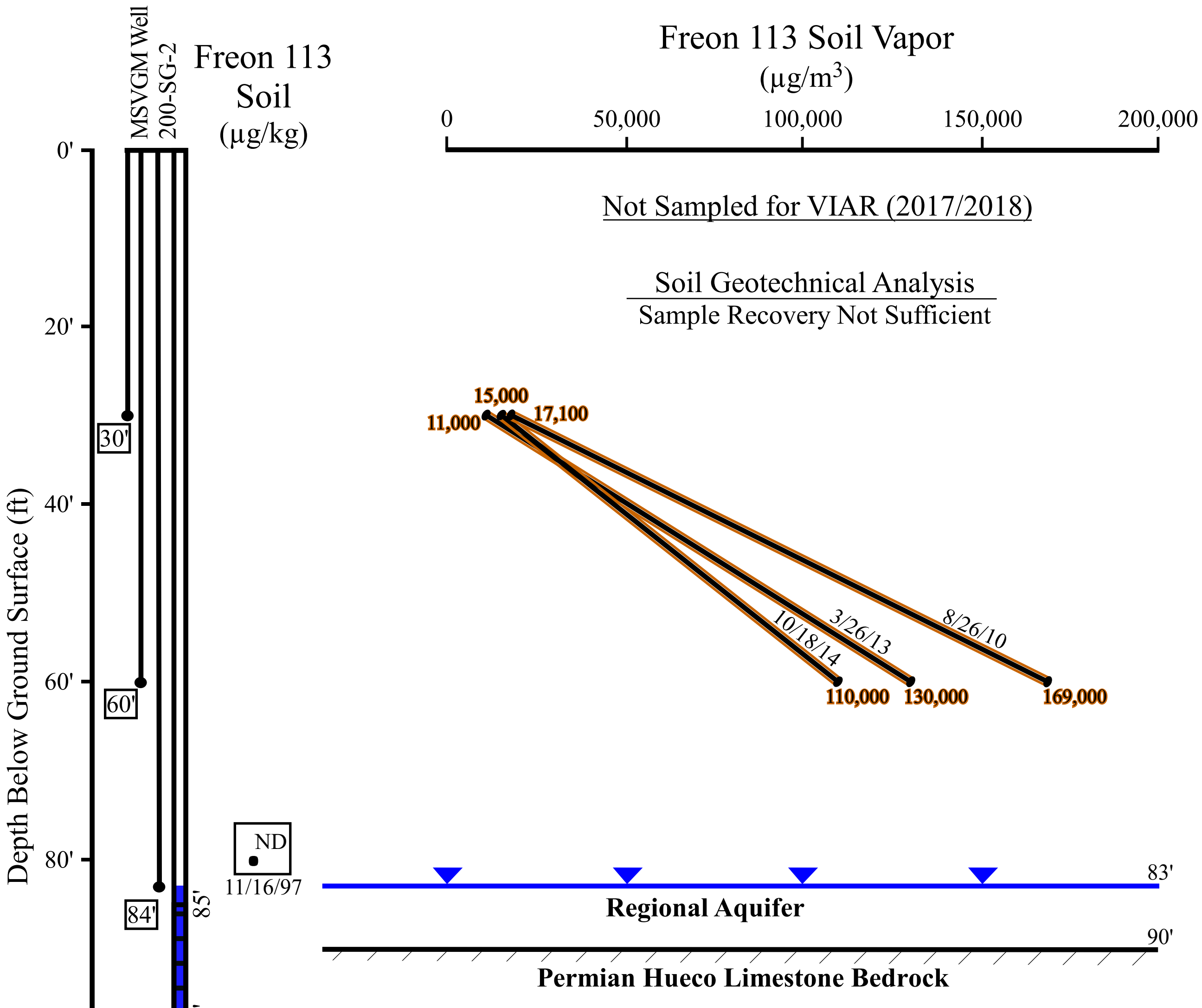
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	**600 ResSoil Tin**			
12				
13	**General Statistics**			
14	Total Number of Observations	15	Number of Distinct Observations	6
15			Number of Missing Observations	0
16	Minimum	3	Mean	6.2
17	Maximum	10	Median	6
18	SD	2.242	Std. Error of Mean	0.579
19	Coefficient of Variation	0.362	Skewness	0.151
20				
21	**Normal GOF Test**			
22	Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk GOF Test**	
23	1% Shapiro Wilk Critical Value	0.835	Data appear Normal at 1% Significance Level	
24	Lilliefors Test Statistic	0.136	**Lilliefors GOF Test**	
25	1% Lilliefors Critical Value	0.255	Data appear Normal at 1% Significance Level	
26	**Data appear Normal at 1% Significance Level**			
27				
28	**Assuming Normal Distribution**			
29	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
30	95% Student's-t UCL	7.22	95% Adjusted-CLT UCL (Chen-1995)	7.176
31			95% Modified-t UCL (Johnson-1978)	7.224
32				
33	**Gamma GOF Test**			
34	A-D Test Statistic	0.518	**Anderson-Darling Gamma GOF Test**	
35	5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level	
36	K-S Test Statistic	0.18	**Kolmogorov-Smirnov Gamma GOF Test**	
37	5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance Level	
38	**Detected data appear Gamma Distributed at 5% Significance Level**			
39				
40	**Gamma Statistics**			
41	k hat (MLE)	7.44	k star (bias corrected MLE)	5.996
42	Theta hat (MLE)	0.833	Theta star (bias corrected MLE)	1.034
43	nu hat (MLE)	223.2	nu star (bias corrected)	179.9
44	MLE Mean (bias corrected)	6.2	MLE Sd (bias corrected)	2.532
45			Approximate Chi Square Value (0.05)	149.9
46	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	146.5
47				

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Assuming Gamma Distribution**											
49	95% Approximate Gamma UCL					7.442	95% Adjusted Gamma UCL					7.613
50												
51	**Lognormal GOF Test**											
52	Shapiro Wilk Test Statistic					0.894	**Shapiro Wilk Lognormal GOF Test**					
53	10% Shapiro Wilk Critical Value					0.901	Data Not Lognormal at 10% Significance Level					
54	Lilliefors Test Statistic					0.203	**Lilliefors Lognormal GOF Test**					
55	10% Lilliefors Critical Value					0.202	Data Not Lognormal at 10% Significance Level					
56	**Data Not Lognormal at 10% Significance Level**											
57												
58	**Lognormal Statistics**											
59	Minimum of Logged Data					1.099	Mean of logged Data					1.756
60	Maximum of Logged Data					2.303	SD of logged Data					0.399
61												
62	**Assuming Lognormal Distribution**											
63	95% H-UCL					7.727	90% Chebyshev (MVUE) UCL					8.193
64	95% Chebyshev (MVUE) UCL					9.081	97.5% Chebyshev (MVUE) UCL					10.31
65	99% Chebyshev (MVUE) UCL					12.74						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution**											
69												
70	**Nonparametric Distribution Free UCLs**											
71	95% CLT UCL					7.152	95% BCA Bootstrap UCL					7
72	95% Standard Bootstrap UCL					7.134	95% Bootstrap-t UCL					7.297
73	95% Hall's Bootstrap UCL					7.258	95% Percentile Bootstrap UCL					7.133
74	90% Chebyshev(Mean, Sd) UCL					7.937	95% Chebyshev(Mean, Sd) UCL					8.724
75	97.5% Chebyshev(Mean, Sd) UCL					9.816	99% Chebyshev(Mean, Sd) UCL					11.96
76												
77	**Suggested UCL to Use**											
78	95% Student's-t UCL					7.22						
79												
80	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
81	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
82	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
83												

Appendix E
Soil Vapor Vertical Concentration Profiles

MSVGM Well 200-SG-2 Vertical Concentration Profile For Freon 113

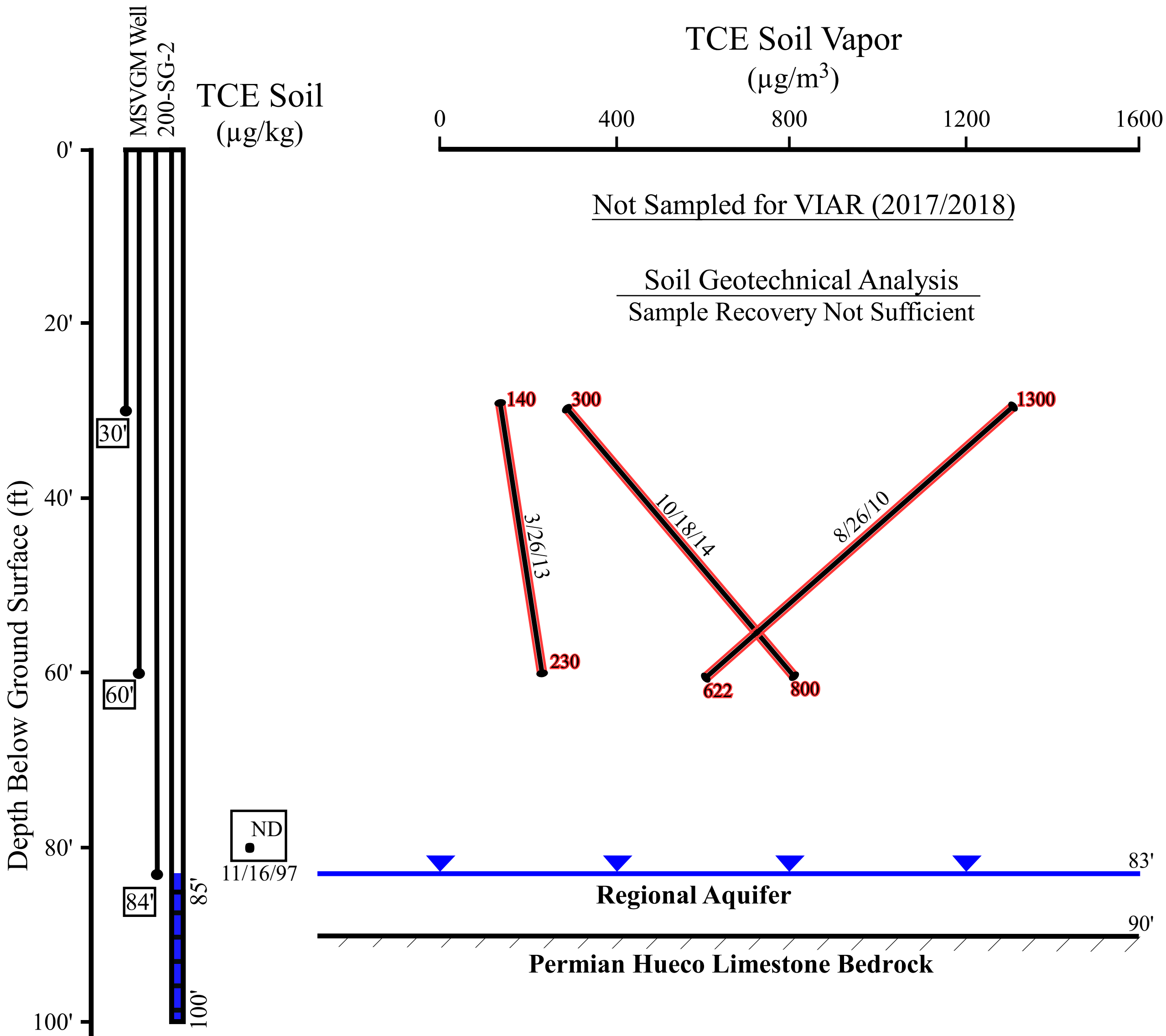


Freon 113 Groundwater

Soil Vapor Event	Groundwater Event	Freon 113 Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m^3)
8/26/2010	8/30/2010	180	3,888,000
3/26/2013	4/10/2013	150	3,240,000
10/8/2014	10/22/2014	120	2,592,000

Note:
ND - Freon 113 soil < 11.0 µg/kg

MSVGM Well 200-SG-2 Vertical Concentration Profile For TCE

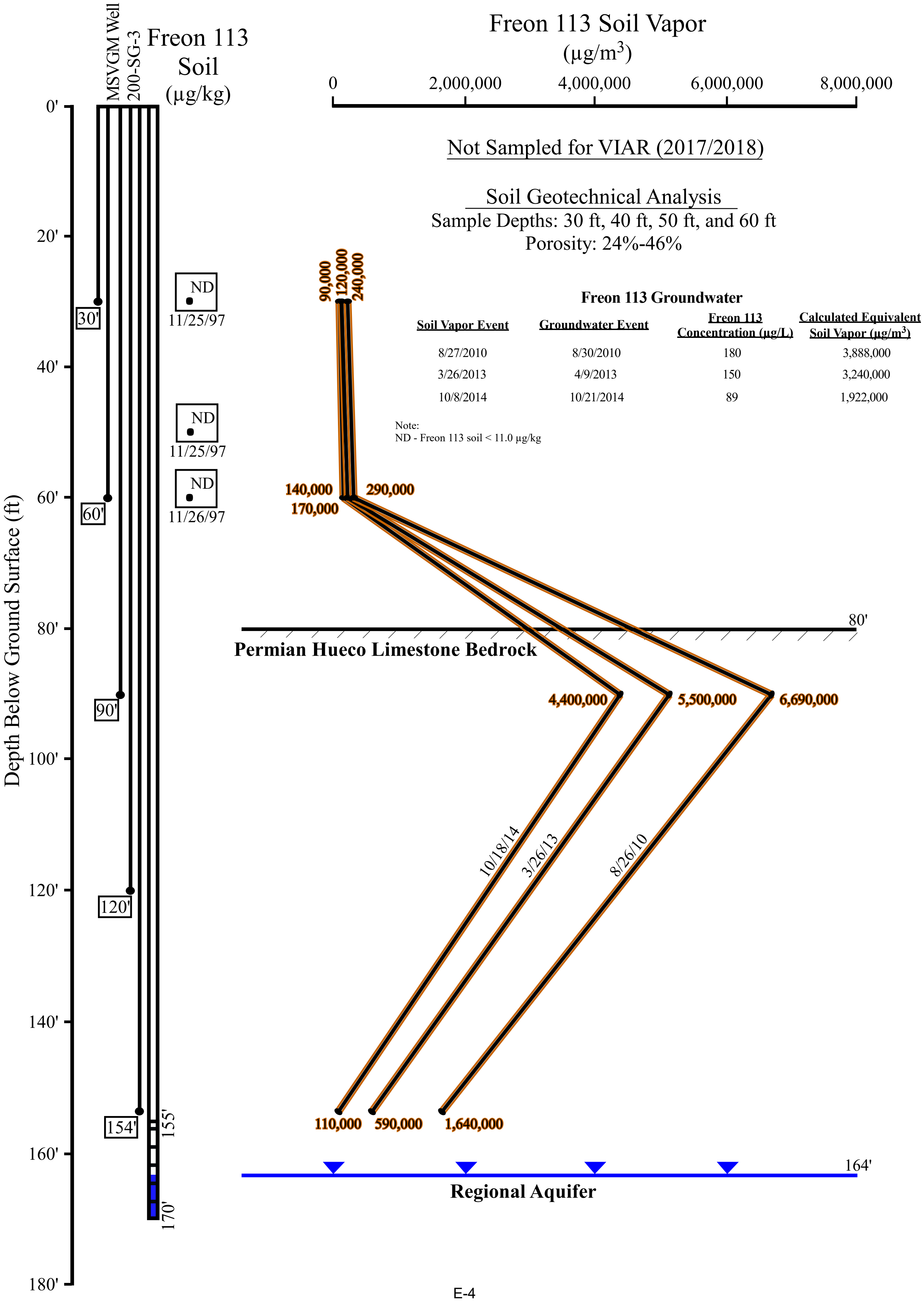


TCE Groundwater

Soil Vapor Event	Groundwater Event	TCE Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m³)
8/26/2010	8/30/2010	1.6	646
3/26/2013	4/10/2013	1.6	646
10/8/2014	10/22/2014	1.2	485

Note:
ND - TCE soil < 5.2 µg/kg

MSVGM Well 200-SG-3 Vertical Concentration Profile For Freon 113



Not Sampled for VIAR (2017/2018)

Soil Geotechnical Analysis

Sample Depths: 30 ft, 40 ft, 50 ft, and 60 ft

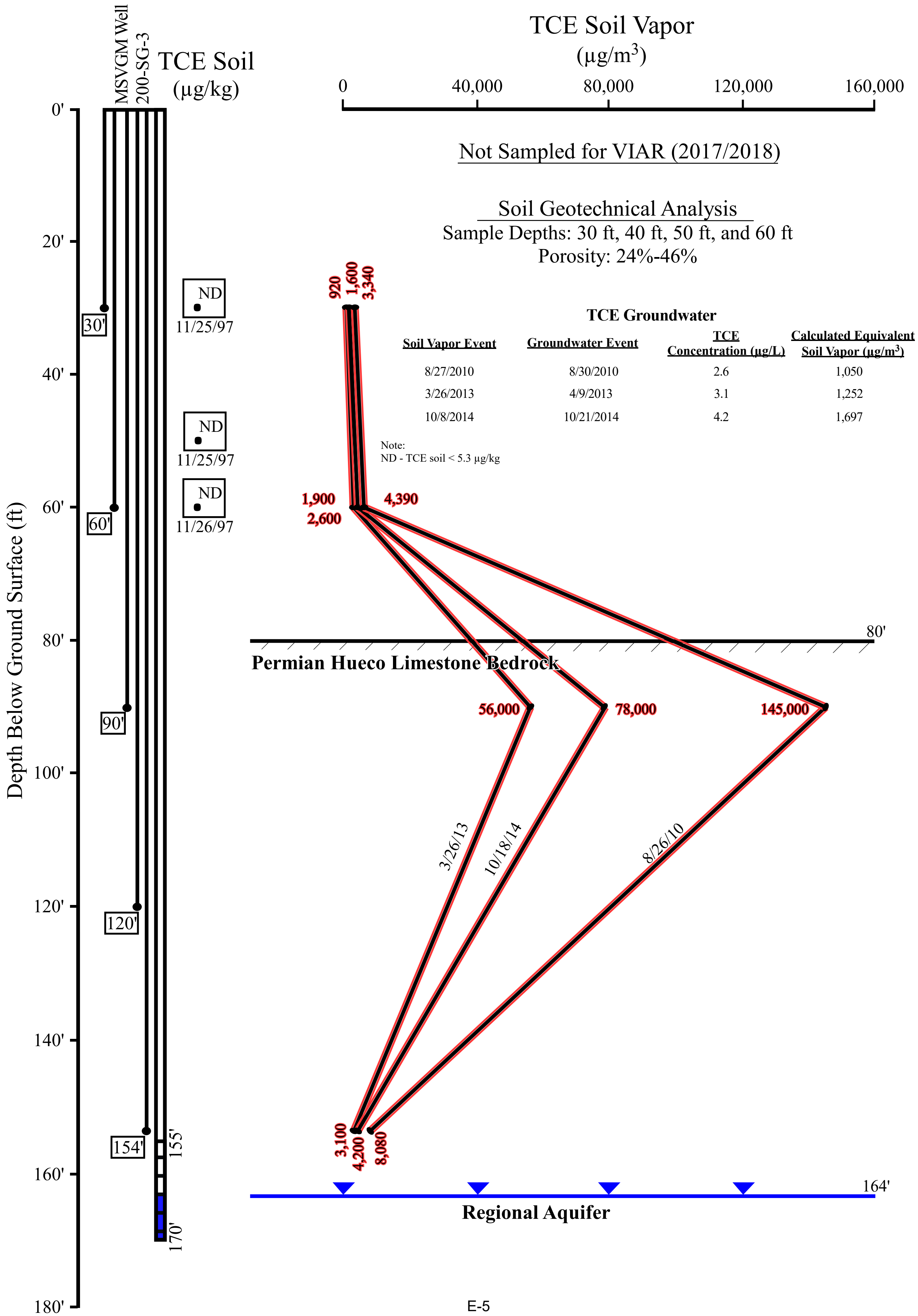
Porosity: 24%-46%

Freon 113 Groundwater

Soil Vapor Event	Groundwater Event	Freon 113 Concentration (µg/L)	Calculated Equivalent Soil Vapor ($\mu g/m^3$)
8/27/2010	8/30/2010	180	3,888,000
3/26/2013	4/9/2013	150	3,240,000
10/8/2014	10/21/2014	89	1,922,000

Note:
ND - Freon 113 soil < 11.0 µg/kg

MSVGM Well 200-SG-3 Vertical Concentration Profile For TCE

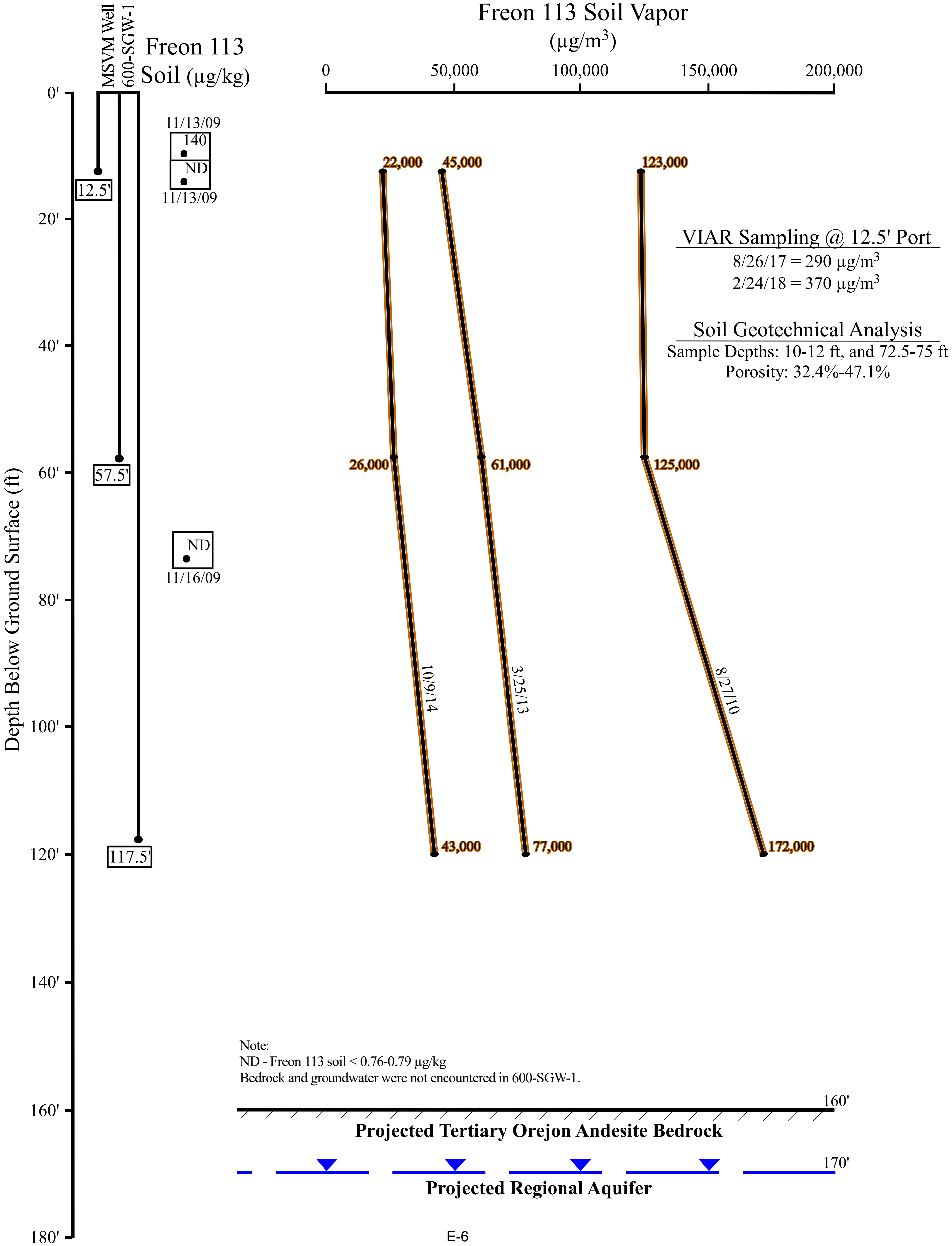


TCE Groundwater

Soil Vapor Event	Groundwater Event	TCE Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m³)
8/27/2010	8/30/2010	2.6	1,050
3/26/2013	4/9/2013	3.1	1,252
10/8/2014	10/21/2014	4.2	1,697

Note:
ND - TCE soil < 5.3 µg/kg

MSVM Well 600-SGW-1 Vertical Concentration Profile For Freon 113



VIAR Sampling @ 12.5' Port

8/26/17 = 290 μg/m³

2/24/18 = 370 μg/m³

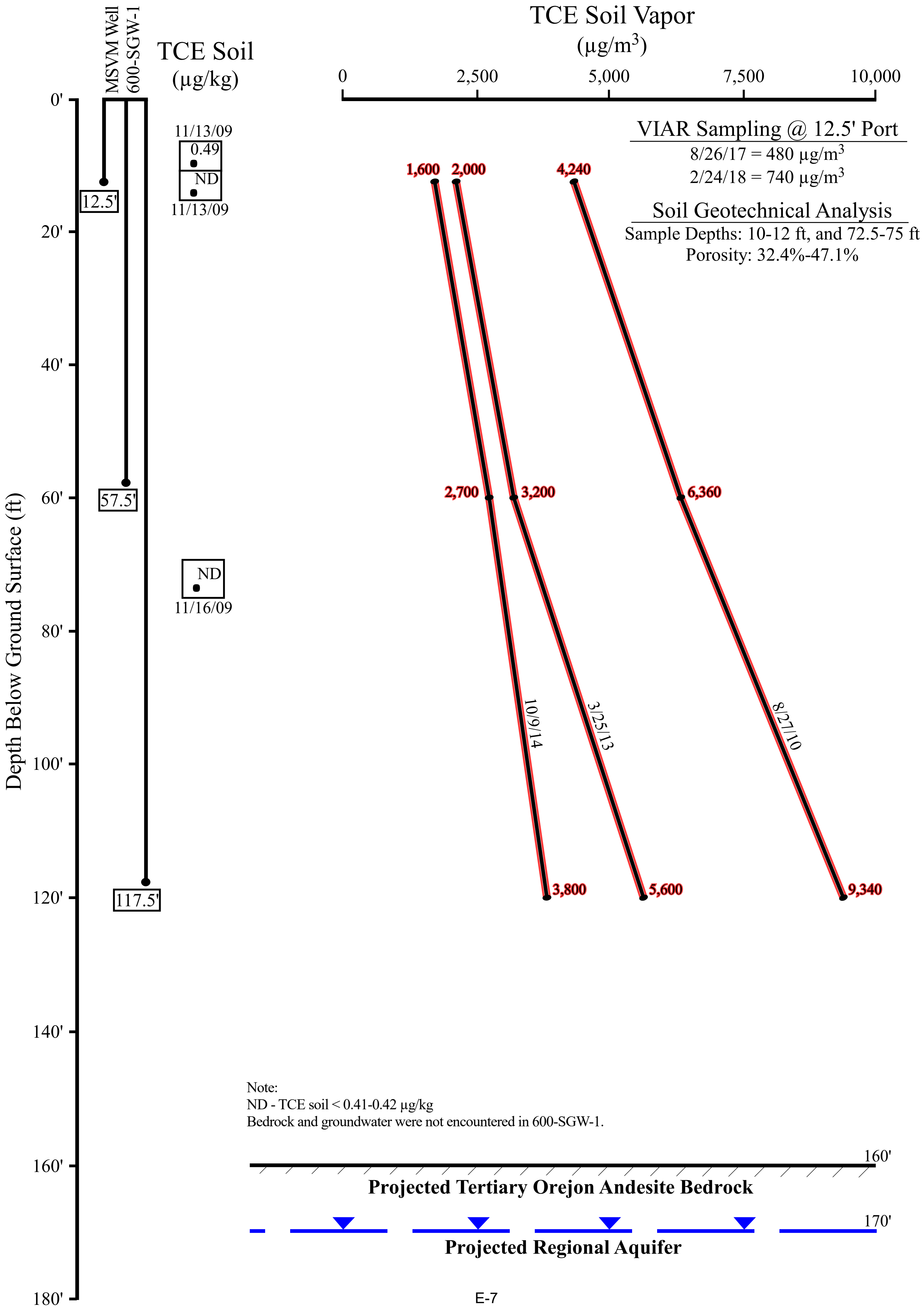
Soil Geotechnical Analysis

Sample Depths: 10-12 ft, and 72.5-75 ft

Porosity: 32.4%-47.1%

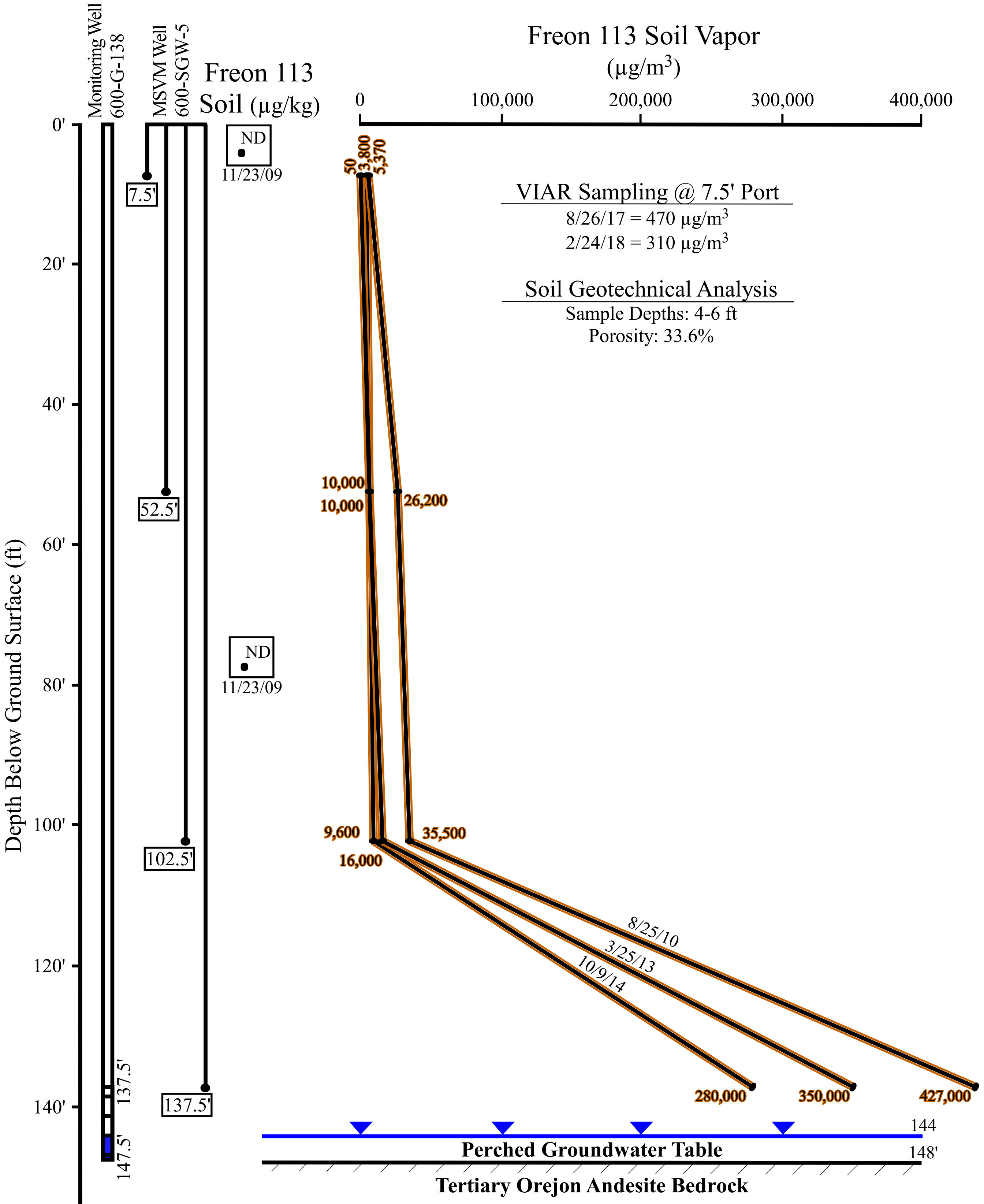
Note:
ND - Freon 113 soil < 0.76-0.79 μg/kg
Bedrock and groundwater were not encountered in 600-SGW-1.

MSVM Well 600-SGW-1 Vertical Concentration Profile For TCE



Note:
ND - TCE soil < 0.41-0.42 µg/kg
Bedrock and groundwater were not encountered in 600-SGW-1.

MSVM Well 600-SGW-5 Vertical Concentration Profile For Freon 113



VIAR Sampling @ 7.5' Port

8/26/17 = 470 µg/m³
2/24/18 = 310 µg/m³

Soil Geotechnical Analysis

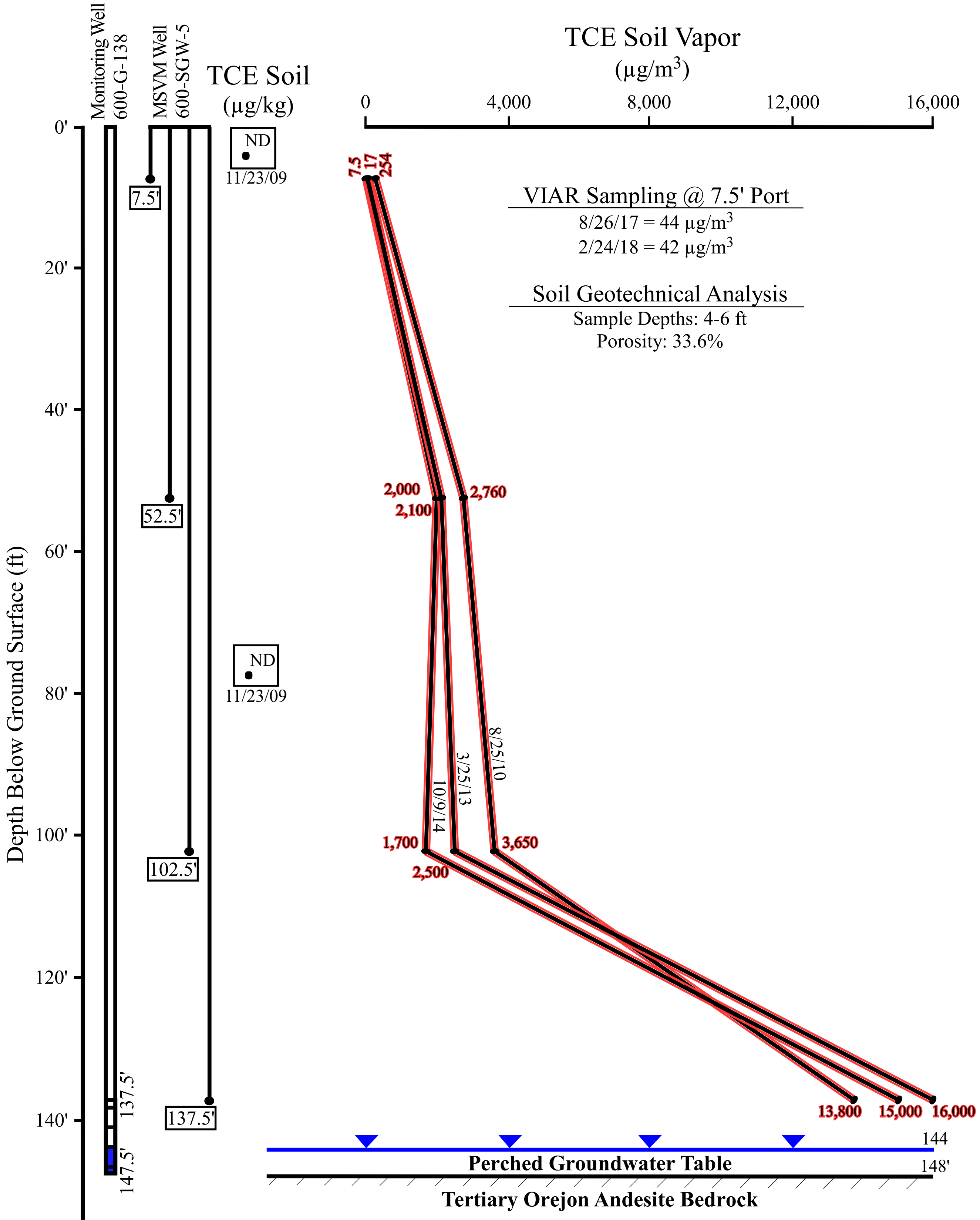
Sample Depths: 4-6 ft
Porosity: 33.6%

Freon 113 Groundwater

Soil Vapor Event	Groundwater Event	Freon 113 Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m³)
8/25/2010	12/21/2009	15	324,000
3/25/2013	12/11/2012	46	993,000
10/9/2014	11/20/2014	13	280,800

Note:
ND - Freon 113 oil < 0.65-0.71 µg/kg

MSVGM Well 600-SGW-5 Vertical Concentration Profile For TCE



VIAR Sampling @ 7.5' Port

8/26/17 = 44 µg/m³

2/24/18 = 42 µg/m³

Soil Geotechnical Analysis

Sample Depths: 4-6 ft

Porosity: 33.6%

TCE Groundwater

Soil Vapor Event	Groundwater Event	TCE Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m³)
8/25/2010	12/21/2009	86	34,000
3/25/2013	12/11/2012	110	44,440
10/9/2014	11/20/2014	65	26,260

Note:
ND - TCE soil < 0.35-0.35 µg/kg

Comments for Second Disapproval of the 200 Area and 600 Area Vapor Intrusion Assessment Report

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
1. Section 4.10, Data Assessment and Review, Pages 27 and 28	**NMED Comment:** The section only addresses the steps used for the project data assessment and usability review. Revise the section to discuss the data usability assessment results. Include data usability reports and sample analysis data reports for the August 2017 and February 2018 sampling events provided as Report Enclosure 3 as additional appendices in the revised Report. Revise the Report accordingly.	A Quality Assurance Report has been prepared for soil vapor data (August 2017 and February 2018) used in this response and is included as Appendix C. A separate QA report for previously submitted soil data is also included in Appendix C.
2. Section 6.0, Screening Level Risk Assessment and Evaluation Lines of Evidence, Pages 32 through 42	**NMED Comment:** The following project risk assessment issues must be addressed in the revised Report as follows: a. Review of the 200 and 600 Area risk screen evaluations indicate that only residential exposure was evaluated, and the risk assessments are incomplete. Additionally, it was noted that if a chemical exhibited both carcinogenic and noncarcinogenic toxicity, only the most conservative screening criteria were used to evaluate risk for a detected chemical of concern (COC) for the vapor intrusion risk screen evaluations. NMED's June 2022 *Risk Assessment Guidance for Site Investigations and Remediation* (RA Guidance), Section 5.0, Use of the SSLs [soil screening levels], specifies that if a chemical exhibits both carcinogenic and noncarcinogenic toxicity, impact based on both forms of toxicity must be evaluated. This requirement applies to risk assessments for vapor intrusion. As an example, Section 6.1.1.1, and Table 6.1, 200 Area Soil Vapor: Residential Cumulative Cancer Risk Assessment data, indicate that benzene was the only carcinogen detected in soil vapor at the 200 Area; this is not accurate. RA Guidance Table A-4, NMED Vapor Intrusion Screening Levels (VISLs), has been updated to include cancer and non-cancer VISLs that must be used to evaluate site risk and hazard for the	All risk and hazard were re-evaluated using the most recent version of ProUCL (Version 5.2). As a result of re-evaluating all risk and hazard using ProUCL version 5.2, four inorganic constituents (cobalt, manganese, molybdenum, and magnesium) were determined to be no more than background and were not carried forward in the evaluation. Dioxins and furan calculations were updated to remove total concentrations as directed by NMED for previous risk and hazard submittals. Per NMED guidance (NMED, 2022c), Section 2.1, only individual congeners should be evaluated to calculate toxicity equivalents. Updated TEQ calculations are provided in Appendix D. Permit citations were also updated to reflect the new NASA WSTF Permit issued in March 2023. a. All vapor risk and hazard has been revised to include both carcinogenic and noncarcinogenic toxicity per the November 2022 NMED RA Guidance, Appendix A-4.

Comments for Second Disapproval of the 200 Area and 600 Area Vapor Intrusion Assessment Report

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
	COCs detected in soil vapor and indoor air samples from the 200 and 600 Areas. The Report must be revised to address these issues.	
	b. ProUCL output files provided in Appendix C, UCL95 Results for Cumulative Risk Assessment, indicate that insufficient data observations were used to derive 95% upper confidence levels (95UCLs) for various contaminants of concern detected in soil vapor and indoor air samples. As an example, Table 6.2, 200 Area Soil Vapor Residential Cumulative Hazard Assessment, lists a 95UCL for trichloroethylene (TCE) as 3.8E+05 µg/ m3. Appendix C ProUCL output files lists six observations for the reported 95UCL. NMED's review has identified only four valid data points unless duplicate sample data is included, and the data set does not appear to be appropriate for 95UCL calculation. Additionally, RA Guidance, Section 2.8.3, Identification of COPCs [contaminants of potential concern], specifies that the maximum detected concentration between the parent and duplicate sample must be applied as the sample result. To further clarify, only the maximum detected concentration between the parent and duplicate samples must be used as an input value in ProUCL calculations. The revised Report must discuss how duplicate sample results were used in the risk assessments. Revise the Report accordingly.	b. All input data files were revised to include only the maximum investigation concentration between the original sample and any duplicate for that sample. Only constituents containing 5 or more detections were used for statistical evaluation. To be conservative, background data sets include the minimum concentration between the original sample and any duplicate for that sample.
	c. For appropriate UCL calculation, RA Guidance Section 2.8.4.1, Discrete Data, specifies that the minimum requirements for calculating UCLs are: 1) each data set must contain at least eight samples (i.e., n ≥ 8) for the analyte being evaluated; and 2) there	c. For both the 200 Area and the 600 Area soil vapor risk and hazard screening, there were not enough samples collected during the investigation to perform reliable statistical calculations. A minimum sample size of eight is required, and only three wells at two times a year for a total of six

Comments for Second Disapproval of the 200 Area and 600 Area Vapor Intrusion Assessment Report

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
	must be a minimum of five detections (i.e., ≥ 5 detected observations) for the analyte being evaluated. Although it is possible to calculate UCLs with small datasets (i.e., n ≤ 8) and low frequencies of detection (i.e., < 5 detected observations), these estimates are not considered reliable and representative enough to make defensible decisions. Therefore, UCLs must only be calculated for data sets that meet the RA Guidance minimum requirements. Alternatively, for datasets with less than four detects or datasets with less than 10 samples and a low level of detection (less than 10%), the median concentration may be used as the exposure point concentration (EPC). Risk screen evaluation with refined EPCs derived from data sets that do not conform to RA Guidance specifications must not be used for risk assessment. The Report must be revised to resolve the identified issues with various refined EPCs used for the 200 and 600 Area risk screen evaluations.	samples per constituent were collected for this 200/600 VIAR investigation. As a result, no UCL95 calculations could be performed, since there were not enough samples for the recommended minimum sample size to perform reliable statistics. Therefore, only maximum concentrations were used for soil vapor screenings.
	d. Section 6.1.1.1, 200 Area Screening Risk Assessment, addresses the use of bias- corrected and accelerated (BCA) bootstrap 95UCL for 1,1-dichloroethene due to the ProUCL recommended 95UCL being greater than the maximum detected concentration for the COC; however, sufficient data to calculate a BCA bootstrap 95UCL was not provided. To clarify, October 2015 *ProUCL Version 5.1.00 Technical Guide,* Section 1.7, Minimum Sample Size Requirements and Power Evaluations, recommends that bootstrap methods must not be used for small data sets with less than 15-20 data point observations. The datasets used for the calculation of 95UCLs in the Report for various COCs including 1,1-dichloroethene appear to contain only	d. No bootstrap UCLs were used for this revised risk screening. The UCL95 was not recalculated for 1,1-dichloroethene due to insufficient sample size to perform reliable statistics (<8). Therefore, the maximum concentration was used for risk and hazard screening.

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
	four valid data point observations; therefore, use of BCA bootstrap methods are not appropriate. To address this issue, either the maximum detected concentration for a contaminant of concern must be retained as the EPC, or if data of sufficient type and integrity are available, the median may potentially be used as an EPC. Revise the Report to address this issue accordingly. e. An additional concern with deriving 95UCLs for use as refined soil vapor and indoor air EPCs is that maximum detected concentrations were from either the 2017 or 2018 sampling event. Based on this observation, it is inferred that historical data used to derive UCLs were of lower concentrations (to mitigate the maximum concentration) and that there is an increasing trend in concentration. However, using historical data to mitigate increasing concentrations with time is not representative of current or future exposure. An EPC must represent a reasonable maximum exposure (RME) while also being representative of current and future receptors. In addition, the EPC must factor in temporal variations between seasons. Using the data from the two current sampling events summarized in Tables 5.1 and 5.2 will accomplish these tasks. However, refined EPCs appear to have been derived using additional data, which were either data from an unspecified prior investigation or included the use of duplicate sample results as standalone data points. Depending on the historical trend of the data used, the revised EPCs are likely underestimated and not representative of the RME. If data from years other than 2017 and 2018 were used, a clear discussion of the trend in the data	e. The data obtained for this investigation was limited to air/vapor in 2017 and 2018. No historical or additional data was used in establishing UCL95s/EPCs for soil vapor and indoor air. However, duplicate data was inadvertently included in the risk ProUCL files. The input files have been revised to exclude duplicate data and only include the maximum concentration between the samples and duplicates. Additional (historical) data was used in the risk work for soils. In Comment 1 of the first disapproval of the 200 and 600 Area VIAR (NMED, 2019), NMED required NASA to perform a cumulative vapor intrusion risk screening evaluation. In addition, NMED required NASA to assess the results of the soil vapor risk screen evaluation with results of a cumulative soil risk screen evaluation. However, since no soil data was collected as part of the vapor intrusion field work, additional data collected prior to 2017 had to be used for soil risk screening. The soil data used was collected under NMED-approved work plans (*200 Area Investigation - Phase II Investigation Work Plan* [NASA, 2013a] and *NASA Response to*

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
	for soil vapor, outdoor air, and indoor air must be included in the revised Report to address the representativeness of the data for evaluating current and future site risk. Additionally, a clear explanation of where the additional data was sourced must be provided and the data tabulated in an additional Excel spreadsheet to be included in an appropriate enclosure to the revised Report. If the additional data was not collected under an NMED-approved work plan, included in an NMED-approved report, and in NMED's Administrative Record for NASA, it cannot be used for risk assessment. The Report must be revised as necessary to address this comment. f. Risk for the industrial worker scenario was not appropriately evaluated for the 200 and 600 Areas. Only a qualitative discussion of comparison of indoor air data to NMED's industrial VISLs and permissible Occupational Safety and Health Administration (OSHA) exposure limits (PELs) was provided in Section 6.2.6, Indoor Air Quality-Risk to Worker. PELs are a tool for an industrial hygienist to monitor workplace environments and are not appropriate for risk assessment required under the White Sands Test Facility Hazardous Waste Permit and in accordance with the RA Guidance. Use of PELs is not an appropriate tool for assessing total risk to a site worker because many of the PELs are outdated and inadequate for ensuring protection of worker health. In addition, comparison to a PEL does not allow for cumulative or total exposure to multiple contaminants that may be detected in environmental samples. The PEL evaluation must be removed from the revised Report. The risk screen evaluation for the industrial	*NMED 03/19/09 Comments on the 600 Area Closure Investigation* [NASA, 2009]). This additional soil data was also included in NMED-approved reports (*NASA WSTF 200 Area Phase II Investigation Report* [NASA, 2015b] and *600 Area Closure Investigation Report Provided in Response to a NMED Notice of Disapproval* [NASA, 2011a]). For soil vapor and indoor air data used in the risk screening evaluation, only the 2017/2018 data obtained during this investigation was used. NASA has properly cited all NMED-approved documents where soil data was obtained from and has revised the report accordingly. f. All discussion of OSHA PELs and comparison of investigation data with OSHA PELs have been removed from the document. Affected sections include: 3.1.5 Decision Rule, Section 5.1 200 Area Soil Vapor, Outdoor Air, Indoor Air Sampling, Section 5.1.2 Building 200 Outdoor Air Analytical Results, 5.1.3 Building 200 Indoor Air Analytical Results, Section 5.2 600 Area Sil Vapor, Outdoor Air, and Indoor Air, Section 5.2.2 Building 637 Outdoor Air Analytical Results, Section 5.2.4 Building 600 Trends and Observations, Section 6.2.6 Indoor Air Quality – Risk to Worker, Section 7.1 Summary of Soil Vapor, Outdoor Air, Indoor Air Sampling and Screening Criteria, Section 7.2.1.2 Outdoor Air, Section 7.2.1.3 Indoor Air, and Section 7.2.2.2 Outdoor Air. Table 1.1, Table 4.3 (previously 5.1), and Table 5.1 (previously 5.2) have also been updated by removing OSHA PEL data.

Comments for Second Disapproval of the 200 Area and 600 Area Vapor Intrusion Assessment Report

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
	exposure scenario must be completed for the 200 and 600 Areas in accordance with the RA Guidance and the results documented in the revised Report. Revise the Report accordingly.	
	g. In accordance with the RA Guidance, exposure to contaminants in soil at the 200 and 600 Areas must be evaluated for the industrial worker and the results of the soil risk screen evaluation added to the results of the soil vapor risk screen evaluations. For the 600 Area, applicable surface soil data between 0 to 4 feet below ground surface are available and may be used to calculate cumulative risk and hazard for industrial workers. Table 6.6, 200 Area Soil Background Threshold Value Comparison, indicates surface soil data may not be available for the 200 Area. In this case, the Report must address the data gap and assess exposure to contaminants in soil for the industrial worker with other available information, if available. The results of the industrial worker soil vapor and indoor air risk screen evaluations for the 200 Area must be reported and discussed in appropriate sections of the revised Report. The Report must be revised accordingly.	g. The industrial exposure scenario has been evaluated and included for all pathways (indoor air, soil vapor, and soils). New Tables 6.2, 6.4, 6.6, 6.8, 6.10, 6.12, 6.17, 6.19, 6.21, 6.23, 6.26, 6.28, 6.30, 6.32, 6.37, 6.39, and 6.41 have been added and Section 6 of the report has been updated with industrial scenario results. Since no soil data in the 0-1 ft depth range is available for the 200 and 600 Areas, data from the shallowest soil sample collected per soil boring was used (for 200 Area soil borings: sample depths used were 0-8 ft and 0-16 ft bgs; for the 600 Area soil borings: sample depths used were 0-3 ft, 0-4 ft 0-6 ft, 0-8 ft, and 0-10 ft bgs). This issue is discussed in a new Section 6.2 Uncertainties.
	h. The risk screen evaluations for the 200 and 600 Areas for residential and industrial worker exposure must be conducted using current NMED or United States Environmental Protection Agency VISLs and site specific NMED-approved risk-based concentrations (RBCs) for carcinogenic and non-carcinogenic toxicity in accordance with the RA Guidance. Revise the Report accordingly.	h. Screening levels used for this disapproval response were VISLs and SSLs from the NMED Risk Assessment Guidance (November 2022), and air and soil RSLs from the EPA Regional Screening Levels (November 2022). WSTF RBCs used were 2022, approved with modification by NMED on February 11, 2022, and resubmitted as a response to NMED in May 2022.

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
	i. All comments included in this letter for residential exposure must also be applied for the required risk screen evaluations for the industrial worker, as applicable. Revise the Report accordingly.	i. All comments that applied to the residential scenario were also applied to the industrial scenario for this disapproval response.
3. Tables 5.1 and 5.2, Summary of 200 and 600 Area Buildings 200 and 637 and Vicinity Soil Vapor, Outdoor Air, and Indoor Air Analytical Results, Pages 73 and 91	**NMED Comment:** The Table 5.1 and 5.2 issues must be addressed as follows: a. Revise Tables 5.1 and 5.2 to include the screening level evaluation results for residential and industrial exposure for COCs detected in site samples. Revise the tables and any affected Report section discussions accordingly. b. Review the analytical reporting limits for all COCs and ensure they have not exceeded respective VISLs or RBCs. COC concentrations reported as non-detect with reporting limits above applicable screening levels must be flagged as data quality exceptions and the identified issues addressed in the revised Report. Revise the Report as necessary. c. The RBCs for the five-foot interval are listed on Tables 5.1 and 5.2. Clarify footnote two to indicate that the data for the five-foot interval represents the most conservative RBC and is listed for comparison only. In addition, the footnote must indicate that the RBC appropriate for the depth of each sample was applied during the risk assessment. Revise the Report accordingly.	a. Tables 4.3 (previously 5.1) and 5.1 (previously 5.2) have been updated with residential and industrial VISLs and WSTF RBCs. Exceedances of VISLs and RBCs can be seen by red shading, and a column has been added for risk / hazard exceedances. b. Several detection limits exceeded NMED VISLs for several COCs in the 200 Area soil vapor samples for well 200-LV-150. These high detection limits have been highlighted in yellow on Table 4.3 and shown with additional detail in Table 4.4. A discussion has been added to Section 4.10 and Section 6.2 Uncertainties. c. RBCs listed on Tables 4.3 and 5.1 have been updated to reflect the appropriate values for the depths the samples were taken. A footnote has been added to each table describing the RBCs: "WSTF RBCs for soil vapor taken from NASA WSTF NMED-approved Soil Vapor RBCs for 2022 (NASA, 2022), approved with modification February 11, 2022 (NMED, 2022a). The RBC listed corresponds to the closest depth bgs the sample was collected. For each sample, the next shallowest depth to sample depth was chosen to be

NMED Comment Number	NMED Comments	NASA Revisions/Responses/Discussion
		conservative, e.g., sampled at 34 ft bgs, the 25 ft RBC depth was used."

National Aeronautics and Space Administration

200 and 600 Area
Vapor Intrusion Assessment Report

June 2018

Revised January 2020

Revised April 2023

NM8800019434

200 and 600 Area
Vapor Intrusion Assessment Report

June 2018

Revised January 2020

Revised April 2023

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Timothy J. Davis
Chief, NASA Environmental Office

Date

National Aeronautics and Space Administration

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Executive Summary

~~Between September 2012 and JanuaryNovember 20154, the National Aeronautics and Space Administration (NASA) performed a phased investigation of the subsurface at the White Sands Test Facility (WSTF) 200 Area.~~ The results of the National Aeronautics and Space Administration (NASA) 200 Area Phase II Investigation Report (IR) submitted on June 29, 2015 ~~investigation~~ indicated that concentrations of contaminants of potential concern (COPC) ~~specific volatile organic compounds (VOCs)~~ in soil vapor at the 200 Area Hazardous Waste Management Units (HWMUs) exceeded New Mexico Environment Department (NMED) and/or WSTF-specific screening criteria. ~~In the 200 Area Phase II Investigation Report (IR) submitted on June 29, 2015, NASA compared analytical results from soil vapor sampling to potentially applicable screening levels (NMED Vapor Intrusion Screening Levels [VISLs; NMED, 201922cb] and WSTF risk-based concentrations [RBCs; NASA, 2019a]). The comparison indicated that industrial/occupational workers could be exposed to VOCs at concentrations presenting risks above target values if the screening assumptions relating to migration of subsurface soil vapor through vadose zone pore space and building foundations into indoor air are applicable. In the IR,~~ NASA recommended a vapor intrusion assessment of the complete vapor pathway in the 200 Area~~for Building 200~~. ~~near the location of the former Clean Room underground storage tank (UST); also known as the 200 Area West Closure HWMU. NMED agreed with NASA's intent to evaluate the potential for a complete vapor intrusion pathway in an approval with modifications provided on November 30, 2015.~~

~~The evaluation of potential soil vapor intrusion in the 600 Area was added. to the assessment following communications between NASA and NMED on the 600 Area Perched Groundwater Extraction Pilot Test Interim Report for Year 2 NMED approval with modifications (NMED, 2015a). NASA has performed several vadose zone investigations at the 600 Area HWMU, and concluded that the source of soil vapor contaminants beneath the 600 Area HWMU is the underlying groundwater. In a November 25, 2015 letter to NMED, NASA proposed an assessment of the 600 Area. Building 637, located southeast of the 600 Area HWMU, is the closest structure and constitutes the location at which a potentially complete vapor intrusion pathway would result in the highest level of present-day exposure. The approach of utilizing Buildings 200 and 637 ensured consistent evaluation of the current worst-case vapor intrusion pathway at the 200 West Closure and 600 Area HWMUs.~~ NASA submitted t~~incorporated all the vapor intrusion assessment requirements into t~~he 200 and 600 Area Vapor Intrusion Assessment Work Plan (VIAWP) ~~, which was submitted to NMED~~ on February 26, 2016, and this was ~~and~~ approved by NMED on May 27, 2016.

This vapor intrusion assessment report (VIAR) follows~~satisfies the components of~~ a tiered vapor intrusion evaluation process~~ presented in the NMED-approved VIAWP~~. The t~~Based on previous vadose zone investigations in the 200 Area and 600 Area, t~~wo locations with the ~~current~~ greatest potential for vapor intrusion were evaluated: the 200 Area on the west side of Building 200 at the location of the former Clean Room tank HWMU; and, 600 Area Building 637 located near the 600 Area HWMU. ~~The VIAR evaluates the potential significance of a complete exposure pathway existing between soil vapor in the vadose zone and industrial/occupational indoor air is performed through by comparing the maximum detected concentrations for vadose zone soil vaporand to the corresponding NMED VISL and/or WSTF RBC.~~ Additional evaluation ~~lines of evidence beyond comparison of soil vapor data to screening criteria are investigated~~ to determine whether soil vapor is a potential source of unacceptable indoor air risks ~~.~~ ~~These~~ include~~d~~ a review of~~evaluation of the integrity of~~ building foundations, ~~identification of the operating characteristics of the~~ building ventilation systems, a temporal trend analysis of VOC source concentrations in groundwater, characterization of the vertical distribution of vadose zone pore vapor, and comparison of the ~~relative~~ concentrations of ~~key~~ COP~~VO~~Cs in source media (soil vapor) and exposure media (indoor air) to assess the contribution of source area CO~~V~~P~~O~~Cs to indoor air risks.

Two semi-annual sampling events were performed in the summer (August 2017) and winter (February 2018)~~ to address differences in seasonal air pressure fluctuations that could influence vapor intrusion~~. ~~The sampling events were performed 182 days apart over weekends on consecutive days, with Building 637 sampled on Saturdays, and Building 200 sampled on Sundays. Each sampling event was coordinated to take place on a 3-day non-working weekend. Heating, ventilation, and air conditioning (HVAC) systems operated on each preceding Friday with minimal impact from personnel, and sampling conditions were excellent. ~~Soil vapor samples were analyzed using EPA Method TO-15~~ in order to achieve the VIAR objectives~~. ~~.~~

In the 200 Area, soil vapor samples were collected from the shallow ports of three~~in~~ MSVM wells on the west side of Building 200. Indoor samples were collected at locations in Building 200 above the subsurface footprint of the former 200 Area Clean Room Tank HWMU and outdoor air samples were collected adjacent to Building 200. ~~200-SV-05 at 9 feet (ft) below ground surface (bgs), 200-SV-09 at 19 ft bgs, and MSVGM well 200-LV-150 at 34 ft bgs, all located within 85 ft of the west side of Building 200. ~~In the 600 Area, samples were collected from the shallow ports in two MSVM wells ~~600-SGW-1 at 12.5 ft bgs, 600-SGW-2 at 12.5 ft bgs, and 600-SGW-5 at 7.5 ft bgs, all located ~~on the west side ~~within 210 ft ~~of Building 637. ~~Indoor and outdoor air samples were collected using eight-hour duration flow controllers operating at the same time. 200 Area indoor samples were collected at locations in Building 200 above and adjacent to the subsurface footprint of the former 200 Area Clean Room Tank HWMU. Outdoor air samples were collected upgradient and adjacent to Building 200. In the 600 Area, ~~I~~i~~ndoor air samples were collected in Building 637 ~~within the single room ~~along with outdoor air samples at adjacent ~~upgradient ~~locations. The

~~Building 200 results reflected higher concentrations for COPCs in the vadose zone MSVM wells for the first semi-annual sampling event (August 2017), which was characterized by elevated outdoor temperatures and potentially increased volatization of COPCs in groundwater. Vadose zone trichloroethene (TCE) concentrations from the three wells sampled exceeded the NMED VISL (328 µg/m^3, NMED, 201922cb) and WSTF RBC at 5 ft bgs (18,000 µg/m^3, NASA, 2019a) for the August 2017 and February 2018 semi-annual sampling events. Tetrachloroethene (PCE) soil vapor concentrations also exceeded the NMED VISL (6,550 µg/m^3) in all three wells for the August semi-annual sampling event and were below the WSTF RBC at 5 ft bgs (460,000 µg/m^3). For the February 2018 sampling event, PCE concentrations exceeded the NMED VISL at 200-LV-150 at 34 ft bgs. Concentrations for outdoor air samples were generally either non-detect or below 1 µg/m^3 for all COPCs. Traces of Freon 11 (maximum 1.2 µg/m^3 in August 2017 and February 2018) and 2-Butanone (maximum 3 µg/m^3 in August 2017) were observed. Concentrations for indoor air samples were generally non-detect or present at trace concentrations for COPCs. No indoor or outdoor air samples exceeded the applicable NMED VISL or WSTF RBC.~~

~~Building 637 results indicated that the higher concentrations for COPCs in the MSVM wells fluctuated between the two semi-annual sampling events characterized by significantly different ambient outdoor temperatures. The effect of increased volatization of COPCs in groundwater during the summer may be less pronounced in the 600 Area due to relatively lower concentrations in the 600 Area aquifer. TCE concentrations within soil vapor for well 600-SGW-1-12.5 (480 µg/m^3 in August 2017 and 740 µg/m^3 in February 2018) and well 600-SGW-2-12.5 (330 µg/m^3 in August 2017) exceed the NMED VISL (328 µg/m^3), and were below the WSTF RBC at 5 ft bgs (18,000 µg/m^3). Other COPC maximum concentrations for the August 2017 and February 2018 sampling events were below the respective NMED VISL and WSTF RBC in soil vapor at 5 ft bgs. The concentrations for COPCs for outdoor air samples were generally non-detect or below 1 µg/m^3 for the COPCs. Traces of Freon 11 (maximum 1.2 µg/m^3 in August 2017), 2-Butanone (maximum 2.4 µg/m^3 in August 2017), and acetone (maximum 10 µg/m^3 in August 2017) were reported. The concentrations for specific indoor COPCs were slightly above the contemporaneous outdoor air samples collected, and significantly below the concentrations observed~~

~~within soil vapor in the shallow vadose zone reported from MSVM wells. The maximum concentration for indoor air samples were generally non-detect or below 1 µg/m^3 for the COPCs. No indoor or outdoor air sample results exceeded the applicable NMED VISL or WSTF RBC.~~

~~Vadose zone soil vapor concentrations of PCE and/or TCE at the locations of the 200 West Closure and 600 Area HWMUs exceeded NMED VISLs and updated NMED-approved WSTF RBCs as expected; and, as explained in the lines of evidences (Section 6.0), the indoor air exposure pathway is complete for Buildings 200 and 637, though this pathway will not impact the health of industrial workers. The subsurface contribution to indoor VOC levels is below the equivalent indoor air screening levels. From the Decision Rule: "If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below risk-based indoor air concentrations shown in Table A-4 of NMED's Soil Screening Guidance for Human Health Risk Assessments VISLs and WSTF RBCs, then current vapor intrusion risks are acceptable." No further investigation or corrective actions are recommended for Building 200 and Building 637 due to the lack of health risk for soil vapor COPCs from the vadose zone into the target buildings.~~

~~200 and 600 Area soil vapor risk and hazard results were combined with 200 and 600 Area soils risk and hazard from investigations performed in 2014 (200 Area Phase II Investigation [NASA, 2014a]) and 2009 (600 Area Closure Investigation [NASA, 2011a]).~~200 and 600 Area soil vapor risk and hazard results were combined with previous soils risk and hazard data. Risk screening~~assessment~~ evaluations for soil vapor include both carcinogenic and noncarcinogenic toxicity and were performed using ProUCL Version 5.2.

For the 200 and 600 Area vadose zone, TCE concentrations in soil vapor exceed the NMED VISL and in the 200 Area, WSTF RBC as well~~at 25 ft bgs~~ for both sampling events. PCE soil vapor concentrations exceed the VISL for both sampling events but are below the RBC at 25 ft bgs. The concentrations for the other remaining COPCs in vadose zone soil vapor are below the VISL (except 1,1-Dichloroethane in the 200 Area) and RBC. Concentrations in Building 200 outdoor and indoor air samples were generally non-detect or below 1 µg/m^3 for COPCs and below the VISL and RBC~~. For the 600 Area, TCE concentrations within soil vapor exceed the VISL but are significantly below the RBC at 10 ft bgs. All other soil vapor concentrations for the remaining COPCs are below the respective VISL and RBC.~~ . ~~The concentrations for COPCs for Building 600 outdoor and indoor air samples were generally non-detect or below 1 µg/m^3 for the COPCs. No concentrations of indoor air COPCs exceeded the VISL or RBC.~~ Cumulatively, TCE and PCE are the risk drivers for soil vapor. Both individual and cumulative risk was exceeded by TCE concentrations for the residential and industrial scenarios in the 200 Area. Even though risk and hazard targets were exceeded for soil vapor, indoor air risk and hazard were below targets. Separate contaminant suites between indoor air and soil vapor, intact building foundations, robust ventilation systems, a generally increasing contaminant concentration trend with depth provide evidence that vapor intrusion is not a significant contributor to indoor air in Building 200 or Building 637.

From the Decision Rule: "If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below risk-based indoor air concentrations…, then current vapor intrusion risks are acceptable." ~~According to NMED Guidance on vapor intrusion pathway designation (NMED, 2022c), there is a complete exposure pathway at the two buildings.~~ Based on this VIAR, NASA concludes that potential vapor intrusion into the buildings does not present a risk of industrial/occupational exposure to personnel, and no additional investigation or vapor intrusion mitigation is required.

The risk screening performed for this VIAR is not intended to be complete at this time, as continued monitoring is planned for the 200 and 600 Areas. NASA will perform continued risk and hazard screening, including soil-to-groundwater and an ecological assessment in accordance with the current

NMED RA Guidance, Volumes I and II at an appropriate time to make corrective action decisions or to seek closure. At that time, NASA will provide a risk report in accordance with the WSTF Permit Section 6.5.

Table of Contents

List of Figures and Tables

List of Acronyms

µg	Microgram
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
AOI	Area of Interest
bgs	Below ground surface
BTV	Background Threshold Value
CAP	RCRA Corrective Action Program
CFR	Code of Federal Regulations
CH4	Methane
CO2	Carbon Dioxide
CoC	Chain-of-custody
COPC	Contaminant of Potential Concern
DQOs	Data Quality Objectives
EDD	Electronic Data Deliverable
EPA	Environmental Protection Agency
Freon 11	Trichlorofluoromethane
Freon 113	1,1,2-Trichloro-1,2,2-Trifluoroethane
ft	Feet/foot
GCL	Geosciences Consultants, Ltd.
GMP	Groundwater Monitoring Plan
GSA	Gardner Spring Arroyo
HAZWOPER	Hazardous Waste Operations and Emergency Response
HIS	Historical Information Summary
HVAC	Heating, Ventilation, and Air Conditioning
HWB	Hazardous Waste Bureau
HWMU	Hazardous Waste Management Unit
HWTL	Hazardous Waste Transmission Line
IDW	Investigation-Derived Waste
in.	Inch(es)
IR	Investigation Report
IWP	Investigation Work Plan
JDMB	Jornada del Muerto Basin
m	Meter
MSVGM	Multiport Soil Vapor and Groundwater Monitoring
MSVM	Multiport Soil Vapor Monitoring
NASA	National Aeronautics and Space Administration
NMED	New Mexico Environment Department
O2	Oxygen
ODEQ	Oregon Department of Environmental Quality
~~OSHA~~	~~Occupational Safety and Health Administration~~
PCC	Post-Closure Care
PCE	Tetrachloroethene
PDF	Portable Document File
PEL	Permissible Exposure Limit(s)
PID	Photoionization Detector
PPE	Personal Protective Equipment
ppm	Part per million
PVC	Polyvinyl Chloride
QA	Quality Assurance

QC	Quality Control
RBC	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
SAM	San Andres Mountains
SCEM	Site Conceptual Exposure Model
SHP	Safety and Health Plan
SOP	Standard Operating Procedure
sq ft	Square foot/feet
SSL	Soil Screening Level
SVE	Soil Vapor Extraction
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
TWA	Time Weighted Average
UST	Underground Storage Tank
VIAR	Vapor Intrusion Assessment Report
VIAWP	Vapor Intrusion Assessment Work Plan
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compounds
WSTF	White Sands Test Facility

1.0 Introduction

National Aeronautics and Space Administration (NASA) submitted the results of the 200 Area Phase II Investigation Report (IR; NASA, 2015b) to the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) on June 29, 2015. The IR described the most recent phase of a comprehensive 200 Area vadose zone investigation and included the results of the comprehensive soil vapor sampling event in the 200 and 600 Areas conducted in October 2014. Based on the results of the IR, NASA proposed a quantitative assessment of the potential complete vapor intrusion pathway for the Building 200 foundation near the location of the former Clean Room underground storage tank (UST; also known as the 200 Area West Closure hazardous waste management unit [HWMU]). NMED agreed with NASA's intent to address potential complete vapor intrusion pathways in their approval with modifications for the IR on November 30, 2015 (NMED, 2015b).

The additional assessment of potential vapor intrusion in the 600 Area was proposed following written communications between NASA and NMED. On April 16, 2015, NASA submitted the 600 Area Perched Groundwater Extraction Pilot Test Interim Status Report – Project Year 2 for NMED review (NASA, 2015a). NMED approved the report with modifications on July 15, 2015, and required further investigation of the source of contamination at or near the HWMU (NMED, 2015a). NASA has already performed several investigations at the 600 Area HWMU, and concluded there is not a continuing source of contamination in the vadose zone beneath the HWMU. In a November 25, 2015 letter to NMED (NASA, 2015d), NASA included a summary of the environmental investigations performed at the 600 Area HWMU, the findings of those investigations, and the NMED responses to NASA's conclusions.

~~Based on the comprehensive sampling of soil, soil vapor, and groundwater, and the strong correlations between groundwater and soil vapor concentrations at the 600 Area HWMU, NASA has demonstrated that the source of soil vapor contaminants beneath and adjacent to the HWMU is the underlying contaminated groundwater. NMED indicated their concurrence with these conclusions based on the approval of these investigation reports. Subsurface vertical concentration profiles are a tool that provide a line of evidence that demonstrates degradation of the contamination source(s) and supports a conclusion for minimal upward diffusion of soil vapor to the site structures and receptors from proximal source areas. Vertical concentration profiles of soil and vapor sampled within the 200 Area and 600 Area HWMU vadose zones and an evaluation relative to concentrations in groundwater are presented and interpreted in Section 6.2.~~

However, it has yet to be determined whether the presence of volatile organic compounds (VOCs) in soil vapor presents a risk to human health~~, or if there are complete exposure pathways between the 600 Area HWMU and human receptors~~. Building 637, located southeast of the Closure, is the closest potential structure that could provide a current pathway for receptor exposure in the 600 Area.

1.1 Facility Location and Description

NASA Johnson Space Center White Sands Test Facility (WSTF) is located at 12600 NASA Road in central Doña Ana County, New Mexico. The site is approximately 12 miles northeast of Las Cruces, New Mexico and 65 miles north of El Paso, Texas (Figure 1.1). The WSTF U.S. Environmental Protection Agency (EPA) Facility Identification Number is NM8800019434. The facility has supported testing of space flight equipment and hazardous materials since 1964. WSTF contains five closed HWMUs that are under post-closure care (PCC) and 37 solid waste management units (SWMUs) within the 200, 300, 400, and 600 Areas. PCC requirements are specified by the NASA WSTF Hazardous Waste Permit (Permit) issued by NMED (2023~~16b~~). Specific regulatory requirements are discussed in Section 1.3.

1.2 WSTF 200 Area and 600 Area Closure Conditions

The field activities performed for the vapor intrusion assessment did not compromise the integrity of the 200 Area former Clean Room Tank HWMU. The original closure cap was removed when the building extension was constructed in 1991. The 200 Area former Clean Room Tank excavation cannot be accessed as it is located under Building 200 which is still in operation. Multiport soil vapor monitoring (MSVM) well 200-SV-05 and multiport soil vapor and groundwater monitoring (MSVGM) well (200-LV-150) are located adjacent to the building. Their installation and sampling do not affect the closure cap.

Activities in the 600 Area for this assessment also did not compromise the integrity of the 600 Area closure cap. As directed by NMED, MSVM wells 600-SGW-2, 600-SGW-5, and 600-SGW-6 were installed through or adjacent to the cap during previous investigations, and no new wells were installed for this assessment. No unintentional damage to either of the HWMU closures was identified during a post-assessment evaluation of closure conditions.

1.3 Regulatory Requirements

The Permit requires that NASA investigate and address historical releases of hazardous waste and hazardous constituents that may have occurred at sites throughout WSTF as part of the Resource Conservation and Recovery Act (RCRA) corrective action process (CAP). The CAP consists of investigation, characterization, and, if necessary, cleanup. The principal components of the CAP are:

- RCRA Facility Assessment.
- RCRA Facility Investigation.
- Interim Corrective Measures (if necessary).
- Corrective Measures Study (if necessary).
- Corrective Measures Implementation (if necessary).

~~Sections V.B.6.a.i through V.B.6.a.v of the Permit (NMED, 2016b) address activities related to investigation of the 200 Area and V.B.6d.i through V.B.6.d.v activities related to the investigation of the 600 Area. These activities have been completed.~~

NMED guidance requires that a quantitative vapor intrusion pathway assessment be performed where a “complete pathway” category exists (NMED, 20~~19~~22c~~b~~). The Permit (NMED, 2023~~16b~~) does not include cleanup standards for soil vapor. However, NMED has issued the latest Risk Assessment Guidance for Site Investigations and Remediation Volume I (NMED, 20~~19~~22c~~b~~) and has directed NASA to use this latest guidance to provide specific information on the development of screening levels for soil vapor contaminants and for evaluating exposure pathways and receptors. These are termed WSTF risk-based concentrations (RBCs; NASA, 2019a, 2017a) (Table 1.1).

In the event the assessment indicates a complete pathway and unacceptable risk is present at either of the two target building locations in the 200 and 600 Areas, NASA would be required to work with NMED to perform a corrective measures evaluation in accordance with Section 3.12~~VII.J~~ of the Permit.

NMED presented the available vapor intrusion screening assessment criteria alternatives in their November 30, 2015, 200 Area Phase II Approval with Modifications (NMED, 2015b). In accordance with an NMED recommendation (NMED, 2015b), NASA updated existing RBCs using available 2018 data in conjunction with the pre-assessment planning and preparation activities for this vapor intrusion assessment. Updated RBCs were available for use as a component for this vapor intrusion screening assessment.

NASA routinely collects groundwater samples from a comprehensive network of monitoring wells at WSTF in accordance with the NMED-approved Groundwater Monitoring Plan (GMP; NASA, 2017b). Groundwater samples are collected for the analysis of the following primary constituents: VOCs; n-nitrosodimethylamine, bromacil, and metals. In addition to routine groundwater samples required by the GMP, samples for other chemical analyses are frequently collected at many of the groundwater monitoring wells. Because these samples are not a direct requirement of the GMP, the results of these analyses are provided in the appropriate project-specific report. This Vapor Intrusion Assessment Report (VIAR) was prepared in response to NMED's approval (NMED, 2016a) of the 200 Area and 600 Area Vapor Intrusion Assessment Work Plan (VIAWP; NASA, 2016b).

1.4 Purpose and Method of Vapor Intrusion Assessment

The process to assess and remediate vapor intrusion in buildings (if required) involves a tiered approach. Firstly, source area vadose zone soil and groundwater VOC concentrations are compared to available regulatory standards, in this case the NMED Soil Screening Levels (SSLs; NMED, 20~~19~~22c~~b~~) and WSTF groundwater cleanup levels (GMP; NASA, 2017b). Secondly, concentrations of VOCs in soil vapor are compared to the latest NMED Vapor Intrusion Screening Levels (VISLs) (NMED, 20~~19~~22c~~b~~) and WSTF RBCs (NASA, 2019a). Both of these comparisons were performed for the original submittal of this report, *200 Area and 600 Area Vapor Intrusion Assessment Report,* dated June 2018. However, as noted by NMED (NMED, 2019~~a~~) in comments to the original submittal, these comparisons did not constitute a complete risk screening for soil vapor because total vapor risk was not calculated for the sum of all COPCs and because, as far as human health risk, the total vapor risk was not added to the soil risk (soil results had not been discussed at all in the June 2018 submittal). This revision revisits the risk screening as required by the NMED Risk Assessment Guidance.

Originally, because specific samples in the 200 Area were identified that exceeded soil vapor screening levels during both soil vapor screening processes (NASA, 2015c), NASA and NMED agreed that the next step in the investigation process would be a vapor intrusion assessment focused on the areas of greatest potential concern. The objective of the 2018 200 Area and 600 Area vapor intrusion assessment was to perform an evaluation of the vapor intrusion pathways at the priority locations within the 200 and 600 Areas that present the most likely routes for vapor intrusion based on previous investigations (Figure 1.2). The investigation and 2018 report moved directly to evaluating the potential for vapor to affect industrial/occupational indoor air in specific buildings in accordance with NMED guidance (NMED, 20~~19~~22c~~b~~). It was predicated that a complete vapor intrusion exposure pathway had already been established. These locations can be described specifically as follows.

- The 200 Area immediately adjacent to, and below the foundation of Building 200 above the location of the former Clean Room tank HWMU, and adjacent to soil borings 200-SB-05 (MSVM well 200-SV-05), 200-SB-06 (MSVGM well 200-LV-150), and 200-SB-09 (MSVM well 200-SV-09). This location provided the highest soil vapor concentrations in the 200 Area vadose zone for 1,1,2-trichloro-1,2,2-trifluoroethane (Freon®[1] 113), TCE, and tetrachloroethene (PCE) during the October 2014 comprehensive soil vapor sampling event (NASA, 2015c). According to the NMED Risk Assessment Guidance for Site Investigations and Remediation (NMED, 20~~19~~22c~~b~~), this location exceeded NMED industrial/occupational VISLs for Freon 113,

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[1] Freon is a registered trademark of The Chemours Company CF, LLC.

TCE, and PCE, WSTF's RBC for TCE at a location that is immediately adjacent to a building, and falls into the "complete pathway" category for vapor intrusion.

- The 600 Area between the 600 Area HWMU and Building 637, located 150 feet (ft) to the southeast, near soil borings 600-SB-02 (MSVM well 600-SGW-02), 600-SB-05 (MSVM well 600-SGW-05), and 600-SB-06 (MSVM well 600-SGW-06). This location provided the highest soil vapor concentrations in the 600 Area vadose zone for TCE and some of the highest for Freon 113 during the October 2014 comprehensive soil vapor sampling event (NASA, 2015c). Building 637 is the most proximal structure to the southeast side of the 600 Area HWMU. This location also exceeded NMED industrial/occupational soil vapor VISLs for TCE and warrants assessment related to potential vapor intrusion.

Steps 1 through 3 listed below were performed as part of this assessment.

- Step 1: Using historical soil vapor investigation data, compare concentrations for vadose zone soil vapor to the corresponding NMED VISL and NMED-approved WSTF RBC to determine whether the vapor intrusion pathway must be evaluated for industrial workers in 200 or 600 Area buildings. NMED VISLs and RBCs are presented in Table 1.1. This evaluation was performed in the June 2018 submittal of this report.
  - Step 2: Evaluate the vapor intrusion pathway and perform human health risk screening for exposure pathways, including soil and soil vapor, using all COPCs, their additive nature, and the soil and soil vapor additive pathways. This evaluation was performed in the June 2018 submittal of this report, and is presented here. This corresponds to Step 1 of a quantitative soil vapor assessment described in Section 2.5.2.3 of NMED (20~~19~~22b).
  - Step 3: If a comparison to soil vapor screening criteria indicates potentially unacceptable risk, as was indicated in the June 2018 submittal of this report, obtain additional information and assess potential human health risks based on multiple lines of evidence. Accordingly, activities that were completed in accordance with the VIAR included visual evaluation of the building foundations and determination of any preferential pathways, identification of the building ventilation systems, collection of shallow soil vapor samples in nearby MSVM and MSVGM wells in conjunction with indoor and outdoor air sampling at the two building locations being evaluated, and evaluation of vertical soil vapor concentrations to determine origin and attenuation from vapor sources. Converging lines of evidence are used to determine whether there are potentially unacceptable risks to present-day industrial workers in the buildings. This corresponds to Step 2 of a quantitative soil vapor assessment described in Section 2.5.2.3 of NMED (20~~19~~22b).

1.5 Vapor Intrusion Screening Levels and Risk Based Concentrations

WSTF industrial/occupational workers could be exposed to VOCs derived from the migration of subsurface soil vapor through pore spaces in the vadose zone and building foundations into indoor air. The NMED Risk Assessment Guidance for Investigations and Remediation (NMED, 2022c~~19b~~) provides preliminary criteria to determine when vapor intrusion pathways must be evaluated:

- If there are compounds present in subsurface media that are sufficiently volatile and toxic, and
- If there are existing or planned buildings where exposure could occur.

"A chemical is considered to be sufficiently volatile if its Henry's law constant is 1 x 10-5 atm-m^3/mole or greater and its molecular weight is approximately 200 g/mole or less. A chemical is considered to be sufficiently toxic if the vapor concentration of the pure component poses an incremental life time cancer risk greater than 1E-05 or the non-cancer hazard index is greater than 1.0" (NMED, 20~~19~~22c~~b~~).

In order to establish whether adverse human health risk is a factor at the 200 and 600 Areas, a risk screening evaluation in accordance with the RA Guidance is initially required. VISLs are not designed to be used as action standards or cleanup levels, but can be used as a tool for screening potential cumulative risks and/or hazards from exposure to volatile and toxic chemicals and to determine if further evaluation may be needed using site-specific data. NMED (2017) indicates that VISLs can be used as a first tier screening assessment under certain conditions, including; the absence of shallow groundwater, no shallow soil contamination within 10 ft of the foundation base, no buildings with subsurface openings, no significant vadose zone advective transport (from landfills producing methane or industrial sites with applicable vapor density), and no leaking vapors from gas transmission lines. NMED VISLs were used for first tier screening due to the following:

- The 200 and 600 Areas have relatively deep groundwater sources (greater than 100 ft) below the building foundation levels.
- Shallow soil contamination resulting in vapor sources was not identified during previous investigations, although samples are greater than 10 ft from the building foundations. The closest soil sample to Building 200 was in soil boring 200-SB-05 located 18 ft from the building at a depth of 8 to 10 ft below ground surface (bgs). The closest soil sample to Building 637 was collected below the 600 Area Closure cap in soil boring 600-SB-05 located 181 ft from the building at a depth of 8 to 10 ft bgs.
- Buildings do not have significant known openings to the subsurface (no sumps or earthen floors) or other significant preferential pathways.
- No known sources exist for advective transport (no vapor-forming chemicals released within an enclosed space where vapors could migrate downward through cracks and openings in floors and into the vadose zone).
- No known leaking gas transmission lines exist at WSTF.

Annually updated WSTF soil vapor RBCs are preferred relative to the screening and evaluation of soil vapor intrusion (NASA, 2019a). WSTF RBCs represent the maximum VOC concentrations allowed in soil vapor at a given depth for a complete vapor intrusion pathway. A VISL is calculated with a depth at or just below the surface (sub-slab). Since RBCs are more site-specific to WSTF than the generic VISLs and are calculated for multiple depths, using RBCs is preferred at WSTF.

First developed in 2012, these RBCs were based on EPA ambient air regional screening levels. The WSTF RBC calculations were completed for multiple depths in the vadose zone to provide a direct reference against soil vapor samples collected at the equivalent depths. To provide the best understanding of potential exposure, soil vapor and air concentrations were referenced and compared to the latest WSTF RBCs for air contaminants (Table 1.1).

1.6 Vapor Intrusion Pathway

No significant concentrations of VOCs were detected in vadose zone soil samples collected during the 200 Area or 600 Area investigations (NASA, 2015c, 2011a). In the 200 Area, organic compounds with more than one detection in soil samples were limited to traces of toluene and acetone at concentrations several orders of magnitude below the applicable NMED SSLs. Traces of acetone were considered an artifact of the sampling and analytical processes. The random horizontal and vertical distribution of trace concentrations of toluene do not support a vadose zone contaminant source. In the 600 Area, traces of trichlorofluoromethane (Freon 11), Freon 113, TCE, and PCE were rarely reported in soil samples, again at concentrations orders of magnitude below applicable NMED SSLs. NMED approved “No Longer Contained in Determinations” for all soils from the 200 Area and 600 Area investigations (NMED, 2009b, 2011b, 2014b~~a~~, 2014c~~b~~). Soils were redistributed at the surface in the vicinity of the soil borings from which they were derived (NASA, 2015c, 2011a). However, VOCs were detected above the applicable NMED VISLs in soil vapor and above the TCE cleanup level for groundwater samples collected in conjunction with the soil samples during these previous investigations.

Chemical analytical data were also obtained from two types of sampling performed for the assessment of the vapor intrusion pathway: passive vadose zone soil vapor sampling and active indoor/outdoor air sampling. Passive vadose zone samples from MSVM and MSVGM wells were used to confirm the presence of VOCs and their relative concentrations at specific depths in the vadose zone. Active indoor and outdoor air samples collected within the target buildings are required for quantitative assessments. Chemicals that should be considered for the vapor intrusion pathway include both volatile and toxic constituents (NMED, 2017). For the 200 and 600 Area building assessments, the vapor intrusion pathway options considered were: 1) incomplete and no action required; 2) potentially complete and a qualitative evaluation required; or 3) complete and quantitative evaluation required.

1.7 Methodologies

The VIAR provides specific information on the following activities:

- Project planning and preparation; NASA developed the required internal planning documents and coordinated the assignment of on and off-site resources for the assessment.
- Assessment activities, including soil vapor sample collection from MSVM and MSVGM wells and indoor and outdoor air sample collection at and adjacent to the target buildings.
- Investigation-derived waste (IDW) management as described in the VIAWP IDW Management Plan (NASA, 2016b; Appendix A).
- Data evaluation to determine if there are COPC concentrations above screening levels for vadose zone soil vapor and/or indoor air at the target buildings, as well as in surface soil. If COPCs are detected at concentrations above screening levels, the data can be used to guide remedial action, if necessary.
- Development and submittal of the 200 Area and 600 Area VIAR to NMED.

2.0 Background

2.1 Soil Vapor Contamination

Concentrations of soil vapor contaminants in the WSTF source areas vadose zone are widespread and have been identified and delineated during previous soil vapor surveys (Geosciences Consultants, Ltd. [GCL], 1986; NASA, 2013b~~a~~). The first shallow soil vapor survey performed at WSTF (GCL, 1986) incorporated all WSTF source areas and areas topographically and hydrologically downgradient to the west. A strong correlation between the footprint of the groundwater contaminant plume and the overlying soil vapor contaminant plume within the vadose zone was observed. Soil vapor concentrations decreased to the west as the depth to the groundwater table increased from approximately 140 ft bgs in the source areas to more than 400 ft bgs in the Jornada del Muerto Basin (JDMB), which was consistent with a groundwater source.

The most recent 200 Area vadose zone investigation included a soil vapor survey that was performed using a phased approach. Fieldwork and laboratory testing activities were completed between June 2012 and January 2013 (Phase I) and June 2014 through January 2015 (Phase II). NMED requested that NASA report the 200 Area Phase I investigation results separately prior to implementing Phase II of the investigation (NMED, 2012). This allowed NMED to evaluate the initial Phase I data and review NASA's strategy for the Phase II investigation.

The Phase I field investigation (NASA, 2013b~~a~~) included the shallow soil vapor survey, which was performed on a grid across the WSTF 200 Area and portions of the adjacent 100, 600, and 800 Areas in order to derive shallow soil vapor isoconcentration maps and delineate additional areas of interest (AOIs). The survey was conducted in two sub-phases using Gore Modules emplaced at a depth of 2.5 ft bgs in a grid pattern on 250-ft centers to evaluate soil vapor adjacent to and surrounding three HWMUs (former 200 Area USTs and former 600 Area surface impoundments), SWMUs 4 through 9, portions of SWMU 10, SWMUs 19 and 20, and six additional targets identified in the 200 Area Historical Information Summary (HIS; NASA, 2012b). The initial survey incorporated 144 survey points. An additional 38 points were installed within the grid to further evaluate specific areas yielding the highest soil vapor concentrations. Each sample module was analyzed for a total of 45 VOCs using EPA Method 8260. Five VOCs showed consistent detections in the vadose zone: TCE; PCE; Freon 11; Freon 113; and total petroleum hydrocarbons (TPH). NASA submitted the results in the 200 Area Phase I Status Report on January 30, 2013 (NASA, 2013b~~a~~). Following NMED review (NMED, 2013a), NASA submitted a revised Phase I IR on August 6, 2013 (NASA, 2013d~~c~~). The revised report was approved by NMED on October 22, 2013 (NMED, 2013b).

The Phase II field investigation comprised subsurface evaluation of 200 Area HWMUs, SWMUs, AOIs outlined in the Phase I IR, and additional locations required by NMED (2013b). Subsurface drilling with soil and bedrock core sampling was followed by the installation of MSVM or MSVGM wells in the boreholes, and finally soil vapor and groundwater sampling (NASA, 2015c). All targets identified for Phase II were evaluated to the depth of bedrock, with the exception of the two 200 Area HWMUs that were investigated to the upper groundwater table located at depth in fractured rock. Fieldwork and laboratory testing activities were performed between June and November 2014. The final component of the 200 Area Phase II investigation comprised a comprehensive vadose zone soil vapor sampling event (NASA, 2015c).

The concentrations of VOCs in soil vapor within the 200 and 600 Areas have declined since the initiation of soil vapor monitoring at WSTF in 2000 with installation of the first MSVGM wells within the 200 Area (NASA, 2004). Subsequent comprehensive soil vapor sampling incorporating all MSVM and MSVGM wells in the 200 and 600 Areas were performed during four semi-annual events (NASA, 2011b, 2012a, 2012d, 2013c~~b~~) required by NMED as a follow up to the 600 Area Closure investigation (NASA, 2011a). Comprehensive soil vapor sampling culminated with the most recent event in October 2014, which was performed as a component of the 200 Area Phase II investigation (NASA, 2015b). A historical data trend analysis to demonstrate the declining concentrations over time between sequential sampling events is included on the vertical concentration profiles provided in Section 6.2 of this vapor intrusion assessment. The vertical concentration profiles demonstrate the decline in soil vapor concentrations over time for two of the primary and most widely distributed contaminants (Freon 113 and TCE) for sampling events performed in August 2010 (NASA, 2011b), March 2013 (NASA, 2013c~~b~~), October 2014 (NASA, 2015b), and for this vapor intrusion assessment in August 2017 and February 2018.

Declines in soil vapor concentrations have been observed in conjunction with a corresponding decline in concentrations of the same contaminants in groundwater (NASA, 2016a). The maximum soil vapor concentrations measured during the most recent (October 2014) comprehensive survey, including the newly installed 200 Area Phase II wells, decreased toward the southwest through the area covered by existing 100 and 200 Area wells and into the 600 Area HWMU along the downgradient path for groundwater plume migration and contamination. NASA submitted the results in the 200 Area Phase II IR on June 29, 2015 (NASA, 2015c). The report was approved with modifications by NMED on November 30, 2015 (NMED, 2015b).

NASA compared these maximum soil vapor concentrations to the equivalent WSTF site-specific RBCs (NASA, 2012c; Figure 2.1 through Figure 2.3) during the last comprehensive soil vapor sampling event (NASA, 2015c). Results indicated that the maximum Freon 113 and PCE soil vapor concentrations measured were one to three orders of magnitude lower than the proposed site-specific WSTF RBCs at that time (NASA, 2012c). TCE is the primary soil vapor contaminant with respect to health risk from vapor intrusion in the 200 and 600 Areas (Figure 2.2). The most concentrated soil vapor areas for TCE exceeded both the NMED VISL and the equivalent WSTF RBCs in the 2014 soil vapor sampling event. Nine specific soil vapor points in seven different monitoring wells exceeded the RBCs and the VISL. These were grouped into three specific locations:

- The former Clean Room UST HWMU and surrounding area located adjacent to Apollo Boulevard on the northwest side of the Building 200 Clean Room (three wells: 200-SV-05, 200-LV-150, and 200-SV-09).
- The west side of the former 200 Area Evaporation Treatment Unit near the former 200 Area Burn Pit (SWMU 9) and the hazardous waste transmission lines (HWTLs) temporary tanker location (part of SWMU 10). This location (200-SG-3) is approximately 300 ft from the most proximal building, and as stated above, TCE concentrations decrease in this direction (from the 200 Area southwest to the 600 Area HWMU).
- The 200-D well cluster area immediately surrounding groundwater monitoring wells 200-D-109 and 200-D-240 (three wells: 200-SV-19, 200-SG-1, and 200-SG-4). This location is approximately 1,600 ft from the most proximal building.

Soil vapor concentrations at the 200 Area former Clean Room UST HWMU were of the greatest potential concern because they were the highest measured within the 200 and 600 Areas. VOC concentrations at this location are the most proximal to and potentially below the northwest side of Building 200. The NMED VISLs for Freon 113 and PCE (Figure 2.3) were also exceeded by the concentrations in the soil vapor at this location.

The highest concentrations of TCE at the 600 Area HWMU were identified within the wells located near the southeast boundary of the closure (Figure 2.2), which is in the closest proximity to Building 637 (wells 600-SGW-2, 600-SGW-5, and 600-SGW-6). Although TCE concentration at these wells exceeded the NMED VISL, they did not exceed the VISLs for Freon 11, Freon 113, or PCE. The concentrations of all four of these VOCs were also below the WSTF RBCs (Table 1.1). The closure boundary is located approximately 100 ft northeast of Building 637.

2.2 Rationale For Selection of Buildings for Vapor Intrusion Assessment

Supporting data and evaluations that demonstrate the rationale for the selection of Building 200 and Building 637 as the locations most likely to present a risk from vapor intrusion are documented in several previous investigations referenced within this report. Elevated concentrations of COPCs in shallow soil vapor in the 200 Area vicinity of Building 200 were most recently confirmed by the results of a qualitative shallow soil vapor survey performed on a grid across the 200 Area (discussed in Sections 2.3, 3.2 and 5.1.2 of the 200 Area Phase I Status Report [NASA, 2013b~~a~~]). Elevated vadose zone soil vapor concentrations identified within MSVM and MSVGM wells subsequently installed in the 200 Area adjacent to Building 200 were discussed in Section 4.3.2.1 of the 200 Area Phase II Investigation Report (NASA, 2015b). Of particular interest is the soil vapor isopleth map for TCE discussed in Section 6.3.3 that identifies RBC exceedances at the former Clean Room Tank HWMU adjacent to Building 200. The elevated TCE concentrations on the northwest side of Building 200 and a comparison to WSTF RBCs are further discussed in Section 7.3.3. A recommendation in Section 8.3 identified the need for a quantitative assessment of the vapor pathway for Building 200 near the location of the former Clean Room Tank; also known as the 200 Area West Closure HWMU.

Soil vapor concentrations in the vadose zone below the 600 Area Closure were first evaluated during the 600 Area Closure Investigation (NASA, 2011a). NASA recommended interim vadose zone soil vapor and groundwater monitoring to assist with the upcoming implementation of the 200 Area investigations. Four *200/600 Area Semi-annual Soil Vapor and Groundwater Data Summaries* were subsequently provided to NMED, culminating with the fourth sample event in March 2013 (NASA, 2013c). MSVM well 600-SGW-2 located on the south corner of the closure was identified as the location well where a single COPC (TCE) exceeded the WSTF RBC. The maximum soil vapor concentration levels for Freon 11, Freon 113, and TCE in the 600 Area MSVM wells were subsequently identified in the deepest port of well 600-SGW-5 at 137.5 ft. These are discussed in Section 4.3.2.3 of the 200 Area Phase II Investigation Report (NASA, 2015b) and do not exceed WSTF RBCs.

The evaluation of potential vapor intrusion in the 600 Area was added to the VIAWP following communications between NASA and NMED following completion of the 200 area Phase II investigation (NASA, 2015b). Following several vadose zone investigations at the 600 Area HWMU, NASA concluded that the source of soil vapor contaminants beneath the 600 Area HWMU is the underlying groundwater. In a November 25, 2015 letter to NMED (NASA, 2015c), NASA proposed an assessment of the 600 Area Building 637, located southeast of the 600 Area HWMU, as the closest structure and primary potential target for exposure. The approach of utilizing Buildings 200 and 637 for the same assessment ensured consistent evaluation of the vapor intrusion pathway at the 200 West Closure and 600 Area HWMUs.

2.3 Operational History

2.3.1 200 Area Activities

The operational history of the 200 Area is provided in the 200 Area HIS (NASA, 2012b). Descriptions are provided for the two 200 Area East Closure USTs, the two West Closure USTs, and seven SWMUs (SWMUs 4 through 10) as identified in the Permit. Six potential AOIs were identified within the HIS (the Chemistry Laboratory Acid Tank Drain Pipe, an additional Building 203 industrial drain pipe, the Chemical Storage Building 253, the 270 Area Military Transport Vehicle Fire Suppression Test Area, two additional 200 Area historical burn pits, and the 250 Area Possible Septic Tank Drainage Source). These areas were evaluated during the 200 Area Phase I shallow soil vapor field investigation.

The 200 Area became operational in 1964 to support propulsion testing facilities for the Apollo program. The Clean Room was first used for the precision cleaning of equipment in 1967 and began to evaluate flammability and toxicity characteristics of materials used in the Apollo spacecraft. By 1970, the Apollo program focused on materials' testing capability for oxygen and propellant-exposure environments. As materials' testing expanded at WSTF, five test facilities were developed, four within or near the 200 Area: the Chemistry and Metallurgical Laboratories (200 Area), the High-Flow Components Facility (250 Area), Hazardous Hypervelocity and Detonation Facilities (270 and 272 Areas), and the Materials Test Facility (800 Area). The 800 Area Materials Test Facility was completed between 1975 and 1979, the 250 High-Flow Components Area was completed between 1989 and 1990, and the 270 and 272 Hypervelocity and Detonation Areas were completed between 1987 and 1991.

In a pollution abatement report to NASA headquarters in June 1984, NASA proposed constructing aboveground evaporation tanks at WSTF to store hazardous waste in order to cease using the 200 Area USTs and the 600 Area surface impoundments (which were not specifically designed for hazardous waste disposal). In the interim, NASA proposed constructing a hazardous waste drain line that would transport (by gravity) 200 Area hazardous wastes directly to the 600 Area surface impoundments. On April 22, 1986, it was discovered that the 8-inch (in.) long vertical carbon steel nozzle on the Clean Room tank (II) had corroded away, and there was an elliptical breach approximately 8 in. by 10 in. in the top of the Clean Room tank (II). Both Clean Room tanks were removed, and the remaining tanks were drained in November 1986. During tank removal, it was discovered that the bottom portion of tank I had completely corroded.

2.3.2 600 Area Activities

The operational history of the 600 Area is summarized in the 600 Area Closure Investigation Work Plan (NASA, 2009). In the mid-1960s, the 600 Area surface impoundments were designed to contain the saltwater backwash produced from regenerating the zeolite beds in the WSTF water softening plant located to the south. The impoundments received the saltwater backwash through an 8-in. diameter pipeline from 1964 to 1984.

From 1968 to 1986, 4,000 to 12,000 gallons of hazardous waste were transported by tanker truck from the 200 Area Clean Room and Chemistry Laboratory Tanks to the surface impoundments per week. White Sands Missile Range's High Energy Laser System Test Facility also contributed process waste from September 1983 to June 1984. The Hazardous Waste Transmission Line (SWMU 10) was constructed in May of 1986 to transport waste from the 200 Area Laboratories to the 600 Area surface impoundments. One month later, on June 13, 1986, the 600 Area impoundments were closed in response to an EPA order, and the pipeline was re-routed to nearby stainless steel tankers for transportation of wastes to an off-site RCRA disposal facility.

2.4 Environmental Setting

The topography at WSTF is typical of the Basin and Range physiographic province of the southwestern United States. The area is characterized by late Tertiary extensional tectonism, with linear mountain ranges separated by broad intermontaine basins in a northwest-trending direction. The adjacent San Andres Mountains (SAM) adjacent and east of WSTF represent an uplifted northwest-trending mountain block that is separated from adjacent mountain ranges to the west by the southern JDMB. WSTF is located on the alluvial-covered bedrock pediment slope that separates the eastern foothills of the SAM from the JDMB.

2.4.1 200 Area and 600 Area Surface Conditions

The 200 Area industrial complex is constructed on a pediment of thin alluvium (18 to 50 ft in thickness) overlying Permian limestone bedrock (Figure 2.4) at an elevation of approximately 4,930 ft above mean sea level. Pennsylvanian to Permian limestones crop out approximately 1,000 ft to the east on the east side of Gardner Spring Arroyo (GSA). The 200 Area is located immediately west of and is bound on the south by the GSA drainage as it diverts westward and downgradient toward the axis of the JDMB (Figure 1.2). Gardner Spring is the only natural surface water feature in the area and is located approximately 2,000 ft northeast of the 200 Area industrial complex within GSA. It is an intermittent spring and ceases to flow for long periods of up to several years between rare periods of heavy mountain-front rainfall.

The 600 Area complex in the vicinity of Building 637 is located on top of an alluvial pediment approximately 150 ft thick overlying Tertiary andesitic bedrock (Figure 2.5) at an elevation of approximately 4,755 ft above mean sea level. No significant drainages are present within the immediate area, and GSA is located approximately 1,500 ft north of the 600 Area HWMU as it moves west toward the JDMB.

Soils in the vicinity of the 200 and 600 Areas are classified as Tencee-Nickel Association Gently Sloping and Steep units (United States Department of Agriculture Soil Conservation Service, 1976). The Tencee Series is comprised of shallow, well-drained soils which formed in calcareous gravelly loamy alluvial sediments on old alluvial fans. The soil is slightly hard, dry, and very friable with common interstitial pores. The soil is approximately 30 to 45% caliche and gravel, is strongly calcareous, and has nearly continuous lime coatings on all clasts. The Nickel series soils comprise deep, well-drained soils on old alluvial fans. They are gravelly, medium textured alluvial sediments with gravel contents to 50%. The Tencee-Nickel, Gently Sloping unit is approximately 65% Tencee Very Gravelly Loam and 20% Nickel Fine Sandy Loam. The soil is nearly level to gently sloping and occurs on old alluvial fans. Included within these soils are arroyo bottoms and areas of soils similar to Tencee and Nickel soils except that they contain less than 35% coarse fragments. The Tencee-Nickel, Steep unit is approximately 45% Tencee Very Gravelly Loam and 40% Nickel Fine Sandy Loam.

The area is characterized by a Chihuahuan Desert Shrub climate, with abundant sunshine, low humidity, slight rainfall, and a large day-to-night temperature variance. The adjacent mountainous terrain influences the climate by blocking the incursion of moisture laden maritime air masses. Sparse biotic resources are typical of those found in the arid southwest. The average rainfall of 10 in. per year makes it difficult to support agriculture. As is typical with all deserts and semi-arid areas, the overall species diversity is low. Vegetation includes a combination of woody shrubs and grasses. These shrubs include Louisiana white sage, creosote bush, honey mesquite, tarbush, broom snakeweed, and lotebush. Common grasses include alkali sacaton, side-oats grama, fluff grass, tobosa grass, and purple three awn. Plant species biodiversity is low relative to that in better drained upland slopes. Shrubs provide a microhabitat for warm season grasses and forbs as well as herptiles and small mammals. WSTF is considered to be a low affectability area, with little capacity to be influenced by physical stimuli. The facility receives little use by wildlife species because it has been physically altered by human disturbance.

2.4.2 200 Area and 600 Area Subsurface Conditions

The predominant alluvial lithology across the area is the poorly indurated piedmont slope facies of the Camp Rice Formation (Seager, 1981). Vadose zone alluvium in the 200 Area (Figure 2.4) and 600 Area (Figure 2.5) near the buildings of interest consists of coalescent alluvial fan deposits derived from the adjacent SAM to the east. The alluvium is an unconsolidated to locally cemented, poorly sorted polygenetic pebble to boulder conglomerate. Lenticular sandy to clayey gravels, sandy silt, and silty clays are interbedded with the conglomerate. Clast lithologies include varieties of subrounded to subangular granite, rhyolite, siltstone, and micritic limestone in sand to boulder-size clasts.

2.4.2.1 200 Area

Previous 200 Area vadose zone investigations have identified moderately cemented caliche horizons a few inches thick at depths ranging from 2 ft bgs to 65 ft bgs. Significant barriers to soil vapor migration have not been encountered within 200 or 600 Area soil borings (e.g., NASA, 1996, 2015c). Well-formed drainages like the GSA that drains south and subsequently west between the 200 Area and 600 Area HWMUs host younger piedmont slope alluvium, characterized by unconsolidated silt, sand, gravel, and loam within the arroyo floor. Alluvial fan materials visible in cut sections of the GSA are indicative of irregular channeled morphologies with grain sizes ranging from clay to well-graded sandy gravel.

Alluvium overlies Pennsylvanian to Permian age limestone bedrock, which occurs at variable depths due to faulting in the area and irregular erosion of the pre-alluvial bedrock surface. The 200 Area bedrock has been fractured pervasively, predominantly on an orthogonal system, with one fracture set trending northeast-southwest and the other fracture set trending northwest-southeast. The shallowest bedrock in the industrialized 200 Area is located in the vicinity of SWMU 4, the Clean Room Discharge Pipe (14 ft bgs), southwest across Road L at well 200-F (17 ft bgs), and at the adjacent 200 Area Clean Room Tank across Apollo Boulevard to the east (18 ft bgs). This accounts for the primary bedrock high in the vicinity of the 200 Area West Closure.

2.4.2.2 600 Area

Alluvium in the vicinity of the 600 Area HWMU is between 140 and 160 ft thick and overlies poorly fractured Tertiary Orejon Andesite bedrock. Fracturing is sparse based on the observation of camera logs recorded in 600 Area HWMU boreholes utilized for groundwater wells, with individual calcite-filled hairline fractures often separated by several tens of feet. Permian limestone is topographically and hydrologically upgradient, juxtaposed against the andesite along the Hardscrabble Hill Fault which lies east of the 600 Area HWMU and Building 637.

2.5 200 Area and 600 Area HWMU Description

2.5.1 200 Area Clean Room Tank Location and Use

A detailed description of the 200 Area Clean Room Tank located in Building 200 is provided in the HIS (NASA 2012b). Activities in the 200 Area Clean Room included the precision cleaning of propulsion system components using solvents and degreasers. Wastes included dilute solutions of organic solvents, heavy metals, inorganic salts and various formulations of Oakite Brand cleaning solutions. Wastes generated from cleaning activities were gravity fed through single-walled stainless steel pipes to the UST located west of the former front of Building 200, in front of the laboratories complex.

The original carbon steel Clean Room tank (I) had a 2,000-gallon capacity, was 14 ft long by 5 ft in diameter, and was installed in 1964. Drawings for this tank do not show corrosion protection. This original Clean Room tank (I) was used until late 1978 or early 1979 and abandoned in place. A new underground Clean Room tank (II) was installed in late 1978 or early 1979 approximately 50 ft to the west of the original tank (I). This carbon steel tank had a 4,000-gallon capacity and was 19 ft long, 6 ft in diameter with a 5/16-in. thick shell. This new tank is believed to have contained external corrosion protection. Wastes were gravity-drained from 50-gallon sinks and the sump of the outdoor Clean Room pad to the tank using 3-in. diameter, schedule 10, grade 304 stainless steel lines. The tank was connected to the drain lines using 3-in. schedule 40 carbon steel. Prior to 1968, excess wastes from the original Clean Room tank (I) were discharged to grade. This process was discontinued in 1968, and the Clean Room tank was used as temporary storage.

2.5.2 600 Area Surface Impoundments Location and Use

A detailed description of the 600 Area HWMU is provided in the 600 Area Closure Investigation Report (NASA, 2011a). The surface impoundments, constructed in 1964, consisted of two adjacent individual 150 ft x 350 ft x 3 ft deep cells, separated by a narrow central berm, and lined with an 8-mil polyvinyl chloride (PVC) liner. This liner was protected by an overlying layer of rip-rap, consisting of large gravel and wire mesh, and sand. The cells received saltwater backwash through an 8-in. diameter pipeline from 1964 to 1984. There is no indication that this pipeline was used at any time for hazardous waste. HWMU closure activities commenced on November 7, 1988, and following construction of the closure, vent wells were installed on May 26, 1989. Concrete lined drainage ditches were constructed along the north, south and east sides of the cap to support the drainage of surface water.

2.6 Previous Vadose Zone Investigations Delineating Contaminant Distribution

The concentrations and distribution of vadose zone soil vapor contaminants in the 200 and 600 Area HWMUs have been defined by previous comprehensive vadose zone investigations (NASA, 2011a, 2013b~~a~~, 2015b) that have all been approved with modifications by NMED (NMED, 2011a, 2013b, 2015a, 2015b). Subsequent monitoring of 200/600 Area soil vapor distribution has been performed through contemporaneous semi-annual sampling of all accessible multiport soil vapor monitoring ports in the 200 and 600 Areas along with groundwater sampling at underlying or nearby locations (NASA, 2012a, 2012d, 2013c~~b~~, 2015b). The 200 Area Phase II IR (NASA, 2015b) presented the results of the latest comprehensive soil vapor sampling event in the 200 and 600 Areas conducted in October 2014.

2.7 Contaminants of Potential Concern

The VIAWP (NASA, 2016) presented a list of 13 VOCs known to have been managed in the 200 Area USTs and potentially discharged at SWMUs during historical operations including: TCE; PCE; Freon 11; Freon 113; 2-butanone (methyl ethyl ketone); 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol (isopropyl alcohol). Waste management practices at WSTF have been continually modified and improved through time to effectively minimize, document, store, and dispose of wastes. Wastes generated in the 200 Area were transported to the 600 Area surface impoundments. The VOCs placed in the 600 Area impoundments were the same as those stored in 200 Area USTs.

2.8 Site Conceptual Exposure Model

A preliminary site conceptual exposure model (SCEM) was developed as part of the 200 and 600 Area VIAWP (NASA, 2016b; Figure 2.6) to provide an understanding of the potential for exposure to hazardous contaminants at the site based on the source of contamination, the release mechanism, the exposure pathway, and the potential receptor(s). Please see Section 6.1 for the SCEM revised based on the results of this investigation.

2.8.1 Contamination Sources

The former UST locations at the 200 Area Clean Room tanks and the 600 Area surface impoundments were the primary contaminant sources. Secondary sources include groundwater directly impacted by releases and soil vapor derived from groundwater that filled fractures within bedrock and pore space within the overlying soils. Subsurface vadose zone soils in the 200 and 600 Areas that were once impacted by the releases have been evaluated through sampling extensively. The soils have been shown to be non-hazardous in nature and are not considered a continuing source of contaminants to groundwater (NASA 2015c, 2011a).

2.8.2 Release Mechanisms

Vadose zone contamination at the 200 Area Clean Room HWMU and 600 Area surface impoundments HWMU resulted from the release of hazardous constituents into the vadose zone between 1964 and 1986. Release mechanisms comprised the infiltration of liquid-phase contaminants into the vadose zone, downward to the groundwater table by the hydrodynamic processes of gravity and precipitation, and infiltration of the vadose zone pore space as vapor-phase contamination.

2.8.3 Potential Exposure Pathways and Receptors

Potential present-day receptors identified in the vicinity of the 200 and 600 Area HWMUs are industrial/occupational workers who occupy buildings adjacent to the HWMU areas while performing their daily duties. The primary potential present-day exposure pathway for these WSTF industrial/occupational site personnel in the 200 and 600 Area buildings addressed in this investigation is the inhalation of volatile contaminants derived from soil vapor and potentially present in indoor air. Soil vapor contamination has been identified from past investigations in the vadose zone near WSTF industrial area buildings (NASA, 2015c, 2011a). Additionally, present-day receptors in Buildings 200 and 637 are potentially exposed to residual soil contamination in the vicinity of these buildings.

Building 637 is situated approximately 100 ft away from the 600 Area surface impoundments HWMU that is the source of VOC releases. In the future, if the HWMU closure cap is removed or compromised and a building is situated at that location, building occupants could be exposed to VOCs when entering that building through vapor intrusion. Because Building 200 is adjacent to the former 200 Area West UST that is the source of VOC releases from the 200 Area Clean Room, potential future receptors for this HWMU are identical to present-day receptors.

There are no current or future residential land use scenarios anticipated in the vicinity of the 200 or 600 Area HWMUs. WSTF is a controlled test site located on the U.S. Army White Sands Missile Range. There are no encroaching residential areas and no present or future residential land use scenarios in this SCEM, though contaminants were screened to the most conservative residential levels. A cumulative risk screen evaluation in conformance with Risk Assessment Guidance has been provided in Section 6.1 as a supporting line of evidence for acceptable risk levels.

The groundwater underlying much of the WSTF industrialized source areas is known to be contaminated and its future use and potential risk to receptors are part of ongoing site-wide evaluations and corrective actions. The water supply wells for the 200 and 600 Areas are located several miles to the west of the investigation areas and are not contaminated. These wells are monitored regularly for the presence of known WSTF groundwater contaminants. A groundwater assessment was not conducted specifically as part of the vapor intrusion assessment. Groundwater assessment activities are regularly reported in NASA's quarterly Periodic Monitoring Reports (NASA, 2018a). These data are also available for review in conjunction with results of the VIAR.

3.0 Scope of Activities

The area of concern on the west side of Building 200 is located directly above the footprint of the 200 Area Clean Room Tank HWMU adjacent to MSVM wells 200-SV-05 and 200-SV-09, and MSVGM well 200-LV-150 (Figure 3.1). The area of concern within Building 637 is approximately 100 ft southeast of the southeast margin of the 600 Area HWMU in close proximity to MSVM wells 600-SGW-1, 600-SGW-2, and 600-SGW-5 (Figure 3.2).

The following additional sampling activities were performed as part of this assessment to evaluate the existence of a complete exposure pathway.

- Sample and evaluate VOC concentrations (including COPCs) in soil vapor in the upper vadose zone utilizing MSVM and MSVGM well ports located in the vicinity of the buildings.
- Sample and evaluate VOC concentrations (including COPCs) in indoor air and outdoor air.

The following activities were performed as part of the vapor intrusion assessment. Some of the preliminary required vapor intrusion activities identified in Steps 1 and 2 of Section 1.4 had already been performed as part of previous investigations in the 200 and 600 Areas (NASA, 2013b~~a~~, 2015c, 2011a).

- Identification of the appropriate vadose zone soil vapor sampling locations (based on the previous 200 Area HIS, 200 and 600 Area IRs, and soil vapor sampling events in the 200 and 600 Areas).
- Determination of a representative number of soil vapor and air samples, specification of the frequency and duration of sampling, and identification of the sampling and analytical methods to be employed.
- Daily planning sessions and health and safety briefings.
- Field collection of soil vapor samples from the uppermost vadose zone located adjacent to the target buildings.
- Field collection of indoor air samples within the buildings and outdoor samples adjacent and upgradient of the buildings.
- Documentation, management, and shipment of soil vapor and indoor and outdoor air samples (including field quality control [QC] samples).
- Performance of laboratory analyses by an accredited laboratory (including laboratory QC samples), analytical reporting, and data processing using the established WSTF data management system.
- Evaluation and interpretation of technical and analytical data for use in development of a final VIAR.

3.1 Data Quality Objectives

The assessment approach was based on “Guidance on Systematic Planning Using the Data Quality Objectives Process” (DQOs; EPA, 2006), the Corrective Action Site Investigations requirements of the Permit (NMED, 2023~~16~~; Part 3~~Section VII.H~~), and Risk Assessment Guidance for Site Investigations and Remediation (NMED, 20~~19~~22c~~b~~). The data acquisition plan (i.e., sampling design) is based on the data quality objective process. The DQOs addressed the qualitative and quantitative nature of the sampling data to ensure that any data collected was appropriate for the intended purpose. Development of the DQOs considers precision, accuracy, representativeness, completeness, comparability of the data, sampling locations, laboratory analyses, detection limits, data quality, and the employment of adequate quality assurance/quality control measures. The VIAR documents the DQO procedures that were followed to assess the potential migration pathway between vadose zone soil vapor contamination and indoor air.

3.1.1 Problem Statements

The 200 Area Clean Room HWMU USTs leaked contaminants to the vadose zone, comprising approximately 18 ft of porous alluvial soil overlying fractured limestone bedrock. The tanks were located at a depth of between 8 and 12 ft bgs. The water table is located at a depth of 140 ft bgs. Soil samples collected during the installation of adjacent soil borings indicated that soil samples did not exceed the regulatory criteria applicable at the time of the investigation and soil remedial action was not required (NASA, 2015c). Groundwater in the area exceeds the NMED cleanup level for TCE. Soil vapor concentrations from samples collected in adjacent MSVM wells and a MSVGM well exceeds NMED VISLs for TCE, PCE, and Freon 113 and the WSTF RBC for TCE. The HWMU is located directly below a northwestern extension of Building 200 that is currently operated by an industrial/occupational labor force. The inaccessible location of this HWMU is the primary constraint to the vapor intrusion assessment (Figure 2.4).

Contaminants from the 600 Area HWMU may have been leaked to the vadose zone characterized by approximately 146 ft of porous alluvial soil overlying poorly-fractured andesite bedrock. A perched (and potentially temporary) water table is currently encountered at a depth of 143 ft bgs, which may be sourced from groundwater recharge during heavy rainfall and up to this time from the adjacent 600 Area Overflow Lagoons that are currently in the process of being removed. Soil samples collected during the installation of soil borings through the Closure cap to bedrock indicated that soil samples did not exceed the regulatory criteria applicable at the time of the investigation and soil remedial action was not required (NASA, 2011a). Groundwater in the area exceeds the New Mexico cleanup level for TCE. Soil vapor concentrations from samples collected in adjacent MSVM and MSVGM wells historically exceed NMED VISLs for TCE, PCE, and Freon 113. The 600 Area HWMU is located approximately 160 ft from Building 637 that is operated by an industrial/occupational labor force.

3.1.2 Study Goals

The primary decision is whether additional corrective actions are warranted at the 200 and 600 Area targets (identified through previous investigation) as a result of the intrusion of soil vapor VOCs from the vadose zone into nearby buildings affecting the indoor air quality. Alternative actions for the decisions include:

- Consider a “Corrective Action Complete” status determination.
- If required, perform a corrective measures evaluation for the site(s) to identify remedial options for mitigation of source(s) of continuing contamination or human health risk.

3.1.3 Information Inputs

The results of previous investigations performed in the 200 and 600 Areas provide information for this VIAR. The results of these previous investigations are documented within the 200 Area HIS (NASA, 2012b), the 200 Area Phase I Status Report (NASA, 2013b~~a~~), the 200 Area Phase II IR (NASA, 2015c), and the 600 Area Closure IR (NASA, 2011a), including:

- Detailed investigation pertinent to the establishment and operational history of the 200 and 600 Area HWMUs.
- Analytical data sets for soil (as part of the risk/hazard screening), soil vapor, and groundwater samples collected during previous investigations at the 200 and the 600 Area HWMUs.

The primary data inputs for the VIAR are the analytical results of soil vapor, indoor air, and outdoor air sampling described in Sections 3.0 and 4.0 of this report.

Two types of soil vapor screening criteria are used as inputs to assess potential risks related to the soil vapor data. These include NMED VISLs (NMED, 20~~19~~22c~~b~~) and WSTF RBCs (NASA, 2019a). NMED VISLs are applicable to soil vapor concentrations present immediately below a building foundation, from where vapors may enter a building. WSTF RBCs are calculated for various depths below a building foundation, and therefore can potentially be applied to assess soil vapor risks from data collected at different depths. Indoor air screening criteria used in this VIAR are taken from NMED (20~~19~~22c~~b~~), and the EPA (EPA, 2019) if no values were provided by NMED. See also Table 1.1 and Section 1.5.

3.1.4 Spatial Extent of Assessment

The horizontal study boundaries are shown in Figure 1.2. The vapor intrusion pathway that is considered a primary potential threat and requires priority assessment is typically for buildings located within 100 ft of the vadose zone soil vapor plume that exceeds established soil vapor RBCs. In this case, NMED VISLs and WSTF RBCs were utilized to identify the targets of greatest concern.

In the 200 Area, soil vapor from the three most proximal MSVM and MSVGM wells located within 85 ft of the former Clean Room Tanks HWMU and air from the most proximal tier of indoor rooms on the west side of Building 200 within a distance of 100 ft of the footprint of the HWMU was evaluated (Figure 2.4). In the 600 Area, soil vapor from the three most proximal MSVM wells within 240 ft of Building 637, and the indoor air within Building 637 (Figure 2.5) were evaluated.

The vertical boundaries of the study are constrained between a maximum depth of 34 ft in the vadose zone as characterized by the maximum depth of upper ports in MSVM and MSVGM wells utilized and the industrial/occupational worker breathing zone of between 3 and 5 ft above ground surface.

3.1.5 Decision Rule

The vapor intrusion assessment addresses COPC soil vapor concentrations within the upper vadose zone surrounding the target buildings and COPC air concentrations inside the buildings. The assessment was performed to determine if a complete pathway is present and whether contaminants are present at concentrations at or above the latest NMED VISLs (NMED, 20~~19~~22c~~b~~) and WSTF RBCs (NASA, 2019a). Updated RBCs were determined concurrently with the pre-assessment planning and preparation phase for this vapor intrusion assessment. ~~Although Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) are referenced in the VIAR for comparative purposes (Table 1.1), they are not considered appropriate criteria for the final decision process of evaluating the risk associated with vapor intrusion. PELs are intended to regulate an employee's exposure to workplace air contaminants as opposed to air contaminants originating from the subsurface.~~

Decisions were structured as follows.

- If the subsurface vadose zone VOC contribution to indoor air levels exceeds indoor air NMED VISLs and updated NMED-approved WSTF RBCs as a result of a confirmed complete exposure pathway under the industrial/occupational worker scenario, then there is an unacceptable current and future risk to building occupants. These levels must be specific to vapor intrusion as opposed to an artifact of an alternate process identified within the building. Corrective action, removal and/or remediation are necessary.
- If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below indoor air NMED VISLs and WSTF RBCs, then current vapor intrusion risks are acceptable.
- If the vapor intrusion assessment fails to fully determine the nature, source, and extent of indoor air contamination, additional investigative measures may be required.

3.2 Assessment Activities

Two semi-annual sampling events (seasonal events within the summer [August 2017] and winter [February 2018]) were performed to address the potential issue of seasonal building pressure gradients that can influence vapor intrusion into buildings. Indoor and outdoor air pressures were not observed to vary significantly (all readings were approximately 30 in. of mercury for both sampling events). Early morning outside temperatures for the August event (67-70 degrees Fahrenheit) were significantly higher than for the February 2018 event (34 to 37 degrees Fahrenheit), with indoor air temperatures maintained in the vicinity of 70 degrees Fahrenheit for both buildings. VOC levels in ambient air can vary over time and may fluctuate diurnally due to the ebb and flow of industrial/occupational activity, and as a result of atmospheric heating and cooling cycles, air pressure changes, and wind speed. During winter months, heated air rises within buildings and exits through the roof. This reduces indoor air pressure, may draw in soil vapor, and potentially increases vapor intrusion rates.

3.2.1 Vadose Zone Soil Vapor Sample Locations and Schedule

Soil vapor samples were collected from the shallowest soil vapor port within the three MSVM or MSVGM wells located closest to the 200 Area and 600 Area target buildings. In the 200 Area, the three wells are all located within 84 ft of the west side of Building 200. In the 600 Area, the three wells are all located within 260 ft of Building 637. The soil vapor wells and specific ports that were sampled are listed below.

- Adjacent to the 200 Area Clean Room Tank HWMU (Figure 3.1, Table 3.1)
    - 200-SV-05 at 9 ft
    - 200-SV-09 at 19 ft
    - 200-LV-150 at 34 ft
- Nearby the 600 Area HWMU (Figure 3.2, Table 3.1)
    - 600-SGW-1 at 12.5 ft
    - 600-SGW-2 at 12.5 ft
    - 600-SGW-5 at 7.5 ft

Six vadose zone samples from the vapor monitoring well network and one duplicate sample were collected from the 200 and 600 Area MSVM and MSVGM wells for each soil vapor sampling event. Additional field QC samples are provided in Section 3.2.3. Two consecutive semi-annual sampling events were performed in August 2017] and February 2018. A total of 14 vadose zone soil vapor samples were collected.

3.2.2 Indoor and Outdoor Air Sample Locations and Schedule

The number and locations of indoor and outdoor air samples was established in the VIAWP (NASA, 2016b) based on building size, proximity to the potential intrusion source, the scale of the vadose zone vapor impact, subsurface heterogeneity, and sample purpose. Increased sample density is typical of a nearby spill or release and heterogeneity in the subsurface. Because no releases have been identified in soil, the soils are relatively homogeneous and porous, and a fractured bedrock and groundwater VOC source is inferred, sample densities were compared to standard guidance (e.g., ODEQ, 2010). Typical sample densities in buildings between 1,000 square feet (sq ft) and 10,000 sq ft in size are one sample per 1,500 sq ft. The sample locations identified in this VIAR (Figure 3.1, Figure 3.2) have a greater density than the standard guidance.

Where rooms exceed 500 sq ft in size as in the case of Building 200, samples were collected at a frequency of approximately one sample per 500 sq ft. Samples were collected within the normal breathing zone at a height of between 3 to 5 ft above the building floor. Ambient outdoor air samples were collected at the same time and using the same method as the indoor samples at each of the two building locations. Indoor and outdoor air sample locations are summarized below.

- Building 200 – Preparation Building (Figure 3.1, Table 3.2)
    - Eight indoor air samples within individual rooms in the areas above and adjacent to the subsurface footprint of the former 200 Area Clean Room Tank HWMU.
    - Two outdoor air samples adjacent to Building 200 near the former 200 Area Clean Room Tank HWMU at locations upgradient of the prevailing wind direction on the day of sampling.
    - One sample duplicate.

- Building 637 – Groundwater Assessment Building (Figure 3.2, Table 3.2)
    - Four indoor air samples in Building 637 distributed in the four quadrants of the single room building.
    - Two outdoor air samples adjacent to the Building 637 on the northeast side at locations upgradient of the prevailing wind direction on the day of sampling.
    - One sample duplicate.

A total of 16 indoor and outdoor air samples and two duplicate samples were collected for each sampling event performed for a total of 18 samples during each event. Two consecutive semi-annual indoor and outdoor air sampling events were performed in August 2017 and February 2018. A total of 36 indoor and outdoor air samples were collected during vapor intrusion assessment fieldwork.

3.2.3 Sampling Procedures

NASA has developed comprehensive internal procedures for soil vapor sample collection and management. These procedures provide specific information on sample management and related documentation, including instructions for sample custody (internal to NASA and external during shipment), storage, packaging, shipment, delivery tracking, and related recordkeeping. These procedures were followed during this assessment to ensure appropriate sample management. Sampling procedures and the equipment used follows generally accepted EPA guidance (EPA, 2015a). Sample collection techniques and flow rates conformed to the specifications for the appropriate EPA sample collection method. Soil vapor samples from MSVM and MSVGM wells, indoor samples, and outdoor samples for each area was collected contemporaneously on the same day within each area. Samples from the 200 and 600 Areas were collected on consecutive days for both semi-annual sampling events. The two semi-annual sampling events were 182 days apart. The following generalized procedures were followed:

- Sampling start times and the initial vacuum gauge readings were recorded in the field sampling logbook and on the internal chain-of-custody (CoC) form.
- For indoor and outdoor air samples, a flow-controller was to be affixed to the canister prior to sampling at a rate pre-set by the laboratory to provide for collection of the samples over an 8-hour period. The indoor and outdoor sampling periods were the same in length, but the outdoor air samples were initiated approximately one hour before starting the indoor samples to reduce potential errors. The EPA estimates that indoor air undergoes a complete exchange every one to two hours. Initiating outdoor air sampling early compensated for this potential lag time.
- Sample valves on each canister were opened to perform sample collection.
- Upon the completion of vadose zone, indoor air, and outdoor air sampling, the valve on the passivated stainless steel canister was closed and the time and ending vacuum pressure recorded in the field sampling logbook and on the internal CoC form.
- Canisters and flow-controllers were shipped back as a single shipment to the analytical laboratory for each of the two semi-annual sampling events.

Disposable gloves were worn to collect soil vapor and indoor air samples and were changed between sampling locations. Gloves and other disposable materials contacting the samples were collected and managed in accordance with the IDW Management Plan in the VIAWP (NASA, 2016b; Appendix A).

Field QC samples were collected to ensure high quality data are generated during the assessment, and were analyzed for the same parameters as the primary samples.

- Indoor and outdoor duplicate samples were collected at a rate of 10% of the project sampling locations (two samples per sampling event).
- Field blanks (one outdoor and one indoor for each of the two target buildings in the 200 Area and 600 Areas at a rate of four samples per sampling event).
- Trip blanks (one per sample shipment).

The samples were managed according to established site procedures that included labeling, CoC documentation, storage, packing, and expedited overnight shipment to the analytical laboratory for analysis.

3.2.4 Analytical Tasks

Soil vapor samples were analyzed using EPA Method TO-15 in order to achieve the assessment DQOs. NASA typically contracts services from off-site National Environmental Laboratory Accreditation Program-accredited analytical laboratories as required to support program and project needs. The analytical tasks required to achieve the project objectives was awarded to the ALS Environmental laboratory. Potential laboratories must respond to a comprehensive statement of work developed to meet the project objectives defined in this VIAR. Analytical standard operating procedures (SOPs), laboratory quality manuals, and other laboratory-specific documentation are provided by the analytical laboratory following award of the contract and are not available in advance. These documents are retained in the project record and are available for NMED review as required.

The overall objective for laboratory analysis is to produce data of known and sufficient quality. Appropriate procedures and QC checks were used so that known and acceptable levels of accuracy and precision are maintained for each data set. All samples were analyzed by a fully qualified laboratory in accordance with the laboratory’s Quality Plan, which ensures that the contract laboratory adheres to standardized analytical protocols and reporting requirements and is capable of producing accurate analytical data.

Method blanks and laboratory QC samples are prepared and analyzed in accordance with the laboratory’s method-specific SOPs. The analytical results of method blanks were reviewed to evaluate the possibility of contamination caused by analytical procedures. At a minimum, the laboratory analyzed method blanks and laboratory control samples at a frequency of 1 in 20 for all batch runs.

3.2.5 Health and Safety

Field activities were conducted in accordance with requirements of Occupational Safety and Health Administration~~SHA~~ Standards for Hazardous Waste Operations and Emergency Response ([HAZWOPER]; 29 Code of Federal Regulations [CFR] 1910.120 [a] – [o], 2013). The WSTF environmental contractor’s corporate-wide Safety and Health Plan (SHP) was augmented with site-specific Job Hazard Analyses to address potential hazards foreseeable for the project and was followed in accordance with applicable requirements of the standards. The augmented SHP addressed safety and health issues pertaining to work activities, including known and reasonably anticipated hazards associated with project scope of work as well as contingencies for unexpected conditions. Project field personnel were required to be current in HAZWOPER training. The SHP was reviewed and approved by the contractor Health and Safety Manager, and no new hazards were encountered that were not addressed by the SHP.

3.2.6 Field Documentation

The field geologist ensured that activities related to this assessment were documented using a field logbook, field data records, and/or any required site-specific procedural documentation. Logbook entries included, as applicable, information such as:

- Standard Daily Header – project name, logbook number, date, weather conditions, team members present and their affiliations (including subcontractors), sample location identification, day's task(s), daily safety meeting topics, required personal protective equipment (PPE), equipment in use, and any calibration information, if applicable.
- Daily activities (time and observations recorded) – site arrival and departure, visitors and the purpose of their visit, vapor sampling information, decontamination (i.e., method, equipment cleaned), reference data sheets or maps, if applicable.
- Daily summary – action items, materials used, changes or deviations made from planned protocol, plan for next day.
- Signatures (field personnel and logbook reviewer).

At a minimum, field records included observations of environmental conditions, sampling conditions, and sample documentation. For analytical samples, the date, location, depth, sample type, collection method, identification number, sampler, and any circumstances, events, or decisions that could impact sample quality were documented by the on-site geologist in the project field logbook. Even though each case may be unique, the geologist must document any conditions that precipitated any decisions for the unsuitability of samples for analyses. In addition to the field logbook entries for sampling events, CoC forms were completed for analytical samples and maintained with project documentation.

Evidential records for the entire project are maintained in hard copy or electronic form and consist of:

- Project VIAR with NMED modifications or deviations redlined.
- Site-specific internal procedural documentation or plans.
- Project logbooks.
- Field data records.
- Sample CoC forms.
- NMED correspondence.
- Final analytical data packages.
- Reports.
- Miscellaneous related records such as photos, maps, drawings, etc.

3.2.7 Investigation-Derived Waste Management Plan

As required in Permit Part 6~~ Attachment 20~~ (Section 6~~20~~.2.13; NMED, 2023~~16b~~), the IDW Management Plan for this vapor intrusion assessment was provided to NMED in the *200 and 600 Area Vapor Intrusion Assessment Work Plan* (NASA, 2016b, Appendix A). The IDW Management Plan provided a description of the potential wastes that could be generated from the 200 and 600 Area as well as procedures for waste management, waste characterization, and waste disposition. Wastes that were generated as part of the assessment comprised: used sampling equipment; PPE; and alcohol free moist wipes used for equipment decontamination.

4.0 Field Data Collection, Assessment, and Review

4.1 Project Documentation

All facets of this assessment were documented in detail by the responsible project personnel. Records are retained in the WSTF Operating Record and can be accessed at any time by authorized WSTF personnel. Sample information and field measurements were recorded in the field logbook by the responsible project field personnel. Records were reviewed by knowledgeable project personnel on a regular basis during the assessment and are retained in the project file. The sample information and field measurements are ultimately archived in the WSTF Records Management System as part of the Operating Record. As required for reporting, these data are also transferred to and archived in operational and historical databases.

4.2 Building Walkthrough Inspections

For most sites, detecting specific COPCs inside a building is not definitive evidence of vapor intrusion since VOCs can also be common contaminants in ambient air and may also have other sources inside buildings. Approximately two weeks prior to collecting the first semi-annual set of indoor and outdoor air samples at Building 200 and Building 637, a pre-sampling inspection was performed to identify conditions that may affect or interfere with the proposed sampling, and where possible to provide temporary mitigation of these conditions. A standard building inspection form (Appendix A; developed from ODEQ, 2010) was used to evaluate the type of structure, floor layout, physical conditions, and airflow of the buildings being studied. The 200 Area building complex includes a network of laboratories and cleaning rooms that contain several of the COPCs identified in Section 2.2 that are commonly used as laboratory chemicals (e.g., acetone, methyl ethyl keytone, isopropyl alcohol).

Potential COPC sources were evaluated within the building by conducting a product inventory and recording the results on the building survey form. The primary objective of the product inventory is to identify potential air sampling interference by characterizing the occurrence and use of chemicals and products throughout the building. This information helped formulate the indoor environment profile. Both Building 200 and Building 637 are single floor structures. Individual rooms were carefully inspected for products and an inventory provided as products stored in another area of the building can affect the air of the room being tested.

An MSA Altair®[2] 5X photo ionization detector (PID) was used for the indoor and outdoor air screening of potential air contaminants (oxygen, carbon monoxide, carbon dioxide, hydrogen sulfide, sulfur dioxide, ammonia, chlorine, and VOCs) at concentrations as low as 1 part per million (ppm). Dry decontamination followed. An alcohol-free moist wipe was used for the PID between screening readings. Any waste materials removed from the equipment and the wipes used were disposed of as IDW and managed in accordance with the VIAWP (NASA, 2016b; Appendix A).

Portable vapor monitoring equipment readings using the PID and a description of any odors present were used to help evaluate potential indoor sources. Where available, chemical ingredients of interest were recorded for each product as best possible. If the ingredients are not listed on the label, each product's exact and full name, and the manufacturer's name, address and phone number, if available were recorded on product inventory forms (Table 4.1, Table 4.2, Appendix A).

Building walkthrough inspections were performed at Building 200 on June 21, 2017, and at Building 637 on June 26, 2017. The junction between walls and the building foundation of the west side of Building 200 and surrounding 600 Area Building 637 were visually evaluated at this time to the best extent

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[2] Altair is a registered trademark of MSA Technology, LLC.

possible for structural integrity, staining, or any other visible defects. No significant foundation issues were identified at either building.

Walkthrough observations were documented using building inspection forms for each of the two buildings (Appendix A) to support evaluation of the vapor intrusion pathway. Each building inspection form includes a product inventory form listing the specific products found in each building that have the potential to affect air quality. Photographs recorded during and immediately following the initial building inspections on June 28, 2017, are provided in Appendix B: Photographs 1 through 18 were taken at Building 200; and~~,~~ Photographs 19 through 26 were taken at Building 637.

4.2.1 Building 200

Building 200 is an industrial building used primarily as a laboratory. The northwest side of the building incorporates machine shops, equipment and materials storage, utility rooms, photo lab, garage, and offices (Appendix A). The building is an insulated single floor structure that was constructed in 1965 The portion of Building 200 on the west side that is of interest relative to the vapor intrusion study is approximately 11,000 square feet in size. The building is cooled using forced refrigerated air through a central air system, with outdoor air infiltration restricted to open doors, door thresholds, windows, and potentially any cracks in the structure walls. Above grade construction comprises sealed concrete walls with some metal paneling in the North Highbay. The floor is composed of poured concrete covered with concrete sealant and 9-in. x 9-in. x 1/16-in. vinyl tile. The heating system relies upon hot air circulation generated using natural gas, which is also used to heat water. The heating and cooling systems are typically run 24 hours a day, seven days a week due to operation of the building as a laboratory. Room 206B (Figure 3.1) was constructed directly above the former fenced yard that was the location for the Clean Room tank HWMU installed in the mid-1960s. The machine shop is equipped with a drill, lathe, and a variety of lubricating oils.

The building is a non-smoking facility and is cleaned as required and on a daily basis on workdays (Monday through Friday) using commercial cleaning materials. A cleaning room is also present for advanced equipment cleaning operations that are performed regularly during the work week. Cosmetics and air fresheners are used regularly by employees. No painting had been performed within the six months preceding the first sampling event, and no new textiles had been installed. Several flume hoods are present on the peripheral interior walls and vent to the outside of the building. Pesticides are applied on a quarterly schedule to address problems with stinging insects, spiders, and scorpions. During the walkthrough, it was noted that several odors were present in the building, which is not atypical of a chemical laboratory. Many individual rooms had distinct odors related to the specific supplies stored within the room. Chemical supplies included solvents and volatile chemicals that are components of oils, lubricants, paints, and adhesives. Potable water is provided by the WSTF supply wells located within the JDMB approximately 5 miles to the west. Sewage is managed through the City of Las Cruces public sanitary system that was connected to the building in 2015. Table 4.1 provides a summary of the products contained within Building 200 as listed within the product inventory form of Appendix A. The products included a variety of glues, acids, paints, flammables, oils, and Freon. Photographs 1 through 18 were taken within a variety of rooms during the walkthrough inspection and are provided in Appendix B.

4.2.2 Building 637

Building 637 is a relatively small and isolated industrial building approximately 1,200 square feet in size (Appendix A). It is used by the WSTF Environmental Department for the groundwater assessment program, primarily for the storage and management of soil, soil vapor, and groundwater sampling equipment and laboratory-provided sample containers. The building is a single floor structure with insulated walls that was constructed in 1992 Airflow through the building is generated by forced air through two evaporative coolers located on the north wall of the building, with outdoor air infiltration through a door and single garage bay door on the northwest side. The above grade construction consists of poured concrete footing and corrugated metal siding sealed with paint. The floor comprises a concrete slab with concrete sealant. Heating is provided by hot air circulation fueled by natural gas. The air conditioning system is typically operated between 7 a.m. to 4 p.m. on workdays on an as-needed basis. The system is usually shut down at weekends when the building is unoccupied. The building contains a workbench with tools and a variety of lubricants in the west corner of the building.

The building is a non-smoking facility. Cleaning products are regularly used to clean work surfaces when required. No cosmetic products are used, no painting had been performed in the six months preceding the first sampling event, no air fresheners are used, and no carpets, drapes, or textiles are present. A pesticide application was performed within a month prior to the building inspection for insects and rodents. Trace odors are present in the building, usually related to chemical preservatives (dilute acids) used for groundwater samples. Potable water is supplied by the WSTF supply wells located within the JDMB approximately five miles to the west. No restroom facilities are present in the building and no sewage management is required. Table 4.2 provides a summary of the products contained within Building 637 as listed within the product inventory form of Appendix A. The products included dilute acid preservatives, cleaning products, oils, lubricants, compressed gas (nitrogen), and fuel in an adjacent outside storage building (gasoline). Photographs 19 through 26 were taken inside and outside Building 637 during the walkthrough inspection and are included in Appendix B.

4.3 Preparation of Buildings

The pre-sampling inspection provided adequate advance notice to the local workforce to minimize potential background sources prior to air sampling through best management practices. At a minimum, it was ensured that containers were tightly sealed. However, no potential sources were actually removed from Building 200 or Building 637. The inability to eliminate potential interference is considered justification for not testing, especially when testing for similar compounds at low levels. Although Freon was observed to be stored in Room 202 where sample B200-IA-05 was located, sample collection proceeded as planned. Room 202 is the former etching room that has been converted to a storage area for various solvents (Appendix A).

Once interfering background sources were removed or minimized to the extent possible, the building ventilation system in Building 200 continued to operate under normal conditions for approximately 48 hours (Friday and Saturday) prior to testing to eliminate residual contamination in the indoor air. Ventilation was accomplished by operating the building’s heating ventilation and air conditioning (HVAC) system. Air samples were intended to represent typical exposure in a mechanically ventilated building, and the operation of HVAC systems during sampling was noted. It was ensured that the building’s HVAC system was operating under normal conditions. In addition, steps were taken to avoid any painting, cleaning, pesticide spraying, or air freshening activities at least two weeks prior to air sampling. No exceptions were noted.

4.4 Field Preparation and Sampling

Vapor intrusion assessment fieldwork included preparation of the buildings to be assessed, sample planning and preparation activities, and sample collection and management. Field activities commenced following appropriate planning and preparation activities and NMED approval of the VIAWP (NMED, 2016a). Field assessment activities required approximately six months in order to complete two semi-annual soil vapor sampling events that were performed in consecutive summer (August 2017) and winter (February 2018) seasons.

4.4.1 Summer Semi-Annual Sampling Event (August 2017)

- Monday August 21 – analytical laboratory sampling equipment and containers shipped to WSTF.
- Friday August 25 – non-working day at WSTF. Buildings 200 and 637 experienced minimal occupation or traffic. HVAC system operating normally 24-7 in Building 200 laboratories. Building 637 HVAC system shut off for weekend.
- Saturday August 26 – Building 637 sampling event performed starting at 0700 hours, completed at 1700 hours.
- Sunday August 27 – Building 200 sampling event performed starting at 0700 hours, completed at 1730 hours.
- Weather conditions at 0700 hours (both days): clear skies, outdoor air pressure approximately 30 in. of mercury, warm with outside temperature 67 to 70 degrees Fahrenheit, trace winds from the northeast at < 2 miles per hour.

4.4.2 Winter Semi-Annual Sampling Event (February 2018)

- Tuesday February 20 – analytical laboratory sampling equipment and containers shipped to WSTF.
- Friday February 23 – non-working day at WSTF. Buildings 200 and 637 experienced minimal occupation or traffic. HVAC system operating normally 24-7 in Building 200 laboratories. Building 637 HVAC system shut off for weekend.
- Saturday February 24 – Building 637 sampling event performed starting at 0700 hours, completed at 1630 hours.
- Sunday February 25 – Building 200 sampling event performed starting at 0640 hours, completed at 1730 hours.
- Weather conditions at 0700 hours (both days): clear skies, outdoor air pressure approximately 30 in. of mercury, outside temperature 34-37 degrees Fahrenheit, no winds.

4.5 Vapor Intrusion Assessment Sampling

The vapor intrusion assessment incorporated soil vapor samples from MSVM and MSVGM wells, outdoor air samples, and indoor air samples. The objective of this sampling was to determine whether indoor air in Building 200 and Building 637 is impacted by intrusion of VOCs from soil vapor. Laboratory containers and analysis were provided by the ALS Environmental Laboratory in Simi Valley, California. Soil vapor grab samples were collected from ports in MSVM and MSVGM wells utilizing 1-liter evacuated canisters provided by the laboratory. Outdoor and indoor air samples for the two buildings targeted for air intrusion analysis (200 Area Building 200 and 600 Area Building 637) were collected in 6-liter canisters equipped with 8-hour flow controllers. All samples were analyzed using EPA Method TO-15 in order to achieve the vapor intrusion assessment DQOs.

4.6 Vadose Zone Soil Vapor Sampling

Soil vapor sampling was conducted following standard site procedures for each of the MSVM or MSVGM well sampling ports. Critical information describing the sampling event was recorded in the field sampling logbooks. Vadose zone soil vapor samples were collected in laboratory-evacuated stainless steel electropolished passivated vessels (passivated stainless steel canisters) certified as clean and provided by the laboratory. The stainless steel construction ensures soil vapor and air samples did not permeate through the vessel wall or degrade due to exposure to light during shipment to the laboratory.

Standard 1-liter canisters were used for soil vapor grab sampling from MSVM and MSVGM wells. These samples were anticipated to be more concentrated than the corresponding indoor and outdoor air samples.

Immediately prior to sampling, the ambient barometric pressure was recorded and vacuum conditions within the passivated stainless steel canisters recorded. Three tubing volumes of air were purged from each sampling port and stainless steel tubing using a LANDTEC®[3] GEM 2000+ gas analyzer to ensure the removal of stagnant air. The pump on a gas analyzer was used to purge the soil vapor well tubing for a minimum of five minutes per zone to evacuate at least three volumes of the ¼ in. tubing and soil vapor port. During purging, concentrations of methane (CH4), carbon dioxide (CO2), and oxygen (O2) indicator parameters were monitored. Each parameter is required to be stable prior to sampling; additional purging was performed as required. A passivated stainless steel canister was then attached to the sampling port, opened, and filled to capacity (Appendix B, Photograph 27). Field QC samples were collected to ensure high quality data were generated during the assessment (Section 3.3.7).

4.7 Indoor and Outdoor Air Sampling

Passivated stainless steel canisters were utilized for indoor and outdoor air sampling. Six-liter volume canisters were used due to the relatively low concentration of analytes anticipated in the indoor and outdoor samples, the 8-hour sampling duration, preferred sampling flow rate for this type of sample, and the sample volume required for the sampling period. Six-liter canisters are typically used to obtain the integrated time-weighted average ambient air samples at sampling times of up to 24 hours. High quality valves were utilized that resist human error in sample collection activities (e.g., over tightening that potentially could cause leaks). Low-flow precision regulators were used with each of the canisters to ensure a consistent airflow over the designated eight-hour sampling duration.

Sample collection intakes were located to approximate the breathing zone for building occupants at heights of 3 to 5 ft above the building floor. Indoor air samples were collected during typical working hours to be representative of typical exposure in a manner as to minimize disruptions to normal building activities (Appendix B, Photograph 28). Outdoor air samples were collected starting one-hour earlier but otherwise at the same times as the indoor samples (Appendix B, Photograph 29). Sampling technicians did not remain in the immediate area of the canisters when samples were being collected.

4.8 Soil Sampling

For the cumulative soil risk screening, soil data for the 200 Area came from the 200 Area Phase II Investigation Report, Appendix E (NASA, 2015b) and soil data for the 600 Area came from the 600 Area Closure Investigation Report, Appendix 13.B (NASA, 2011a). The soil analytical data used is provided in Excel format and included in Enclosure 4.

4.9 Off-site Laboratory Data

Data packages from the laboratory consisted of two primary components: comprehensive reports submitted as Adobe portable document files (PDF) for review and archiving (provided as an enclosure to this report); and electronic data deliverable (EDD) files to facilitate transfer of chemical analytical data into WSTF's analytical database(s). The PDF reports included the laboratory name, report date, sample-specific information, analyte names and Chemical Abstract Service numbers, analytical results, QC sample results, data qualifiers and narratives, pertinent analytical notes, laboratory reviewer signatures,

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[3] LANDTEC is a registered trademark of Q.E.D. Environmental Systems, Inc.

and a variety of other information specific to the laboratory and analytical method. The EDD files include the associated electronic data and follow the same review and approval cycle as the PDF report.

4.10 Data Assessment and Review

A quality assurance (QA) specialist evaluated the sample data, field, and laboratory QC results for acceptability with respect to the project quality objectives. Chemical analytical data was compared with the project DQOs and evaluated using the data validation guidelines contained in EPA guidance documents, the latest version of SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," and industry-accepted QA/QC methods and procedures (EPA, 2013). A QA report for the vapor data and a second report for the previous soil data are provided in Appendix C.

A comprehensive review of sample analytical data was conducted. Prior to conducting the review, the following information (where required and applicable) was compiled and provided.

- The NMED-approved VIAWP.
- Field sampling and geologist logs.
- Laboratory reports.
- Statements of work and the laboratory Quality Management Plan.
- EDD Files.
- SOPs.
- Data tools.

Data review elements included:

Step I: Verification – Verification (review for completeness) is the confirmation by examination and provision of objective evidence that the specified requirements (sampling and analytical) have been completed (EPA, 2005).

Data verification is the process of determining whether data have been collected or generated as required by the project documents. The process consists of the following categories: 1) verifying that field sampling operations were performed as outlined in the vapor intrusion assessment Investigation Work Plan (IWP; NASA 2016b); 2) verifying that the data collection procedures and protocols were followed; 3) verifying completeness to establish that sufficient data necessary to meet project objectives have been collected; and 4) checking that QC sample results meet control limits defined in the analytical methods.

Step II: Validation – Validation is the confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Validation is a sampling and analytical process that includes evaluating compliance with method, procedure, or contract requirements and extends to evaluating against criteria based on the quality objectives developed (EPA, 2005).

The purpose of validation is to assess the performance of the sampling and analysis processes to determine the quality of specified data. Data validation consists of the following objectives: 1) verifying that measurements (field and laboratory) meet the user's needs; and 2) providing information to the data user regarding data quality by assignment of individual data qualifiers based on the associated degree of variability. Data management personnel performed data validation in accordance with the requirements in this IWP and existing WSTF procedures.

Step III: Usability Assessment – Usability assessment is the determination of the adequacy of data, based on the results of validation and verification, for the decisions being made. The usability process involves assessing whether the process execution and resulting data meet project quality objectives (EPA, 2005).

The goal of the usability assessment is to determine the quality of each data point and to identify data that are not acceptable to support project quality objectives. Data may be qualified as being unusable or rejected (R), as based on established quality review protocols. Data qualified as estimated concentrations (J) are less precise, or less accurate, than unqualified data but are still acceptable for use. The data users, with support from the contractor environmental data management staff, are responsible for assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses. The data reporting included a discussion of data limitations and their effect on data interpretation activities.

A review of COPC detection limits obtained from the laboratory compared to regulatory screening levels was conducted. Several COPCs in the 200 Area had dilution issues for the soil vapor samples where detection limits reached were higher than regulatory screening levels. The issue arises when there are very high concentrations of a VOC in a sample. For the instruments to read the contaminants, the sample must be diluted, and sometimes diluted by orders of magnitude. However, this can cause other VOCs to be masked, since dilution raises the detection limits for other VOCs. Soil vapor samples from well 200-LV-150 at 34 ft bgs contain high concentrations of VOCs. The August 2017 samples contain a dilution of 6600, and in February 2018, a dilution of 1530 was needed. These dilutions resulted in VOC detection limits greater than VISLs or air RSLs. Detection limits higher than applicable regulatory screening levels are highlighted in yellow on Table 4.3 and provided with dilutions on Table 4.4. COPCs affected include carbon tetrachloride, chloroform, ethylbenzene, heptane, 2-hexanone, 2-propanol, TCE, and 1,2,4-trimethylbenzene.

Examples to illustrate the elevated dilution and detection limits include TCE and chloroform. TCE detection limits were 920 µg/m^3 for August 2017 and 430 µg/m^3 for February 2018. These detection limits are above the residential cancer and noncancer VISLs (69.5 and 147 µg/m^3, respectively) and the industrial noncancer VISL (328 µg/m^3). However, the very high concentrations of TCE detected in the 200-LV-150 samples required the large dilutions (410,000 µg/m^3 and 140,000 µg/m^3). These large dilutions (6600 and 1530) also caused elevated detection limits for other VOCs, such as chloroform. The August 2017 and February 2018 detection limits for chloroform for soil vapor in well 200-LV-150 were 1,100 and 260 µg/m^3, which are above the residential and industrial cancer VISLs of 40.7 µg/m^3 and 199 µg/m^3. Chloroform was not detected in soil vapor samples in 200-LV-150. However, due to the high detection limits, it is not possible to determine if chloroform was present in 200-LV-150 samples above regulatory cancer limits. Table 4.4 provides details of the other six affected constituents.

5.0 Summary of Soil Vapor, Outdoor Air, and Indoor Air Data

The chemical analytical results from the two semi-annual soil vapor sampling events were verified, validated, and used to develop the final VIAR. Laboratory reports for the two semi-annual sampling events (Sampling Event #1 in August 2017 and Sampling Event #2 in February 2018) are provided as an enclosure to this report. A complete set of tabulated analytical results for all soil vapor and air samples is provided as an enclosure to this report.

5.1 200 Area Soil Vapor, Outdoor Air, and Indoor Air Sampling

Figure 5.1 posts the analytical results for soil vapor, indoor air, and outdoor air samples in association with the sample locations within and immediately surrounding Building 200 in the 200 Area. Analytical results for the four primary COPCs anticipated to be present (TCE, PCE, Freon 11, and Freon 113) are shown for both semi-annual sampling events performed on August 27, 2017 and February 25, 2018.

Table 4.3~~5.1~~ provides a summary of the maximum observed contaminant concentrations for subsurface soil vapor within wells adjacent to Building 200, the maximum contaminant concentrations for outdoor air adjacent to Building 200, and the maximum contaminant concentrations for indoor air samples. Results are provided for all 13 COPCs identified in Section 2.6 of this report (TCE; PCE; Freon 11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) for the August 2017 and February 2018 semi-annual sampling events. Table 4.3~~5.1~~ also compares the maximum contaminant concentrations reported to the available vapor intrusion screening levels: NMED VISLs~~;~~ and WSTF RBCs~~; and the OSHA PEL TWA~~ (Section 1.5).

5.1.1 200 Area Soil Vapor Analytical Results

~~Soil vapor grab samples were collected in 1-liter canisters from wells 200-SV-05 at 9 ft bgs, 200-SV-09 at 19 ft bgs, and 200-LV-150 at 34 ft bgs. All three wells are located within 85 ft of the west side of Building 200. Figure 5.1 shows detected TCE concentrations within soil vapor for all three wells for both semi-annual sampling events.~~For both semi-annual sampling events, the TCE soil vapor concentrations from well 200-LV-150 at 34 ft (410,000 and 140,000 µg/m^3), well 200-SV-05 at 9 ft (40,000 and 26,000 µg/m^3), and well 200-SV-09 at 19 ft (35,000 and 31,000 µg/m^3) significantly exceeded both the NMED residential and industrial VISLs (69.5 µg/m^3 noncancer, 147 µg/m^3 cancer, 328 µg/m^3 noncancer, and 1,120 µg/m^3 cancer). For WSTF RBCs, well 200-LV-150 significantly exceeded the appropriate RBCs at 25 ft bgs (residential: 4,900 µg/m^3 noncancer and 11,000 µg/m^3 cancer; industrial: 84,000 µg/m^3 noncancer and 280,000 µg/m^3 cancer).

For wells 200-SV-05 and 200-SV-09, residential RBCs were exceeded (1,500 µg/m^3 noncancer and 3,400 µg/m^3 cancer at 5 ft bgs; and 2,300 µg/m^3 noncancer and 5,400 µg/m^3 cancer at 10 ft bgs), but not all industrial RBCs were exceeded. In well 200-SV-05 (at 9 ft), concentrations (40,000 and 26,000 µg/m^3) exceeded the industrial noncancer RBC (18,000 µg/m^3 at 5 ft) but not the industrial cancer RBCs (60,000 µg/m^3 at 5 ft). In well 200-SV-09 (at 19 ft), the August 2017 sample (35,000 µg/m^3) exceeded only the industrial noncancer RBC (34,000 µg/m^3 at 10 ft) but not the industrial cancer RBC (120,000 µg/m^3 at 10 ft). In February 2018, the 200-SV-09-19 sample concentration (31,000 µg/m^3) was below both industrial RBCs (34,000 µg/m^3 noncancer and 120,000 µg/m^3 cancer at 10 ft).

~~Table 4.35.1 presents the maximum TCE soil vapor concentrations from MSVGM well 200-LV-150-34 (410,000 µg/m^3 in August 2017), which significantly exceeds both the NMED VISL (328 µg/m^3) and the WSTF RBC at 5 ft bgs (18,000 µg/m^3) for both semi-annual sampling events. This is also the case for the other two MSVM wells 200-SV-05 and 200-SV-09 (Figure 5.1). PCE soil vapor concentrations are also elevated, again most notable in well 200-LV-150-34 (maximum 570,000 µg/m^3 in August 2017) and exceed the NMED VISL (6,550 µg/m^3) in all three wells for the August 2017 sampling event and in well 200-LV-150 at 34 ft bgs for the February 2018 sampling event (Figure 5.1, Table 4.35.1). The maximum concentrations for PCE are all below the WSTF RBC at 5 ft bgs (460,000 µg/m^3) for both semi-annual sampling events.~~PCE soil vapor concentrations exceeded the NMED residential noncancer and cancer and industrial noncancer VISLs (1,390 µg/m^3 noncancer, 3,600 µg/m^3 cancer, and 6,550 µg/m^{3}noncancer) in all three soil vapor wells for the August 2017 sampling event (200-LV-150 at 34 ft was 57,000 µg/m^3; 200-SV-05 at 9 ft was 9,500 µg/m^3; and 200-SV-09 at 19 ft was 6,600 µg/m^3). The industrial cancer VISL (17,600 µg/m^3) was exceeded only in well 200-LV-150 in August 2017.

For the February 2018 sampling event, PCE exceeded all the NMED VISLs (residential: 1,390 µg/m^3 noncancer, 3,600 µg/m^3 cancer; industrial: 6,550 µg/m^3 noncancer, 17,600 µg/m^3 cancer) in well 200-LV-

150 (36,000 µg/m^3) and the residential VISLs in 200-SV-05 and 200-SV-09 (5,300 and 5,400 µg/m^3, respectively). February 2018 concentrations of PCE were below industrial VISLs.

Both August 2017 (well 200-LV-150 at 34 ft was 57,000 µg/m^3; well 200-SV-05 at 9 ft was 9,500 µg/m^3; and well 200-SV-09 at 19 ft was 6,600 µg/m^3) and February 2018 concentrations of PCE (well 200-LV-150 at 34 ft was 36,000 µg/m^3; well 200-SV-05 at 9 ft was 5,300 µg/m^3; and well 200-SV-09 at 19 ft was 5,400 µg/m^3) in all soil vapor wells are all below the WSTF RBCs at the appropriate corresponding depths (residential: 340,000 cancer and 130,000 µg/m^3 noncancer at 25 ft bgs; 93,000 cancer and 35,000 µg/m^3 noncancer at 5 ft; and 150,000 cancer and 58,000 µg/m^3 noncancer at 10 ft. Industrial: 2,300,000 µg/m^3 noncancer and 6,000,000 µg/m^3 cancer at 25 ft; 460,000 µg/m^3 noncancer and 12,000,000 µg/m^3 cancer at 5 ft; and 910,000 µg/m^3 noncancer and 2,400,000 µg/m^3 cancer at 10 ft).

All 11 remaining maximum concentrations for COPCs in vadose zone soil vapor (Freon11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) are below the corresponding NMED VISL and WSTF RBC. ~~The maximum concentration identified within the August 2017 and February 2018 semi-annual sampling events are listed along with the corresponding vapor intrusion screening level in Table 4.35.1.~~

5.1.2 Building 200 Outdoor Air Analytical Results

~~Outdoor air samples were collected in 6-liter canisters equipped with low flow valves from two locations outside Building 200: 200-OA-1 located adjacent to the outside southwest wall near Room 205, and 200-OA-2 located approximately 35 feet northeast of Room 206 (Figure 5.1). These locations were used for both the August 2017 and February 2018 sampling events.~~

~~The concentrations of COPCs in o~~Outdoor air samples were either non-detect or below 1 µg/m^3 for TCE, PCE, Freon 113, 1,1,1-trichloroethane, chloroform, benzene, ethylbenzene, toluene, xylenes, acetone, and 2-propanol. Traces of Freon 11 (maximum 1.2 µg/m^3 in August 2017 and February 2018) and 2-Butanone (maximum 3 µg/m^3 in August 2017) were also detected~~reported as shown by the maximum concentrations in Table 4.35.1. No specific vapor intrusion screening level is applicable to the outdoor air concentrations, although they are well below the OSHA PEL TWAs~~.

5.1.3 Building 200 Indoor Air Analytical Results

~~Indoor air samples were collected in 6-liter canisters equipped with low flow valves from eight locations inside Building 200 (Figure 5.1). The locations represented individual rooms or workspaces within the area immediately above and adjacent to the former Clean Room Tank HWMU (Appendix B, Photos 19 through 22). The same eight locations were used during both the August 2017 and February 2018 semi-annual sampling events. Concentrations of COPCs were generally slightly higher than the contemporaneous outdoor air samples collected, but well below the concentrations observed within soil vapor in the shallow vadose zone reported from MSVM and MSVGM wells.~~ No indoor air concentrations exceeded NMED VISLs.

The maximum concentration for indoor air samples were non-detect or below 1 µg/ m^3 for four COPCs: PCE; 1,1,1-trichloroethane; chloroform; and~~,~~ ethylbenzene~~ (Table 4.35.1)~~. Trace concentrations were observed for eight COPCs: TCE (maximum 1.3 µg/m^3 in February 2018); Freon 11 (maximum 22 µg/m^3 in August 2017); 2-Butanone (maximum 8.7 µg/m^3 in August 2017); benzene (maximum 1.6 µg/m^3 in February 2018); toluene (maximum 22 µg/m^3 in August 2017); xylenes (maximum 1.5 µg/m^3 in August 2017); acetone (maximum 29 µg/m^3 in August 2017); and~~,~~ 2-propanol (maximum 68 µg/m^3 in August 2017). The highest~~A low~~ concentration of Freon 113 of 3,200 µg/m^3~~ of Freon 113~~ was reported in August 2017 from sample location 200-IA-5. This maximum concentration is one and two orders of magnitude below the NMED VISL for residential and industrial indoor air of 31,300 and 147,000 µg/m^3, respectively ~~and three orders of magnitude below the OSHA PEL TWA of 7,670,000 µg/m^3 (Table 4.35.1)~~.

5.1.4 Building 200 Trends and Observations

The following section describes trends and observations ~~were made~~ for the 200 Area vapor~~air intrusion~~ analytical results ~~presented in Table 4.35.1~~.

- ~~Vadose zone TCE concentrations in soil vapor from MSVM wells 200-SV-05 at 9 ft bgs, 200-SV-09 at 19 ft bgs, and 200-LV-150 at 34 ft bgs exceed NMED VISL (328 µg/m^3) and WSTF RBC at 5 ft bgs (18,000 µg/m^3) for the August 2017 and February 2018 semi-annual sampling events. The shallow WSTF RBC at 5 ft bgs represents the lowest reference concentration in each well and is therefore the most conservative and likely to overestimate risk. PCE soil vapor concentrations exceed the NMED VISL (6,550 µg/m^3) in all three wells for the August 2017 sampling event but are below the WSTF RBC at 5 ft bgs (460,000 µg/m^3). In February 2018, only the PCE sample from 200-LV-150 at 34 ft bgs exceeded the NMED VISLs. The concentrations for the 11 remaining COPCs in vadose zone soil vapor are below the corresponding NMED VISLs and WSTF RBCs.~~
- Soil vapor~~Higher~~ COPC concentrations were higher in~~for COPCs in the vadose zone MSVM and MSVGM wells are reported from~~ the ~~first~~ summer semi-annual sampling event (August 2017), characterized by elevated outdoor temperatures, compared to the winter sampling event~~. This is true~~ for all four~~five~~ WSTF primary COPCs detected ~~in the vadose zone~~: (TCE, PCE, Freon 11, and Freon 113~~, and benzene~~).
- The highest~~maximum~~ concentrations detected in vapor in the investigation were for TCE, PCE, and Freon 113. Maximum concentrations for TCE, PCE, and Freon 113 were ~~in the vadose zone are~~ reported from well 200-LV-150-34, and the maximum concentration for Freon 11 from well 200-SV-05. These wells are both located downgradient of the former Clean Room Tank HWMU with respect to surface topography, bedrock topography, and groundwater flow. From the 200 Area Phase II investigation (NASA, 2015b), residual concentrations of the primary COPCs are present within microfractures of vadose zone bedrock, as demonstrated through core analysis.
- The highest~~low~~ indoor air concentration for Freon 113 of 3,200 µg/m^3 (in August 2017) was reported from sample location 200-IA-5 within Room 202 (Figure 5.1). The product inventory form (Table 4.1) indicates that steel canisters containing Freon are stored in this secure, unoccupied storage room. Room 202 is used exclusively for materials storage and is utilized periodically for chemical storage and chemical management activities.
- The trace indoor air concentration for 2-propanol of 68 µg/m^3 reported in August 2017 is from sample location 200-IA-3 within the equipment storage area of Room 205 ~~(Figure 5.1; Appendix B, Photograph 17)~~. 2-propanol is used in the manufacture of a wide variety of industrial and household chemicals and is a common ingredient in chemicals such as antiseptics, disinfectants and detergents that are stored in this room. Room 205 is used exclusively for equipment and storage and is occupied only during maintenance activities.
- ~~C~~Indoor air concentrations of COPCs were generally slightly higher than the contemporaneous outdoor air samples collected, but well below the concentrations observed within soil vapor in the shallow vadose zone reported from MSVM and MSVGM wells.

5.2 600 Area Soil Vapor, Outdoor Air, and Indoor Air

The analytical results for all soil vapor and air sample locations within and immediately surrounding Building 637 in the 600 Area are provided in Figure 5.2. The concentrations of the primary WSTF

COPCs (TCE, PCE, Freon 11, and Freon 113) are provided for two semi-annual sampling events performed on August 26, 2017 and February 24, 2018.

Table 5.1~~2~~ summarizes the maximum contaminant concentrations observed for subsurface soil vapor within the MSVM wells located closest to Building 637, the maximum contaminant concentrations for outdoor air adjacent to Building 637, and the maximum contaminant concentrations for indoor air samples for both of the semi-annual sampling events. Results are provided for all COPCs identified in Section 2.6 of this report (TCE; PCE; Freon11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) with a comparison to the available vapor intrusion screening levels: NMED VISLs~~;~~ and WSTF RBCs~~; and the OSHA PEL TWA~~ (Section 1.5).

5.2.1 600 Area Soil Vapor Analytical Results

~~Soil vapor grab samples were collected in 1-liter canisters from wells 600-SGW-1 at 12.5 ft bgs, 600-SGW-2 at 12.5 ft bgs, and 600-SGW-5 at 7.5 ft bgs. The three MSVM wells are on the 600 Area HWMU at distances of between 180 ft to 210 ft from Building 637. Figure 5.2 shows TCE concentrations within soil vapor for well 600-SGW-1-12.5 (480 µg/m^3 in August 2017 and 740 µg/m^3 in February 2018) and well 600-SGW-2-12.5 (330 µg/m^3 in August 2017) that exceed the NMED VISL (328 µg/m^3), but are significantly below the WSTF RBC at 5 ft bgs (18,000 µg/m^3)~~TCE concentrations in well 600-SGW-1 (480 and 740 µg/m^3) exceed~~.~~ residential VISLs (69.5 and 147 µg/m^3) and the industrial noncancer VISL (328 µg/m^3), but not the industrial cancer VISL (1,120 µg/m^3) for both sampling events. Well 600-SGW-2 TCE concentrations (330 and 270 µg/m^3) exceed the residential VISLs for both sampling events, but only exceed the industrial noncancer VISL for the August 2017 event (330 µg/m^3). TCE concentrations were below the industrial noncancer VISL in February 2018 and the industrial cancer VISL in both 2017 and 2018. TCE soil vapor concentrations were below RBCs at 10 ft bgs (residential: 2,300 µg/m^3 noncancer and 5,400 µg/m^3 cancer; industrial: 34,000 µg/m^3 noncancer and 120,000 µg/m^3 cancer). Well 600-SGW-5 TCE concentrations (44 and 42 µg/m^3) were below all VISLs.

~~Table 5.12 presents the maximum TCE soil vapor concentrations from 600 Area MSVM well 600-SGW-1-12.5.~~ All other maximum concentrations for the 12 remaining COPCs for both the August 2017 and February 2018 sampling events (PCE; Freon 11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) are below the respective NMED VISLs and WSTF RBCs at the appropriate depths~~in soil vapor at 5 ft bgs~~.

5.2.2 Building 637 Outdoor Air Analytical Results

~~Air samples were collected from two outdoor locations using 6-liter canisters equipped with low flow valves from two locations outside Building 637: 600-OA-1 located 20 ft northeast of the north corner of Building 637, and 600-OA-2 located approximately 20 feet northeast of the east corner of Building 637 (Figure 5.2). These locations were sampled during both the August 2017 and February 2018 events.~~

The concentrations of COPCs in outdoor air samples were either non-detect or below 1 µg/m^3 for 10 of the 13 COPCs (TCE, PCE, Freon 113, 1,1,1-trichloroethane, chloroform, benzene, ethylbenzene, toluene, xylenes, and 2-propanol). Traces of Freon 11 (maximum 1.2 µg/m^3 in August 2017), 2-Butanone (maximum 2.4 µg/m^3 in August 2017), and acetone (maximum 10 µg/m^3 in August 2017) were also detected~~reported as shown by the maximum concentrations in Table 5.12, with all outdoor air concentrations well below the OSHA PEL TWAs listed~~.

5.2.3 Building 637 Indoor Air Analytical Results

~~Indoor air samples were collected in 6-liter canisters equipped with low flow valves from locations in each of the four corners inside Building 637. Building 637 comprises a single open space with no individual rooms or workspaces (Appendix B, Photos 19 through 22) at a location that represents one of the closest occupied receptors adjacent to the former 600 Area HWMU (Figure 5.2). The four sampling locations were used during both the August 2017 and February 2018 semi-annual sampling events. The concentrations of specific COPCs were slightly above the contemporaneous outdoor air samples collected, but significantly below the concentrations observed within soil vapor in the shallow vadose zone reported from MSVM wells.~~

The maximum concentration for indoor air samples were non-detect or below 1 μg/m^3 for nine of the 13 COPCs: TCE; PCE; Freon 113; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; and, xylenes~~ (Table 5.12)~~. Trace concentrations of three COPCs were also observed: Freon 11 (maximum 1.4 μg/m^3 in February 2018); 2-Butanone (maximum 5.3 μg/m^3 in August 2017); acetone (maximum 16 μg/m^3 in August 2017); and, 2-propanol (maximum 3.4 μg/m^3 in August 2017). No indoor air concentrations exceeded NMED VISLs.

5.2.4 Building 600 Trends and Observations

The following section describes trends and observations ~~were made from a review of~~for the 600 Area ~~air intrusion~~vapor analytical results~~ presented in Table 5.12~~.

- ~~TCE concentrations within soil vapor for well 600-SGW-1-12.5 (480 μg/m^3 in August 2017 and 740 μg/m^3 in February 2018) and well 600-SGW-2-12.5 (330 μg/m^3 in August 2017) exceed the NMED VISL (328 μg/m^3), but are significantly below the WSTF RBC at 5 ft bgs (18,000 μg/m^3). All other maximum concentrations for the remaining COPCs for both the August 2017 and February 2018 sampling events are below the respective NMED VISL and WSTF RBC in soil vapor at 5 ft bgs.~~
- ~~The concentrations for COPCs for outdoor air samples were generally non-detect or below 1 μg/m^3 for the COPCs. Traces of Freon 11 (maximum 1.2 μg/m^3 in August 2017), 2-Butanone (maximum 2.4 μg/m^3 in August 2017), and acetone (maximum 10 μg/m^3 in August 2017) were reported. All outdoor air concentrations well below the OSHA PEL TWAs.~~
- The indoor air concentrations for specific COPCs were slightly above the contemporaneous outdoor air samples collected, but significantly below the concentrations observed within soil vapor in the shallow vadose zone reported from MSVM wells.~~ The maximum concentration for indoor air samples were generally non detect or below 1 μg/m^3 for the COPCs. Trace concentrations were observed for three COPCs: Freon 11 (maximum 1.4 μg/m^3 in February 2018); 2-Butanone (maximum 5.3 μg/m^3 in August 2017); acetone (maximum 16 μg/m^3 in August 2017); and, 2-propanol (maximum 3.4 μg/m^3 in August 2017). No concentrations of indoor air COPCs exceeded the NMED VISLs.~~
- The higher concentrations for COPCs in the vadose zone MSVM wells are variable between the summer (August 2017) and winter (February 2018) sampling events characterized by significantly different ambient outdoor temperatures. Of the four primary COCs, TCE and PCE are slightly higher for February 2017, and Freon 11 and Freon 113 are slightly higher for August 2017. This irregularity is true for 12 of the 13 COPCs detected in the vadose zone. The rationale may be related to limited amounts of groundwater available as a source for contaminants within poorly fractured andesite bedrock, and lower concentrations of VOCs in the local aquifer. The effect of increased volatilization during hotter (summer) months is less apparent than higher flow/higher contaminant concentrations areas such as the 200 Area fractured limestone aquifer.
- Analytical results for the four indoor air sample locations are also compatible with each other due to the open nature of the building with no divides or separate offices.

5.3 Potential Bias due to Field Sampling Conditions

The VIAWP was followed at all times including the performance of field sampling, and no potential biases due to field conditions were reported. The same analytical laboratory, sampling containers, and supplies were used for both the August 2017 and February 2018 sampling events. The same facility preparation and sampling protocol was also followed at Buildings 200 and 637 for each of the two events. Climatic conditions remained favorable throughout. The two semi-annual sampling events were performed 182 days apart during the summer and winter seasons as required by the VIAWP.

6.0 Screening Level Risk Assessment,~~ and Evaluation of~~ Uncertainties, and Lines of Evidence

6.1 Screening Level Risk Assessment

This investigation was designed to evaluate whether there was unacceptable risk or hazard to WSTF workers in the most likely location at WSTF for current vapor intrusion, buildings adjacent to the 200 Area west closure HWMU and the 600 Area HWMU. A comprehensive risk/hazard screening assessment was not planned nor originally performed, and no soil borings were planned nor completed for this vapor intrusion investigation. However, in the disapproval of the initial VIAR, NMED requested that NASA perform a combined health risk and hazard screening~~, including~~ evaluating soil vapor combined with soil data (NMED, 2019~~a~~). Since no soil data was collected as part of the vapor intrusion field work, additional data collected prior to 2017 was used for soil risk and hazard screening. The soil data used was collected under NMED-approved work plans (*200 Area Investigation – Phase II Investigation Work Plan* [NASA, 2013a] and *NASA Response to NMED 03/19/09 Comments on the 600 Area Closure Investigation* [NASA, 2009]). This additional soil data was also previously included in NMED-approved reports (*NASA WSTF 200 Area Phase II Investigation Report* [NASA, 2015b] and *600 Area Closure Investigation Report Provided in Response to a NMED Notice of Disapproval* [NASA, 2011a]. Soil vapor and indoor air data used in the risk and hazard screening evaluation were collected for this investigation in 2017 and 2018 only. Analytical data used are provided in Excel format in Enclosure 4.

As requested, and ~~P~~per NMED Guidance (NMED, 20~~19~~22c~~b~~), a cumulative screening risk assessment is conducted at both the 200 and 600 Areas for the following potential exposure pathways: inhalation of intruding soil vapors, inhalation of indoor air, and the ingestion, dermal contact, or inhalation of chemicals present in soils. Figure 6.1 is the SCEM revised based on the results of this investigation and risk assessment.

~~Both the VOC inhalation and soil contact exposure pathways are evaluated for carcinogenic and non-carcinogenic effects. Relevant NMED screening levels for each media (NMED, 2019b) are used when available.~~ Consistent with Section 2.8.2 of the NMED Risk Assessment Guidance (20~~19~~22c~~b~~), soil data from samples at any depth within 0 to 10 ft of the ground surface can be screened using residential or construction worker scenarios, whereas data from the 0 to 1 ft interval are applicable for evaluating industrial exposures. However, soil samples for the 200 and 600 Area investigations were not collected in the 0 to 1 ft depth range. The 200 and 600 Area investigations were originally designed to identify the locations of the greatest soil contamination. Samples were obtained where contamination was suspected. Since WSTF sites have been used for multiple purposes over time, surface soils have been disturbed and clean fill added at multiple WSTF sites. Due to the disturbed surface soils and the goal of locating the highest soil contaminant concentrations, surface soils were not collected for the 200 and 600 Area investigations, and the industrial pathway was not initially evaluated. In addition, no soil vapor wells on site at WSTF were designed with ports in the 0 to 1 ft bgs depth range. However, for this revision per NMED comments in the NMED Disapproval (NMED, 2022b), the industrial pathway was evaluated using the shallowest soil and vapor samples collected for the 200 and 600 Area investigations, even though the depths sampled were greater than 1 ft bgs. (The shallowest depths are: 200 Area soils: 8 and

16 ft bgs; 600 Area soils: 3, 4, 6, and 10 ft bgs; 200 Area soil vapor: 9, 19, and 34 ft bgs; and 600 Area soil vapor: 7.5 and 12.5 ft bgs) ~~Soil data are initially compared to the residential screening levels because they are protective of all land use and support evaluation of data collected from deeper than 0 to 1 ft bgs~~.

In accordance with NMED Risk Assessment Guidance Section 2.8.4 (NMED, 20~~19~~22c~~b~~), when a constituent's maximum detected value exceeded or neared NMED screening levels, an exposure point concentration (EPC) can be calculated. If sufficient data are available, EPA's ProUCL software (most recent version EPA, 2022a~~15a~~) is used to calculate the constituent's 95 percent Upper Confidence Limit (UCL95) of the mean concentration. Ideally, a minimum of eight samples collected with at least five detections is preferred for calculating statistics. The UCL95 is then compared to the applicable screening level. When a detected constituent has no NMED screening level, EPA screening levels (EPA, 2022b~~19~~) are used. Finally, WSTF RBCs (NASA, 2022~~19a~~) can be used for soil vapor as screening levels containing more site-specific criteria~~,~~ and should be compared against if NMED screening targets are not met. If less than eight samples or less than five detections were present for constituents, the maximum concentration was used as the EPC.

~~The only detected constituents found in indoor air throughout this investigation for which no published inhalation screening level is available are 2,2,4-Trimethylpentane, Ethanol, and Freon 21. For two of the constituents, NASA used a similar chemical that had NMED or EPA screening criteria as surrogates. For Freon 21, NMED screening criteria for Freon 12 was used, and for Ethanol, EPA screening criteria for methanol was used. The organic chemical 2,2,4-Trimethylpentane is a component of gasoline and diesel, but is not associated with any historical operations related to the 200 and 600 Area HWMUs that are the focus of this investigation. The relatively low measured concentrations (0.36 to 0.39µg/m^3) and few detections (2 of 52 samples, both with J QA flags) indicate that this chemical is unlikely to present significant health risks/hazards.~~

The cumulative screening risk assessment is performed with vapor analytical data from this investigation, as well as soil data from previous investigations conducted in the 200 and 600 Areas (NASA, 2015b; 2011a). Soil vapor and indoor air quality data collected during this investigation are the most relevant to the goals of this risk screening~~assessment~~ and are therefore used as key input parameters in the cumulative screening assessments. ~~No soil data was collected during the course of this investigation, but soil data collected during previous investigations in each area are used to assess potential cumulative risks across all relevant exposure pathways. As discussed in Section 4.5, soil data for the 200 Area comes from the 200 Area Phase II Investigation Report, Appendix E (NASA, 2015b), and soil data for the 600 Area comes from the 600 Area Closure Investigation Report, Appendix 13.B (NASA, 2011a).Enclosure 3~~

6.1.1 200 Area Screening Risk Assessment

6.1.1.1 200 Area – Soil Vapor ~~Cumulative~~ Screening Risk Assessment

For this investigation, soil vapor samples were collected from the shallowest vapor ports in three wells in the 200 Area. Since two separate sampling events (August 2017 and February 2018) were conducted, there is a total of six samples per constituent for the 200 Area. Per NMED (2022c) and EPA (2022a) guidance, six samples are not a sufficient number to perform reliable statistics. Therefore, the maximum concentration per constituent was used in all screening for 200 Area soil vapor.

Table 6.1 contains the ~~cumulative~~ 200 Area residential soil vapor cancer risk screening~~assessment for soil vapor concentrations in the 200 Area~~ compared to NMED VISLs. Benzene, tetrachloroethene (PCE) and trichloroethylene (TCE) ~~is~~ are the only carcinogenic constituents detected. Benzene ~~and~~ has a residential cancer risk of 6.67E-06. PCE and TCE are the risk drivers, each having a cancer risk that exceeds the target if 1E-05 (1.58E-04 and 2.79E-02, respectively). The total~~cumulative~~ cancer risk is 2.81E-02~~7E-06~~, which exceeds~~is below~~ the target of 1E-05 set by the NMED (NMED, 20~~19~~22c~~b~~). ~~The laboratory reports are provided as an enclosure to this report.~~

Table 6.2 contains the 200 Area industrial soil vapor cancer risk screening compared to NMED VISLs. Like the residential scenario, the industrial scenario risk drivers are PCE and TCE, each exceeding the risk target (3.24E-05 and 3.66E-03, respectively). The total soil vapor industrial risk is 3.69E-03, which exceeds the target of 1E-05.

Since both the residential and industrial pathways exceeded the cancer target compared to NMED VISLs, 200 Area maximum soil vapor concentrations were compared to more site-specific and approved WSTF RBCs (NASA, 2022; NMED, 2022a). Table 6.3 compares the maximum concentration to the RBC at the next shallowest depth. For example, the maximum benzene concentration was detected at 19 ft bgs, and this was compared to the RBC at 10 ft bgs. The risk driver for maximum concentrations compared to WSTF RBCs remains TCE at an individual risk of 3.73E-04. The total risk for 200 Area residential soil vapor is 3.75E-04, which exceeds the risk target of 1E-05. Table 6.4 presents the 200 Area~~cumulative~~ industrial soil vapor cancer risk screening results compared with WSTF RBCs. TCE is near the target risk level at 1.46E-05, and the total risk is 1.48E-05, which equals or just exceeds the NMED target of 1E-05.

The 200 Area residential soil vapor noncancer hazard screening~~assessment for 200 Area soil vapor concentrations~~ comparing~~ed~~ maximum concentrations to NMED VISLs is shown in Table 6.5. Eight constituents are detected, with PCE, TCE, and 1,1-Dichloroethene exceeding their respective NMED VISLs. ~~UCL95 values are calculated for both PCE and TCE. The UCL95 recommended by ProUCL software for 1,1-Dichloroethene exceeds the maximum sample concentration, so the UCL95 value for the 95% bias-corrected accelerated (BCa) bootstrap UCL is used for this constituent, as recommended by a statistician intimately familiar with ProUCL (Paul Black of Neptune and Company, Inc.). ProUCL version 5.1 technical guide defines the bootstrap method as "generally superior…for small data sets or where sample distributions are non-normal" (EPA, 2015b).~~ The total hazard for 200 Area residential soil vapor is 5.94E+03, which exceeds the NMED hazard index~~target~~ of 1~~.0~~E+00~~ (NMED, 2019b)~~.

Table 6.6 presents the 200 Area maximum soil vapor concentrations compared to industrial noncancer VISLs for the six detected constituents. PCE and TCE exceeded the NMED hazard index of 1 (at 8.70E+00 and 1.25E+03, respectively). The total hazard is 1.26E+03.

Since NMED targets for hazard were exceeded using the~~ generic~~ VISLs, the data are~~ cumulatively~~ compared against more site-specific WSTF RBCs, as shown in ~~Table 6.3~~Table 6.7. The RBCs take into account site-specific conditions and are expected to better reflect the actual risk to human health and hazard on-site (NASA, 2019a). Constituents are compared against the RBC value at the nearest depth shallower than the sample depth since shallower RBCs are smaller numbers (more conservative; NASA, 2022~~19a~~). The cumulative hazard is reduced to 8.42~~7.8~~E+01, which still exceeds the respective NMED screening target of 1E+00. TCE is the only constituent that~~which~~ independently exceeds screening levels, and is a risk driver (at 8.37E+01 individually).

Table 6.8 shows the 200 Area industrial soil vapor hazard screening using WSTF RBCs. TCE still exceeds the NMED target of 1E+00 (at 4.88E+00) and results in a total hazard of 4.91E+00.

6.1.1.2 200 Area - Indoor Air~~ Cumulative~~ Screening Risk Assessment

~~Table 6.4~~Table 6.9 contains the~~ cumulative~~ residential cancer risk screening for~~ the~~ 200 Area indoor air ~~assessment~~. All eight~~five~~ detected constituents are below their respective NMED indoor air screening levels. The total~~cumulative~~ cancer risk is ~~9E-06~~1.24E-05, which ~~is ~~approximately equals~~below~~ the target of 1E-05 set by the NMED~~ (NMED, 2019b)~~.

The 200 Area industrial indoor air cancer risk is calculated using maximum concentrations compared to NMED indoor air VISLs in Table 6.10. No individual constituent nor the total combined cancer risk (2.31E-06) exceeds the NMED target of 1E-05.

~~Table 6.5~~Table 6.11 contains the ~~cumulative~~ screening residential hazard assessment for the 200 Area indoor air ~~assessment~~. There are 29~~4~~ detected constituents, all of which are below their respective NMED indoor air screening levels. Because a sufficient number of samples were present to obtain reliable statistical results, UCL95 values are calculated for 14 constituents. The other 10 constituents did not have enough detections to perform reliable statistics and therefore, the maximum concentrations were used. The output files for UCL95 calculations are provided in Appendix D~~Freon-113, TCE, and 2-Propanol~~. The cumulative residential indoor air hazard is 6.09E-01 which is below the target of 1.0E+00 set by the NMED ~~(NMED, 2019b)~~.

Table 6.12 provides the 200 Area industrial indoor air hazard screening. This table uses the same UCL95 calculated concentrations or maximum concentrations as Table 6.11. For the industrial indoor air pathway, no individual or combined hazard (2.73E-01) exceeded the NMED target of 1E+00.

6.1.1.3 200 Area – Soils ~~Cumulative~~ Screening Risk Assessment

Figure 6.2~~1~~ shows the WSTF background soil areas. The 200 Area is within WSTF background Area 2. ~~Table 6.6~~Table 6.13 shows the 200 Area maximum soil concentrations versus the Area 2 Background Threshold Value (BTV) comparisons that are used to determine what COPCs are initially indicative of WSTF background and are therefore not COPCs in the 200 Area. ~~, and~~ ~~Table 6.7~~Table 6.14 contains the maximum detected 200 Area soil concentrations for essential nutrients compared to WSTF BTVs for Area 2. If maximum detected values for a constituent are below previously established background concentrations within the same depth range ~~(NASA, 2015d)~~, the constituent is no longer considered to be a COPC. Using maximum 200 Area soil concentrations compared to BTVs, the only COPCs were mercury and nitrate/nitrite. Mercury was detected in one sample in the 200 Area (at 0.003 mg/kg) and must be retained as a COPC because mercury was not detected in background Area 2 in sufficient enough quantity to calculate a BTV or compare populations~~In WSTF background Area 2~~ in the 8 to 12 ft depth range~~, mercury was not detected~~. ~~Therefore, the single detection of mercury in the 200 Area soil data was retained as a COPC.~~ Using ProUCL software, the populations of nitrate/nitrite were compared between WSTF background Area 2 and the 200 Area soil data. When duplicate data are present, the most conservative value of the sample and duplicate was used. For background soil Area 2, the lower of the two concentrations was used, and the maximum 200 Area investigation soil concentration of the sample and duplicate was used. Nitrate/nitrite in 200 Area soils were not greater than background nitrate/nitrite Area 2 concentrations. Therefore, nitrate/nitrite was not retained as a 200 Area soil COPC (~~Table 6.8~~Table 6.15). The ProUCL data input file is provided as an enclosure and all ProUCL output files are provided in Appendix D~~C~~.

~~Table 6.9~~Table 6.16 contains the ~~cumulative~~ residential cancer risk screening for the 200 Area soils. Risk was calculated using data from soil borings 200-SB-05 through 200-SB-13, shown in Figure 6.3~~2~~ (wells 200-SB-6 and 200-SB-7 subsequently renamed 200-LV-150 and 200-KV-150, respectively), at depths between 0-10 ft bgs, except for soil boring 200-SB-10, for which no sample was collected within the 0 to 10 ft interval. For this well, the shallowest sample (collected at 16 ft bgs) was used for the 200 Area risk/hazard screening. All 200 Area soil samples used in this screening were collected during the 200 Area Phase II Investigation ~~Report~~ (NASA, 2015b). 200 Area soil analytical data from the Phase II investigation are provided in excel format in Enclosure 4~~3~~. The only COPCs detected in 200 Area soils for the residential scenario were dioxins and furans. The toxicity equivalents were calculated per the NMED Guidance (NMED, 20~~19~~22c~~b~~) and are presented in Appendix D~~C~~. For this revision, toxicity equivalents (TEQs) were updated to exclude total dioxin/furan data. Per Section 2.1 of the NMED

Guidance (NMED, 2022c), only individual congeners were evaluated~~Appendix D.~~ As required, the maximum dioxin/furan TEQ concentration was used for the risk screening and compared to 2,3,7,8-TCDD (Tetrachlorodibenzo –p-dioxin). The resulting total~~cumulative~~ cancer risk is 6E-08 (Table 6.16) which is below the respective target of 1E-05 set by the NMED ~~(NMED, 2019b)~~.

Table 6.17 provides the 200 Area industrial soil cancer risk for dioxins and furans. The risk of 1E-08 does not exceed the NMED target of 1E-05.

~~Table 6.10~~Table 6.18 contains the ~~cumulative~~ 200 Area residential soils hazard screening~~assessment for the 200 Area soils~~, calculated using the same soil data from the 200 Area Phase II Investigation Report (~~NASA, 2015b~~provided in excel format in Enclosure 4~~Appendix C~~). Three COPCs (mercury, toluene and~~including many~~ dioxins/furans) are detected in these soil samples, all of which are below their respective NMED SSLs. The TEQs for the dioxins/furans were calculated (Appendix D~~C~~) and then compared to the NMED residential noncancer SSL. The total hazard is 6.67E-03 which is below the target of 1.0E+00 set by the NMED (NMED, 20~~19~~22c~~b~~).

Table 6.19 compares the 200 Area maximum soil concentrations of mercury, toluene, and dioxins and furans to the industrial hazard screening levels. The total hazard is 5.47E-04, which is below the target of 1E+00.

6.1.1.4 200 Area – Cumulative Screening Risk Assessment for Residential Exposure

A screening of worker risks related to both indoor inhalation and soil exposure pathways for the 200 Area is provided in this section for ~~here under~~ both the residential and industrial exposure scenarios ~~to be conservative. Table 6.21~~ . Table 6.20 shows summed cancer risk and hazard for exposure to soil vapor and soil for the residential scenario in the 200 Area. The 200 Area has cumulative cancer risk of ~~7E-06~~4E-04 and a cumulative chemical hazard of ~~8.0~~8E+01. Table 6.21 shows the summed cancer risk and hazard for exposure to soil vapor and soil for the industrial scenario in the 200 Area. The 200 Area cumulative industrial cancer risk is 1.48E-05, and the cumulative industrial hazard is 4.91E+00. All cumulative risk and hazard exceed targets.

All analytical data ~~(laboratory reports and an Excel file data summary)~~ for the 200 Area cumulative screening risk assessment are included as an enclosure to this report (vapor laboratory reports are in Enclosure 3 and analytical data in excel format are in Enclosure 4).

6.1.2 600 Area Screening Risk Assessment

6.1.2.1 600 Area – Soil Vapor ~~Cumulative~~ Screening Risk Assessment

For this investigation, soil vapor samples were collected from the shallowest vapor ports in three wells in the 600 Area (600-SGW-1 at 12.5 ft bgs, 600-SGW-2 at 12.5 ft bgs, and 600-SGW-5 at 7.5 ft bgs). Since two separate sampling events (August 2017 and February 2018) were conducted, there is a total of six samples per constituent for the 600 Area. Per NMED (2022c) and EPA (2022a) guidance, six samples are not a sufficient number to perform reliable statistics. Therefore, the maximum concentration per constituent was used in all screening for 600 Area soil vapor.

The 600 Area risk/hazard screening was performed in the same way that the 200 Area risk/hazard screening was done. 600 Area soil vapor analytical data was compared to NMED VISLs (and EPA RSLs if no VISL was available) as a first screen. ~~Table 6.11~~Table 6.22 contains the ~~cumulative~~ 600 Area residential soil vapor cancer risk compared to NMED VISLs~~for the 600 Area soil vapor assessment~~. There are 11~~eight~~ detected constituents, all of which are below their respective NMED VISLs, except

TCE (5.03E-05).~~ A UCL95 value was calculated for chloroform.~~ The total~~cumulative~~ cancer risk is ~~9E-06~~6.15E-05, which exceeds~~is below~~ the NMED target risk of 1E-05 (NMED, 20~~19~~22c~~b~~).

Table 6.23 provides the comparison of the maximum concentrations to industrial VISLs for soil vapor in the 600 Area. All of the 11 detected constituents are below their respective NMED VISLs, and the total 600 Area industrial soil vapor cancer risk of 8.90E-06 is below the NMED target of 1E-05.

Since the total risk for the 600 Area residential soil vapor pathway exceeded the target compared to VISLs, the more site-specific WSTF RBCs were used for comparison to maximum soil vapor concentrations in Table 6.24. The total 600 Area residential soil vapor cancer risk is 2.20E-06, which is below the target cancer risk of 1E-05 (NMED, 2022c).

~~Table 6.12~~Table 6.25 contains the~~ cumulative~~ residential hazard assessment for soil vapor in the 600 Area ~~soil vapor assessment~~. There are 28~~3~~ constituents detected with only TCE exceeding its NMED VISL (1.06E+01).~~ A UCL95 value is calculated for TCE.~~ The total hazard for the 600 Area soil vapor is ~~7.9E+00~~1.08E+01, which exceeds the NMED target hazard of 1~~.0~~E+00 (NMED, 20~~19~~22c~~b~~).

The 600 Area industrial soil vapor hazard is shown in Table 6.26. Like the residential scenario, TCE is the only constituent that exceeded the individual noncancer VISLs (2.26E+00). The total hazard is 2.30E+00, which also exceeds the target of 1E+00 (NMED, 2022c).

The 600 Area soil vapor~~ cumulative~~ hazard assessment~~ also~~ using~~es~~ WSTF RBCs~~,~~ is shown in ~~Table 6.13~~Table 6.27. The RBCs take into account site specific conditions and are expected to better reflect the actual risk to human health on-site than~~when compared to~~ NMED VISLs (NASA, 2022c~~19a~~). Constituents are compared against the RBC value at the nearest depth shallower than the sample depth since shallower RBCs are more conservative. There are no available RBCs for 1,2-Dichloroethane, 1,4-Dichlorobenzene, Ethylbenzene, Toluene, m,p-Xylene, and o-Xylene~~, or 1,2,4-Trimethylbenzene~~, so the NMED VISLs were used as screening levels for these constituents. For cis-1,2-dichloroethene and 1,2,4-Trimethylbenzene, the EPA RSL for resident air was used since there were no RBCs or NMED VISLs established. The cumulative hazard is reduced to ~~2.5~~3.63E-01, which is below the NMED target hazard of 1~~.0~~E+00 (NMED, 20~~19~~22c~~b~~). There are no constituents that~~which~~ exceed WSTF RBCs.

Table 6.28 presents the 600 Area industrial soil vapor maximum concentrations to WSTF RBCs. All constituents were below the corresponding WSTF RBC for the industrial scenario, and the total hazard for soil vapor is 3.25E-02, also below the target to 1E+00 (NMED, 2022c).

6.1.2.2 600 Area – Indoor Air~~ Cumulative~~ Risk Assessment

~~Table 6.14~~Table 6.29 contains the~~ cumulative~~ 600 Area residential indoor air cancer risk screening assessment~~ for the 600 Area indoor air assessment~~. The four~~three~~ detected constituents are below their respective NMED indoor air screening levels. The total~~cumulative~~ cancer risk is ~~3~~2.49E-06 which is below the NMED target risk of 1E-05 (NMED, 20~~19~~22c~~b~~).

Table 6.30 contains the 600 Area industrial indoor air cancer risk screening. All four detected constituents are below their respective NMED indoor air industrial screening levels, and the total cancer risk is 5.09E-07, which is also below the 1E-05 target (NMED, 2022c).

~~Table 6.15~~Table 6.31 contains the~~ cumulative~~ residential hazard assessment for~~ the~~ 600 Area indoor air ~~assessment~~. There are 16~~3~~ detected constituents, all of which are below their respective NMED indoor air screening levels. The cumulative hazard is ~~8.2E-02~~1.05E-01 which is below the NMED target hazard of 1~~.0~~E+00 (NMED, 20~~19~~22c~~b~~).

The 600 Area industrial indoor air hazard screening is presented in Table 6.32. No constituent exceeded any individual VISLs. The total hazard (6.44E-02) also was below the target of 1E+00 (NMED, 2022c).

6.1.2.3 600 Area – Soils ~~Cumulative~~ Risk Assessment

Figure 6.~~1~~2 shows the WSTF background soil areas. The 600 Area is within WSTF background Area 4. ~~Table 6.16~~Table 6.33 shows BTV comparisons that are used to determine background constituents in the 600 Area. If maximum detected values for a constituent are below previously established background concentrations within the same depth range (NASA, 2015d), the constituent is no longer considered to be a COPC. Using maximum 600 Area soil concentrations compared to BTVs, potential COPCs were antimony, barium, beryllium, boron, cadmium, chromium, cobalt, copper, manganese, mercury, molybdenum, NO_2/NO_3, perchlorate, thallium, tin, and zinc. Essential nutrient maximum concentrations that exceeded BTVs were magnesium, potassium, and sodium (~~Table 6.17~~Table 6.34). Following comparison of 600 Area soils data to the ~~WSTF~~ BTVs, the two populations of data were compared for 600 Area soil constituents that had a maximum concentration that exceeded the ~~WSTF~~ BTV. Using ProUCL software (Version 5.2), the populations were compared between WSTF background Area 4 and the 600 Area soil data. When duplicate data are present, the most conservative value between the sample and duplicate was used. (For background soil Area 4, the lower of the two concentrations was used, and the maximum 600 Area investigation soil concentration of the sample and duplicate was used.) Antimony, boron, ~~C~~cadmium, chromium, ~~cobalt, manganese, molybdenum, and~~ NO_2/NO_3, perchlorate, thallium, and tin in 600 Area soils were retained as COPCs (Table 6.33 and ~~Table 6.18~~Table 6.35). Sodium was also ~~R~~retained as an essential nutrient~~s included magnesium and sodium~~ (Also shown on ~~Table 6.18~~Table 6.35).

~~Table 6.19~~Table 6.36 and Table 6.37 contain~~s~~ the ~~cumulative~~ cancer risk screenings for the 600 Area soils, calculated using data from soil borings 600-SB-1 through 600-SB-10, shown in Figure 6.4~~3~~, collected between 0 to 10 ft bgs in the 600 Area Closure Investigation Report (NASA, 2011a). There are six~~even~~ detected carcinogenic constituents, all of which are below their respective NMED SSLs (residential in Table 6.36 and industrial in Table 6.37). The cumulative cancer risk is ~~2~~1.80E-06 for residential risk and 3.40E-07 for industrial risk, which are~~is~~ both below the NMED target risk of 1E-05 (NMED, 20~~19~~22c~~b~~).

~~Table 6.20~~Table 6.38 contains the ~~cumulative~~ residential hazard assessment for the 600 Area soils calculated using data from the 600 Area Closure Investigation Report (NASA, 2011a). There are 19~~25~~ constituents detected in these soil samples, of which thallium is the only analyte to exceed its respective NMED residential SSL (6.63E+00). The total~~cumulative~~ residential hazard including thallium is ~~1.0E+01~~6.66E+00, which exceeds the target of 1E+00.

Table 6.39 shows 600 Area industrial soil hazard. All constituents, including ~~and without~~ thallium, are below the target of 1E+00. is ~~2.5E-01~~2.8E-02. The total industrial hazard is 4.01E-01, which is also below the 1E+00 target (NMED, 2022c). ~~The maximum detected thallium soil concentration (7.6 mg/kg) is, however, below the NMED industrial scenario screening criterion of 13 mg/kg. For industrial land use, the cumulative hazard would be 0.98, indicating adverse health effects are unlikely under present-day and anticipated future industrial land use at WSTF.~~

6.1.2.4 600 Area – Cumulative Screening Risk Assessment for all Exposure Pathways

A screening of worker risks related to both indoor inhalation and soil exposure pathways for the 600 Area is provided here. ~~Table 6.22~~Table 6.40 shows summed cancer risk and chemical hazard for exposure to soil vapor and soil in the 600 Area. The 600 Area has a cumulative cancer risk of ~~1E-05~~4E-06 and a chemical hazard of ~~1.5E+01~~7E+00.

All analytical data (vapor laboratory reports and an Excel file data summary for vapor and soils) for the 600 Area cumulative screening risk assessment are included as an enclosure to this report. ~~All d~~Data for statistics for the 600 Area~~ cumulative screening risk assessment~~ are provided~~shown~~ in Appendix D~~C~~.

6.2 Uncertainties

6.2.1 Constituents without Published Screening Values

The only detected constituents found in vapor throughout this investigation for which no published inhalation screening level is available are 2,2,4-Trimethylpentane, ethanol, and Freon 21. The organic chemical 2,2,4-Trimethylpentane is a component of gasoline and diesel but is not associated with any historical operations related to the 200 and 600 Area HWMUs that are the focus of this investigation. The relatively low measured concentrations (0.36 to 0.39 µg/m^3) and few detections (2 of 52 samples, both with J QA flags and adjacent to each other in the 200 Area Building [samples 200-IA-3 and 200-IA-4; Figure- 3.1]) indicate that this chemical is unlikely to present significant health risks/hazards.

All three constituents (Ethanol, Freon 12, 2,2,4-Trimethylpentane) were detected in low concentrations (Ethanol: 1.5-9.6 µg/m^3; Freon 21: 0.84-6 µg/m^3 detected 6 out of 52 samples; 2,2,4-Trimethylpentane: 0.36 and 0.39 µg/m^3, detected 2 out of 52 samples), and none were detected in soils, likely indicating there is not a continuous soil source. In addition, the hazard calculations using approved WSTF RBCs included Ethanol (using methanol as a surrogate) and Freon 21 (using Freon 12 as a surrogate). No significant hazard was contributed by either ethanol or Freon 21 (Table 6.27 and Table 6.28).

6.2.2 Small Sample Sizes

The goal of the 200/600 VI investigation was to obtain indoor air, outdoor air, and soil vapor samples at the 200 and 600 Area over two seasonal changes and compare results to NMED VISLs and RBCs (if there were VISL exceedances). This could determine if further evaluation was warranted. Performing a comprehensive health risk was not part of the original scope. However, NASA was directed by NMED to perform health risk for this investigation, which usually involves performing statistical calculations. Both NMED and EPA recommend a minimum of 8 to 10 samples to perform reliable statistics. Only two sets of samples within three soil vapor wells per area were collected for this investigation (resulting in a total of 6 samples per constituent). Therefore, no EPCs such as UCL95 could be calculated for soil vapor. Since the maximum concentrations were used for risk and hazard, this creates uncertainty (biased high) in the risk and hazard results. A receptor is unlikely to be exposed to only the maximum concentrations of constituents, so the risk and hazard are currently conservative and likely do not represent real conditions.

6.2.3 Industrial Pathway Sample Depths

The initial 200 Area Phase II and 600 Area HWMU investigations were not designed specifically for risk assessment. Since they were designed to find the greatest concentrations of contaminants and WSTF soils have historically been disturbed, removed, and clean fill added, neither soil samples nor soil vapor samples were collected from the 0-1 ft bgs depth range for this investigation. The shallowest soils depths sampled and used for this risk screening were 8 and 16 ft bgs for the 200 Area and 3, 4, 6, and 10 ft bgs for the 600 Area. For soil vapor, the 200 Area was sampled at 9, 19, and 34 ft bgs, and the 600 Area was sampled at 7.5 and 12.5 ft bgs. This imparts uncertainty to the risk and hazard for the industrial pathway. Lines of evidence can support risk and hazard conclusions.

6.2.4 Large Dilution and Elevated Detection Limits

When a laboratory needs to dilute a sample a large amount due to very high concentrations of one or more VOCs, this causes the detection limits of other VOCs to be artificially raised. Especially when the detection limits are greater than corresponding regulatory screening levels, this creates uncertainty for the health risk and hazard evaluations. It cannot be stated that the constituent is not present in the sample in greater concentrations than the screening level. This could potentially bias the risk and hazard screening low, meaning there could be more contamination at higher risk and hazards than the risk screening indicates. For this evaluation, eight VOC constituents had detection limits greater than NMED VISLs due to large dilutions for soil vapor samples in well 200-LV-150 (sampled at 34 ft bgs).

6.3 Lines of Evidence

Since there are always uncertainties associated with risk and hazard screenings, lines of evidence can be applied to provide more confidence in the risk and hazard screening conclusions. The following lines of evidence can be applied for this 200/600 Area VIAR.

~~6.1.3~~6.3.1 Conservative Risk Using Maximum Concentrations

When either an individual COPC or the combined sum exceeds NMED screening levels, risk, or hazard using maximum COPC concentrations, further evaluation is required ~~(NMED, 2019b)~~. As stated in Section 2.8.4 of the NMED Guidance, UCL95 (the 95 percent upper confidence limit of the arithmetic mean) concentration of a contaminant may be calculated to represent an average concentration likely to be contacted over time. However, due to small sample size, UCL95 values could not be calculated for soil vapor. In addition, many constituents were only detected once or only a few times, requiring retaining the maximum concentration as the EPC. ~~Throughout this health risk screening, only constituents considered risk drivers (COPCs that individually exceeded targets or caused the cumulative sum to exceed targets) had their respective UCL95 values calculated. Using UCL95 concentrations for only a few COPCs did result in less risk/hazard than the NMED required targets of 1E-05/1. However, if the UCL95 calculations had been applied to all constituents, the cumulative health risks/hazards would be lower than our results currently show. NASA understands that using mostly maximum concentrations~~This will result in conservative estimates of risk/hazard.

~~6.1.4~~6.3.2 Soil Vapor Vertical Concentration Profiles

Soil vapor vertical concentration profiles for 200 and 600 Area wells were constructed to present the distribution of COPCs in the vadose zone and identify any sourcing relationships to the local contaminated groundwater aquifer. The evaluation includes a temporal element with comparison of shallow soil vapor port analytical results generated specifically for the VI assessment to historical soil vapor analytical data collected for previous investigations (NASA, 2011b; NASA, 2013c~~b~~; and NASA, 2015b). Historical soil vapor sampling events included all accessible ports within 200 and 600 Area MSVM and MSVGM wells that were sampled collectively as single events in order to provide a results snapshot using soil vapor isopleth maps. Vertical concentration profiles also incorporate soil sample analytical results collected during borehole installation, the soil porosity from geotechnical soil sample analyses, and groundwater analytical results from contemporaneous sampling events performed to support the soil vapor investigations. COPC concentrations in groundwater were used to calculate the equivalent soil vapor concentrations in equilibrium with groundwater using Henry's Coefficient (NMED, 2019). The calculated values are compared to soil vapor concentrations from the most proximal port located above groundwater.

With the exception of TCE, soil vapor analytical results for the majority of COPCs for the VI assessment and historical sampling events (PCE; Freon11; Freon 113; 2-butanone; 1,1,1-trichloroethane; chloroform; benzene; ethylbenzene; toluene; xylenes; acetone; and 2-propanol) are below the respective NMED VISL and WSTF RBC in soil vapor. For the optimum vertical concentration profiling of soil vapor, the COPCs Freon 113 and TCE were selected as they consistently display greater frequency of detection, relatively high concentrations, and more widespread vertical distribution. Freon 113 and TCE also represent two of the primary COPCs known to have been released from historical activities within the 200 and 600 Areas (NASA, 2012b). Vertical concentration profiles for select 200 and 600 Area wells are provided in Appendix E~~D~~, with a summary of the profiles presented in ~~Table 6.23~~Table 6.42.

~~6.1.4.1~~6.3.2.1 200 Area - Wells 200-SG-2 and 200-SG-3

MSVGM wells 200-SG-2 and 200-SG-3 were utilized for vertical concentration profiles for the 200 Area vadose zone, in lieu of VI assessment wells 200-SV-05 and 200-SV-09 located adjacent to Building 200. Wells 200-SV-05 and 200-SV-09 comprise single port constructions directly above Permian Hueco limestone bedrock at 9 ft and 19 ft respectively, which preclude the ability to plot vertical concentration profiles. VI assessment MSVGM well 200-LV-150 was also not utilized for vertical concentration profiles because the shallow port at 34 ft was blocked during the only comprehensive sampling event performed (NASA, 2015), leaving only two lower ports accessible at 64 ft and 84 ft. The three ports are also all located below shallow alluvium - Permian Hueco Limestone bedrock interface at 18 ft, with bedrock elevated as a geological horst block along two subparallel faults below the industrialized 200 Area. The bedrock vadose zone in this area is not characterized by the high porosity and permeability of the relatively thick vadose zone alluvial section found in other parts of the 200 Area and the 600 Area. The bedrock vadose zone below the former Clean Room Tank HWMU located adjacent to Building 200 has been demonstrated to host residual COPCs within irregular low permeability bedrock fractures sampled in cores (NASA, 2015b).

Wells 200-SG-2 and 200-SG-3 were not utilized for shallow soil vapor sampling as part of the vapor intrusion assessment due to their distance from Building 200 of approximately 1,200 ft and 700 ft, respectively. The wells were installed in 1998 as part of the well 200-D area vadose zone investigation (NASA, 2004), through a thicker section of vadose zone alluvium peripheral to the industrialized 200 Area. Well 200-SG-2 was installed south of the industrialized 200 Area within a borehole drilled to a depth of 240 ft bgs. The borehole intercepted Permian Hueco Limestone bedrock at 90 ft bgs, and groundwater was initially identified at 230 ft bgs during drilling. The confined groundwater subsequently increased in elevation to a depth of 83 ft bgs. Three soil vapor ports were positioned at depths of 30 ft, 60 ft, and 84 ft bgs. The first two ports are located within the alluvial vadose zone, and the deep port is located within bedrock comprising interbedded limestone, shale, and sandstone. A screened groundwater monitoring zone is present at a depth of 85 ft to 100 ft bgs. Because confined groundwater increased in elevation above the bottom port, it became submerged and non-operational. The middle soil vapor port positioned approximately 23 ft above the local water table is now utilized as the deep port.

MSVGM well 200-SG-3 was installed south of the 200 Area buildings in the vicinity of the former hazardous waste evaporation tanks within a borehole drilled to a depth of 250 ft bgs. The borehole intercepted Permian Hueco Limestone bedrock at 80 ft bgs, and groundwater at 190 ft bgs during drilling. The groundwater table subsequently increased in elevation to a depth of 164 ft bgs. Five soil vapor ports were located at depths of 30 ft, 60 ft, 90 ft, 120 ft (reported as blocked following installation), and 154 ft bgs. The shallow two ports are located within the alluvial vadose zone, and the three deeper ports are located within bedrock comprising interbedded limestone, shale, and sandstone. A screened groundwater monitoring zone is present between 155 ft and 170 ft bgs, with the deep soil vapor port located 10 ft above the local groundwater table.

Evaluation of the vertical concentration profiles in the 200 Area at wells 200-SG-2 and 200-SG-3 (Appendix E~~D~~, ~~Table 6.23~~Table 6.42) indicate variable and complex relationships between soil vapor in the vadose zone and groundwater. Proximal to Building 200, residual COPCs sourced from the former

Clean Room Tank HWMU characterize fractured Permian Hueco limestone bedrock. Relatively low and variable permeability in the fractured interbedded limestone, sandstone, and shale comprises the majority of the vadose zone along and within the horst block. Adjacent to the industrialized 200 Area where the alluvial vadose zone is thicker, shallower soil vapor ports located within alluvium or proximal to the upper bedrock section (well 200-SG-3, port at 90 ft) display generally increasing trends with depth, that are characteristic of the vadose zone at the 600 Area Closure (Section 6.2.2).

Soil vapor ports within the fractured limestone section do not display the same increasing COPC concentration trend as the alluvial vadose zone and are more irregular in profile. This trend could potentially be attributed to irregular vadose zone sources in the fractured bedrock vadose zone and local groundwater aquifer. Localized sources in these areas may be sourced by the infiltration of COPCs observed at surface (NASA, 2012b) through the alluvial soil to the bedrock interface, with subsequent migration down dip along relatively low permeability bedding planes or within bedding plane solution channels saturated below the local groundwater table. Vertical concentration profiles generally demonstrate declining soil vapor concentrations over time since the inception of soil vapor sampling in this area, which coincides with declining COPC trends in groundwater (NASA, 2019a). Where COPC concentrations in groundwater were used to calculate the equivalent equilibrium soil vapor concentrations, the results for the deep port in the respective well were within one order of magnitude for Freon 113 and the same order of magnitude for TCE.

~~6.1.4.2~~6.3.2.2 600 Area - Wells 600-SGW-1 and 600-SGW-5

600 Area MSVM wells 600-SGW-1 and 600-SGW-5 were utilized for vertical concentration profiles in the vicinity of Building 637. The shallow port in each well (12.5 ft and 7.5 ft, respectively) was used to collect shallow soil vapor samples as part of the VI assessment. Well 600-SGW-1 was installed in 2009 as part of a closure investigation through the 600 Area closure cap within a borehole drilled to 135 ft bgs. The borehole was not advanced to the projected depth of bedrock (anticipated at between 160 ft and 170 ft) due to drilling difficulties with the sonic drilling method. Three soil vapor ports were located at 12.5 ft, 57.5 ft, and 117.5 ft bgs. Well 600-SGW-1 is located 184 ft from Building 637, and all vapor ports within the well have been sampled several times during previous investigations, providing a record of historical vertical profiles.

MSVM well 600-SGW-5 was also installed as part of the closure investigation immediately adjacent to the east corner of the 600 Area closure cap within a borehole drilled to 156 ft bgs. The well comprises four soil vapor ports located at 7.5 ft, 52.5 ft, 102.5 ft, and 137.5 ft. During borehole installation, perched groundwater was encountered at 144 ft on top of the alluvium-poorly fractured Tertiary Orejon andesite interface at 148 ft bgs. Well 600-SGW-5 is the most proximal well to building 637 at a distance of 181 ft, and was historically sampled as part of the same events as well 600-SGW-1. Because of the identification of perched groundwater in the borehole, the well was twinned with monitoring well 600-G-138 in 2011 to evaluate the perched groundwater. The results for Freon 113 and TCE for groundwater samples collected from 600-G-138 within the same timeframe as the soil vapor samples from well 600-SGW-5 are used to compare the soil vapor COPC concentration in equilibrium with groundwater to soil vapor in the deepest port at 137.5 ft.

The vertical concentration profiles in the 600 Area evaluated for wells 600-SGW-1 and 600-SGW-5 (Appendix E~~D~~, ~~Table 6.23~~Table 6.42) indicate a relationship between soil vapor in the vadose zone and groundwater. Both wells are located within an area characterized by an alluvial vadose zone with high porosity and permeability. The spectrum of soil vapor ports in these wells show consistently increasing COPC concentrations with depth and proximity to either perched groundwater or the local groundwater table. Vertical concentration profiles also demonstrate declining soil vapor concentrations over time since the inception of soil vapor sampling in this area that coincides with local declines in COPC concentrations in groundwater. Where COPC concentrations in groundwater at well 600-G-138 were used to calculate the equivalent equilibrium soil vapor concentrations, the results were comparable and within the same order of magnitude for the deep port in well 600-SG-5 located 7 ft above perched groundwater.

~~6.1.5~~6.3.3 Integrity of Building Slabs

Building 200 was constructed in 1964 as a semi-permanent structure with a reinforced concrete floor (NASA, 1994). The concrete slab floor is 6 in. in thickness. The facility was intended for its present use as a laboratory with offices and is fully suitable for this use. Details of the Building 200 construction characteristics identified through the building inspection performed for the vapor intrusion assessment are provided in Appendix A. The floor is composed of a poured concrete slab covered with concrete sealant and 9-in. x 9-in. x 1/16-in. vinyl tiling. No significant cracks were observed in the concrete foundation slab during the building inspection around the outside periphery of Building 200 or inside within areas of exposed concrete floor. Therefore, known vapor intrusion routes of entry through the foundation slab are limited to diffusion through the concrete slab.

Building 637 was built in 1991 as a semi-permanent structure with a reinforced concrete floor (NASA, 1994). The concrete slab floor is 6 in. in thickness. The facility was intended for its present use for sample storage and is fully suitable for this use. Details of the Building 637 construction characteristics are provided in Appendix A. The floor comprises a poured concrete slab covered with concrete sealant. No significant cracks were observed in the concrete foundation during the building inspection around the outside periphery of the building or within the interior concrete floor. Therefore, known vapor intrusion routes of entry through the foundation slab are limited to diffusion through the concrete slab.

~~6.1.6~~6.3.4 Ventilation Systems

Building 200 comprises a single floor structure. Airflow is through cycled air, and outdoor air infiltration can enter the building through open doors, door thresholds, and air ducts in the roof. Heating is through hot air circulation sourced by natural gas, and air conditioning is provided through central air. The HVAC systems run constantly throughout the day in order to preserve the laboratory environment (Appendix A).

Building 637 comprises a single floor structure. During summer months, airflow is through forced central air generated by evaporative coolers located on the ground on the north side of the building. Outdoor air infiltration could potentially be generated through the evaporative cooler intakes or on occasions when the bay door on the west side of the building is open. Heating is through hot air circulation sourced by natural gas. The HVAC systems run intermittently due to the irregular usage of the building on working days (Appendix A).

~~6.1.7~~6.3.5 Personnel Management Practices

The practices for chemical storage and chemical waste management in Buildings 200 and 637 have been continually modified and improved through time at WSTF as part of the ongoing health, safety, and environmental culture. Personnel management practices have effectively promoted the minimization, documentation, storage, and disposal of wastes. These practices include: the training of WSTF employees operating within the target buildings to manage potential chemical sources of vapors appropriately; communication of best practices for chemicals management from managers through supervisors to workers; communication of the safety culture awareness; establishing chemical best management policies; and, providing constant supervision and monitoring of the work environment. Development and streamlining of the personnel management practices has helped minimize the potential for vapor intrusion into the buildings and vapor circulation within the buildings.

~~6.1.8~~6.3.6 Indoor Air Quality – Risk to Worker

In Building 200, the concentration of 3,200 µg/m^3 of Freon 113 reported in August 2017 from sample location 200-IA-5 within Room 202 is two orders of magnitude below the NMED VISL for industrial indoor air of 147,000 µg/m^3~~ and three orders of magnitude below the OSHA PEL TWA of 7,670,000 µg/m^3~~ (Table 4.3~~5.1~~). The product inventory form (Table 4.1) indicates that steel canisters containing Freon are stored in this secure, unoccupied storage room. A trace indoor air concentration for 2-propanol of 68 µg/m^3 reported in August 2017 from sample location 200-IA-3 within Room 205 is one~~four~~ order~~s~~ of magnitude below the residential and industrial RSLs ~~OSHA PEL TWA of 984,000 µg/m^3~~ (Table 4.3~~5.1~~). 2-propanol is a common ingredient in chemicals such as antiseptics, disinfectants and detergents that are stored in this room. Room 205 is used exclusively for equipment and storage and is occupied only during maintenance activities. The workers are protected under this scenario.

In Building 637, a trace indoor air concentration for acetone of 16 µg/m^3 reported in August 2017 from sample location 600-IA-2 is four orders of magnitude below the NMED VISL for industrial indoor air of 152,000 µg/m^3~~ and five orders of magnitude below the OSHA PEL TWA of 2,380,000 µg/m^3~~ (Table 5.1~~2~~). Acetone is a common solvent used for cleaning tools occasionally used in the building. The workers are protected under this scenario.

~~6.1.9~~6.3.7 Concentration Ratios of Detected Constituents in Soil Vapor and Indoor Air

If vapor intrusion impacted indoor air quality in Building 200 or 637 one would expect to see a similar detection pattern and ratio of constituent concentrations for indoor air and soil vapor samples. However, analytical results from the two semi-annual indoor air and soil vapor sampling events show that the types and concentrations of VOCs in indoor air in Buildings 200 and 637 are unrelated to soil vapor measurements in those areas. This supports a conclusion that any constituents detected in indoor air samples did not enter the building through vapor intrusion from the vadose zone. The trace level constituents present within the buildings are not unexpected due to the inventoried storage of chemicals within the Building 200 laboratories and Building 637 sample storage areas (see Section 6.6 and Appendix A).

TCE, PCE, and 1,1-Dichloroethene were the three primary risk drivers which exceeded screening levels in the 200 Area soil vapor samples as follows:

- TCE was detected in all eight of the vadose zone soil vapor samples collected. Of the 18 indoor air samples, TCE was only detected in eight of the samples.
- PCE was again detected in all eight of the vadose zone soil vapor samples collected. There was only one detection of PCE within the 18 indoor air samples, and the detection was a trace amount (0.28 ug/m^3).
- 1,1-Dichloroethene was detected again in all eight of the soil vapor samples, while the constituent was non-detect for all 18 indoor air samples.

~~6.2~~6.4 Assessment of Worker Risks for Occupants of Buildings 200 and 637

The three constituents which exceed NMED screening levels in 200 Area soil vapor coexist in all of the soil vapor samples. This same correlation between these constituents does not exist in indoor air samples, indicating that soil vapor is not the source of the trace indoor detections.

The primary risk driver that exceeded NMED VISLs in the 600 area was TCE. TCE was detected in each of the eight soil vapor samples collected within the 600 Area during this investigation. However, TCE was not detected in any of the ten indoor air samples that were collected in Building 637. The absence of

TCE in indoor air samples is a strong line of evidence that TCE in soil vapor in the 600 Area does not present a risk to present-day workers.

Industrial/occupational workers at WSTF who occupy buildings in the vicinity of the former 200 Area Clean Room Tank HWMU and the 600 Area HWMU while performing their daily duties are the primary potential receptors for COPC vapor intrusion. RA Guidance Section 2.5.2.1 (NMED, 20~~19~~22c~~b~~) states that the vapor intrusion pathway may only be considered incomplete if all soil vapor sample concentrations results are 100 percent non-detect. A cumulative health risk assessment was requested as part of the vapor intrusion investigation by the NMED (NMED, 20~~19~~22c~~b~~). The assessment was included in the revised report, and was completed in accordance with the RA Guidance to evaluate the pathway between soil vapor in the 200 and 600 Area vadose zones and indoor air in the vicinity of adjacent Buildings 200 and 637. Lines of evidence considered include:

- A cumulative screening level risk assessment.
- Evaluation of vertical concentration profiles within the 200 and 600 Areas.
- The results of the visual inspection of the buildings including the integrity of the building foundations, quality of the ventilation systems, and an evaluation of personnel management practices.
- Quantitative screening assessment of vadose zone soil vapor, outdoor air, and indoor air laboratory results with comparison to available vapor intrusion soil vapor screening levels and industrial exposure scenario air screening levels.

Evaluation of the lines of evidence support the conclusion that no additional investigation or vapor intrusion mitigation is required in Building 200 or Building 637.

Although vadose zone soil vapor concentrations of PCE and/or TCE at the locations of the 200 West Closure and 600 Area HWMUs exceeded NMED VISLs and updated NMED-approved WSTF RBCs as expected, indoor air exposure within Buildings 200 and 637 presents no unacceptable risk. The subsurface contribution to indoor VOC levels is below the equivalent indoor air screening levels.

~~Table 6.21~~Table 6.20,~~ and~~ ~~Table 6.22~~Table 6.21, Table 6.40, and Table 6.41 show the cumulative risk of soil and soil vapor within the 200 and 600 Areas, respectively. This calculation does not include results from indoor air sampling and is therefore representative of future risk. The same risk drivers remain present in this assessment.

7.0 Summary and Conclusions

7.1 Summary of Soil Vapor, Outdoor Air, and Indoor Air Sampling and Screening Criteria

The investigation reported in this VIAR used a tiered approach to evaluate the potential for vapor intrusion in the WSTF 200 and 600 Areas. The vapor intrusion pathway between soil vapor in the vadose zone and industrial/occupational indoor air at two locations identified through previous investigations was evaluated by comparing the maximum detected concentrations to the corresponding NMED VISLs, and WSTF RBCs. Additional lines of evidence were reviewed including evaluation of the building foundations and ventilation systems, and evaluation of the results of indoor and outdoor air sampling at these locations.

Adjacent to the 200 Area Clean Room Tank HWMU, soil vapor samples were collected from shallow soil vapor ports in MSVM wells 200-SV-05 at 9 ft bgs, 200-SV-09 at 19 ft bgs, and MSVGM well 200-LV-150 at 34 ft bgs. All three wells are located within 85 ft of the west side of Building 200. Air samples were collected simultaneously with the vadose zone samples. Indoor air samples were collected at locations in Building 200 above and adjacent to the subsurface footprint of the former 200 Area Clean Room Tank HWMU along with outdoor air samples adjacent to Building 200.

In the 600 Area, soil vapor samples were collected from shallow soil vapor ports in MSVM wells 600-SGW-1 at 12.5 ft bgs, 600-SGW-2 at 12.5 ft bgs, and 600-SGW-5 at 7.5 ft bgs, all located within 210 ft of Building 637. Indoor air samples were collected in Building 637 within the single room of the building, along with outdoor air samples at adjacent locations.

Sample collection activities at both locations were performed as two single semi-annual events in the summer (August 2017) and winter (February 2018) to address potential seasonal differences in HVAC performance and related air pressure fluctuations that could affect vapor intrusion. Vadose zone, indoor air, and outdoor air samples were collected over non-working three-day weekends on the same day within each area, and on consecutive days for both sampling events. Indoor and outdoor air sampling procedures were performed to assess the potential contribution of background levels of VOCs in ambient air to measured VOC concentrations in indoor air. Soil vapor samples were analyzed using EPA Method TO-15 in order to achieve the project DQOs. 2022~~17~~ NMED VISLs and 2022~~18~~ WSTF RBCs (submitted to NMED for review December~~June~~ 14~~9~~, 2021~~18~~; ~~final~~ memorandum approved with modification by NMED on February~~December~~ 11~~7~~, 2022~~18~~, and resubmitted May 10, 2022), which incorporate new toxicity data and exposure factors,~~ as well as the effects of mutagenicity,~~ were used for screening soil vapor data. Potential health effects related to inhalation of indoor air data were screened using NMEDs air screening levels~~ and OSHA PELs~~. NMED industrial soil screening levels were used to support the all-pathways cumulative screening assessment.

7.2 Conclusions

7.2.1 200 Area

7.2.1.1 Vadose Zone Soil Vapor

The shallow soil vapor port within three wells adjacent to Building 200 (and the location of the former Clean Room Tank HWMU) were utilized for the air intrusion evaluation. All three wells (200-LV-150-34, 200-SV-05, and 200-SV-09) have historically shown TCE soil vapor concentrations that exceed WSTF RBCs (NASA, 2015, Phase II report). Vadose zone TCE concentrations in soil vapor from MSVM wells 200-SV-05 at 9 ft bgs, 200-SV-09 at 19 ft bgs, and 200-LV-150 at 34 ft bgs exceed NMED VISL (11,000 and 280,000 µg/m^3 cancer and 69.5 and 328 µg/m^3 noncancer) and WSTF RBC at 25 ft bgs (4,900 and ~~18~~84,000 µg/m^3 noncancer) for the August 2017 and February 2018 semi-annual sampling events performed for this vapor intrusion assessment. PCE soil vapor concentrations exceed the NMED VISL (3,600 and 17,600 µg/m^3 cancer and 1,390 and 6,550 µg/m^3 noncancer) in all three wells for the August 2017 sampling event but are below the WSTF RBC at 25 ft bgs (~~460,000~~340,000 and 6,000,000 cancer and 130,000 and 2,300,000 µg/m^3 noncancer). In February 2018, only the PCE sample from 200-LV-150 at 34 ft bgs exceeded the NMED VISLs. The concentrations for the other~~11~~ remaining COPCs in vadose zone soil vapor are below the corresponding NMED VISLs (except 1,1-Dichloroethane) and WSTF RBCs.

7.2.1.2 Outdoor Air

Concentrations in Building 200 outdoor air samples were generally either non-detect or below 1 µg/m^3 for COPCs. Traces of Freon 11 (maximum 1.2 µg/m^3 in August 2017 and February 2018) and 2-Butanone (maximum 3 µg/m^3 in August 2017) were observed~~. Concentrations of COPCs are below OSHA PEL TWAs at all outdoor air sampling locations~~. Based on this simple comparison, NASA concludes that outdoor air does not present a significant risk of industrial/occupational exposure and no additional investigation or mitigation is required at this time.

7.2.1.3 Indoor Air

Concentrations in Building 200 indoor air samples were generally non-detect or present at trace concentrations for COPCs. One low concentration of Freon 113 of 3,200 µg/m^3 was reported in August 2017 at location 200-IA-5. This concentration is two orders of magnitude below the NMED VISL for industrial indoor air (147,000 µg/m^3)~~ and three orders of magnitude below the OSHA PEL TWA (7,670,000 µg/m^3)~~. All indoor air concentrations for all COPCs were well below NMED VISLs. As stated in the NMED Risk Assessment Guidance for Site Investigations and Remediation (NMED, 20~~19~~22c~~b~~), the “application of the VISLs is appropriate as a first-tier screening assessment.” Although the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, the subsurface contribution to indoor VOC levels is below indoor air NMED VISLs and WSTF RBCs.

The Decision Rule from the approved work plan (provided in Section 3.1.4) states that “If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below indoor air NMED VISLs and WSTF RBCs, then current vapor intrusion risks are acceptable.” Based on the results of a visual inspection of the structural stability WSTF Building 200, an evaluation of personnel management practices, and the quantitative assessment of soil vapor and air sample laboratory results with comparison to available vapor intrusion screening levels including NMED VISLs and WSTF RBC, NASA concludes the following:

- According to NMED Guidance on vapor intrusion pathway designation (NMED, 20~~19~~22c~~b~~), there is a complete exposure pathway in the 200 Area.
- Potential vapor intrusion into Building 200 does not present a risk of industrial/occupational exposure to personnel working in the building.
- No additional investigation or vapor intrusion mitigation is required in Building 200.

7.2.2 600 Area

7.2.2.1 Vadose Zone Soil Vapor

The shallow soil vapor ports within three wells located on the 600 Area HWMU adjacent to Building 637 were sampled as part the air intrusion evaluation. Well 600-SGW-2 has periodically yielded concentrations of TCE that have exceeded WSTF site-specific RBCs (NASA, 2013c 200/600 semi-annual fourth report), although TCE concentrations remained below the RBC for the last sampling event (NASA, 2015 Phase II report). TCE concentrations within soil vapor for well 600-SGW-1-12.5 (480 µg/m^3 in August 2017 and 740 µg/m^3 in February 2018) and well 600-SGW-2-12.5 (330 µg/m^3 in August 2017) exceed the NMED VISL (69.5 and 328 µg/m^3), but are significantly below the WSTF RBC at 10~~5~~ ft bgs (~~18,000~~5,400 µg/m^3). All other maximum concentrations for the remaining COPCs for both the August 2017 and February 2018 sampling events are below the respective NMED VISL and WSTF RBC in soil vapor~~ at 5 ft bgs~~. Based on the historical soil vapor data and soil vapor results presented in the VIAR, NASA concludes that activities related to the ongoing 600 Area Perched Groundwater Extraction Pilot Test (NASA, 2018b) and upcoming 600 Area Perched Groundwater Investigation (NMED, 2017b) will address concerns related to the presence of VOCs in soil vapor in the area.

7.2.2.2 Outdoor Air

The concentrations for COPCs for Building 600 outdoor air samples were generally non-detect or below 1 µg/m^3 for the COPCs. Traces of Freon 11 (maximum 1.2 µg/m^3 in August 2017), 2-butanone (maximum 2.4 µg/m^3 in August 2017), and acetone (maximum 10 µg/m^3 in August 2017) were reported. ~~All outdoor air concentrations well below the OSHA PEL TWAs~~. Based on this comparison, NASA concludes that outdoor air does not present a significant risk of industrial/occupational exposure and no additional investigation or mitigation is required at this time.

7.2.2.3 Indoor Air

The Building 600 indoor air concentrations for specific COPCs were slightly above the contemporaneous outdoor air samples collected, but significantly below the concentrations observed within soil vapor in the shallow vadose zone reported from MSVM wells. The maximum concentration for indoor air samples were generally non detect or below 1 µg/m^3 for the COPCs. Trace concentrations were observed for three COPCs: Freon 11 (maximum 1.4 µg/m^3 in February 2018); 2-Butanone (maximum 5.3 µg/m^3 in August 2017); acetone (maximum 16 µg/m^3 in August 2017); and~~,~~ 2-propanol (maximum 3.4 µg/m^3 in August 2017). No concentrations of indoor air COPCs exceeded the NMED VISLs.

The Decision Rule from the approved work plan (provided in Section 3.1.4) states that "If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below indoor air NMED VISLs and WSTF RBCs, then current vapor intrusion risks are acceptable." Based on the results of a visual inspection of the structural stability WSTF Building 637, an evaluation of personnel management practices, and the quantitative assessment of soil vapor and air sample laboratory results with comparison to available vapor intrusion screening levels including NMED VISLs and WSTF RBC, NASA concludes the following:

- According to NMED Guidance on vapor intrusion pathway designation (NMED, 2022c~~19b~~), there is a complete exposure pathway in the 600 Area.
- Potential vapor intrusion into Building 637 does not present a risk of industrial/occupational exposure to personnel working in the building.
- No additional investigation or vapor intrusion mitigation is required in Building 637.

8.0 Recommendations

Based on the background data presented in this report, the comparison of analytical results to applicable regulatory screening level criteria, and the performance of a cumulative screening level risk assessment, NASA concludes that there is a complete vapor intrusion pathway within the 200 and 600 areas, but there is no unacceptable impact to human health within Building 200 and 637, respectively.

From the Decision Rule: "If the vadose zone soil vapor concentrations exceed NMED VISLs and updated NMED-approved WSTF RBCs, but the subsurface contribution to indoor VOC levels is below risk-based indoor air concentrations shown in Table A-4 of NMED's Soil Screening Guidance for Human Health Risk Assessments VISLs and WSTF RBCs, then current vapor intrusion risks are acceptable." No further soil vapor investigation or corrective actions are recommended for Building 200 and Building 637 due to the lack of unacceptable health risk of soil vapor COPCs from the vadose zone into the target buildings.

The risk screening performed for this VIAR is not intended to be complete at this time, as continued monitoring is planned for the 200 and 600 Areas. NASA will perform continued risk and hazard screening, including soil-to-groundwater and an ecological assessment in accordance with the current NMED RA Guidance, Volumes I and II at an appropriate time to make corrective action decisions or to seek closure. At that time, NASA will provide a risk report in accordance with the WSTF Permit ~~Attachment 20~~Section 6.5.

In accordance with Permit Sections 2.3, 7.3.5, and Attachment 5~~ V~~ (NMED, 2023~~16b~~), NASA will continue to perform the necessary post-closure care inspections and activities at both the 200 Area and 600 Area closures. Planned activities include continued groundwater monitoring in accordance with Permit Section 3.3, 4.3, and 7.3.4~~V.B.2~~, surface impoundment requirements of Section 7.3.5.1~~V.B.3~~, landfill requirements of Section 7.3.5.2~~V.B.4~~, and the security measures described in Section 7.3.5.4~~V.B.5~~. NASA will continue to perform inspections and maintenance as specified in Permit Attachment 5~~Section V.C~~.

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Figures

Figure 1.1 **WSTF Location Map**

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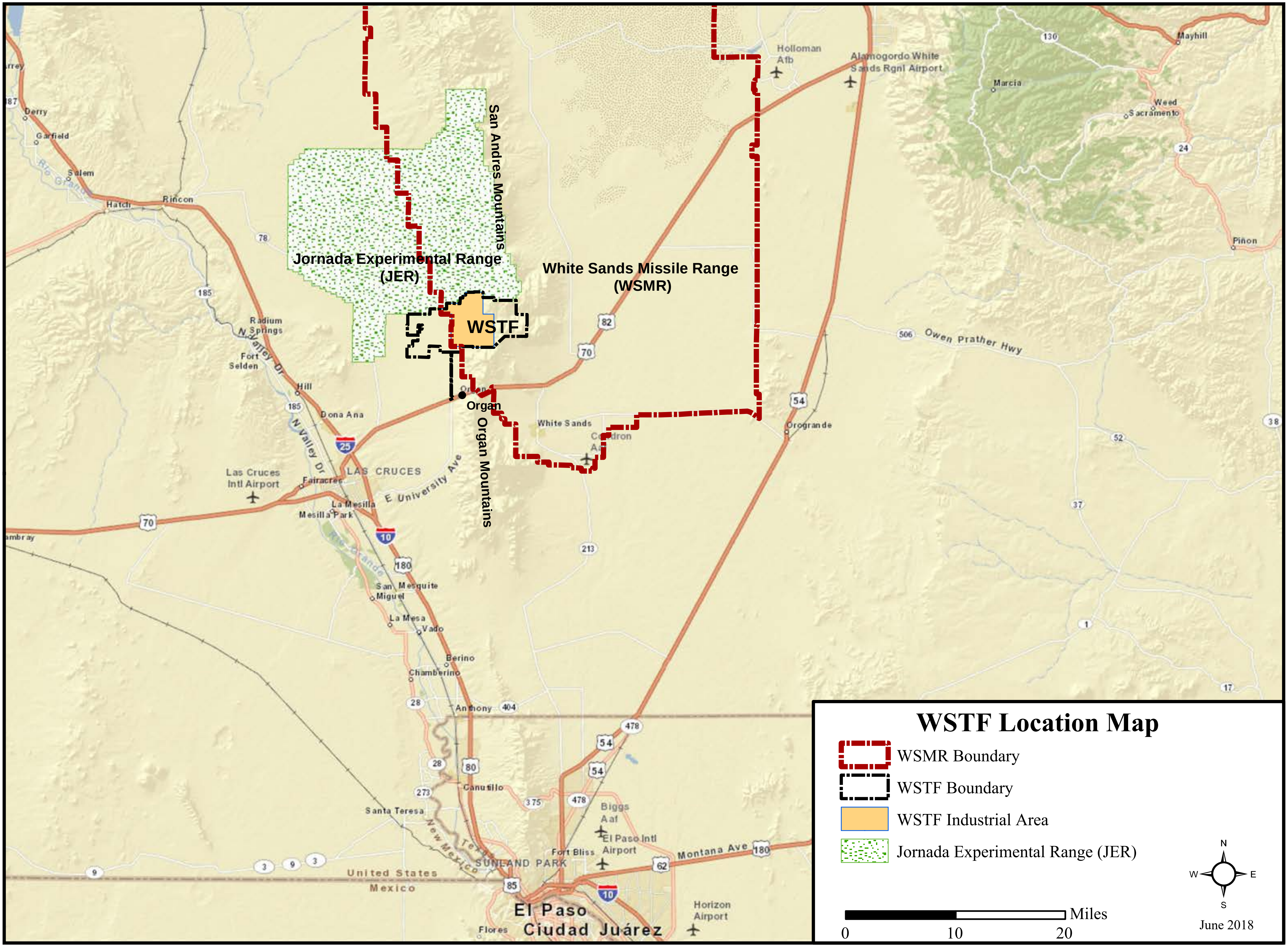

WSTF Location Map

June 2018

Figure 1.2 **Vapor Intrusion Assessment Building Location Map**

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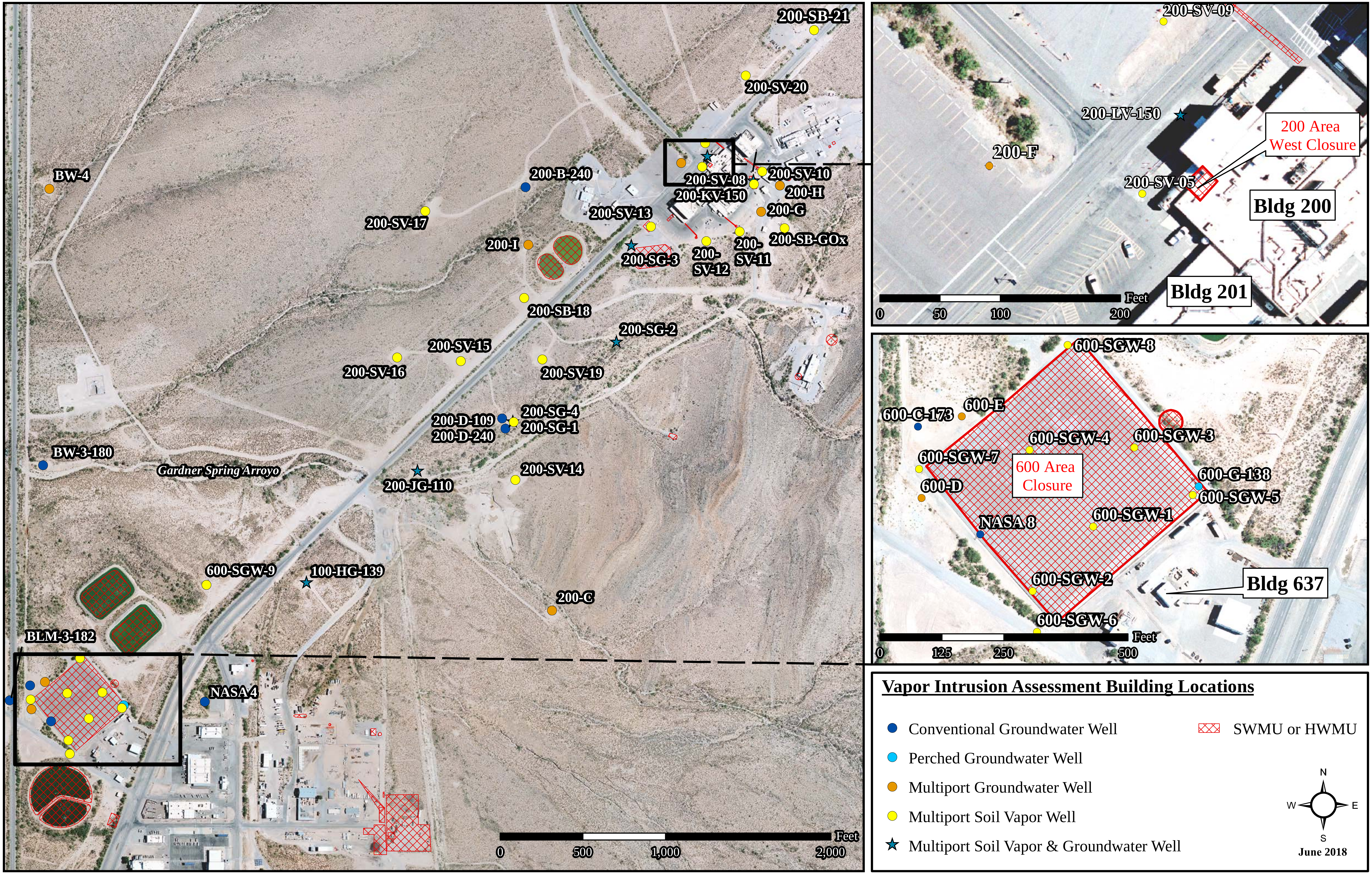


Vapor Intrusion Assessment Building Locations

● Conventional Groundwater Well

● Perched Groundwater Well

● Multiport Groundwater Well

● Multiport Soil Vapor Well

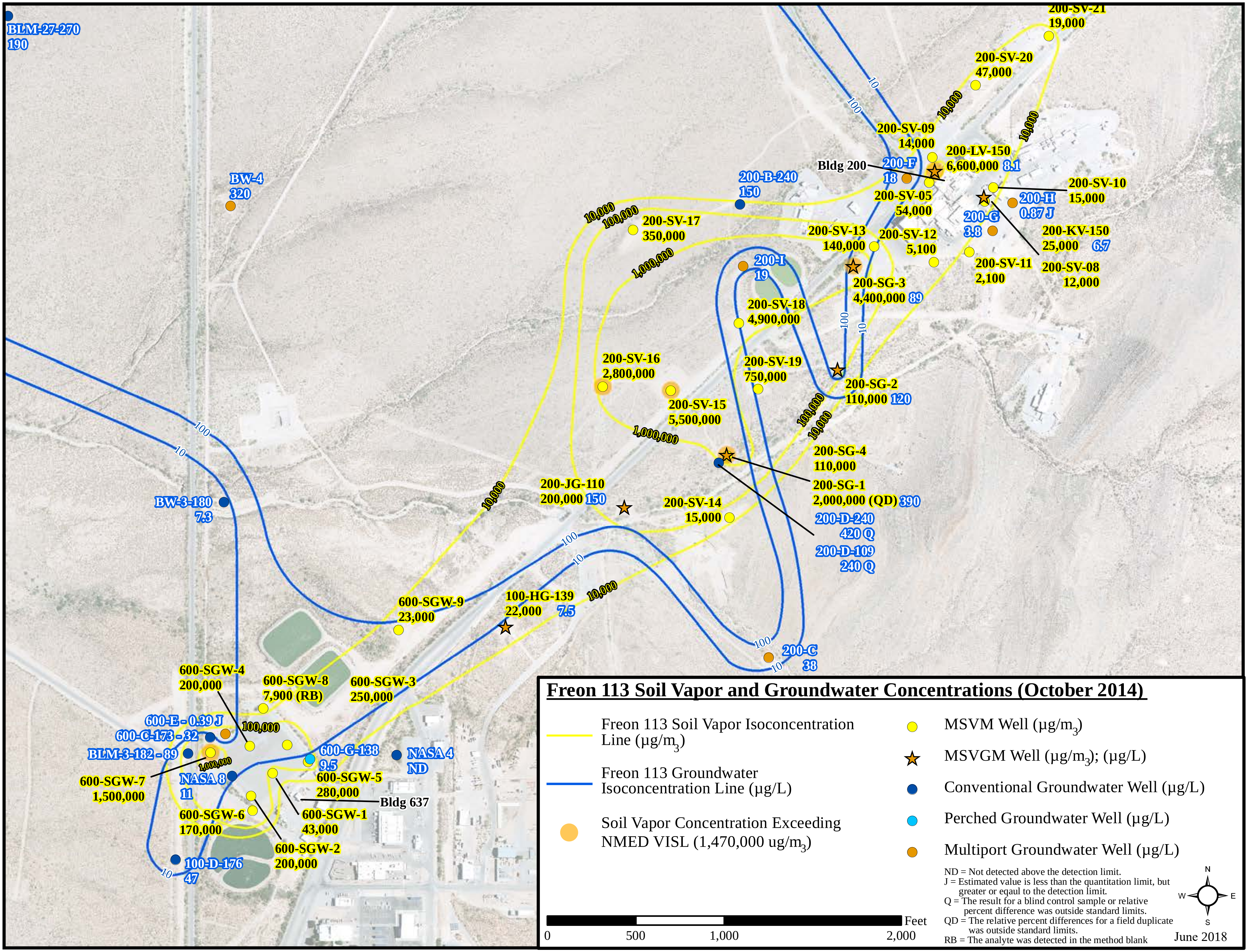
★ Multiport Soil Vapor & Groundwater Well

▨ SWMU or HWMU

June 2018

Figure 2.1 Freon 113 Soil Vapor and Groundwater Concentrations (Oct-14)

(SEE NEXT PAGE)



Freon 113 Soil Vapor and Groundwater Concentrations (October 2014)

ND = Not detected above the detection limit.
J = Estimated value is less than the quantitation limit, but greater or eqaul to the detection limit.
Q = The result for a blind control sample or relative percent difference was outside standard limits.
QD = The relative percent differences for a field duplicate was outside standard limits.
RB = The analyte was detected in the method blank

June 2018

Figure 2.2 Trichloroethene Soil Vapor and Groundwater Concentrations (Oct-14)

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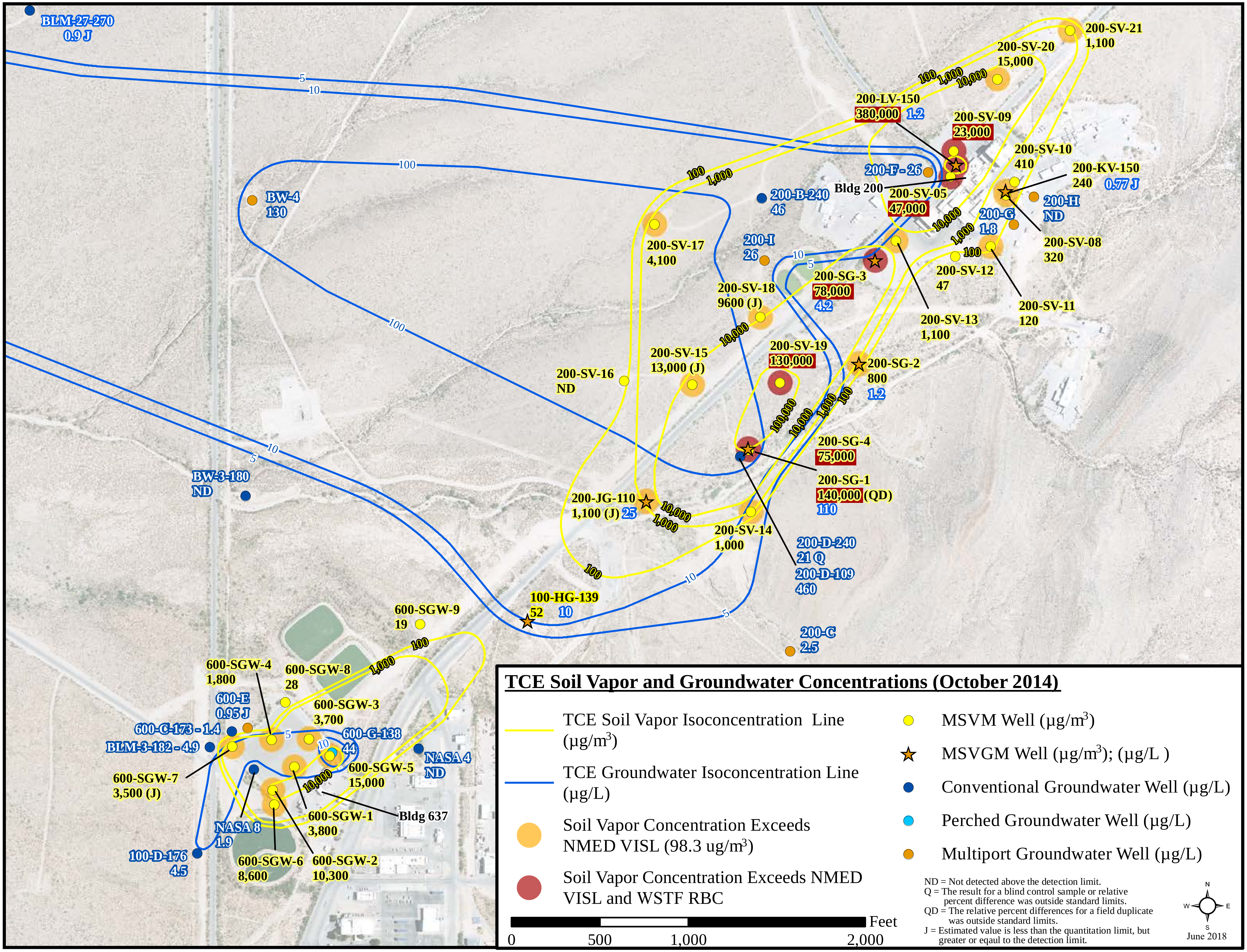

TCE Soil Vapor and Groundwater Concentrations (October 2014)

—	TCE Soil Vapor Isoconcentration Line ($\mu g/m^3$)
—	TCE Groundwater Isoconcentration Line ($\mu g/L$)
●	Soil Vapor Concentration Exceeds NMED VISL (98.3 ug/m^3)
●	Soil Vapor Concentration Exceeds NMED VISL and WSTF RBC
●	MSVM Well ($\mu g/m^3$)
★	MSVGM Well ($\mu g/m^3$); ($\mu g/L$)
●	Conventional Groundwater Well ($\mu g/L$)
●	Perched Groundwater Well ($\mu g/L$)
●	Multiport Groundwater Well ($\mu g/L$)

ND = Not detected above the detection limit.
Q = The result for a blind control sample or relative percent difference was outside standard limits.
QD = The relative percent differences for a field duplicate was outside standard limits.
J = Estimated value is less than the quantitation limit, but greater or eqaul to the detection limit.

June 2018

Figure 2.3 Tetrachloroethene Soil Vapor and Groundwater Concentrations (Oct-14)

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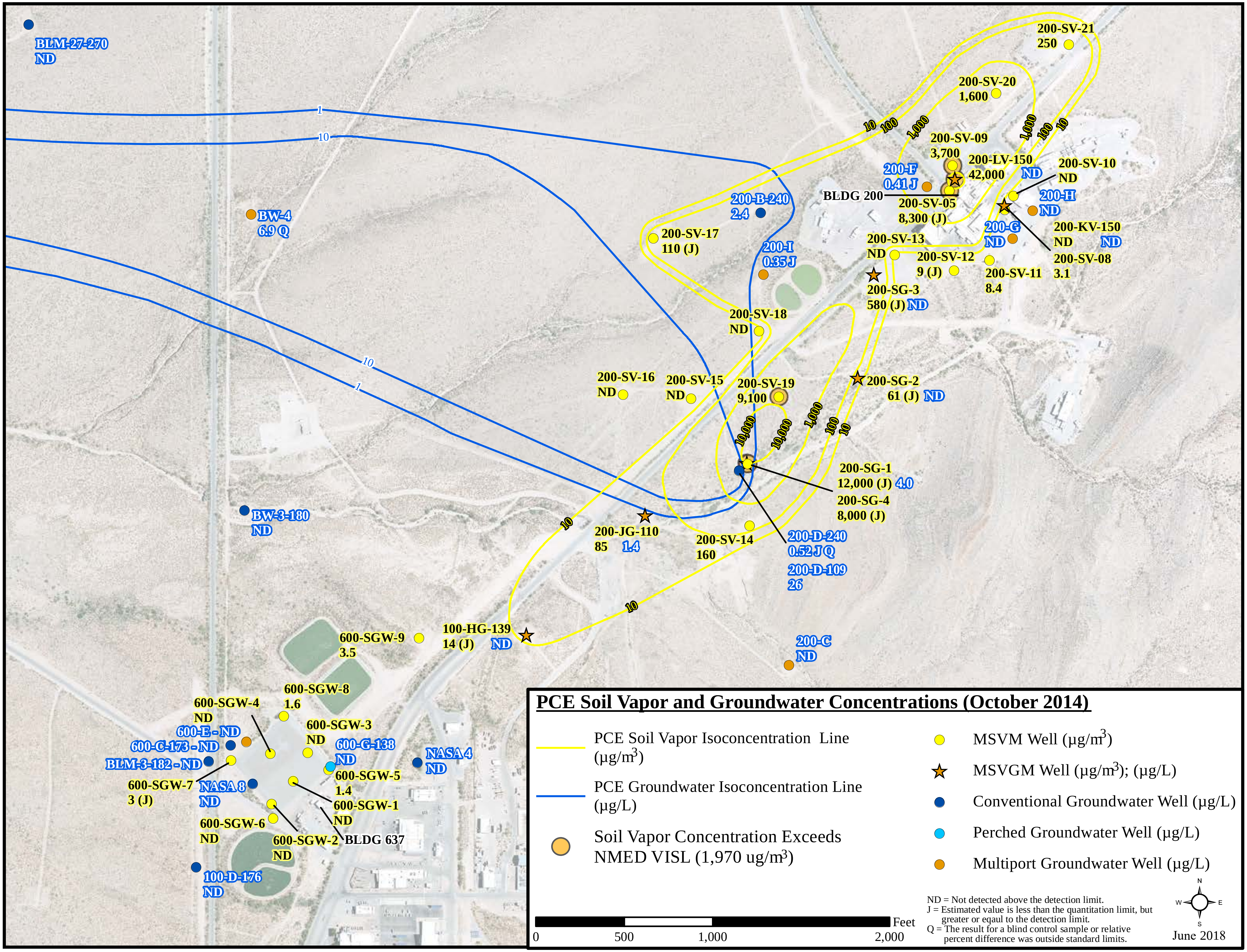

PCE Soil Vapor and Groundwater Concentrations (October 2014)

ND = Not detected above the detection limit.
J = Estimated value is less than the quantitation limit, but greater or eqaul to the detection limit.
Q = The result for a blind control sample or relative percent difference was outside standard limits.

June 2018

Figure 2.4 **Building 200 Site Conditions**

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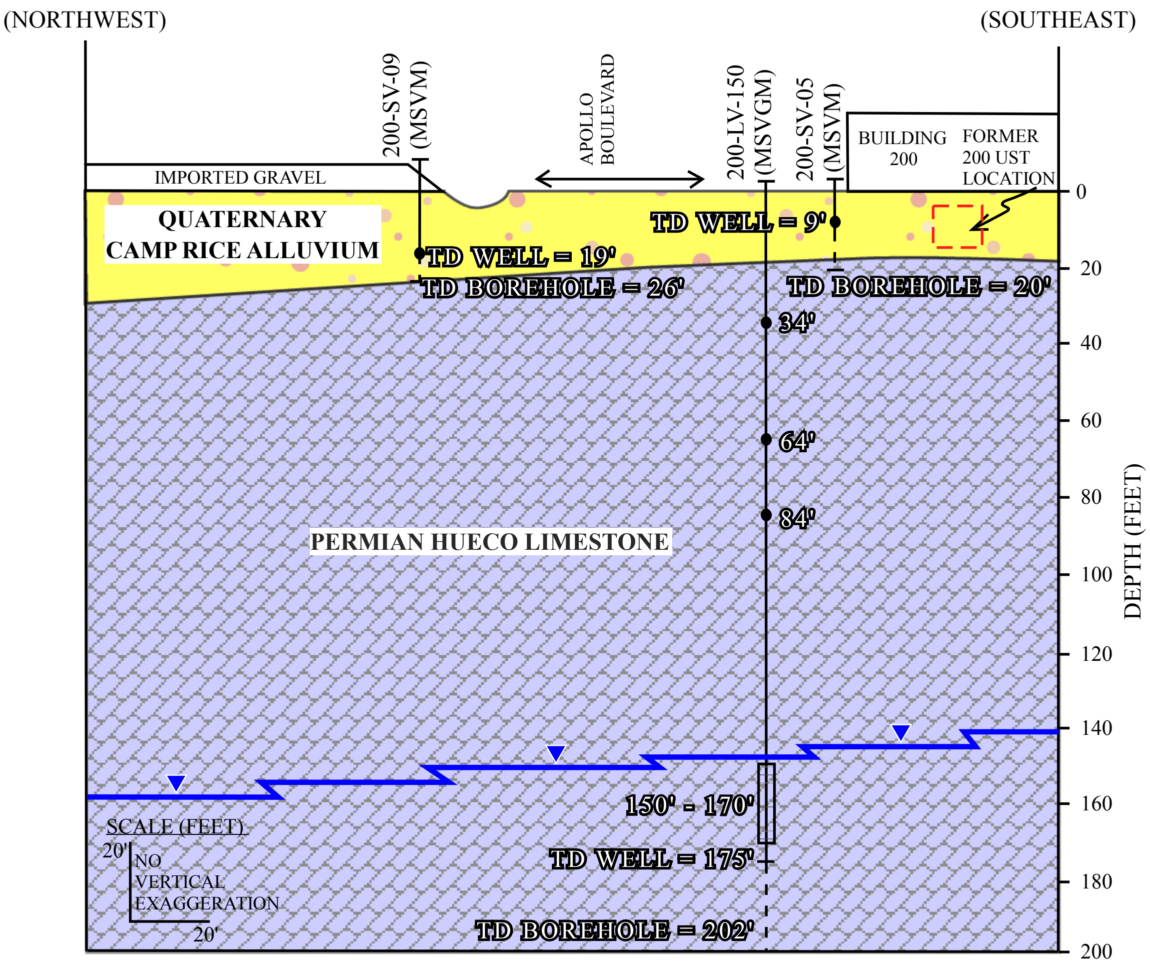
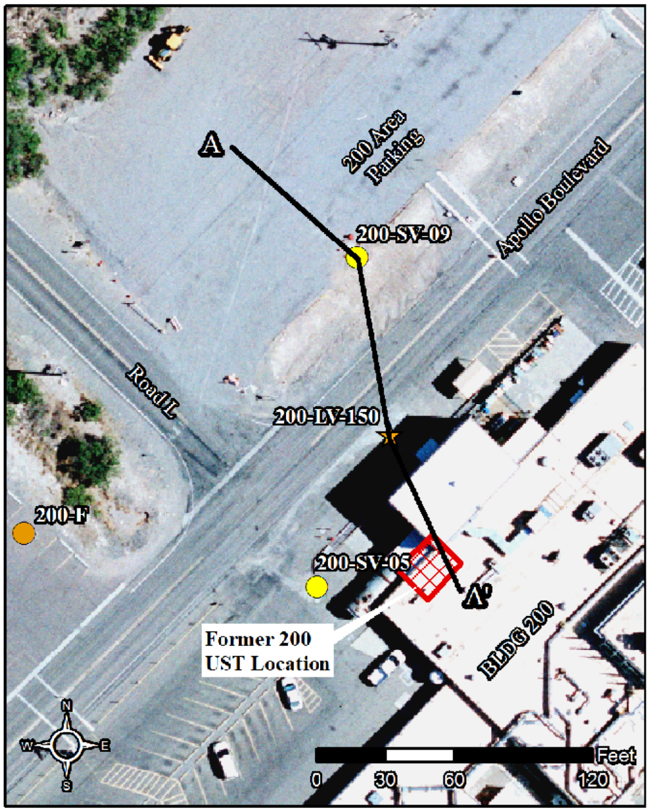
Building 200 Site Conditions



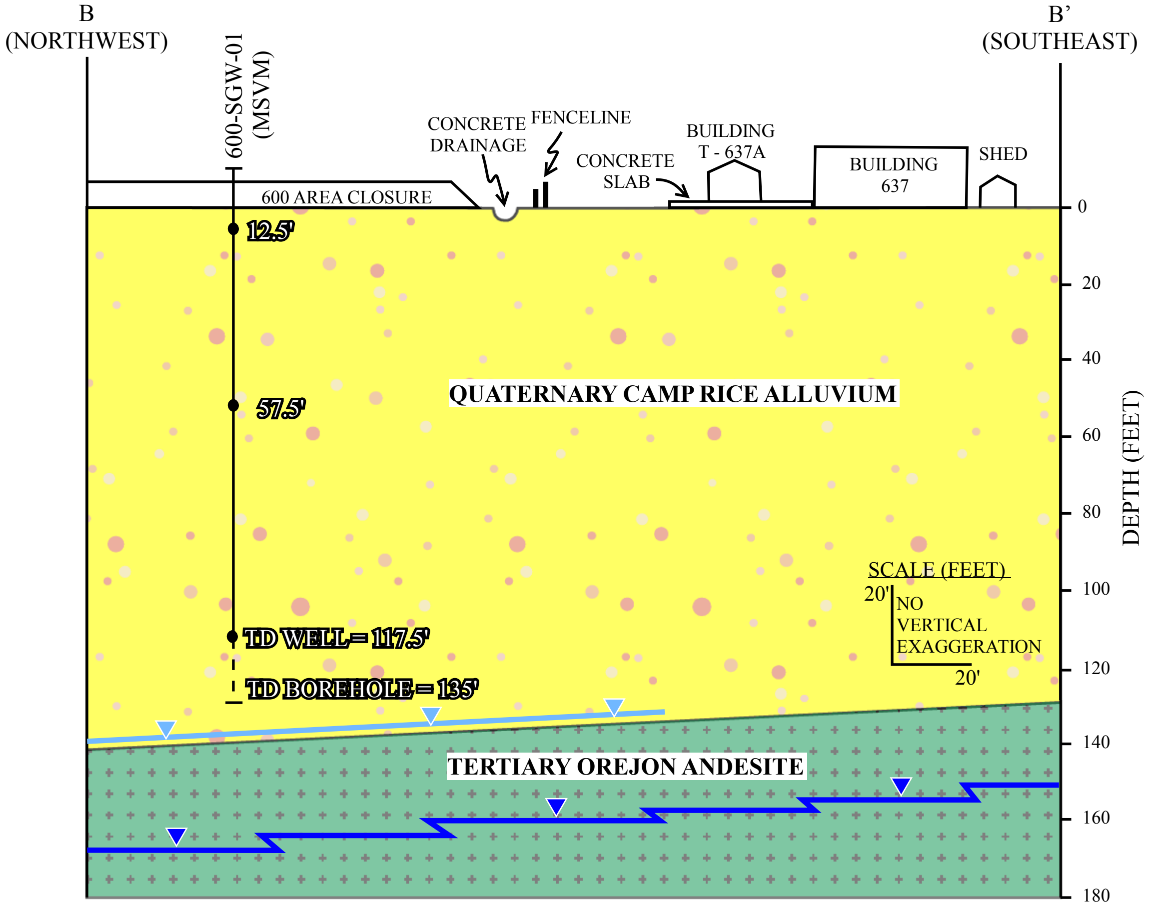


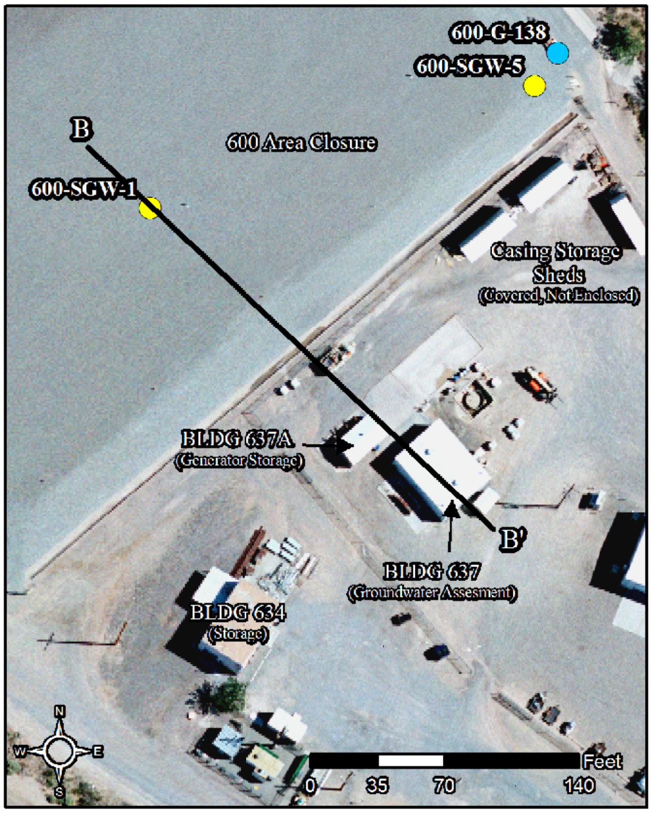
TD WELL =9' TD BOREHOLE =20'	MSVM WELL WITH VAPOR PORTS (DEPTH IN FEET)
84' 150' - 170' TD WELL =9' TD BOREHOLE =20'	MSVGM WELL WITH VAPOR PORTS AND GROUNDWATER MONITORING ZONES (DEPTH IN FEET)
🟨	QUATERNARY CAMP RICE ALLUVIUM
▨	PERMIAN HUECO LIMESTONE
▼	WATER TABLE (INFERRED FROM MONITORING WELL DATA)
—	CROSS-SECTION EXTENT (A-A')
🟥	HWMU
●	MULTIPORT GROUNDWATER WELL
★	MSVGM WELL
●	MSVM WELL

Figure 2.5 **Building 637 Site Conditions**

(SEE NEXT PAGE)

Building 637 Site Conditions



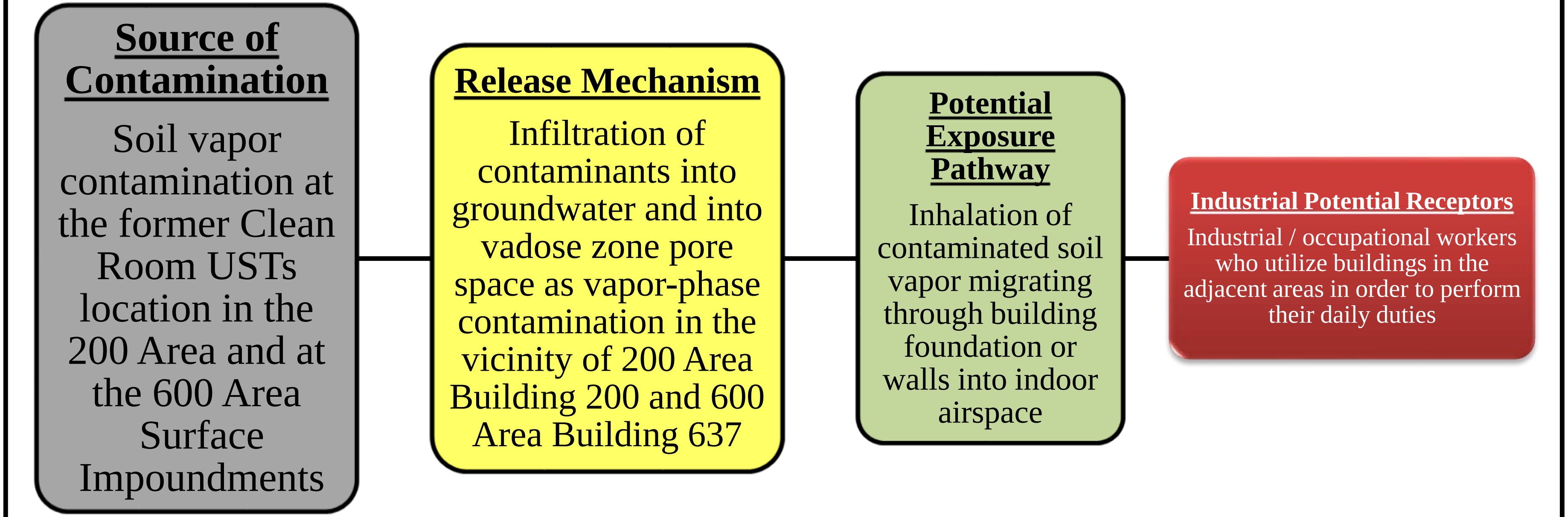


TD WELL =9' TD BOREHOLE =20'	MSVM WELL WITH VAPOR PORTS (DEPTH IN FEET)
🟨	QUATERNARY CAMP RICE ALLUVIUM
🟩	TERTIARY OREJON ANDESITE
▼	WATER TABLE (INFERRED FROM MONITORING WELL DATA)
▽	PERCHED WATER TABLE (INFERRED FROM WELL 600-G-138)
—	CROSS-SECTION EXTENT (B-B')
🟡	MSVM WELL
🔵	PERCHED GROUNDWATER WELL

Figure 2.6 **Site Conceptual Exposure Model**

(SEE NEXT PAGE)

Site Conceptual Exposure Model



Source of Contamination

Soil vapor contamination at the former Clean Room USTs location in the 200 Area and at the 600 Area Surface Impoundments

Release Mechanism

Infiltration of contaminants into groundwater and into vadose zone pore space as vapor-phase contamination in the vicinity of 200 Area Building 200 and 600 Area Building 637

Potential Exposure Pathway

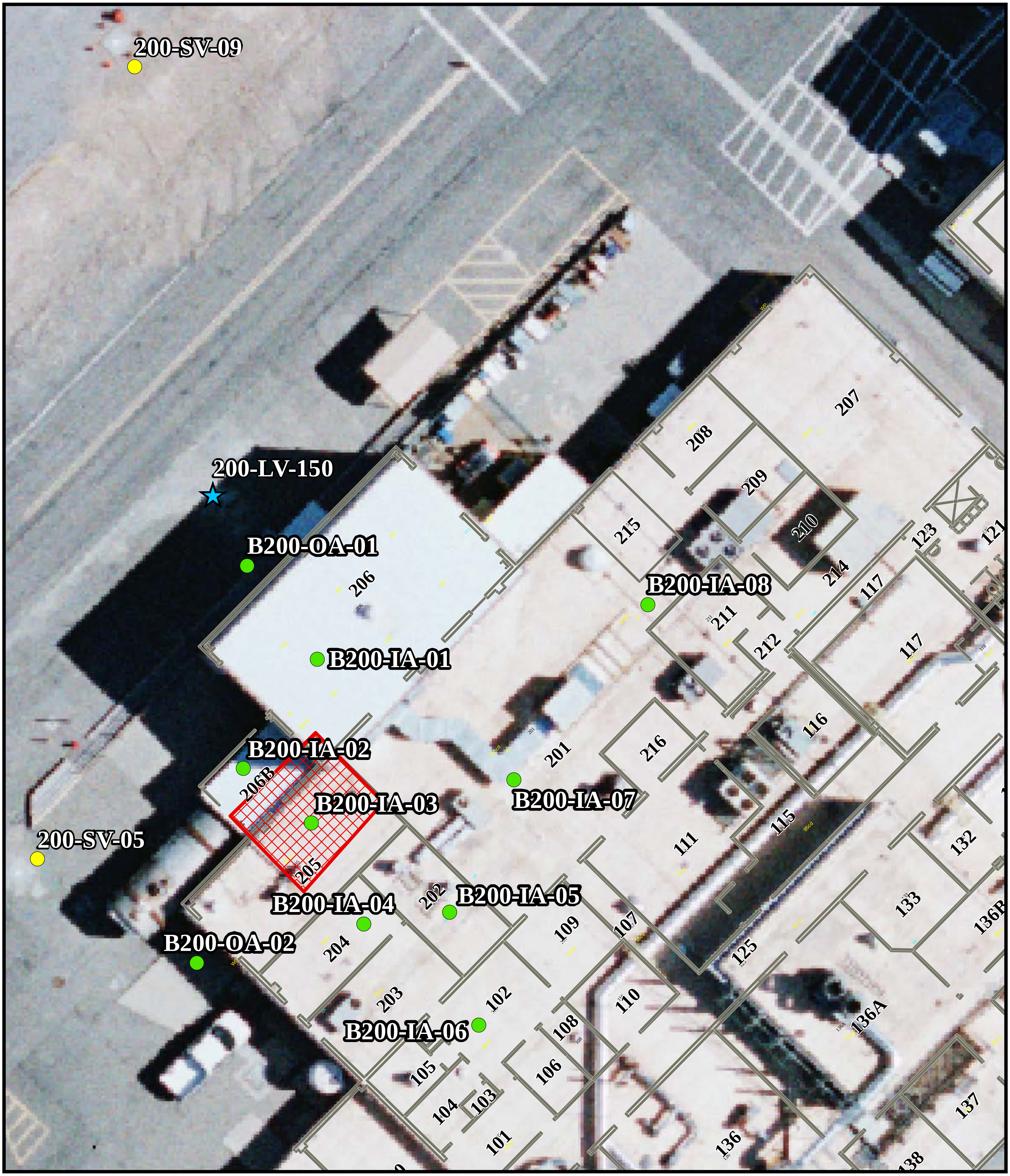
Inhalation of contaminated soil vapor migrating through building foundation or walls into indoor airspace

Industrial Potential Receptors

Industrial / occupational workers who utilize buildings in the adjacent areas in order to perform their daily duties

Figure 3.1 **West Building 200 Soil Vapor and Air Sampling Locations**

(SEE NEXT PAGE)



West Building 200 Soil Vapor and Air Sampling Locations

● Air Sample Location

● MSVM Sample

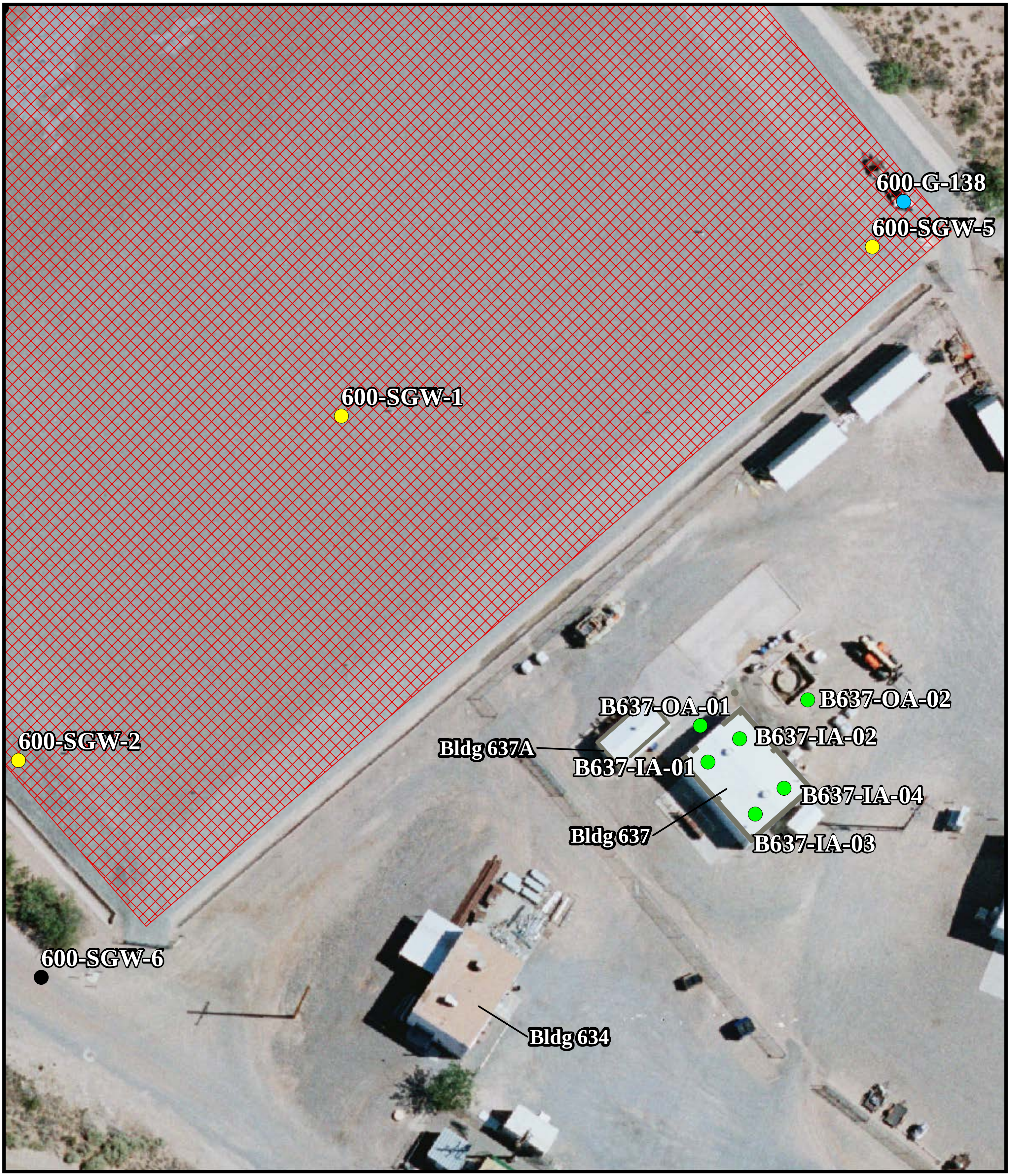
★ MSVGM Well Sample

▨ HWMU

June 2018

Figure 3.2 **Building 637 Soil Vapor and Air Sampling Locations**

(SEE NEXT PAGE)



Building 637 Soil Vapor and Air Sampling Locations

● Air Sample Location

● MSVM Well Sample

● MSVGM Well

● Perched GW Monitoring Well

▨ SWMU

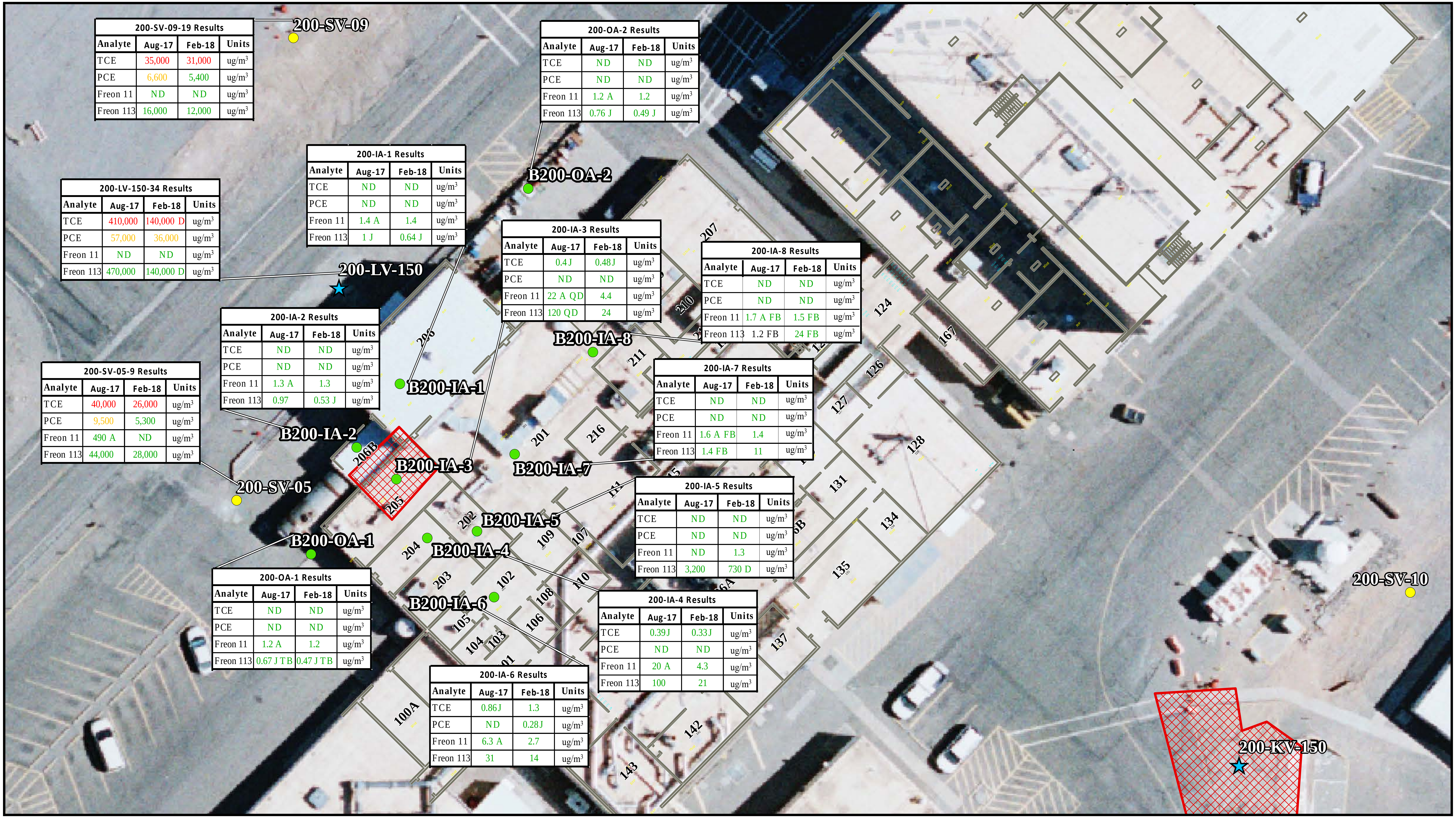
0 15 30 60 Feet

N W E S

June 2018

Figure 5.1 West Building 200 Soil Vapor and Air Sampling Locations and Analytical Results

(SEE NEXT PAGE)



200-SV-09-19 Results			
Analyte	Aug-17	Feb-18	Units
TCE	35,000	31,000	ug/m^3
PCE	6,600	5,400	ug/m^3
Freon 11	ND	ND	ug/m^3
Freon 113	16,000	12,000	ug/m^3

200-OA-2 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.2 A	1.2	ug/m^3
Freon 113	0.76 J	0.49 J	ug/m^3

200-IA-1 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.4 A	1.4	ug/m^3
Freon 113	1 J	0.64 J	ug/m^3

200-LV-150-34 Results			
Analyte	Aug-17	Feb-18	Units
TCE	410,000	140,000 D	ug/m^3
PCE	57,000	36,000	ug/m^3
Freon 11	ND	ND	ug/m^3
Freon 113	470,000	140,000 D	ug/m^3

200-IA-3 Results			
Analyte	Aug-17	Feb-18	Units
TCE	0.4 J	0.48 J	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	22 A QD	4.4	ug/m^3
Freon 113	120 QD	24	ug/m^3

200-IA-8 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.7 A FB	1.5 FB	ug/m^3
Freon 113	1.2 FB	24 FB	ug/m^3

200-IA-2 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.3 A	1.3	ug/m^3
Freon 113	0.97	0.53 J	ug/m^3

200-SV-05-9 Results			
Analyte	Aug-17	Feb-18	Units
TCE	40,000	26,000	ug/m^3
PCE	9,500	5,300	ug/m^3
Freon 11	490 A	ND	ug/m^3
Freon 113	44,000	28,000	ug/m^3

200-IA-7 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.6 A FB	1.4	ug/m^3
Freon 113	1.4 FB	11	ug/m^3

200-IA-5 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	ND	1.3	ug/m^3
Freon 113	3,200	730 D	ug/m^3

200-OA-1 Results			
Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.2 A	1.2	ug/m^3
Freon 113	0.67 J TB	0.47 J TB	ug/m^3

200-IA-4 Results			
Analyte	Aug-17	Feb-18	Units
TCE	0.39J	0.33J	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	20 A	4.3	ug/m^3
Freon 113	100	21	ug/m^3

200-IA-6 Results			
Analyte	Aug-17	Feb-18	Units
TCE	0.86J	1.3	ug/m^3
PCE	ND	0.28J	ug/m^3
Freon 11	6.3 A	2.7	ug/m^3
Freon 113	31	14	ug/m^3

West Building 200 Soil Vapor and Air Sampling Locations and Analytical Results

●	Air Sample Location	●	MSVM Sample
★	MSVGM Well Sample	▨	HWMU

0 25 50 100 Feet

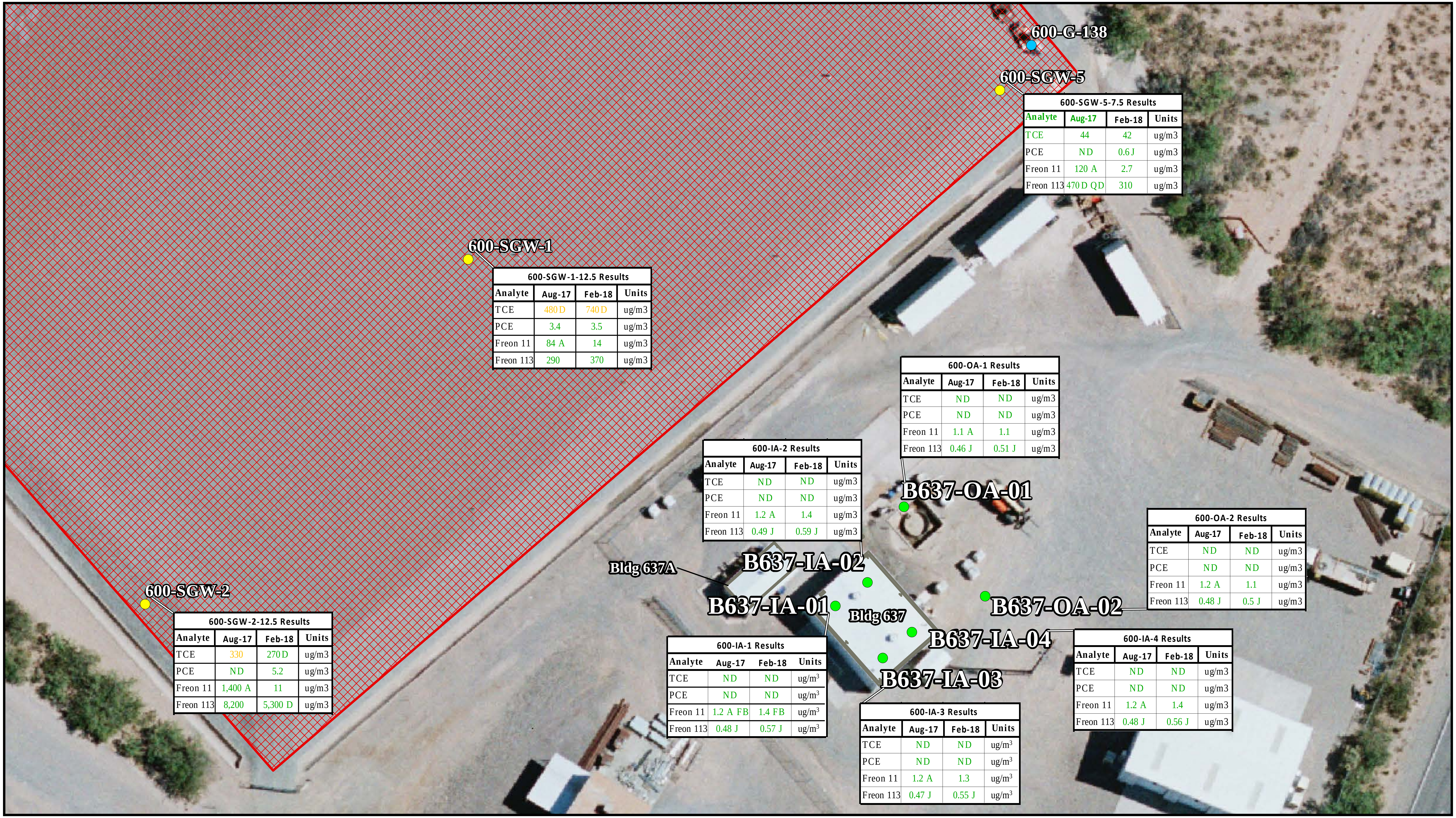
N
W E
S

Notes: 100 Concentration below NMED VISL and WSTF RBC 1,000 Concentration exceeds NMED VISL 10,000 Concentration exceeds NMED VISL and WSTF RBC
See Table 5.1 for Data Flags (A,D,FB,J,TB)

January 2020

Figure 5.2 Building 637 Soil Vapor and Air Sampling Locations and Analytical Results

(SEE NEXT PAGE)



600-SGW-5-7.5 Results

Analyte	Aug-17	Feb-18	Units
TCE	44	42	ug/m3
PCE	ND	0.6 J	ug/m3
Freon 11	120 A	2.7	ug/m3
Freon 113	470 D QD	310	ug/m3

600-SGW-1-12.5 Results

Analyte	Aug-17	Feb-18	Units
TCE	480 D	740 D	ug/m3
PCE	3.4	3.5	ug/m3
Freon 11	84 A	14	ug/m3
Freon 113	290	370	ug/m3

600-OA-1 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m3
PCE	ND	ND	ug/m3
Freon 11	1.1 A	1.1	ug/m3
Freon 113	0.46 J	0.51 J	ug/m3

600-IA-2 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m3
PCE	ND	ND	ug/m3
Freon 11	1.2 A	1.4	ug/m3
Freon 113	0.49 J	0.59 J	ug/m3

600-OA-2 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m3
PCE	ND	ND	ug/m3
Freon 11	1.2 A	1.1	ug/m3
Freon 113	0.48 J	0.5 J	ug/m3

600-SGW-2-12.5 Results

Analyte	Aug-17	Feb-18	Units
TCE	330	270 D	ug/m3
PCE	ND	5.2	ug/m3
Freon 11	1,400 A	11	ug/m3
Freon 113	8,200	5,300 D	ug/m3

600-IA-1 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.2 A FB	1.4 FB	ug/m^3
Freon 113	0.48 J	0.57 J	ug/m^3

600-IA-4 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m3
PCE	ND	ND	ug/m3
Freon 11	1.2 A	1.4	ug/m3
Freon 113	0.48 J	0.56 J	ug/m3

600-IA-3 Results

Analyte	Aug-17	Feb-18	Units
TCE	ND	ND	ug/m^3
PCE	ND	ND	ug/m^3
Freon 11	1.2 A	1.3	ug/m^3
Freon 113	0.47 J	0.55 J	ug/m^3

Building 637 Soil Vapor and Air Sampling Locations and Analytical Results

● Air Sample Location ● MSVM Well Sample ● Perched GW Monitoring Well ▨ HWMU

0 25 50 100 Feet

N W E S

Notes: 100 Concentration below NMED VISL and WSTF RBC 1,000 Concentration exceeds NMED VISL 10,000 Concentration exceeds NMED VISL270 D and WSTF RBC

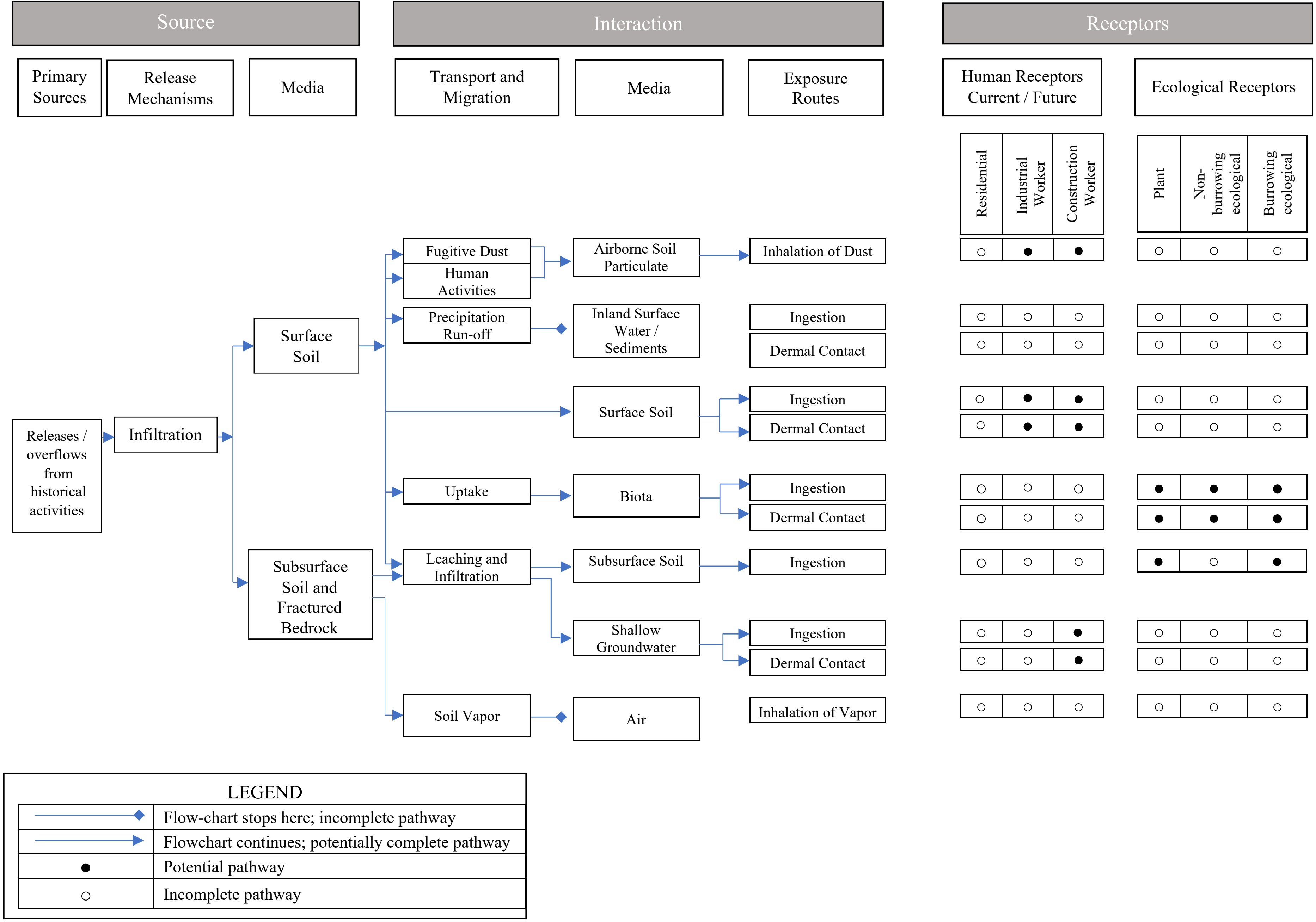
See Table 5.1 for Data Flags (A,D,FB,J)

June 2018

Figure 6.1 ~~WSTF Background Soil Area Map~~Revised Site Conceptual Exposure Model

(SEE NEXT PAGE)

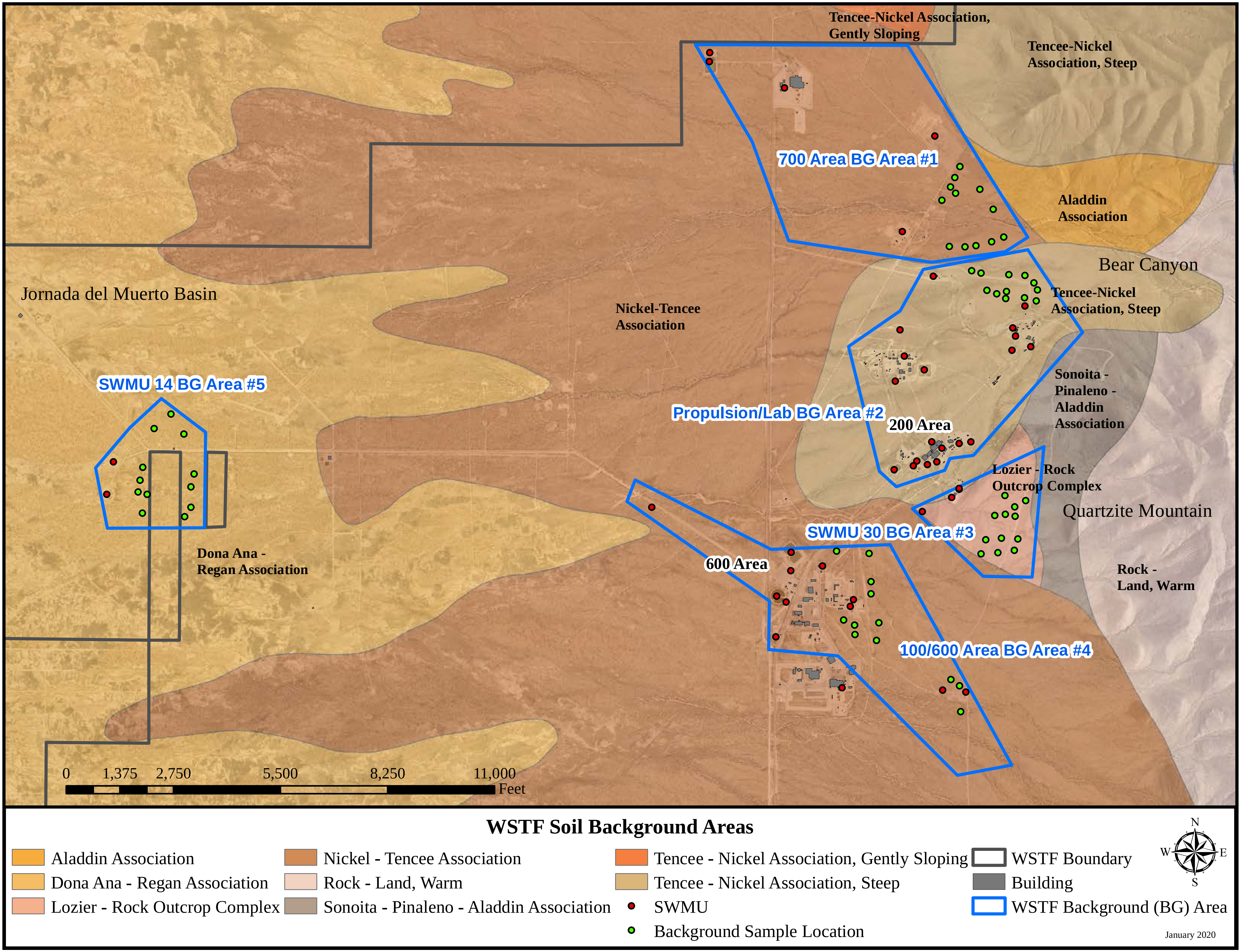
Figure 2.2 Site Conceptual Exposure Model 200 and 600 Areas Vapor Intrusion



Media	Exposure Routes	Residential	Industrial Worker	Construction Worker	Plant	Non-burrowing ecological	Burrowing ecological
Airborne Soil Particulate	Inhalation of Dust	○	●	●	○	○	○
Inland Surface Water / Sediments	Ingestion	○	○	○	○	○	○
	Dermal Contact	○	○	○	○	○	○
Surface Soil	Ingestion	○	●	●	○	○	○
	Dermal Contact	○	●	●	○	○	○
Biota	Ingestion	○	○	○	●	●	●
	Dermal Contact	○	○	○	●	●	●
Subsurface Soil	Ingestion	○	○	○	●	○	●
Shallow Groundwater	Ingestion	○	○	●	○	○	○
	Dermal Contact	○	○	●	○	○	○
Air	Inhalation of Vapor	○	○	○	○	○	○

Figure 6.2 WSTF Background Soil Area Map~~200 Area Soil Boring Locations~~

(SEE NEXT PAGE)



WSTF Soil Background Areas

Figure 6.3 **200 Area Soil Boring Locations~~600 Area Soil Boring Locations~~**

(SEE NEXT PAGE)

200 Area Soil, Soil Vapor, and Groundwater Monitoring Locations

★ MSVM Boring/Well

■ MSVGM Boring/Well

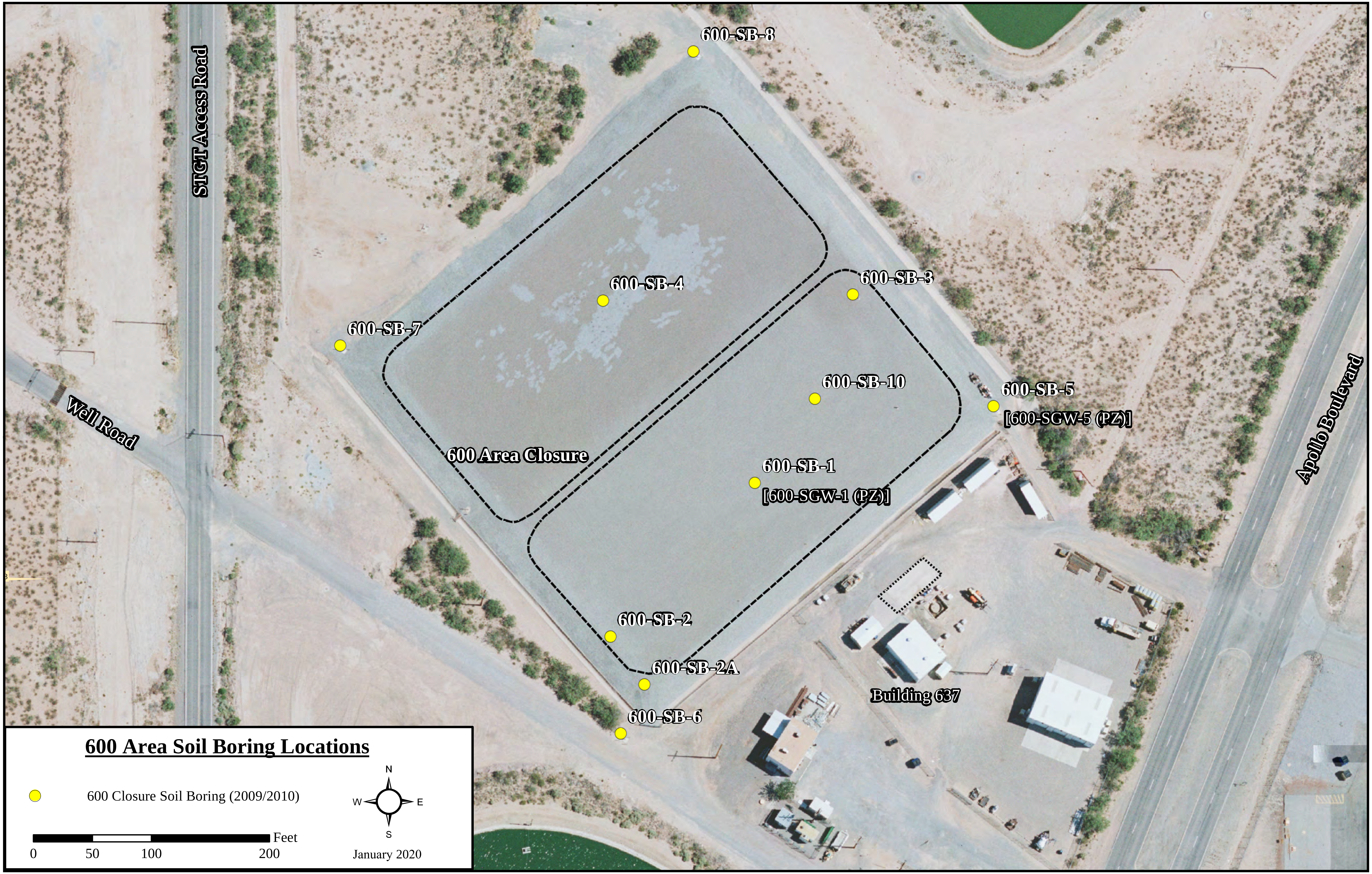
0 100 200 400 Feet

N
W E
S

April 2023

Figure 6.4 600 Area Soil Boring Locations

(SEE NEXT PAGE)


600 Area Soil Boring Locations

January 2020

Tables

Table 1.1 Comparison of Soil Vapor and Air Concentration Guidance Levels

Chemical	**NMED VISLs**[1]			**WSTF RBCs**[2,3]		**~~OSHA STANDARDS~~**		
	Industrial/ Occupational Indoor Air (µg/m^3)			**Commercial Worker @ 5-ft bgs (µg/m^3)**	**Commercial Worker @ 10-ft bgs (µg/m^3)**	**~~Commercial Worker @ 10-ft bgs (µg/m^3)~~**	**~~Limits for Air Contaminants PEL TWA~~**~~[4]~~ **~~(ppm)~~**	**~~Limits for Air Contaminants PEL TWA~~**~~[4]~~ **~~(µg/m^3)~~**
TCE	9.83	328		18,000[2] *(8,800[3])*	34,000[2] *(14,000[3])*	~~100~~	~~537,000~~	
PCE	197	6,550		460,000[2] *(210,000[3])*	910,000[2] *(350,000)*	~~100~~	~~678,000~~	
Freon 11	3,440	115,000		6,400,000[2] *(130,000,000[3])*	13,000,000[2] *(210,000,000[3])*	~~1,000~~	~~5,600,000~~	
Freon 113	147,000	4,920,000		440,000,000[2] *(180,000,000[3])*	900,000,000[2] *(310,000,000[3])*	~~1,000~~	~~7,600,000~~	

Notes:

[1] = NMED, 20~~19~~22c~~b~~.

[2] = NASA, 2019a (NASA WSTF NMED-approved Soil Vapor RBCs for 2018)

[3] = NASA, 2017a (NASA WSTF NMED-approved Soil Vapor RBCs for 2017).

~~[4] = OSHA (n.d.) Personal Exposure Limit (PEL) 8-hour time weighted average (TWA).~~

Table 3.1 Soil Vapor Monitoring Well Sampling Locations

Well ID	Location Description	Well Type	Soil Vapor Sample Port Locations (ft bgs)	Groundwater Sample Location (ft bgs)	Horizontal Distance to Building (ft)	Concentrations for Primary Contaminants from Oct-14 (µg/m^3)
200 Area in the vicinity of the Clean Room Tank HWMU Located Below the East Side of Building 200						
200-SV-05	West side of B. 200 southwest of the former Clean Room Tank location	MSVM	9	---	28	Freon 11 = 160 (J) Freon 113 = 54,000 TCE = 47,000 PCE = 8,300 (J)
200-LV-150	Immediately west and adjacent to B. 200 at the former Clean Room Tank location	MSVGM	34, 64, 84	150 - 170	18	Freon 11 = ND Freon 113 = 6,600,000 TCE = 380,000 PCE = 42,000
200-SV-09	Across Apollo Boulevard to the west of B. 200 at location for former Clean Room Discharge pipe	MSVM	19	---	84	Freon 11 = ND Freon 113 = 14,000 TCE = 23.000 PCE = 3,700
600 Area in the Vicinity of the Southeast Side of the 600 Area Closure Near Building 637						
600-SGW-1	Northwest of B. 637 within southeast cell of former 600 Area surface impoundments	MSVM	12.5, 57.5, 117.5	---	184	Freon 11 = ND Freon 113 = 43,000 TCE = 3,800 PCE = ND
600-SGW-2	West of B. 637 along southwest side of southeast cell of former 600 Area surface impoundments	MSVM	12.5, 47.5, 107.5, 150	---	260	Freon 11 = ND Freon 113 = 200,000 TCE = 10,300 PCE = ND
600-SGW-5	North of B. 637 at east corner of southeast cell of former 600 Area Surface Impoundments	MSVM	7.5, 52.5, 102.5, 137.5	---	181	Freon 11 = 1,200 (J) Freon 113 = 280,000 TCE = 15,000 PCE = 1.4

Notes:
(J) = Estimated value is less than the quantitation limit, but greater than or equal to the detection limit.
MSVM = Multiport Soil Vapor Monitoring, MSVGM = Multiport Soil Vapor and Groundwater Monitoring
- Two semi-annual sampling rounds are proposed to provide seasonal samples. Indoor and outdoor air pressure will be monitored during sampling.
- Approximately seven vadose zone samples (one duplicate) per semi-annual sampling event and 14 samples total.

Table 3.2 Indoor and Outdoor Air Sampling Locations

Indoor Air (IA)/ Outdoor Air (OA) Sample ID	Horizontal Distance from Primary Vadose Zone Vapor Source* (ft)	Sample Type and Frequency	Indoor/ Outdoor Air Sample Collection Location	Sample Collection Strategies	Sample Container and Analysis	Sample Notes
Building 200 (West Side 200 Area) in the Vicinity of the Clean Room Tank HWMU						
B200-IA-01	13	Indoor/outdoor air grab sample. Two semi-annual sampling events in the summer and winter seasons.	3 to 5 ft above ground surface in typical breathing zone	Indoor samples will be collected with outer wall windows and doors closed to minimize any contribution from outside air and will be distributed through rooms as applicable. Outdoor air samples from a representative upwind location away from any wind obstructions.	3-Liter passivated stainless steel canister, analysis by TO-15	Flow controller over 8-hour period
B200-IA-02	4					
B200-IA-03	0					
B200-IA-04	12					
B200-IA-05	22					
B200-IA-06	40					
B200-IA-07	24					
B200-IA-08	60					
B200-OA-01	33					
B200-OA-02	23					
Building 637 in the Vicinity of the Southeast Side of the 600 Area Closure						
B637-IA-01	92	Indoor/outdoor air grab sample. Two semi-annual sampling events in the summer and winter seasons.	3 to 5 ft above ground surface in typical breathing zone	Indoor samples will be collected with outer wall windows and doors closed to minimize any contribution from outside air and will be distributed through rooms as applicable. Outdoor air samples from a representative upwind location away from any wind obstructions.	3-Liter passivated stainless steel canister, analysis by TO-15	Flow controller over 8-hour period
B637-IA-02	93					
B637-IA-03	118					
B637-IA-04	118					
B637-OA-01	100					
B637-OA-02	100					

Notes:

* = Primary elevated vapor source in the 200 Area is the footprint of the former Clean Room Tank excavation (HWMU). Primary elevated vapor source in the 600 Area is MSVM well 600-SGW-05.

- Two semi-annual sampling rounds are proposed to provide seasonal samples. Indoor and outdoor air pressure will be monitored during sampling.
- Approximately 18 indoor and outdoor air samples (two duplicates) per semi-annual sampling event and 36 samples total.

Table 4.1 Product Inventory Form for 200 Area Building 200 on 6/21/2017

Room Location/ (Sample Location)	Product Description	Size (units)	Condition	Chemical Ingredients	MSA Altair 5X PID Reading (ppm)	Photo Y/N
Photo Lab Rm 102 (B200-IA-06)	Glue Paper		In Use	Heat-activated Adhesive	0	Y
	Flammables Cabinet	~3 ft^3	In Use	Various chemicals	1	
	Fire Extinguisher		Unopened	Possible fluorocarbon propelling agent	0	
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
	Hand Sanitizer	2 liters	In Use	Ethyl Alcohol	0	
Photo Lab Room 203	Fire Extinguisher		Ready to Use	Possible fluorocarbon propelling agent	0	Y
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
	Gator Board		In Use	Adhesive Backing	0	
Photo Lab Room 204, Storage Shelves (B200-IA-04)	Adhesive Tape	50 ft roll	Open & Unopened	Adhesive Backing	0	Y
	Dry Erase Markers		Unopened	Solvent (ethanol ?)	0	
	Kodak Lens Cleaner		Unopened		0	
Room 202 (B200-IA-05)	Sure Coat	5 gal buckets	Unopened & Used	Epoxy	0	Y
	Freon	Steel canisters	Unopened	Freon	0	
Room 201	FilterMate Vapor Extractor	Machine	In Use	?	0	Y
	Hydraulic Drill Press	Machine	In Use	Lubes/Oils	0	
Room 111	Cleaners	Open Vats	In Use	Oakite, oxidizers, sulfuric acids	0	Y
Room 201 (B200-IA-08) (B200-IA-07)	drain to sanitary sewer (outside room 111)	Utility Sink	In Use	?	0	Y
	Flammable Cabinets #2 & #3	1 large, 1 small	In Use	Alcohols, chlorinated solvents, Rustoleum spray paints, WD-40	0	
	Flammable Cabinet #1	Small	In Use	Paints, solvents, lubes	0	

Room Location/ (Sample Location)	Product Description	Size (units)	Condition	Chemical Ingredients	MSA Altair 5X PID Reading (ppm)	Photo Y/N
Room 216 Assembly Room	Krytox		In Use	?	0	Y
Room 206 (CSS HighBay) (B200-IA-01)	Several products		In Use	Oakite, IPA, Acids, Satellite Accumulation Area containing chemical ingredients identified for other rooms.	0	Y
Room 206B Workbench Area (B200-IA-02)	Marker Pens Oils used for assembly	Small	In Use	?	0	Y
Room 205 Utility Room (B200-IA-03)	Active Drain to Sewer Bags of water softening pellets		In Use	Citric acid anhydrous	0	Y
Room 204	Various		In Use	Full of petrochemicals, acids, corrosives, vacuum pump oils.	0	Y

Table 4.2 Product Inventory form for 200 Area Building 637 on 6/26/2017

Room Location/ (Sample Location)	Product Description	Size (units)	Condition	Chemical Ingredients	MSA Altair 5X PID Reading (ppm)	Photo Y/N
Building 637 (B637-IA-1 B637-IA-2 B637-IA-3 B637-IA-4)	Sample Bottles (with Preservative)	40 mL – 1 L	Unopened	Dilute hydrochloric acid, sulfuric acid, sodium hydroxide	0	Y
	Fire Extinguisher	0.5 cu ft	Unopened	Possible fluorocarbon propelling agent	0	
	Hand Sanitizer	1 L	In Use	Ethyl Alcohol	0	
Building T-637A	Flammables Cabinet	0.25 L – 1 L	In Use	Silicone spray, isopropyl alcohol, gasoline, Rustoleum products	0	Y
	Corrosives Cabinet	14 oz	In Use	Sodium hydroxide	0	
	Generators	8 cu ft	In Use	Gasoline and oil	0	
	Steam Cleaners	8 cu ft	In Use	Gasoline and oil	0	
	Oils/Lubricants	1 L	Unopened	Various motor oils and lubricants (WD40)	0	
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
Building T-637B	Groundwater Sampling Equipment Electronics	50 ft – 500 ft reels	In Use		0	Y
Compressed Nitrogen Storage Area Adjacent to B637	Compressed Gas Cylinders	1.5 cu ft	In Use	Nitrogen	0	N

Table 4.3 Summary of 200 Area Building 200 and Vicinity Soil Vapor, Outdoor Air, and Indoor Air Analytical Results

COPC	Sample Type	8/27/17 Sample Event (µg/m³)	Sample Location	Method Detection Limit (µg/m³)	2/25/18 Sample Event (µg/m³)	Sample Location	Method Detection Limit (µg/m³)	NMED VISL or RSL* Residential Soil Vapor nc / c (µg/m³)¹	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m³)¹	NMED VISL or RSL* Industrial Soil Vapor nc / c (µg/m³)¹	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m³)¹	WSTF RBC Residential ft bgs nc / c (µg/m³)²	WSTF RBC Industrial ft bgs nc / c (µg/m³)²	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
TCE	Soil Vapor (MSVM Well) Maximum	410,000	200-LV-150-34	920	140,000 (D)	200-LV-150-34	430	69.5 / 147	NA	328 / 1,120	NA	4,900 / 11,000	84,000 / 280,000	Yes: Res risk VISLs (2.79E-02) Res risk RBCs (3.73E-04) Res haz VISLs (5.90E+03) Res haz RBCs (8.37E+01) Indus risk VISLs (3.66E-03) Indus haz VISLs (1.25E+03) Indus haz RBCs (4.88E+00)
	B200 Outdoor Air Maximum	<0.26	200-OA-1	0.26	<0.21	200-OA-1	0.21	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	0.86	200-IA-6	0.27	1.3	200-IA-6	0.20	NA	2.09 / 4.42	NA	9.83 / 33.6	NA	NA	No
PCE	Soil Vapor (MSVM Well) Maximum	57,000	200-LV-150-34	920	36,000	200-LV-150-34	210	1,390 / 3,600	NA	6,550 / 17,600	NA	130,000 / 340,000	2,300,000 / 6,000,000	Yes: Res risk VISLs (1.58E-04) Res haz VISLs (4.10E+01) Indus risk VISLs (3.24E-05) Indus haz VISLs (8.70E+00)
	B200 Outdoor Air Maximum	<0.26	200-OA-1	0.26	<0.21	200-OA-1	0.21	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	ND	200-IA-6	0.27	0.28 (J)	200-IA-6	0.20	NA	41.7 / 108	NA	197 / 529	NA	NA	No
Freon 11	Soil Vapor (MSVM Well) Maximum	490 (A)	200-SV-05-9	94	<52	200-SV-05-9	52	24,300 / ---	NA	115,000 / ---	NA	530,000 / ---	6,400,000 / ---	No
	B200 Outdoor Air Maximum	1.2 (A)	200-OA-1	0.32	1.2	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	22 (A, QD)	200-IA-3	0.32	4.4	200-IA-3	0.26	NA	730 / ---	NA	3,440 / ---	NA	NA	No
Freon 113	Soil Vapor (MSVM Well) Maximum	470,000	200-LV-150-34	1,100	140,000 (D)	200-LV-150-34	520	1,040,000 / ---	NA	4,920,000 / ---	NA	120,000,000 / ---	2,300,000,000 / ---	No
	B200 Outdoor Air Maximum	0.76 (J)	200-OA-2	0.29	0.49 (J)	200-OA-2	0.26	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	3,200	200-IA-5	6.6	730 (D)	200-IA-5	2.7	NA	31,300 / ---	NA	147,000 / ---	NA	NA	No
2-Butanone	Soil Vapor (MSVM Well) Maximum	<1,400	200-LV-150-34	1,400	<320	200-LV-150-34	320	174,000 / ---	NA	819,000 / ---	NA	9,600,000 / ---	160,000,000 / ---	No
	B200 Outdoor Air Maximum	3 (J, TB)	200-OA-1	0.39	0.42	200-OA-2	0.32	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	8.7	200-IA-3	0.30	2 (J)	200-IA-2	0.36	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No
1,1,1-trichloroethane	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	174,000 / ---	NA	819,000 / ---	NA	13,000,000 / ---	220,000,000 / ---	No
	B200 Outdoor Air Maximum	<0.32	200-OA-1	0.32	<0.25	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RSL* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RSL* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential ft bgs nc / c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc / c (µg/m^3)[2]	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
1,1,1-trichloroethane	B200 Indoor Air Maximum	<0.38	200-IA-1	0.38	<0.27	200-IA-1	0.27	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No
Chloroform	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	3,410 / 40.7	NA	16,100/199	NA	210,000 / 2,500	3,700,000 / 46,000	No
	B200 Outdoor Air Maximum	0.35 (J)	200-OA-1	0.32	ND	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	0.33 (J)	200-IA-3	0.25	0.39 (J)	200-IA-3	0.26	NA	102 / 1.22	NA	5.98 / 5.98	NA	NA	No
Benzene	Soil Vapor (MSVM Well) Maximum	80 (J)	200-SV-09-19	67	<52	200-SV-09-19	52	1,040 / 120	NA	4,920 / 588	NA	29,000 / 3,400	400,000 / 49,000	No
	B200 Outdoor Air Maximum	<0.27	200-OA-2	0.27	0.3 (J)	200-OA-2	0.24	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	1.1	200-IA-4	0.29	1.6	200-IA-8	0.27	NA	31.3 / 3.60	NA	17.6 / 17.6	NA	NA	No
Ethylbenzene	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<240	200-LV-150-34	240	34,800 / 374	NA	164,000 / 1,840	NA	---	---	No
	B200 Outdoor Air Maximum	<0.30	200-OA-1	0.30	<0.24	200-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	0.47 (J)	200-IA-3	0.23	<0.30	200-IA-3	0.30	NA	1,040 / 11.2	NA	55.1 / 55.1	NA	NA	No
Toluene	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	174,000 / ---	NA	819,000 / ---	NA	---	---	No
	B200 Outdoor Air Maximum	0.39 (J, TB)	200-OA-1	0.32	<0.25	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	7.2 (J)	200-IA-5	6.6	1.1	200-IA-3	0.26	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No
Xylenes	Soil Vapor (MSVM Well) Maximum	<2,000	200-LV-150-34	2,000	<460	200-LV-150-34	460	3,480 / ---	NA	16,400 / ---	NA	---	---	No
	B200 Outdoor Air Maximum	<0.56	200-OA-1	0.56	<0.44	200-OA-1	0.44	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.5	200-IA-3	0.44	<0.47	200-IA-3	0.47	NA	104 / ---	NA	492 / ---	NA	NA	No
Acetone	Soil Vapor (MSVM Well) Maximum	<5,100	200-LV-150-34	5,100	<1,200	200-LV-150-34	1,200	1,080,000 / ---	NA	5,080,000 / ---	NA	53,000,000 / ---	860,000,000 / ---	No
	B200 Outdoor Air Maximum	13 (TB)	200-OA-1	1.4	2.4	200-OA-2	1.2	NA	NA	NA	NA	NA	NA	NA
	B200 Indoor Air Maximum	29 (QD)	200-IA-3	1.4	8.7	200-IA-2	1.3	NA	32,300 / ---	NA	152,000 / ---	NA	NA	No
2-propanol[3]	Soil Vapor (MSVM Well) Maximum	<2,800	200-LV-150-34	2,800	<640	200-LV-150-34	640	210* / ---	NA	880* / ---	NA	350,000 / ---	5,600,000 / ---	No
	B200 Outdoor Air Maximum	4.3	200-OA-2	0.71	<0.66	200-OA-2	0.66	NA	NA	NA	NA	NA	NA	NA

COPC	Sample Type	8/27/17 Sample Event (µg/m³)	Sample Location	Method Detection Limit (µg/m³)	2/25/18 Sample Event (µg/m³)	Sample Location	Method Detection Limit (µg/m³)	NMED VISL or RSL* Residential Soil Vapor nc / c (µg/m³)¹	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m³)¹	NMED VISL or RSL* Industrial Soil Vapor nc / c (µg/m³)¹	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m³)¹	WSTF RBC Residential ft bgs nc / c (µg/m³)²	WSTF RBC Industrial ft bgs nc / c (µg/m³)²	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
2-propanol	B200 Indoor Air Maximum	68 (QD)	200-IA-3	0.61	4.3	200-IA-1	0.67	NA	210* / ---	NA	880* / ---	NA	NA	No
1,1-Dichloroethene	Soil Vapor (MSVM Well) Maximum	12,000	200-LV-150-34	1,100	7,500	200-LV-150-34	260	6,950 / ---	NA	32,800 / ---	NA	400,000 / ---	6,700,000 / ---	Yes: Res haz VISLs (1.73E+00)
	B.200 Outdoor Air Maximum	<0.32	200-OA-1	0.32	<0.25	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	<0.38	200-IA-1	0.38	<0.27	200-IA-1	0.27	NA	209 / ---	NA	983 / ---	NA	NA	No
1,2,4-Trimethylbenzene[3]	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	63 / ---	NA	260 / ---	NA	---	---	No
	B.200 Outdoor Air Maximum	<0.28	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.92	200-IA-3	0.22	ND	200-IA-1	0.24	NA	63 / ---	NA	260 / ---	NA	NA	No
2,2,4-Trimethylpentane	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	---	NA	---	NA	---	---	No
	B.200 Outdoor Air Maximum	<0.28	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.39 (J)	200-IA-3	0.28	<0.24	200-IA-1	0.24	NA	---	NA	---	NA	NA	No
2-Hexanone[3]	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<240	200-LV-150-34	240	31* / ---	NA	130-*/ ---	NA	7,1000 / ---	1,200,000 / ---	No
	B.200 Outdoor Air Maximum	0.62 (J)	200-OA-1	0.30	<0.24	200-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.1	200-IA-3	0.30	0.39 (J)	200-IA-2	0.28	NA	31* / ---	NA	130* / ---	NA	NA	No
4-Methyl-2-pentanone (methyl isobutyl ketone)	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<240	200-LV-150-34	240	104,000 / ---	NA	492,000 / ---	NA	7,200,000 / ---	120,000,000 / ---	No
	B.200 Outdoor Air Maximum	0.42	200-OA-1	0.30	<0.24	200-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	24	200-IA-3	0.23	<0.25	200-IA-1	0.25	NA	3,130 / ---	NA	14,700 / ---	NA	NA	No
Carbon Disulfide	Soil Vapor (MSVM Well) Maximum	64 (J)	200-SV-09-19	63	<230	200-LV-150-34	230	24,300 / ---	NA	115,000 / ---	NA	610,000 / --- 1,200,000 / ---	8,100,000 / ---19,000,000 / ---	No
	B.200 Outdoor Air Maximum	0.73 (J A TB)	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.47 (J A)	200-IA-1	0.33	<0.24	200-IA-1	0.24	NA	730 / ---	NA	3,440 / ---	NA	NA	No
Carbon Tetrachloride	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	3,480 / 156	NA	16,400 / 765	NA	---	---	No
	B.200 Outdoor Air Maximum	0.41	200-OA-2	0.25	0.4	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA

COPC	Sample Type	8/27/17 Sample Event (µg/m³)	Sample Location	Method Detection Limit (µg/m³)	2/25/18 Sample Event (µg/m³)	Sample Location	Method Detection Limit (µg/m³)	NMED VISL or RSL* Residential Soil Vapor nc / c (µg/m³)¹	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m³)¹	NMED VISL or RSL* Industrial Soil Vapor nc / c (µg/m³)¹	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m³)¹	WSTF RBC Residential ft bgs nc / c (µg/m³)²	WSTF RBC Industrial ft bgs nc / c (µg/m³)²	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
	B.200 Indoor Air Maximum	0.45	200-IA-1	0.33	0.41	200-IA-3	0.23	NA	104 / 4.68	NA	22.9 / 22.9	NA	NA	No
Chloromethane	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	3,130 / 520	NA	14,700 / 2,550	NA	140,000 / 22,000	2,100,000 / 370,000	No
	B.200 Outdoor Air Maximum	0.42 (J TB)	200-OA-1	0.28	0.57 (J)	200-OA-2	0.23	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.37 (J)	200-IA-6	0.29	0.6 (J)	200-IA-3	0.23	NA	93.9 / 15.6	NA	76.5 / 76.5	NA	NA	No
Ethanol	Soil Vapor (MSVM Well) Maximum	<5,300	200-LV-150-34	5,300	<1,200	200-LV-150-34	1,200	---	NA	---	NA	26,000,000 / ---	400,000,000 / ---	No
	B.200 Outdoor Air Maximum	56	200-OA-1	1.5	<1.2	200-OA-1	1.2	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	23	200-IA-3	1.2	11	200-IA-1	1.3	NA	---	NA	---	NA	NA	No
Freon 12 (Dichloro-difluoro-methane)	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	1,200	200-LV-150-34	260	3,480 / ---	NA	16,400 / ---	NA	220,000 / ---	3,800,000 / ---	No
	B.200 Outdoor Air Maximum	2.3 (TB)	200-OA-1	0.32	2.4	200-OA-1	0.25 (TB)	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	2.7	200-IA-4	0.31	2.7	200-IA-3	0.26	NA	104 / ---	NA	492 / ---	NA	NA	No
Freon 21 (Dichloro-fluoromethane)	Soil Vapor (MSVM Well) Maximum	<1,600	200-LV-150-34	1,600	<370	200-LV-150-34	370	---	NA	---	NA	220,000 / ---	4,300,000 / --	No
	B.200 Outdoor Air Maximum	<0.45	200-OA-1	0.45	<0.35	200-OA-1	0.35	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	3.5	200-IA-3	0.45	<0.38	200-IA-1	0.38	NA	---	NA	---	NA	NA	No
Heptane[3]	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	420* / ---	NA	1,800* / ---	NA	1,000,000 / ---	18,000,000 / ---	No
	B.200 Outdoor Air Maximum	<0.32	200-OA-1	0.32	<0.25	200-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.33 (J)	200-IA-3	0.25	<0.27	200-IA-1	0.27	NA	420* / ---	NA	1,800* / ---	NA	NA	No
Hexane	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	24,300 / ---	NA	115,000 / ---	NA	1,600,000 / ---	28,000,000 / ---	No
	B.200 Outdoor Air Maximum	0.35 (J TB)	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.2	200-IA-3	0.22	1.1	200-IA-3	0.25	NA	730 / ---	NA	3,440 / ---	NA	NA	No
Methylene Chloride	Soil Vapor (MSVM Well) Maximum	<1,100	200-LV-150-34	1,100	<260	200-LV-150-34	260	20,900 / 33,800	NA	98,300 / 459,000	NA	1,100,000 / 1,700,000	18,000,000 / 79,000,000	No
	B.200 Outdoor Air Maximum	<0.32	200-OA-1	0.32	0.42 (J)	200-OA-2	0.26	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.6	200-IA-4	0.31	0.43 (J)	200-IA-2	0.29	NA	626 / 1,010	NA	2,950 / 13,800	NA	NA	No

COPC	Sample Type	8/27/17 Sample Event ($\mu g/m^3$)	Sample Location	Method Detection Limit ($\mu g/m^3$)	2/25/18 Sample Event ($\mu g/m^3$)	Sample Location	Method Detection Limit ($\mu g/m^3$)	NMED VISL or RSL* Residential Soil Vapor nc / c ($\mu g/m^3$)[1]	NMED VISL or RBC* Residential Indoor Air nc / c ($\mu g/m^3$)[1]	NMED VISL or RSL* Industrial Soil Vapor nc / c ($\mu g/m^3$)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c ($\mu g/m^3$)[1]	WSTF RBC Residential ft bgs nc / c ($\mu g/m^3$)[2]	WSTF RBC Industrial ft bgs nc / c ($\mu g/m^3$)[2]	Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
Styrene	Soil Vapor (MSVM Well) Maximum	<990	200-LV-150-34	990	<230	200-LV-150-34	230	34,800 / ---	NA	164,000 / ---	NA	---	---	No
	B.200 Outdoor Air Maximum	<0.28	200-OA-1	0.28	<0.22	200-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	1.9	200-IA-3	0.22	<0.24	200-IA-1	0.24	NA	1,040 / ---	NA	4,920 / ---	NA	NA	No
Tetrahydro-furan[3]	Soil Vapor (MSVM Well) Maximum	<1,300	200-LV-150-34	1,300	<310	200-LV-150-34	310	2,100* / ---	NA	1,800* / ---	NA	3,600,000 / ---	59,000,000 / ---	No
	B.200 Outdoor Air Maximum	<0.38	200-OA-1	0.38	1.2	200-OA-2	0.30	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	0.29 (J)	200-IA-3	0.29	<0.32	200-IA-1	0.32	NA	2,100* / ---	NA	1,800* / ---	NA	NA	No
trans-1,2-Dichloroethene	Soil Vapor (MSVM Well) Maximum	<1,300	200-LV-150-34	1,300	<290	200-LV-150-34	290	1,390 / ---	NA	6,550 / ---	NA	---	---	No
	B.200 Outdoor Air Maximum	<0.36	200-OA-1	0.36	<0.28	200-OA-1	0.28	NA	NA	NA	NA	NA	NA	NA
	B.200 Indoor Air Maximum	2.2 (FB)	200-IA-8	0.36	1.8 (FB)	200-IA-8	0.32	NA	41.7 / ---	NA	197 / ---	NA	NA	No

Notes:
Red = VISL or RBC exceeded.
Yellow = Detection limit exceeds VISL or RBC.
Flags = (D) reported result is from a dilution, (J) result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit, (A) result of an analyte for a laboratory control sample (LCS), initial calibration verification (ICV) or continuing calibration verification (CCV) was outside standard limits, (QD) relative percent difference for a field duplicate was outside standard limits, (TB) analyte was detected in the trip blank, (FB) analyte was detected in the field blank.
--- = Not available.
NA = Not applicable.
nc / c = noncancer / cancer
[1] = NMED VISLs taken from Risk Assessment Guidance for Site Investigations and Remediation November 2022 (NMED, 2022c).
[2] = WSTF RBCs for soil vapor taken from NASA WSTF NMED-approved Soil Vapor RBCs for 2022 (NASA, 2022), approved with modification February 11, 2022 (NMED, 2022a). The RBC listed corresponds to the closest depth bgs the sample was collected. For each sample, the next shallowest depth to the sample depth was chosen to be conservative, e.g., sampled at 34 ft bgs, the 25 ft RBC depth was used.
*[3] = No NMED VISL was listed, so EPA RSL for air was used (EPA, 2022b).

Table 4.4 Detection Limits Exceeding Screening Levels Well 200-LV-150

Constituent	Detected?	Detection Limit	Screening Level Exceeded ($\mu g/m^3$)	Dilution
Carbon tetrachloride	No	990 and 230 990	Residential cancer VISL 156; Industrial cancer VISL 765	6600 and 1530
Chloroform	No	1,100 and 260	Resident cancer VISL 40.7; Industrial cancer VISL 199	6600 and 1530
Ethylbenzene	No	1,100	Residential cancer VISL 374	6600
Heptane	No	1,100	Residential air (noncancer) RSL 420	6600
2-Hexanone	No	1,100 and 240	Residential air (noncancer) RSL 31; Industrial air (noncancer) RSL 130	6600 and 1530
2-Propanol (Isopropanol)	No	2,800 and 640 2,800	Residential air (noncancer) RSL 210; Industrial air (noncancer) RSL 880	6600 and 1530
Trichloroethylene (TCE)	Yes	920 and 430	Residential noncancer VISL 69.5; Residential cancer VISL 147; Industrial noncancer VISL 328	6600 and 3060
1,2,4-Trimethylbenzene	No	990 and 230 990	Residential air (noncancer) RSL 63; Industrial air (noncancer) RSL 260	6600 and 1530

Note: Well was sampled at 34 ft bgs.

~~Table 5.1 Summary of 200 Area Building 200 and Vicinity Soil Vapor, Outdoor Air, and Indoor Air Analytical Results~~

~~COPC~~	~~Sample Type~~	~~8/27/17 Sample Event (µg/m³)~~	~~Sample Location~~	~~Method Detection Limit (µg/m³)~~	~~2/25/18 Sample Event (µg/m³)~~	~~Sample Location~~	~~Method Detection Limit (µg/m³)~~	~~NMED VISL Residential Soil Vapor nc / c (µg/m³)¹~~	~~NMED VISL Residential Indoor Air nc / c (µg/m³)¹~~	~~NMED VISL Industrial Soil Vapor nc / c (µg/m³)¹~~	~~NMED VISL Industrial Indoor Air nc / c (µg/m³)¹~~	~~WSTF RBC ResidentialSoil Vapor in@ 5 ft bgs nc / c (µg/m³)²~~	~~WSTF RBC Industrial in ft bgs nc / c (µg/m³)²~~	~~OSHA PEL TWA (8-Hr) (µg/m³) Exceeds Risk / Hazard?~~
~~TCE~~	~~Soil Vapor (MSVM Well) Maximum~~	~~410,000~~	~~200-LV-150-34~~	~~920~~	~~140,000 (D)~~	~~200-LV-150-34~~	~~430~~	~~69.5 / 147~~	~~NA~~	~~328 / 1,120~~	~~NA~~	~~4,900 / 11,00018,000~~	~~84,000 / 280,000~~	~~Yes:~~ ~~Res risk (2.79E-02) VISLs~~ ~~Res risk (3.73E-04) RBCs~~ ~~Res haz (5.90E+03) VISLs~~ ~~Res haz (8.37E+01) RBCsNA~~ ~~Indus risk (3.66E-03) VISLs~~ ~~Indus haz (1.25E+03) VISLs~~ ~~Indus haz (4.88E+00) RBCs~~
	~~B200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.26~~	~~ND~~	~~200-OA-1~~	~~0.21~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA537,000~~
	~~B200 Indoor Air Maximum~~	~~0.86~~	~~200-IA-6~~	~~0.27~~	~~1.3~~	~~200-IA-6~~	~~0.20~~	~~NA~~	~~2.09 / 4.42~~	~~NA~~	~~9.83 / 33.6~~	~~NA~~	~~NA~~	~~No537,000~~
~~PCE~~	~~Soil Vapor (MSVM Well) Maximum~~	~~57,000~~	~~200-LV-150-34~~	~~920~~	~~36,000~~	~~200-LV-150-34~~	~~210~~	~~1,390 / 3,600~~	~~NA~~	~~6,550 / 17,600~~	~~NA~~	~~130,000 / 340,000460,000~~	~~2,300,000 / 6,000,000~~	~~Yes:NA~~ ~~Res risk (1.58E-04) VISLs~~ ~~Res haz (4.10E+01) VISLs~~ ~~Indus risk (3.24E-05) VISLs~~ ~~Indus haz (8.70E+00) VISLs~~
	~~B200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.26~~	~~ND~~	~~200-OA-1~~	~~0.21~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA678,000~~
	~~B200 Indoor Air Maximum~~	~~ND~~	~~200-IA-6~~	~~0.27~~	~~0.28 (J)~~	~~200-IA-6~~	~~0.20~~	~~NA~~	~~41.7 / 108~~	~~NA~~	~~197 / 529~~	~~NA~~	~~NA~~	~~No678,000~~
~~Freon 11~~	~~Soil Vapor (MSVM Well) Maximum~~	~~490 (A)~~	~~200-SV-05-9~~	~~94~~	~~ND~~	~~200-SV-05-9~~	~~52~~	~~24,300 / ---~~	~~NA~~	~~115,000 / ---~~	~~NA~~	~~530,000 / --- 6,400,000~~	~~6,400,000 / ---~~	~~NoNA~~
	~~B200 Outdoor Air Maximum~~	~~1.2 (A)~~	~~200-OA-1~~	~~0.32~~	~~1.2~~	~~200-OA-1~~	~~0.25~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA5,620,000~~
	~~B200 Indoor Air Maximum~~	~~22 (A, QD)~~	~~200-IA-3~~	~~0.32~~	~~4.4~~	~~200-IA-3~~	~~0.26~~	~~NA~~	~~730 / ---~~	~~NA~~	~~3,440 / ---~~	~~NA~~	~~NA~~	~~No5,620,000~~
~~Freon 113~~	~~Soil Vapor (MSVM Well) Maximum~~	~~470,000~~	~~200-LV-150-34~~	~~1,100~~	~~140,000 (D)~~	~~200-LV-150-34~~	~~520~~	~~1,040,000 / ---~~	~~NA~~	~~4,920,000 / ---~~	~~NA~~	~~120,000,000 / ---440,000,000~~	~~2,300,000,000 / ---~~	~~NoNA~~
	~~B200 Outdoor Air Maximum~~	~~0.76 (J)~~	~~200-OA-2~~	~~0.29~~	~~0.49 (J)~~	~~200-OA-2~~	~~0.26~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA7,670,000~~
~~Freon 113 (cont.)~~	~~B200 Indoor Air Maximum~~	~~3,200~~	~~200-IA-5~~	~~6.6~~	~~730 (D)~~	~~200-IA-5~~	~~2.7~~	~~NA~~	~~31,300 / ---~~	~~NA~~	~~147,000 / ---~~	~~NA~~	~~NA~~	~~No7,670,000~~
~~2-Butanone~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,400~~	~~ND~~	~~200-LV-150-34~~	~~320~~	~~174,000 / ---~~	~~NA~~	~~819,000 / ---~~	~~NA~~	~~9,600,000 / --- 35,000,000~~	~~160,000,000 / ---~~	~~NoNA~~
	~~B200 Outdoor Air Maximum~~	~~3 (J, TB)~~	~~200-OA-1~~	~~0.39~~	~~0.42~~	~~200-OA-2~~	~~0.32~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA590,000~~
	~~B200 Indoor Air Maximum~~	~~8.7~~	~~200-IA-3~~	~~0.30~~	~~2 (J)~~	~~200-IA-2~~	~~0.36~~	~~NA~~	~~5,210 / ---~~	~~NA~~	~~24,600 / ---~~	~~NA~~	~~NA~~	~~No590,000~~
~~1,1,1-trichloroethane~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,100~~	~~ND~~	~~200-LV-150-34~~	~~260~~	~~174,000 / ---~~	~~NA~~	~~819,000 / ---~~	~~NA~~	~~13,000,000 / ---46,000,000~~	~~220,000,000 / ---~~	~~NoNA~~

~~COPC~~	~~Sample Type~~	~~8/27/17 Sample Event (µg/m³)~~	~~Sample Location~~	~~Method Detection Limit (µg/m³)~~	~~2/25/18 Sample Event (µg/m³)~~	~~Sample Location~~	~~Method Detection Limit (µg/m³)~~	~~NMED VISL Residential Soil Vapor nc / c (µg/m³)[1]~~	~~NMED VISL Residential Indoor Air nc / c (µg/m³)[1]~~	~~NMED VISL Industrial Soil Vapor nc / c (µg/m³)[1]~~	~~NMED VISL Industrial Indoor Air nc / c (µg/m³)[1]~~	~~WSTF RBC ResidentialSoil Vapor in@ 5 ft bgs nc / c (µg/m³)[2]~~	~~WSTF RBC Industrial in ft bgs nc / c (µg/m³)[2]~~	~~OSHA PEL TWA (8-Hr) (µg/m³) Exceeds Risk / Hazard?~~
	~~B200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.32~~	~~ND~~	~~200-OA-1~~	~~0.25~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA1,911,000~~
	~~B200 Indoor Air Maximum~~	~~ND~~	~~200-IA-1~~	~~0.38~~	~~ND~~	~~200-IA-1~~	~~0.27~~	~~NA~~	~~5,210 / —~~	~~NA~~	~~24,600 / —~~	~~NA~~	~~NA~~	~~No1,911,000~~
~~Chloroform~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,100~~	~~ND~~	~~200-LV-150-34~~	~~260~~	~~3,410 / 40.7~~	~~NA~~	~~199 / 3,200~~	~~NA~~	~~210,000 / 2,5009,800~~	~~3,700,000 / 46,000~~	~~NoNA~~
	~~B200 Outdoor Air Maximum~~	~~0.35 (J)~~	~~200-OA-1~~	~~0.32~~	~~ND~~	~~200-OA-1~~	~~0.25~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA244,000~~
	~~B200 Indoor Air Maximum~~	~~0.33 (J)~~	~~200-IA-3~~	~~0.25~~	~~0.39 (J)~~	~~200-IA-3~~	~~0.26~~	~~NA~~	~~102 / 1.22~~	~~NA~~	~~5.98 / 5.98~~	~~NA~~	~~NA~~	~~No244,000~~
~~Benzene~~	~~Soil Vapor (MSVM Well) Maximum~~	~~80 (J)~~	~~200-SV-09-19~~	~~67~~	~~ND~~	~~200-SV-09-19~~	~~52~~	~~1,040 / 120~~	~~NA~~	~~4,920 / 588~~	~~NA~~	~~29,000 / 3,40026,000~~	~~400,000 / 49,000~~	~~NoNA~~
	~~B200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-2~~	~~0.27~~	~~0.3 (J)~~	~~200-OA-2~~	~~0.24~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA3,190~~
	~~B200 Indoor Air Maximum~~	~~1.1~~	~~200-IA-4~~	~~0.29~~	~~1.6~~	~~200-IA-8~~	~~0.27~~	~~NA~~	~~31.3 / 3.60~~	~~NA~~	~~17.6 / 17.6~~	~~NA~~	~~NA~~	~~No3,190~~
~~Ethylbenzene~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,100~~	~~ND~~	~~200-LV-150-34~~	~~240~~	~~34,800 / 374~~	~~NA~~	~~164,000 / 1,840~~	~~NA~~	~~—~~	~~—~~	~~NoNA~~
	~~B200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.30~~	~~ND~~	~~200-OA-1~~	~~0.24~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA434,000~~
	~~B200 Indoor Air Maximum~~	~~0.47 (J)~~	~~200-IA-3~~	~~0.23~~	~~ND~~	~~200-IA-3~~	~~0.30~~	~~NA~~	~~1,040 / 11.2~~	~~NA~~	~~55.1 / 55.1~~	~~NA~~	~~NA~~	~~No434,000~~
~~Toluene~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,100~~	~~ND~~	~~200-LV-150-34~~	~~260~~	~~174,000 / —~~	~~NA~~	~~819,000 / —~~	~~NA~~	~~—~~	~~—~~	~~NoNA~~
	~~B200 Outdoor Air Maximum~~	~~0.39 (J, TB)~~	~~200-OA-1~~	~~0.32~~	~~ND~~	~~200-OA-1~~	~~0.25~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA754,000~~
	~~B200 Indoor Air Maximum~~	~~7.2 (J)~~	~~200-IA-5~~	~~6.6~~	~~1.1~~	~~200-IA-3~~	~~0.26~~	~~NA~~	~~5,210 / —~~	~~NA~~	~~24,600 / —~~	~~NA~~	~~NA~~	~~No754,000~~
~~Xylenes~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~2,000~~	~~ND~~	~~200-LV-150-34~~	~~460~~	~~3,480 / —~~	~~NA~~	~~16,400 / —~~	~~NA~~	~~—~~	~~—~~	~~NoNA~~
	~~B200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.56~~	~~ND~~	~~200-OA-1~~	~~0.44~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA434,000~~
~~Xylenes (cont.)~~	~~B.200 Indoor Air Maximum~~	~~1.5~~	~~200-IA-3~~	~~0.44~~	~~ND~~	~~200-IA-3~~	~~0.47~~	~~NA~~	~~104 / —~~	~~NA~~	~~492 / —~~	~~NA~~	~~NA~~	~~No434,000~~
~~Acetone~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~5,100~~	~~ND~~	~~200-LV-150-34~~	~~1,200~~	~~1,080,000 / —~~	~~NA~~	~~5,080,000 / —~~	~~NA~~	~~53,000,000 / —200,000,000~~	~~860,000,000 / —~~	~~NoNA~~
	~~B200 Outdoor Air Maximum~~	~~13 (TB)~~	~~200-OA-1~~	~~1.4~~	~~2.4~~	~~200-OA-2~~	~~1.2~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA2,380,000~~
	~~B200 Indoor Air Maximum~~	~~29 (QD)~~	~~200-IA-3~~	~~1.4~~	~~8.7~~	~~200-IA-2~~	~~1.3~~	~~NA~~	~~32,300 / —~~	~~NA~~	~~152,000 / —~~	~~NA~~	~~NA~~	~~No2,380,000~~
~~2-propanol[3]~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~2,800~~	~~ND~~	~~200-LV-150-34~~	~~640~~	~~210 / —~~	~~NA~~	~~880 / —~~	~~NA~~	~~350,000 / — 1,300,000~~	~~5,600,000 / —~~	~~NoNA~~

~~COPC~~	~~Sample Type~~	~~8/27/17 Sample Event (µg/m^3)~~	~~Sample Location~~	~~Method Detection Limit (µg/m^3)~~	~~2/25/18 Sample Event (µg/m^3)~~	~~Sample Location~~	~~Method Detection Limit (µg/m^3)~~	~~NMED VISL Residential Soil Vapor nc / c (µg/m^3)[1]~~	~~NMED VISL Residential Indoor Air nc / c (µg/m^3)[1]~~	~~NMED VISL Industrial Soil Vapor nc / c (µg/m^3)[1]~~	~~NMED VISL Industrial Indoor Air nc / c (µg/m^3)[1]~~	~~WSTF RBC ResidentialSoil Vapor in@ 5 ft bgs nc / c (µg/m^3)[2]~~	~~WSTF RBC Industrial in ft bgs nc / c (µg/m^3)[2]~~	~~OSHA PEL TWA (8-Hr) (µg/m^3) Exceeds Risk / Hazard?~~
	~~B200 Outdoor Air Maximum~~	~~4.3~~	~~200-OA-2~~	~~0.71~~	~~ND~~	~~200-OA-2~~	~~0.66~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA984,000~~
	~~B200 Indoor Air Maximum~~	~~68 (QD)~~	~~200-IA-3~~	~~0.61~~	~~4.3~~	~~200-IA-1~~	~~0.67~~	~~NA~~	~~210 / —~~	~~NA~~	~~880 / —~~	~~NA~~	~~NA~~	~~No984,000~~
~~1,1-Dichloroethene~~	~~Soil Vapor (MSVM Well) Maximum~~	~~12,000~~	~~200-LV-150-34~~	~~1,100~~	~~7,500~~	~~200-LV-150-34~~	~~260~~	~~6,950 / —~~	~~NA~~	~~32,800 / — 2,870~~	~~NA~~	~~400,000 / — 130,000~~	~~6,700,000 / —~~	~~Yes:NA Res haz (1.73E+00) VISLs~~
	~~B.200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.32~~	~~ND~~	~~200-OA-1~~	~~0.25~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA405,000~~
	~~B.200 Indoor Air Maximum~~	~~ND~~	~~200-IA-1~~	~~0.38~~	~~ND~~	~~200-IA-1~~	~~0.27~~	~~NA~~	~~209 / —~~	~~NA~~	~~983 / —86~~	~~NA~~	~~NA~~	~~No405,000~~
~~1,2,4-Trimethylbenzene[3]~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~990~~	~~ND~~	~~200-LV-150-34~~	~~230~~	~~63 / —~~	~~NA~~	~~260 / —~~	~~NA~~	~~—~~	~~—~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.28~~	~~ND~~	~~200-OA-1~~	~~0.22~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA—~~
~~1,2,4-Trimethylbenzene[3]~~	~~B.200 Indoor Air Maximum~~	~~0.92~~	~~200-IA-3~~	~~0.22~~	~~ND~~	~~200-IA-1~~	~~0.24~~	~~NA~~	~~63 / —~~	~~NA~~	~~260 / —~~	~~NA~~	~~NA~~	~~No—~~
~~2,2,4-Trimethylpentane~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~990~~	~~ND~~	~~200-LV-150-34~~	~~230~~	~~—~~	~~NA~~	~~—~~	~~NA~~	~~—~~	~~—~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.28~~	~~ND~~	~~200-OA-1~~	~~0.22~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA—~~
	~~B.200 Indoor Air Maximum~~	~~0.39 (J)~~	~~200-IA-3~~	~~0.28~~	~~ND~~	~~200-IA-1~~	~~0.24~~	~~NA~~	~~—~~	~~NA~~	~~—~~	~~NA~~	~~NA~~	~~No—~~
~~2-Hexanone[3]~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,100~~	~~ND~~	~~200-LV-150-34~~	~~240~~	~~31 / —~~	~~NA~~	~~130 / —~~	~~NA~~	~~7,1000 / — 250,000~~	~~1,200,000 / —~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~0.62 (J)~~	~~200-OA-1~~	~~0.30~~	~~ND~~	~~200-OA-1~~	~~0.24~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA410,000~~
	~~B.200 Indoor Air Maximum~~	~~1.1~~	~~200-IA-3~~	~~0.30~~	~~0.39 (J)~~	~~200-IA-2~~	~~0.28~~	~~NA~~	~~31 / —~~	~~NA~~	~~130 / —~~	~~NA~~	~~NA~~	~~No410,000~~
~~4-Methyl-2-pentanone (methyl isobutyl ketone)~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,100~~	~~ND~~	~~200-LV-150-34~~	~~240~~	~~104,000 / —~~	~~NA~~	~~492,000 / —~~	~~NA~~	~~7,200,000 / — 26,000,000~~	~~120,000,000 / —~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~0.42~~	~~200-OA-1~~	~~0.30~~	~~ND~~	~~200-OA-1~~	~~0.24~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA410,000~~
	~~B.200 Indoor Air Maximum~~	~~24~~	~~200-IA-3~~	~~0.23~~	~~ND~~	~~200-IA-1~~	~~0.25~~	~~NA~~	~~3,130 / —~~	~~NA~~	~~14,700 / —~~	~~NA~~	~~NA~~	~~No410,000~~
~~Carbon Disulfide~~	~~Soil Vapor (MSVM Well) Maximum~~	~~64 (J)~~	~~200-SV-09-19~~	~~63~~	~~ND~~	~~200-LV-150-34~~	~~230~~	~~24,300 / —~~	~~NA~~	~~115,000 / —~~	~~NA~~	~~610,000 / — 1,200,000 / — 4,400,000~~	~~8,100,000 / — 19,000,000 / —~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~0.73 (J A TB)~~	~~200-OA-1~~	~~0.28~~	~~ND~~	~~200-OA-1~~	~~0.22~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA62,000~~
	~~B.200 Indoor Air Maximum~~	~~0.47 (J A)~~	~~200-IA-1~~	~~0.33~~	~~ND~~	~~200-IA-1~~	~~0.24~~	~~NA~~	~~730 / —~~	~~NA~~	~~3,440 / —~~	~~NA~~	~~NA~~	~~No62,000~~
~~Carbon Tetrachloride~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~990~~	~~ND~~	~~200-LV-150-34~~	~~230~~	~~3,480 / 156~~	~~NA~~	~~16,400 / 765~~	~~NA~~	~~—~~	~~—~~	~~NoNA~~

~~COPC~~	~~Sample Type~~	~~8/27/17 Sample Event (µg/m³)~~	~~Sample Location~~	~~Method Detection Limit (µg/m³)~~	~~2/25/18 Sample Event (µg/m³)~~	~~Sample Location~~	~~Method Detection Limit (µg/m³)~~	~~NMED VISL Residential Soil Vapor nc / c (µg/m³)~~[1]	~~NMED VISL Residential Indoor Air nc / c (µg/m³)~~[1]	~~NMED VISL Industrial Soil Vapor nc / c (µg/m³)~~[1]	~~NMED VISL Industrial Indoor Air nc / c (µg/m³)~~[1]	~~WSTF RBC ResidentialSoil Vapor in@ 5 ft bgs nc / c (µg/m³)~~[2]	~~WSTF RBC Industrial in ft bgs nc / c (µg/m³)~~[2]	~~OSHA PEL TWA (8-Hr) (µg/m³) Exceeds Risk / Hazard?~~
	~~B.200 Outdoor Air Maximum~~	~~0.41~~	~~200-OA-2~~	~~0.25~~	~~0.4~~	~~200-OA-1~~	~~0.22~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA63,000~~
	~~B.200 Indoor Air Maximum~~	~~0.45~~	~~200-IA-1~~	~~0.33~~	~~0.41~~	~~200-IA-3~~	~~0.23~~	~~NA~~	~~104 / 4.68~~	~~NA~~	~~22.9 / 22.9~~	~~NA~~	~~NA~~	~~No63,000~~
~~Chloromethane~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~990~~	~~ND~~	~~200-LV-150-34~~	~~230~~	~~3,130 / 520~~	~~NA~~	~~14,700 / 2,550~~	~~NA~~	~~140,000 / 22,00087,000~~	~~2,100,000 / 370,000~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~0.42 (J TB)~~	~~200-OA-1~~	~~0.28~~	~~0.57 (J)~~	~~200-OA-2~~	~~0.23~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA207,000~~
	~~B.200 Indoor Air Maximum~~	~~0.37 (J)~~	~~200-IA-6~~	~~0.29~~	~~0.6 (J)~~	~~200-IA-3~~	~~0.23~~	~~NA~~	~~93.9 / 15.6~~	~~NA~~	~~76.5 / 76.5~~	~~NA~~	~~NA~~	~~No207,000~~
~~Ethanol~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~5,300~~	~~ND~~	~~200-LV-150-34~~	~~1,200~~	~~—~~	~~NA~~	~~——~~	~~NA~~	~~98,000,00026,000,000 / —~~	~~400,000,000 / —~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~56~~	~~200-OA-1~~	~~1.5~~	~~ND~~	~~200-OA-1~~	~~1.2~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA1,884,000~~
~~Ethanol (cont.)~~	~~B.200 Indoor Air Maximum~~	~~23~~	~~200-IA-3~~	~~1.2~~	~~11~~	~~200-IA-1~~	~~1.3~~	~~NA~~	~~—~~	~~NA~~	~~——~~	~~NA~~	~~NA~~	~~No1,884,000~~
~~Freon 12 (Dichloro-difluoro-methane)~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,100~~	~~1,200~~	~~200-LV-150-34~~	~~260~~	~~3,480 / —~~	~~NA~~	~~16,400 / —~~	~~NA~~	~~220,000 / — 810,000~~	~~3,800,000 / —~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~2.3 (TB)~~	~~200-OA-1~~	~~0.32~~	~~2.4~~	~~200-OA-1~~	~~0.25 (TB)~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA4,495,000~~
	~~B.200 Indoor Air Maximum~~	~~2.7~~	~~200-IA-4~~	~~0.31~~	~~2.7~~	~~200-IA-3~~	~~0.26~~	~~NA~~	~~104 / —~~	~~NA~~	~~492 / —~~	~~NA~~	~~NA~~	~~No4,495,000~~
~~Freon 123a~~	~~Soil Vapor (MSVM Well) Maximum~~	~~6,600 (TIC)~~	~~200-LV-150-34~~	~~NA~~	~~3,000 (TIC)~~	~~200-LV-150-34~~	~~NA~~			~~—~~	~~NA~~	~~240,000,000~~		~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~ND (*)~~	~~200-OA-1~~	~~NA~~	~~ND (*)~~	~~200-OA-1~~	~~NA~~			~~NA~~	~~NA~~	~~NA~~		~~NA—~~
	~~B.200 Indoor Air Maximum~~	~~ND (*)~~	~~200-IA-1~~	~~NA~~	~~ND (*)~~	~~200-IA-1~~	~~NA~~			~~NA~~	~~—~~	~~NA~~		~~No—~~
~~Freon 21 (Dichloro-fluoromethane)~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,600~~	~~ND~~	~~200-LV-150-34~~	~~370~~	~~—~~	~~NA~~	~~——~~	~~NA~~	~~910,000220,000 / —~~	~~4,300,000 / -~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.45~~	~~ND~~	~~200-OA-1~~	~~0.35~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA4,209,000~~
	~~B.200 Indoor Air Maximum~~	~~3.5~~	~~200-IA-3~~	~~0.45~~	~~ND~~	~~200-IA-1~~	~~0.38~~	~~NA~~	~~—~~	~~NA~~	~~——~~	~~NA~~	~~NA~~	~~No4,209,000~~
~~Heptane~~[3]	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,100~~	~~ND~~	~~200-LV-150-34~~	~~260~~	~~420 / —~~	~~NA~~	~~1,800 / —~~	~~NA~~	~~1,000,000 / — 3,800,000~~	~~18,000,000 / —~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.32~~	~~ND~~	~~200-OA-1~~	~~0.25~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA2,049,000~~
~~Heptane~~[3] ~~(cont.)~~	~~B.200 Indoor Air Maximum~~	~~0.33 (J)~~	~~200-IA-3~~	~~0.25~~	~~ND~~	~~200-IA-1~~	~~0.27~~	~~NA~~	~~420 / —~~	~~NA~~	~~1,800 / —~~	~~NA~~	~~NA~~	~~No2,049,000~~
~~Hexane~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~990~~	~~ND~~	~~200-LV-150-34~~	~~230~~	~~24,300 / —~~	~~NA~~	~~115,000 / —~~	~~NA~~	~~1,600,000 / — 5,900,000~~	~~28,000,000 / —~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~0.35 (J TB)~~	~~200-OA-1~~	~~0.28~~	~~ND~~	~~200-OA-1~~	~~0.22~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA1,759,000~~
	~~B.200 Indoor Air Maximum~~	~~1.2~~	~~200-IA-3~~	~~0.22~~	~~1.1~~	~~200-IA-3~~	~~0.25~~	~~NA~~	~~730 / —~~	~~NA~~	~~3,440 / —~~	~~NA~~	~~NA~~	~~No1,759,000~~

~~COPC~~	~~Sample Type~~	~~8/27/17 Sample Event (µg/m^3)~~	~~Sample Location~~	~~Method Detection Limit (µg/m^3)~~	~~2/25/18 Sample Event (µg/m^3)~~	~~Sample Location~~	~~Method Detection Limit (µg/m^3)~~	~~NMED VISL Residential Soil Vapor nc / c (µg/m^3)[1]~~	~~NMED VISL Residential Indoor Air nc / c (µg/m^3)[1]~~	~~NMED VISL Industrial Soil Vapor nc / c (µg/m^3)[1]~~	~~NMED VISL Industrial Indoor Air nc / c (µg/m^3)[1]~~	~~WSTF RBC ResidentialSoil Vapor in@ 5 ft bgs nc / c (µg/m^3)[2]~~	~~WSTF RBC Industrial in ft bgs nc / c (µg/m^3)[2]~~	~~OSHA PEL TWA (8-Hr) (µg/m^3) Exceeds Risk / Hazard?~~
~~Methylene Chloride~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,100~~	~~ND~~	~~200-LV-150-34~~	~~260~~	~~20,900 / 33,800~~	~~NA~~	~~98,300 / 459,000~~	~~NA~~	~~1,100,000 / 1,700,0003,900,000~~	~~18,000,000 / 79,000,000~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.32~~	~~0.42 (J)~~	~~200-OA-2~~	~~0.26~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA87,000~~
	~~B.200 Indoor Air Maximum~~	~~1.6~~	~~200-IA-4~~	~~0.31~~	~~0.43 (J)~~	~~200-IA-2~~	~~0.29~~	~~NA~~	~~626 / 1,010~~	~~NA~~	~~2,950 / 13,800~~	~~NA~~	~~NA~~	~~No87,000~~
~~Styrene~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~990~~	~~ND~~	~~200-LV-150-34~~	~~230~~	~~34,800 / ---~~	~~NA~~	~~164,000 / ---~~	~~NA~~	~~---~~	~~---~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.28~~	~~ND~~	~~200-OA-1~~	~~0.22~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA426,000~~
	~~B.200 Indoor Air Maximum~~	~~1.9~~	~~200-IA-3~~	~~0.22~~	~~ND~~	~~200-IA-1~~	~~0.24~~	~~NA~~	~~1,040 / ---~~	~~NA~~	~~4,920 / ---~~	~~NA~~	~~NA~~	~~No426,000~~
~~Tetrahydro_furan[3]~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,300~~	~~ND~~	~~200-LV-150-34~~	~~310~~	~~2,100 / ---~~	~~NA~~	~~1,800 / ---~~	~~NA~~	~~3,600,000 / ---13,000~~	~~59,000,000 / ---~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.38~~	~~1.2~~	~~200-OA-2~~	~~0.30~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA590,000~~
	~~B.200 Indoor Air Maximum~~	~~0.29 (J)~~	~~200-IA-3~~	~~0.29~~	~~ND~~	~~200-IA-1~~	~~0.32~~	~~NA~~	~~2,100 / ---~~	~~NA~~	~~1,800 / ---~~	~~NA~~	~~NA~~	~~No590,000~~
~~trans-1,2-Dichloroethene~~	~~Soil Vapor (MSVM Well) Maximum~~	~~ND~~	~~200-LV-150-34~~	~~1,300~~	~~ND~~	~~200-LV-150-34~~	~~290~~	~~1,390 / ---~~	~~NA~~	~~6,550 / ---9,380~~	~~NA~~	~~---~~	~~---~~	~~NoNA~~
	~~B.200 Outdoor Air Maximum~~	~~ND~~	~~200-OA-1~~	~~0.36~~	~~ND~~	~~200-OA-1~~	~~0.28~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA---~~
	~~B.200 Indoor Air Maximum~~	~~2.2 (FB)~~	~~200-IA-8~~	~~0.36~~	~~1.8 (FB)~~	~~200-IA-8~~	~~0.32~~	~~NA~~	~~41.7 / ---~~	~~NA~~	~~197 / ---295~~	~~NA~~	~~NA~~	~~No---~~

~~Notes:~~

~~Red = Concentration exceeds quantitative standard screening level.~~

~~Green = Concentration is below quantitative standard screening level.~~

~~Yellow = Detection limit exceeds quantitative standard screening level.~~

~~Flags = (D) reported result is from a dilution, (J) result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit, (A) result of an analyte for a laboratory control sample (LCS), initial calibration verification (ICV) or continuing calibration verification (CCV) was outside standard limits, (QD) relative percent difference for a field duplicate was outside standard limits, (TB) analyte was detected in the trip blank, (FB) analyte was detected in the field blank.~~

~~--- = Not available.~~

~~NA = Not applicable.~~

~~nc / c = noncancer / cancer~~

~~[1] = NMED VISLs taken from Risk Assessment Guidance for Site Investigations and Remediation November 2022June, 2019 (NMED, 201922cb).~~

~~[2] = WSTF RBCs for soil vapor taken from NASA WSTF NMED-approved Soil Vapor RBCs for 202218 (NASA, 202219a), approved with modification February 11, 2022 (NMED, 2022a). The RBC listed corresponds to the closest depth bgs the sample was collected. For each sample, the next shallowest depth to the sample depth was chosen to be conservative, e.g., sampled at 34 ft bgs, the 25 ft RBC depth was used.~~

~~[3] = No NMED VISL was listed, so EPA RSL for air was used (EPA, 2022b).OSHA PEL TWAs taken Pocket Guide to Chemical Hazards September 2010 Edition (NIOSH, 2010).~~

Table 5.~~2~~1 Summary of 600 Area Building 637 and Vicinity Soil Vapor, Outdoor Air, and Indoor Air Analytical Results

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential~~Soil Vapor@ 5~~ ft bgs nc /c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (µg/m^3)[2]	~~OSHA PEL TWA (8-Hr) (µg/m^3)~~Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
TCE	Soil Vapor (MSVM Well) Maximum	480 (D)	600-SGW-1-12.5	5.8	740 (D)	600-SGW-1-12.5	5.3	69.5 / 147	NA	328 / 1,120	NA	2,300 / 5,400~~18,800~~	34,000 / 120,000	Yes: Res cancer VISLs (5.03E-05) Res nonc VISLs (1.06E+01) Indus nonc VISLs (2.26E+00)~~NA~~
	B637 Outdoor Air Maximum	<0.29~~ND~~	600-OA-1	0.29	<0.21~~ND~~	600-OA-1	0.21	NA	NA	NA	NA	NA	NA	NA~~537,000~~
	B637 Indoor Air Maximum	<0.24~~ND~~	600-IA-1	0.24	<0.22~~ND~~	600-IA-1	0.22	NA	2.09 / 4.42	NA	9.83 / 33.6	NA	NA	No~~537,000~~
PCE	Soil Vapor (MSVM Well) Maximum	3.4	600-SGW-1-12.5	0.58	5.2	600-SGW-2-12.5	0.53	1,390 / 3,600	NA	6,550 / 17,600	NA	58,000 / 150,000~~460,000~~	910,000 / 2,400,000	No~~NA~~
	B637 Outdoor Air Maximum	<0.29~~ND~~	600-OA-1	0.29	<0.21~~ND~~	600-OA-1	0.21	NA	NA	NA	NA	NA	NA	NA~~678,000~~
	B637 Indoor Air Maximum	<0.24~~ND~~	600-IA-1	0.24	<0.22~~ND~~	600-IA-1	0.22	NA	41.7 / 108	NA	197 / 529	NA	NA	No~~678,000~~
Freon 11	Soil Vapor (MSVM Well) Maximum	1,400 (A)	600-SGW-2-12.5	18	14	600-SGW-1-12.5	0.65	24,300 / ---	NA	115,000 / ---	NA	840,000 / --- ~~6,400,000~~	31,000,000 / ---	No~~NA~~
	B637 Outdoor Air Maximum	1.2 (A)	600-OA-2	0.31	1.1	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA~~5,620,000~~
	B637 Indoor Air Maximum	1.2 (A)	600-IA-2	0.29	1.4	600-IA-2	0.26	NA	730 / ---	NA	3,440 / ---	NA	NA	No~~5,620,000~~
Freon 113	Soil Vapor (MSVM Well) Maximum	8,200	600-SGW-2-12.5	18	5,300 (D)	600-SGW-2-12.5	17	1,040,000 / ---	NA	4,920,000 / ---	NA	55,000,000 / --- ~~440,000,000~~	900,000,000 / ---	No~~NA~~
~~Freon 113 (cont.)~~	B637 Outdoor Air Maximum	0.48 (J)	600-OA-2	0.31	0.51 (J)	200-OA-2	0.25	NA	NA	NA	NA	NA	NA	NA~~7,670,000~~
	B637 Indoor Air Maximum	0.49 (J)	600-IA-2	0.29	0.59 (J)	600-IA-2	0.26	NA	31,300 / ---	NA	147,000 / ---	NA	NA	No~~7,670,000~~
2-Butanone	Soil Vapor (MSVM Well) Maximum	12 (J, FB)	600-SGW-1-12.5	0.87	5 (J)	600-SGW-5-7.5	0.81	174,000 / ---	NA	819,000 / ---	NA	4,800,000 / --- 3,200,000 / --- ~~35,000,000~~	66,000,000 / --- 35,000,000 / ---	No~~NA~~
	B637 Outdoor Air Maximum	2.4 (J)	600-OA-1	0.44	0.42 (J)	600-OA-2	0.31	NA	NA	NA	NA	NA	NA	NA~~590,000~~
	B637 Indoor Air Maximum	5.3 (J)	600-IA-4	0.44	0.52 (J, FB)	600-IA-1	0.34	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No~~590,000~~
1,1,1-trichloroethane	Soil Vapor (MSVM Well) Maximum	0.76 (J)	600-SGW-1-12.5	0.70	3.6	600-SGW-2-12.5	0.65	174,000 / ---	NA	819,000 / ---	NA	6,100,000 / --- ~~46,000,000~~	90,000,000 / ---	No~~NA~~
	B637 Outdoor Air Maximum	<0.36~~ND~~	600-OA-1	0.36	<0.25~~ND~~	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA~~1,911,000~~

COPC	Sample Type	8/27/17 Sample Event ($\mu g/m^3$)	Sample Location	Method Detection Limit ($\mu g/m^3$)	2/25/18 Sample Event ($\mu g/m^3$)	Sample Location	Method Detection Limit ($\mu g/m^3$)	NMED VISL or RBC* Residential Soil Vapor nc / c ($\mu g/m^3$)[1]	NMED VISL or RBC* Residential Indoor Air nc / c ($\mu g/m^3$)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c ($\mu g/m^3$)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c ($\mu g/m^3$)[1]	WSTF RBC Residential~~Soil Vapor@ 5~~ ft bgs nc /c ($\mu g/m^3$)[2]	WSTF RBC Industrial ft bgs nc /c ($\mu g/m^3$)[2]	~~OSHA PEL TWA (8-Hr) ($\mu g/m^3$)~~Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
	B.637 Indoor Air Maximum	<0.29~~ND~~	600-IA-1	0.29	<0.29~~ND~~	600-IA-1	0.29	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No~~1,911,000~~
Chloroform	Soil Vapor (MSVM Well) Maximum	31	600-SGW-1-12.5	0.70	41	600-SGW-1-12.5	0.65	3,410 / 40.7	NA	199 / 3,200	NA	100,000 / 1,200~~9,800~~	1,500,000 / 19,000	No~~NA~~
	B.637 Outdoor Air Maximum	<0.36~~ND~~	600-OA-1	0.36	<0.25~~ND~~	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA~~244,000~~
	B.637 Indoor Air Maximum	<0.29~~ND~~	600-IA-1	0.29	<0.27~~ND~~	600-IA-1	0.27	NA	102 / 1.22	NA	5.98 / 5.98	NA	NA	No~~244,000~~
Benzene	Soil Vapor (MSVM Well) Maximum	3.2 (FB)	600-SGW-1-12.5	0.66	1.3 (J, FB)	600-SGW-1-12.5	0.61	1,040 / 120	NA	4,920 / 588	NA	29,000 / 3,400~~26,000~~	400,000 / 49,000	No~~NA~~
	B.637 Outdoor Air Maximum	<0.34~~ND~~	600-OA-1	0.34	0.25 (J)	600-OA-2	0.24	NA	NA	NA	NA	NA	NA	NA~~3,190~~
	B.637 Indoor Air Maximum	0.33 (J)	600-IA-4	0.26	0.4 (J)	600-IA-1	0.26	NA	31.3 / 3.60	NA	17.6 / 17.6	NA	NA	No~~3,190~~
Ethylbenzene	Soil Vapor (MSVM Well) Maximum	1.6 (J)	600-SGW-1-12.5	0.66	<0.61~~ND~~	600-SGW-1-12.5	0.61	34,800 / 374	NA	164,000 / 1,840	NA	---	---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.34~~ND~~	600-OA-1	0.34	<0.24~~ND~~	600-OA-2	0.24	NA	NA	NA	NA	NA	NA	NA~~434,000~~
	B.637 Indoor Air Maximum	<0.28~~ND~~	600-IA-1	0.28	<0.26~~ND~~	600-IA-1	0.26	NA	1,040 / 11.2	NA	55.1 / 55.1	NA	NA	No~~434,000~~
Toluene	Soil Vapor (MSVM Well) Maximum	0.87 (J)	600-SGW-5-7.5	0.67	<0.65~~ND~~	600-SGW-1-12.5	0.65	174,000 / ---	NA	819,000 / ---	NA	---	---	No~~NA~~
	B.637 Outdoor Air Maximum	0.35 (J)	600-OA-2	0.31	<0.25~~ND~~	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA~~754,000~~
	B.637 Indoor Air Maximum	0.6 (J)	600-IA-4	0.36	0.32 (J)	600-IA-4	0.25	NA	5,210 / ---	NA	24,600 / ---	NA	NA	No~~754,000~~
Xylenes	Soil Vapor (MSVM Well) Maximum	<1.1~~ND~~	600-SGW-1-12.5	1.1	<32~~ND~~	600-SGW-1-12.5	32	3,480 / ---	NA	16,400 / ---	NA	---	---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.63~~ND~~	600-OA-1	0.63	<0.44~~ND~~	600-OA-1	0.44	NA	NA	NA	NA	NA	NA	NA~~434,000~~
~~Xylenes (cont.)~~	B.637 Indoor Air Maximum	<0.52~~ND~~	600-IA-1	0.52	<0.48~~ND~~	600-IA-1	0.48	NA	104 / ---	NA	492 / ---	NA	NA	No~~434,000~~
Acetone	Soil Vapor (MSVM Well) Maximum	22	600-SGW-5-7.5	3.0	27	600-SGW-5-7.5	3.0	1,080,000 / ---	NA	5,080,000 / ---	NA	19,000,000 / --- ~~200,000,000~~	200,000,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	10 (J)	600-OA-1	1.6	2.2 (J)	600-OA-1	1.1	NA	NA	NA	NA	NA	NA	NA~~2,380,000~~

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential~~Soil Vapor@ 5~~ ft bgs nc /c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (µg/m^3)[2]	~~OSHA PEL TWA (8-Hr) (µg/m^3)~~Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
	B.637 Indoor Air Maximum	28	600-IA-4	1.2	4.7 (J, FB)	600-IA-1	1.1	NA	32,300 / ---	NA	152,000 / ---	NA	NA	No~~2,380,000~~
2-propanol (Isopropanol or Isopropyl alcohol)	Soil Vapor (MSVM Well) Maximum	<1.6~~ND~~	600-SGW-1-12.5	1.6	<45~~ND~~	600-SGW-2-12.5	45	210* / ---	NA	880* / ---	NA	180,000 / --- ~~1,300,000~~	2,400,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.88~~ND~~	600-OA-1	0.88	0.66 (J)	600-OA-2	0.62	NA	NA	NA	NA	NA	NA	NA~~984,000~~
	B.637 Indoor Air Maximum	3.4	600-IA-4	0.88	1.1 (J)	600-IA-4	0.62	NA	210* / ---	NA	880* / ---	NA	NA	No~~984,000~~
1,1-Dichloroethane	Soil Vapor (MSVM Well) Maximum	5.7	600-SGW-1-12.5	0.66	5.2	600-SGW-1-12.5	0.61	--- / 585	NA	---2,870	NA	--- / 17,000~~130,000~~	--- / 250,000	No~~NA~~
	B.637 Outdoor Air Maximum	<0.34~~ND~~	600-OA-1	0.34	<0.24~~ND~~	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA~~405,000~~
	B.637 Indoor Air Maximum	<0.28~~ND~~	600-IA-1	0.28	<0.27~~ND~~	600-IA-1	0.27	NA	--- / 17.5	NA	--- / 86	NA	NA	No~~405,000~~
1,2,4-Trimethyl-benzene[3]	Soil Vapor (MSVM Well) Maximum	0.92 (J)	600-SGW-1-12.5	0.62	<0.57~~ND~~	600-SGW-1-12.5	0.57	63 / ---	NA	260 / ---	NA	---	---	No~~NA~~
~~1,2,4-Trimethyl-benzene3 (cont.)~~	B.637 Outdoor Air Maximum	<0.32~~ND~~	600-OA-1	0.32	<0.22~~ND~~	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA~~---~~
	B.637 Indoor Air Maximum	<0.26~~ND~~	600-IA-1	0.26	<0.26~~ND~~	600-IA-1	0.26	NA	63 / ---	NA	260 / ---	NA	NA	No~~---~~
1,2-Dichloroethane	Soil Vapor (MSVM Well) Maximum	0.73 (J)	600-SGW-1-12.5	0.66	<0.61~~ND~~	600-SGW-1-12.5	0.61	243 / 36	NA	1,150 / 176	NA	---	---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.34~~ND~~	600-OA-1	0.34	<0.24~~ND~~	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA~~202,000~~
	B.637 Indoor Air Maximum	<0.28~~ND~~	600-IA-1	0.28	<0.27~~ND~~	600-IA-1	0.27	NA	7.30 / 1.08	NA	5.29 / 5.29	NA	NA	No~~202,000~~
1,4-Dichlorobenzene	Soil Vapor (MSVM Well) Maximum	1.9 (J)	600-SGW-1-12.5	0.58	<0.58~~ND~~	600-SGW-1-12.5	0.58	27,800 / 85.1	NA	131,000 / 417	NA	---	---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.29~~ND~~	600-OA-1	0.29	<0.29~~ND~~	600-OA-1	0.29	NA	NA	NA	NA	NA	NA	NA~~451,000~~
	B.637 Indoor Air Maximum	<0.24~~ND~~	600-IA-1	0.24	<0.24~~ND~~	600-IA-1	0.24	NA	834 / 2.55	NA	12.5 / 12.5	NA	NA	No~~451,000~~
2-Hexanone	Soil Vapor (MSVM Well) Maximum	<0.66~~ND~~	600-SGW-1-12.5	0.66	1 (J)	600-SGW-5-7.5	0.62	31* / ---	NA	130* / ---	NA	34,000 / --- 22,000 / --- ~~250,000~~	490,000 / --- 250,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.34~~ND~~	600-OA-1	0.34	<0.24~~ND~~	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA~~410,000~~

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential~~Soil Vapor@ 5~~ ft bgs nc /c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (µg/m^3)[2]	~~OSHA PEL TWA (8-Hr) (µg/m^3)~~Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
	B.637 Indoor Air Maximum	1.1	600-IA-4	0.26	<0.27~~ND~~	600-IA-1	0.27	NA	31* / ---	NA	130* / ---	NA	NA	No~~410,000~~
4-Methyl-2-pentanone methyl isobutyl ketone)	Soil Vapor (MSVM Well) Maximum	<0.66~~ND~~	600-SGW-1-12.5	0.66	<0.61~~ND~~	600-SGW-1-12.5	0.61	104,000 / ---	NA	492,000 / ---	NA	3,500,000 / --- ~~26,000,000~~	51,000,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.34~~ND~~	600-OA-1	0.34	<0.24~~ND~~	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA~~410,000~~
	B.637 Indoor Air Maximum	0.5 (J)	600-IA-4	0.34	<0.27~~ND~~	600-IA-1	0.27	NA	3,130 / ---	NA	14,700 / ---	NA	NA	No~~410,000~~
Bromodichloromethane	Soil Vapor (MSVM Well) Maximum	0.62 (J)	600-SGW-1-12.5	0.62	0.59 (J)	600-SGW-1-12.5	0.57	--- / 25.3	NA	--- / 124	NA	--- / 980~~7,900~~	--- / 15,000	No~~NA~~
	B.637 Outdoor Air Maximum	<0.32~~ND~~	600-OA-1	0.32	<0.22~~ND~~	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA~~---~~
	B.637 Indoor Air Maximum	<0.26~~ND~~	600-IA-1	0.26	<0.26~~ND~~	600-IA-1	0.26	NA	--- / 0.759	NA	3.72 / 3.72	NA	NA	No~~---~~
Carbon Disulfide	Soil Vapor (MSVM Well) Maximum	86 (A FB)	600-SGW-1-12.5	0.62	<0.57~~ND~~	600-SGW-1-12.5	0.57	24,300 / ---	NA	115,000 / ---	NA	610,000 / --- ~~4,400,000~~	8,100,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.32~~ND~~	600-OA-1	0.32	<0.22~~ND~~	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA~~62,000~~
	B.637 Indoor Air Maximum	<0.26~~ND~~	600-IA-1	0.26	<0.26~~ND~~	600-IA-1	0.26	NA	730 / ---	NA	3,440 / ---	NA	NA	No~~62,000~~
Carbon Tetrachloride	Soil Vapor (MSVM Well) Maximum	<0.62~~ND~~	600-SGW-1-12.5	0.62	<0.57~~ND~~	600-SGW-1-12.5	0.57	3,480 / 156	NA	16,400 / 765	NA	---	---	No~~NA~~
	B.637 Outdoor Air Maximum	0.41 (J)	600-OA-1	0.32	0.4 (J)	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA~~63,000~~
~~Carbon Tetrachloride~~	B.637 Indoor Air Maximum	0.41 (J)	600-IA-1	0.26	0.45 (J)	600-IA-1	0.24	NA	104 / 4.68	NA	22.9 / 22.9	NA	NA	No~~63,000~~
Chloroethane (Ethyl chloride)	Soil Vapor (MSVM Well) Maximum	2 (J)	600-SGW-1-12.5	0.70	1.7 (J)	600-SGW-1-12.5	0.65	348,000 / ---	NA	1,640,000 / ~~---~~	NA	8,900,000 / --- ~~64,000,000~~	120,000,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.36~~ND~~	600-OA-1	0.36	<~~ND~~0.25	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA~~2,638,000~~
	B.637 Indoor Air Maximum	<0.29~~ND~~	600-IA-1	0.29	<0.27~~ND~~	600-IA-1	0.27	NA	10,400 / ---	NA	49,200 / ---	NA	NA	No~~2,638,000~~
Chloromethane	Soil Vapor (MSVM Well) Maximum	1.5 (J FB)	600-SGW-1-12.5	0.62	1.2 (J FB)	600-SGW-1-12.5	0.57	3,130 / 520	NA	14,700 / 2,550	NA	72,000 / 12,000~~87,000~~	900,000 / 160,000	No~~NA~~
	B.637 Outdoor Air Maximum	0.39 (J)	600-OA-1	0.32	0.63 (J)	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA~~207,000~~
	B.637 Indoor Air Maximum	0.33 (J)	600-IA-4	0.32	0.65 (J)	600-IA-4	0.22	NA	93.9 / 15.6	NA	76.5 / 76.5	NA	NA	No~~207,000~~

COPC	Sample Type	8/27/17 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	2/25/18 Sample Event (µg/m^3)	Sample Location	Method Detection Limit (µg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (µg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (µg/m^3)[1]	WSTF RBC Residential~~Soil Vapor@ 5~~ ft bgs nc /c (µg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (µg/m^3)[2]	~~OSHA PEL TWA (8-Hr) (µg/m^3)~~Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
cis-1,2-Dichloroethene	Soil Vapor (MSVM Well) Maximum	0.82 (J)	600-SGW-1-12.5	0.66	<0.61~~ND~~	600-SGW-1-12.5	0.61	42* / ---	NA	180* / ---	NA	---	---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.34~~ND~~	600-OA-1	0.34	<0.24~~ND~~	600-OA-1	0.24	NA	NA	NA	NA	NA	NA	NA~~---~~
	B.637 Indoor Air Maximum	<0.28~~ND~~	600-IA-1	0.28	<0.26~~ND~~	600-IA-1	0.26	NA	42* / ---	NA	180* / ---	NA	NA	No~~---~~
Ethanol	Soil Vapor (MSVM Well) Maximum	9.6 (J FB)	600-SGW-1-12.5	3.3	<3.0~~ND~~	600-SGW-1-12.5	3.0	NE	NA	NE~~---~~	NA	15,000,000 / --- ~~98,000,000~~	170,000,000 / ---	No~~NA~~
~~Ethanol (cont.)~~	B.637 Outdoor Air Maximum	3.5 (J)	600-OA-2	1.5	2.6 (J)	600-OA-2	1.2	NA	NA	NA	NA	NA	NA	NA~~1,884,000~~
	B.637 Indoor Air Maximum	20	600-IA-4	1.7	4.2 (J FB)	600-IA-1	1.3	NA	NA	NA	NA	NA	NA	No~~1,884,000~~
Freon 12 (Dichlorodifluoromethane)	Soil Vapor (MSVM Well) Maximum	2.4	600-SGW-5-7.5	0.67	2.2 (FB)	600-SGW-1-12.5	0.65	3,480 / ---	NA	16,400 / ---	NA	70,000 / --- 110,000 / --- ~~810,000~~	810,000 / --- 1,600,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	2.3	600-OA-1	0.36	2.1	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA~~4,495,000~~
	B.637 Indoor Air Maximum	2.3 (FB)	600-IA-1	0.29	2.3 (FB)	600-IA-1	0.27	NA	104 / ---	NA	492 / ---	NA	NA	No~~4,495,000~~
Freon 21 (Dichlorofluoro-methane)	Soil Vapor (MSVM Well) Maximum	10	600-SGW-1-12.5	0.99	6	600-SGW-1-12.5	0.91	NE	NA	NE~~---~~	NA	120,000 / --- ~~910,000~~	1,800,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.50~~ND~~	600-OA-1	0.50	<0.35~~ND~~	600-OA-1	0.35	NA	NA	NA	NA	NA	NA	NA~~4,209,000~~
	B.637 Indoor Air Maximum	<0.41~~ND~~	600-IA-1	0.41	<0.38~~ND~~	600-IA-1	0.38	NA	NA	NA	NA	NA	NA	No~~4,209,000~~
Heptane	Soil Vapor (MSVM Well) Maximum	<0.70~~ND~~	600-SGW-1-12.5	0.70	<0.65~~ND~~	600-SGW-1-12.5	0.65	420* / ---	NA	1,800* / ---	NA	490,000 / ---	7,300,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	<0.36~~ND~~	600-OA-1	0.36	<0.25~~ND~~	600-OA-1	0.25	NA	NA	NA	NA	NA	NA	NA~~2,049,000~~
	B.637 Indoor Air Maximum	0.3 (J)	600-IA-4	0.28	<0.27~~ND~~	600-IA-1	0.27	NA	420* / ---	NA	1,800* / ---	NA	NA	No~~2,049,000~~
Hexane	Soil Vapor (MSVM Well) Maximum	1.5 (J FB)	600-SGW-1-12.5	0.62	<0.57~~ND~~	600-SGW-1-12.5	0.57	24,300 / ---	NA	115,000 / ---	NA	780,000 / --- ~~5,900,000~~	11,000,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	0.82 (J)	600-OA-1	0.32	<0.22~~ND~~	600-OA-1	0.22	NA	NA	NA	NA	NA	NA	NA~~1,759,000~~
	B.637 Indoor Air Maximum	0.79 (J)	600-IA-4	0.32	<0.24~~ND~~	600-IA-1	0.24	NA	730 / ---	NA	3,440 / ---	NA	NA	No~~1,759,000~~
Methylene Chloride	Soil Vapor (MSVM Well) Maximum	24	600-SGW-1-12.5	0.70	24	600-SGW-1-12.5	0.65	20,900 / 33,800	NA	98,300 / 459,000	NA	550,000 / 870,000~~3,900,000~~	7,400,000 / 33,000,000	No~~NA~~

COPC	Sample Type	8/27/17 Sample Event (μg/m^3)	Sample Location	Method Detection Limit (μg/m^3)	2/25/18 Sample Event (μg/m^3)	Sample Location	Method Detection Limit (μg/m^3)	NMED VISL or RBC* Residential Soil Vapor nc / c (μg/m^3)[1]	NMED VISL or RBC* Residential Indoor Air nc / c (μg/m^3)[1]	NMED VISL or RBC* Industrial Soil Vapor nc / c (μg/m^3)[1]	NMED VISL or RBC* Industrial Indoor Air nc / c (μg/m^3)[1]	WSTF RBC Residential~~Soil Vapor@ 5~~ ft bgs nc /c (μg/m^3)[2]	WSTF RBC Industrial ft bgs nc /c (μg/m^3)[2]	~~OSHA PEL TWA (8-Hr) (μg/m^3)~~Exceeds Risk / Hazard? (Calculated risk or hazard exceeded)
	B.637 Outdoor Air Maximum	<0.36~~ND~~	600-OA-1	0.36	0.43 (J)	600-OA-2	0.25	NA	NA	NA	NA	NA	NA	NA~~87,000~~
	B.637 Indoor Air Maximum	<0.29~~ND~~	600-IA-1	0.29	0.55 (J FB)	600-IA-1	0.27	NA	626 / 1,010	NA	2,950 / 13,800	NA	NA	No~~87,000~~
Tetrahydrofuran	Soil Vapor (MSVM Well) Maximum	0.85 (J)	600-SGW-1-12.5	0.83	<0.76~~ND~~	600-SGW-1-12.5	0.76	2,100* / ---	NA	1,800* / ---	NA	1,800,000 / --- ~~13,000~~	24,000,000 / ---	No~~NA~~
	B.637 Outdoor Air Maximum	1.1	600-OA-1	0.42	<0.29~~ND~~	600-OA-1	0.29	NA	NA	NA	NA	NA	NA	NA~~590,000~~
~~Tetrahydro-furan~~~~[3]~~ ~~(cont.)~~	B.637 Indoor Air Maximum	<0.34~~ND~~	600-IA-1	0.34	<0.32~~ND~~	600-IA-1	0.32	NA	2,100* / ---	NA	1,800* / ---	NA	NA	No~~590,000~~

Notes:
🟥Red = VISL or RBC exceeded.

Flags = (D) reported result is from a dilution, (J) result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit, (A) result of an analyte for a laboratory control sample (LCS), initial calibration verification (ICV) or continuing calibration verification (CCV) was outside standard limits, (QD) relative percent difference for a field duplicate was outside standard limits, (TB) analyte was detected in the trip blank, (FB) analyte was detected in the field blank.
--- = Not available~~.~~
NA = Not applicable~~.~~
NE = Not Established
[1] = NMED VISLs taken from Risk Assessment Guidance for Site Investigations and Remediation ~~June, 2019~~November 2022 (NMED, 20~~19~~22c~~b~~).
[2] = WSTF RBCs for soil vapor taken from NASA WSTF NMED-approved Soil Vapor RBCs for 2022~~18~~ (NASA, 2022~~19a~~), approved with modification February 2022 (NMED, 2022a). The RBC listed corresponds to the closest depth bgs the sample was collected. For each sample, the next shallowest depth to the sample depth was chosen to be conservative, e.g., sampled at 34 ft bgs, the 25 ft RBC depth was used

*~~[3]~~ = No NMED VISL was listed, so EPA RSL for air was used (EPA, 2022b).~~OSHA PEL TWAs taken Pocket Guide to Chemical Hazards September 2010 Edition (NIOSH, 2010).~~

Table 6.1 200 Area Soil Vapor: Residential ~~Cumulative~~ Cancer Risk (VISLs) ~~Assessment~~

Constituent	Maximum Concentration (μg/m^3)	VISL ~~Screening Level~~[2] (μg/m^3)	Cancer Risk[1]
Benzene	8.00E+01	1.20E+02	6.67E-06
PCE	5.70E+04	3.60E+03	1.58E-04
TCE	4.10E+05	1.47E+02	2.79E-02
Total 200 Area Residential Soil Vapor Cancer Risk			2.81E-02~~7E-06~~

Notes:

[1] Cancer Risk =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Residential Vapor Intrusion Screening Levels (NMED, 20~~19~~22c~~b~~)

Table 6.2 200 Area Soil Vapor: Industrial Cancer Risk (VISLs)

Constituent	Maximum Concentration (μg/m^3)	VISL[2] (μg/m^3)	Cancer Risk[1]
Benzene	8.00E+01	5.88E+02	1.36E-06
PCE	5.70E+04	1.76E+04	**3.24E-05**
TCE	4.10E+05	1.12E+03	**3.66E-03**
Total 200 Area Industrial Soil Vapor Cancer Risk			**3.69E-03**

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Industrial Vapor Intrusion Screening Levels (NMED, 2022c)

Bold values indicate an exceedance of screening levels.

Table 6.3 200 Area Soil Vapor: Residential Cancer Risk (RBCs)

Constituent	Maximum Concentration (μg/m^3)	Depth Maximum Detected (ft bgs)	RBC[2] (μg/m^3)	RBC Depth Used (ft bgs)	Cancer Risk[1]
Benzene	8.00E+01	19	3.40E+03	10	2.35E-07
PCE	5.70E+04	34	3.40E+05	25	1.68E-06
TCE	4.10E+05	34	1.10E+04	25	**3.73E-04**
Total 200 Area Residential Soil Vapor Cancer Risk					**3.75E-04**

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table 2a, Derivation of Vapor Risk-Based Concentrations: Resident (NASA, 2022).

Bold values indicate an exceedance of screening levels.

RBC – WSTF Risk Based Concentration

Table 6.4 200 Area Soil Vapor: Industrial Cancer Risk (RBCs)

Constituent	Maximum Concentration (µg/m^3)	Depth Maximum Detected (ft bgs)	RBC[2] (µg/m^3)	RBC Depth Used (ft bgs)	Cancer Risk[1]
Benzene	8.00E+01	19	4.90E+04	10	1.63E-08
PCE	5.70E+04	34	6.00E+06	25	9.50E-08
TCE	4.10E+05	34	2.80E+05	25	**1.46E-05**
Total 200 Area Industrial Soil Vapor Cancer Risk					**1.48E-05**

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table 3a, Derivation of Vapor Risk-Based Concentrations: Commercial Worker (NASA, 2022).

Bold values indicate an exceedance of screening levels.

RBC – WSTF Risk Based Concentration

Table 6.5~~2~~ 200 Area Soil Vapor: Residential ~~Cumulative~~ (Noncancer) Hazard Index (VISLs) ~~Assessment~~

Constituent	Maximum Concentration ~~Or UCL95~~ (µg/m^3)	VISL ~~Screening Level~~[2] (µg/m^3)	Hazard Quotient[1]
Benzene	8.00E+01	1.04E+03	7.69E-02
Carbon disulfide	6.40E+01	2.43E+04	2.63E-03
Freon-12 (Dichlorodifluoromethane)	1.20E+03	3.48E+03	3.45E-01
1,1-Dichloroethene	1.20E+04~~**7.35E+03**[3,4]~~	6.95E+03	**~~1.06~~1.73E+00**
~~Tetrachloroethene~~ PCE	~~3~~5.70E+04~~[3,4]~~	1.39E+03	**~~2.66~~4.10E+01**
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	4.70E+05	1.04E+06	4.52~~1~~E-01
~~Trichloroethylene~~ TCE	~~3.8~~4.10E+05~~[3]~~	6.95E+01	**~~5.51~~5.90E+03**
Freon-11 (Trichlorofluoromethane)	4.90E+02	2.43E+04	2.02E-02
~~Freon-123a (1,2-Dichloro-1,1,2-trifluoroethane)~~	~~6.60E+03~~	~~1.04E+06[5]~~	~~6.35E-03~~
Total 200 Area Residential Soil Vapor Hazard Index			**~~5.54~~5.94E+03**

Notes:

[1] Hazard =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Residential Vapor Intrusion Screening Levels (NMED, 20~~19~~22c~~b~~), unless otherwise noted.

~~[3] These entries are UCL95 values calculated using ProUCL software.~~

~~[4] The UCL95 ProUCL software recommended was higher than the maximum concentration, so the UCL95 used was from BCa Bootstrap.~~

~~[5] No NMED or EPA screening level for Freon 123a is available, so Freon 113 NMED screening level was used.~~

Bold values indicate an exceedance of ~~NMED~~ screening levels ~~or target hazard~~.

Table 6.6 200 Area Soil Vapor: Industrial (Noncancer) Hazard Index (VISLs)

Constituent	Maximum Concentration (µg/m^3)	VISL[2] (µg/m^3)	Hazard Quotient[1]
Benzene	8.00E+01	4.92E+03	1.63E-02
Carbon disulfide	6.40E+01	1.15E+05	5.57E-04
Freon-12 (Dichlorodifluoromethane)	1.20E+03	1.64E+04	7.32E-02
1,1-Dichloroethene	1.20E+04	3.28E+04	3.66E-01
PCE	5.70E+04	6.55E+03	**8.70E+00**
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	4.70E+05	4.92E+06	9.55E-02
TCE	4.10E+05	3.28E+02	**1.25E+03**
Freon-11 (Trichlorofluoromethane)	4.90E+02	1.15E+05	4.26E-03
Total 200 Area Industrial Soil Vapor Hazard Index			**1.26E+03**

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Industrial Vapor Intrusion Screening Levels (NMED, 2022c), unless otherwise noted.

Bold values indicate an exceedance of screening levels.

Table 6.7~~3~~ 200 Area Soil Vapor: Residential~~ Cumulative~~ (Noncancer) Hazard Index~~ Assessment~~ (RBCs)

Constituent	Maximum Concentration ~~Or UCL95~~ (µg/m^3)	Depth Maximum Detected (ft bgs)	RBC[2] (µg/m^3)	RBC Depth Used (ft bgs)	Hazard Quotient[1]
Benzene	8.00E+01	19	2.90E+04	10	2.76E-03
Carbon disulfide	6.40E+01	19	6.10E+05	10	1.05E-04
Freon-12 (Dichlorodifluoromethane)	1.20E+03	34	2.20E+05	25	5.45E-03
1,1-Dichloroethene	1.20E+04~~7.35E+03~~~~[2,3]~~	34	4.00E+05	25	~~1.84~~3.00E-02
~~Tetrachloroethene~~ PCE	~~3.~~5.70E+04~~[2,3]~~	34	1.30E+05	25	~~2.85~~4.38E-01
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	4.70E+05	34	1.20E+08	25	3.92E-03
~~Trichloroethylene~~ TCE	~~3.83~~4.10E+05~~[2]~~	34	4.90E+03	25	**~~7.82~~8.37E+01**
Freon-11 (Trichlorofluoromethane)	4.90E+02	9	5.30E+05	5	9.25E-04
~~Freon-123a (1,2-Dichloro-1,1,2-trifluoroethane)~~	~~6.60E+03~~		~~6.60E+07~~		~~1.00E-04~~
Total 200 Area Residential Soil Vapor Hazard Index					**~~7.9~~8.42E+01**

Notes:

[1] Hazard =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E+00.

[2] Table 2a, Derivation of Vapor Risk-Based Concentrations: Resident (NASA, 2022).~~[2] These entries are UCL95 values calculated using ProUCL software.~~

~~[3] The UCL95 ProUCL software recommended was higher than the maximum concentration, so the UCL95 used was from BCa Bootstrap.~~

Bold values indicate an exceedance of NMED screening levels or target hazard.

RBC – WSTF Risk Based Concentration

Table 6.8 200 Area Soil Vapor: Industrial (Noncancer) Hazard Index (RBCs)

Constituent	Maximum Concentration (µg/m^3)	Depth Maximum Detected (ft bgs)	RBC[2] (µg/m^3)	RBC Depth Used (ft bgs)	Hazard Quotient[1]
Benzene	8.00E+01	19	4.00E+05	10	2.00E-04
Carbon disulfide	6.40E+01	19	8.10E+06	10	7.90E-06
Freon-12 (Dichlorodifluoromethane)	1.20E+03	34	3.80E+06	25	3.16E-04
1,1-Dichloroethene	1.20E+04	34	6.70E+06	25	1.79E-03
PCE	5.70E+04	34	2.30E+06	25	2.48E-02
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	4.70E+05	34	2.30E+09	25	2.04E-04
TCE	4.10E+05	34	8.40E+04	25	**4.88E+00**

Freon-11 (Trichlorofluoromethane)	4.90E+02	9	6.40E+06	5	7.66E-05
Total 200 Area Industrial Soil Vapor Hazard Index					**4.91E+00**

Notes:
[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.
[2] Table 3a, Derivation of Vapor Risk-Based Concentrations: Commercial Worker (NASA, 2022).
Bold values indicate an exceedance of screening levels.
RBC – WSTF Risk Based Concentration

Table 6.9~~4~~ 200 Area Indoor Air: Residential ~~Cumulative~~ Cancer Risk (VISLs) ~~Assessment~~

Constituent	**Maximum Concentration (µg/m³)**	**Indoor Air VISL~~Screening Level~~[2] (µg/m³)**	**Cancer Risk[1]**
Benzene	1.60E+00	3.60E+00	4.44E-06
Carbon tetrachloride	4.50E-01	4.68E+00	9.62E-07
Chloroform	3.90E-01	1.22E+00	3.20~~19~~E-06
Chloromethane	6.00E-01	1.56E+01	3.85E-07
Ethylbenzene	4.70E-01	1.12E+01	4.20~~18~~E-07
Methylene chloride	1.60E+00	1.01E+03	1.58E-08
PCE	2.80E-01	1.08E+02	2.59E-08
TCE	1.30E+00	4.42E+00	2.94E-06
Total 200 Area Residential Indoor Air Cancer Risk			1.24E-05~~9E-06~~ or 1E-05

Notes:
[1] Cancer Risk =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E-05.
[2] Table A-4, NMED Residential Indoor Air Screening Levels (NMED, 20~~19~~22c~~b~~).

Table 6.10 200 Area Indoor Air: Industrial Cancer Risk

Constituent	**Maximum Concentration (µg/m³)**	**Indoor Air VISLs[2] (µg/m³)**	**Cancer Risk[1]**
Benzene	1.60E+00	1.76E+01	9.09E-07
Carbon tetrachloride	4.50E-01	2.29E+01	1.97E-07
Chloroform	3.90E-01	5.98E+00	6.52E-07
Chloromethane	6.00E-01	7.65E+01	7.84E-08
Ethylbenzene	4.70E-01	5.51E+01	8.53E-08
Methylene chloride	1.60E+00	1.38E+04	1.16E-09

PCE	2.80E-01	5.29E+02	5.29E-09
TCE	1.30E+00	3.36E+01	3.87E-07
Total 200 Area Industrial Indoor Air Cancer Risk			2.31E-06

Notes:
[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.
[2] Table A-4, NMED Industrial Indoor Air Screening Levels (NMED, 2022c).

Table 6.11~~5~~ 200 Area Indoor Air: Residential~~ Cumulative~~(Noncancer) Hazard Index (VISLs)~~Assessment~~

Constituent	Max~~imum~~. Concentration Or UCL95 (μg/m^3)	Indoor Air ~~Screening Level~~VISLs[2] (μg/m^3)	Hazard Quotient[1]
Acetone[3]	~~2.90~~1.21E+01	3.23E+04	~~8.97~~3.76E-04
Benzene[3]	7.05E-01	3.13E+01	2.25E-02
2-Butanone (Methyl ethyl ketone)[3]	~~8.70~~2.75E+00	5.21E+03	5.28E-04~~1.67E-03~~
Carbon disulfide	4.70E-01	7.30E+02	6.44E-04
Carbon tetrachloride[3]	4.11E-01	1.04E+02	3.95E-03
Chloroform	3.90E-01	1.02E+02	3.82E-03
Chloromethane[3]	5.27E-01	9.39E+01	5.61E-03
Ethylbenzene	4.70E-01	1.04E+03	4.52E-04
Freon-12 (Dichlorodifluoromethane~~1,2-Dichloro-1,1,2-trifluoroethane~~)[3]	~~2.70~~2.50E+00	1.04E+02	~~2.59~~2.41E-02
trans-1,2-Dichloroethene	2.20E+00	~~6.26~~4.17E+01	~~3.52~~5.28E-02
n-Hexane[3]	6.24E-01~~1.20E+00~~	7.30E+02	8.55E-04~~1.64E-03~~
4-Methyl-2-pentanone (Methyl isobutyl ketone)	2.40E+01	3.13E+03	7.67E-03
Methylene chloride[3]	5.84E-01~~1.60E+00~~	6.26E+02	9.33E-04~~2.56E-03~~
Styrene	1.90E+00	1.04E+03	1.83~~2~~E-03
~~Tetrachloroethene~~ PCE	2.80E-01	4.17E+01	6.71E-03
Toluene[3]	~~7.20~~2.68E+00	5.21E+03	5.14E-04~~1.38E-03~~
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)[3]	6.19E+02~~2.26E+03[3]~~	3.13E+04	~~7.23~~1.98E-02
~~Trichloroethylene~~ TCE[3]	5.21E-01~~[3,4]~~	2.09E+00	2.49E-01
Freon-11 (Trichlorofluoromethane)[3]	7.57E+00~~2.20E+01~~	7.30E+02	~~3.01~~1.04E-02
m,p-Xylene	1.50E+00	1.04E+02	1.44E-02
o-Xylene	6.00E-01	1.04E+02	5.75E-03
1,2,4-Trimethylbenzene[4]	9.20E-01	6.30E+01[4]	1.46E-02
2,2,4-Trimethylpentane	3.90E-01	NE~~/A~~~~[5]~~	N~~/~~A
2-Hexanone[4]	1.10E+00	3.10E+01[4]	3.55E-02
2-Propanol (Isopropanol)[3,4]	~~3.06~~2.63E+01~~[3]~~	2.10E+02[4]	~~1.46~~1.25E-01
Ethanol[3]	8.64E+00~~2.30E+01~~	NE~~2.10E+04~~~~[6]~~	NA~~1.10E-03~~
Freon-21 (Dichlorofluoromethane)	3.50E+00	NE~~1.04E+02~~~~[7]~~	NA~~3.37E-02~~
Heptane[4]	3.30E-01	4.20E+02[4]	7.86E-04

Tetrahydrofuran[4]	2.90E-01	2.10E+03[4]	1.38E-04
Total 200 Area Residential Indoor Air Hazard Index			6.09E-01

Notes:

[1] Hazard =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Residential Indoor Air Screening Levels (NMED, 20~~19~~22c~~b~~), unless otherwise noted.

[3] These entries are UCL95 values calculated using ProUCL software.

[4] EPA Regional Screening Level Residential ~~Indoor~~ Air (EPA, 2022) used when NMED screening levels are unavailable.

NA – Not Applicable

NE – Not Established~~[5] No screening level available for this constituent.~~

~~[6] No NMED or EPA screening level for Freon 21 is available, so Freon 12 NMED screening level was used.~~

~~[7] No NMED or EPA screening level for Ethanol is available, so Methanol EPA screening level was used.~~

Table 6.12 200 Area Indoor Air: Industrial (Noncancer) Hazard Index (VISLs)

Constituent	Maximum Concentration Or UCL95 ($\mu g/m^3$)	Indoor Air VISLs~~Screening Level~~[2] ($\mu g/m^3$)	Hazard Quotient[1]
Acetone[3]	1.21E+01	1.52E+05	7.99E-05
Benzene[3]	7.05E-01	1.76E+01	4.01E-02
2-Butanone (Methyl ethyl ketone)[3]	2.75E+00	2.46E+04	1.12E-04
Carbon disulfide	4.70E-01	3.44E+03	1.37E-04
Carbon Tetrachloride[3]	4.11E-01	2.29E+01	1.79E-02
Chloroform	3.90E-01	5.98E+00	6.52E-02
Chloromethane[3]	5.27E-01	7.65E+01	6.89E-03
Ethylbenzene	4.70E-01	5.51E+01	8.53E-03
Freon-12 (Dichlorodifluoromethane)[3]	2.50E+00	4.92E+02	5.09E-03
trans-1,2-Dichloroethene	2.20E+00	1.97E+02	1.12E-02
n-Hexane[3]	6.24E-01	3.44E+03	1.81E-04
4-Methyl-2-pentanone (Methyl isobutyl ketone)	2.40E+01	1.47E+04	1.63E-03
Methylene chloride[3]	5.84E-01	2.95E+03	1.98E-04
Styrene	1.90E+00	4.92E+03	3.86E-04
PCE	2.80E-01	1.97E+02	1.42E-03
Toluene[3]	2.68E+00	2.46E+04	1.09E-04
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)[3]	6.19E+02	1.47E+05	4.21E-03
TCE[3]	5.21E-01	9.83E+00	5.30E-02
Freon-11 (Trichlorofluoromethane)[3]	7.57E+00	7.30E+02	1.04E-02
m,p-Xylene	1.50E+00	4.92E+02	3.05E-03
o-Xylene	6.00E-01	4.92E+02	1.22E-03
1,2,4-Trimethylbenzene[4]	9.20E-01	2.60E+02	3.54E-03
2,2,4-Trimethylpentane	3.90E-01	NE	NA
2-Hexanone[4]	1.10E+00	1.30E+02	8.46E-03
2-Propanol (Isopropanol)[3,4]	2.63E+01	8.80E+02	2.99E-02
Ethanol[3]	8.64E+00	NE	NA
Freon-21 (Dichlorofluoromethane)	3.50E+00	NE	NA
Heptane[4]	3.30E-01	1.80E+03	1.83E-04
Tetrahydrofuran[4]	2.90E-01	8.80E+03	3.30E-05

Total 200 Area Industrial Indoor Air Hazard Index	2.73E-01

Notes:
[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.
[2] Table A-4, NMED Industrial Indoor Air Screening Levels (NMED, 2022c), unless otherwise noted.
[3] These entries are UCL95 values calculated using ProUCL software.
[4] EPA Regional Screening Level Industrial Air (EPA, 2022) used when NMED screening levels are unavailable.
NA – Not Applicable
NE – Not Established

Table 6.13~~6~~ 200 Area Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	200 Area Max. Detected Concentration (mg/kg)	Soil Background Area 2 BTV (95% UTL) 8-12 ft (mg/kg)	Conclusion
Aluminum, Total	8-10	6,460	12,577	Below background
Antimony, Total	8-10	1.2	1.77	Below background
Arsenic, Total	8-10	13.7	14.2	Below background
Barium, Total	8-10	108	137	Below background
Beryllium, Total	8-10	0.49	0.609	Below background
Cadmium, Total	8-10	0.95	1.42	Below background
Chromium, Hex	8-10	0.04	3.78	Below background
Chromium, Total	8-10	9.26	9.41	Below background
Cobalt, Total	8-10	5.35	5.49	Below background
Copper, Total	8-10	8.21	8.29	Below background
Iron, Total	8-10	19,300	39,313	Below background
Lead, Total	8-10	13	21.6	Below background
Manganese, Total	8-10	321	404	Below background
Mercury, Total	8-10	0.003	NE~~A~~	**Include as COPC**
Molybdenum, Total	8-10	1.8	3.65	Below background
Nickel, Total	8-10	11	17.1	Below background
NO_2/NO_3	8-10	7.4	3.1	**Compare populations**
Strontium, Total	8-10	250	896	Below background
Titanium, Total	8-10	111	273	Below background
Uranium, Total	8-10	1.76	3.26	Below background
Vanadium, Total	8-10	42.2	50.1	Below background
Zinc, Total	8-10	68	96.5	Below background

Notes:
NE~~A~~ = ~~Not Applicable.~~ Not Established. Constituent was not detected in sufficient samples to establish a BTV.

Table 6.14~~7~~ 200 Area Essential Nutrient Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	200 Area Max. Detected Concentration (mg/kg)	Soil Background Area 2 BTV (95% UTL) 8-12 ft (mg/kg)	Conclusion
Calcium, Total	8-16[1]	108,000	109,364	Below background
Chloride	8-10	16	579	Below background
Magnesium, Total	8-10	28,400	47,233	Below background
Potassium, Total	8-10	1,870	2,942	Below background
Sodium, Total	8-10	200	796	Below background

Notes:

[1] No analytical samples were collected between 0-10 ft bgs for 200-SB-10, so the shallowest sample was used for that soil boring (16 ft bgs).

~~[1] No analytical samples were collected between 0-10 ft bgs for 200-SB-10, so the shallowest sample was used for that soil boring (16 ft bgs).~~

Table 6.15~~8~~ Population Comparison of Background and 200 Area Soil Data

Constituent	Area 2	Conclusion
NO_2/NO_3	BG >= 200 Area	200 Area soil data is no more than Background data. Delete as COPC.

Table 6.16~~9~~ 200 Area Soil: Residential~~ Cumulative~~ Cancer Risk~~ Assessment~~

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Cancer Risk[1]
Dioxins/Furans	~~3.11~~2.99E-07	4.90E-05[3]	~~6.35~~6.10E-08
Total 200 Area Residential Soil Cancer Risk			6E-08

Notes:

[1] Cancer Risk =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-1, NMED Residential Soil Screening Levels (NMED, 20~~19~~22c~~b~~).

[3] Per NMED Guidance (November~~June,~~ 2022~~19~~), dioxin/furan concentrations were compared to 2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin).

Table 6.17 200 Area Soil: Industrial Cancer Risk

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Cancer Risk[1]
Dioxins/Furans	2.99E-07	2.38E-04[3]	1.26E-08
Total 200 Area Industrial Soil Cancer Risk			1E-08

Notes:
[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.
[2] Table A-1, NMED Industrial Soil Screening Levels (NMED, 2022c).
[3] Per NMED Guidance (November 2022), dioxin/furan concentrations were compared to 2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin).

Table 6.18~~0~~ 200 Area Soil: Residential ~~Cumulative~~ (Noncancer) Hazard Index ~~Assessment~~

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Hazard Quotient[1]
Mercury (elemental)	3.00E-03	2.38E+01	1.26E-04
Toluene	2.10E+00	5.23E+03	4.02E-04
Dioxins/Furans	3.11E-07	5.06E-05[3]	6.15E-03
Total 200 Area Residential Soil Hazard Index			6.7E-03

Notes:
[1] Hazard =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E+00.
[2] Table A-1, NMED Residential Soil Screening Levels (NMED, 20~~19~~22c~~b~~).
[3] Per NMED Guidance (November~~June~~ 2022~~19~~), dioxin/furan concentrations were compared to 2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin).

Table 6.19 200 Area Soil: Industrial (Noncancer) Hazard Index

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Hazard Quotient[1]
Mercury (elemental)	3.00E-03	2.35E+01	1.28E-04
Toluene	2.10E+00	6.13E+04	3.43E-05
Dioxins/Furans	3.11E-07	8.08E-04[3]	3.85E-04
Total 200 Area Industrial Soil Hazard Index			5.47E-04

Notes:
[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.
[2] Table A-1, NMED Industrial Soil Screening Levels (NMED, 2022c).
[3] Per NMED Guidance (November 2022), dioxin/furan concentrations were compared to 2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin).

Table 6.20 200 Area Cumulative Residential Risk and Hazard; All Pathways

Pathway	**Cancer Risk**	**Hazard**	**Source Risk / Hazard**
Soil Vapor	**3.75E-04**	**8.42E+01**	Table 6.3 (RBCs) / Table 6.7 (RBCs)
Soil	6.35E-08	6.67E-03	Table 6.16 / Table 6.18
Total	**3.75E-04**	**8.42E+01**	

Notes:
Bold values indicate exceedance of NMED target.

Table 6.21 200 Area Cumulative Industrial Risk and Hazard; All Pathways

Pathway	**Cancer Risk**	**Hazard**	**Source Risk / Hazard**
Soil Vapor	**1.48E-05**	**4.91E+00**	Table 6.4 (RBCs) / Table 6.8 (RBCs)
Soil	1.31E-08	5.47E-04	Table 6.17 / Table 6.19
Total	**1.48E-05**	**4.91E+00**	

Notes:
Bold values indicate exceedance of NMED target.

Table 6.22~~11~~ 600 Area Soil Vapor: Residential~~ Cumulative~~ Cancer Risk (VISLs)~~ Assessment~~

Constituent	Maximum Concentration ~~Or UCL95~~ (µg/m³)	VISLs~~Screening Level~~[2] (µg/m³)	Cancer Risk[1]
Benzene	3.20E+00	1.20E+02	2.67E-07
Bromodichloromethane	6.20E-01	2.53E+01	2.45E-07
Chloroform	~~3.20~~4.10E+01[3]	4.07E+01	**1.01E-05**~~7.86E-06~~
Chloromethane	1.50E+00	5.20E+02	2.88E-08
1,4-Dichlorobenzene	1.90E+00	8.51E+01	2.23E-07
1,1-Dichloroethane	5.70E+00	5.85E+02	9.74E-08
1,2-Dichloroethane	7.30E-01	3.60E+01	2.03E-07
Ethylbenzene	1.60E+00	3.74E+02	4.287E-08
Methylene chloride	2.40E+01	3.38E+04	7.10E-09
PCE	5.20E+00	3.60E+03	1.44E-08
TCE	7.40E+02	1.47E+02	**5.03E-05**
Total 600 Area Residential Soil Vapor Cancer Risk			**6.15E-05**~~9E-06~~

Notes:

[1] Cancer Risk =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Residential Vapor Intrusion Screening Levels (VISLs; NMED, 20~~19~~22c~~b~~).

Bold values indicate an exceedance of screening levels.~~[3] These entries are UCL95 values calculated using ProUCL software.~~

Table 6.23 600 Area Soil Vapor: Industrial Cancer Risk (VISLs)

Constituent	Maximum Concentration (µg/m³)	VISLs[2] (µg/m³)	Cancer Risk[1]
Benzene	3.20E+00	5.88E+02	5.44E-08
Bromodichloromethane	6.20E-01	1.24E+02	5.00E-08
Chloroform	4.10E+01	1.99E+02	2.06E-06
Chloromethane	1.50E+00	2.55E+03	5.88E-09
1,4-Dichlorobenzene	1.90E+00	4.17E+02	4.56E-08
1,1-Dichloroethane	5.70E+00	2.87E+03	1.99E-08
1,2-Dichloroethane	7.30E-01	1.76E+02	4.15E-08
Ethylbenzene	1.60E+00	1.84E+03	8.70E-09
Methylene chloride	2.40E+01	4.59E+05	5.23E-10
PCE	5.20E+00	1.76E+04	2.95E-09
TCE	7.40E+02	1.12E+03	6.61E-06
Total 600 Area Industrial Soil Vapor Cancer Risk			8.90E-06

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Industrial Vapor Intrusion Screening Levels (VISLs; NMED, 2022c).

Table 6.24 600 Area Soil Vapor: Residential Cancer Risk (RBCs)

Constituent	**Maximum Concentration (µg/m³)**	**Depth Maximum Detected (ft bgs)**	**RBC[2] (µg/m³)**	**RBC Depth Used (ft bgs)**	**Cancer Risk[1]**
Benzene	3.20E+00	12.5	3.40E+03	10	9.41E-09
Bromodichloromethane	6.20E-01	12.5	9.80E+02	10	6.33E-09
Chloroform	4.10E+01	12.5	1.20E+03	10	3.42E-07
Chloromethane	1.50E+00	12.5	1.20E+04	10	1.25E-09
1,4-Dichlorobenzene[3]	1.90E+00	12.5	8.51E+01	10	2.23E-07
1,1-Dichloroethane	5.70E+00	12.5	1.70E+04	10	3.35E-09
1,2-Dichloroethane[3]	7.30E-01	12.5	3.60E+01	10	2.03E-07
Ethylbenzene[3]	1.60E+00	12.5	3.74E+02	10	4.28E-08
Methylene chloride	2.40E+01	12.5	8.70E+05	10	2.76E-10
PCE	5.20E+00	12.5	1.50E+05	10	3.47E-10
TCE	7.40E+02	12.5	5.40E+03	10	1.37E-06
Total 600 Area Residential Soil Vapor Cancer Risk					2.20E-06

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table 2a, Derivation of Vapor Risk-Based Concentrations: Resident (NASA, 2022).

[3] NMED screening level (Table A-4 NMED VISLs; NMED 2022c) used when WSTF RBC screening levels are unavailable.

RBC - WSTF Risk Based Concentration

Table 6.25~~12~~ 600 Area Soil Vapor: Residential ~~Cumulative~~ (Noncancer) Hazard Index (VISLs) ~~Assessment~~

Constituent	Maximum Concentration ~~Or UCL95~~ (µg/m³)	VISLs~~Screening Level~~[2] (µg/m³)	Hazard Quotient[1]
Acetone	2.70E+01	1.08E+06	2.50E-05
Benzene	3.20E+00	1.04E+03	3.08E-03
2-Butanone (Methyl ethyl ketone)	1.20E+01	1.74E+05	6.90E-05
Carbon disulfide	8.60E+01	2.43E+04	3.54~~3~~E-03
Chloroform	4.10E+01	3.41E+03	1.20E-02
Chloromethane	1.50E+00	3.13E+03	4.79E-04
Cis-1,2-dichloroethene[3]	8.20E-01	4.20E+01~~NA~~~~[3]~~	1.95E-02~~NA~~
1,2-Dichloroethane	7.30E-01	2.43E+02	3.00E-03
1,4-Dichlorobenzene	1.90E+00	2.78E+04	6.83E-05
Ethylbenzene	1.60E+00	3.48E+04	4.60E-05
Freon-12 (Dichlorodifluoromethane)	2.40E+00	3.48E+03	6.90E-04
Ethyl chloride (Chloroethane)	2.00E+00	3.48E+05	5.75E-06
n-Hexane	1.50E+00	2.43E+04	6.17~~6~~E-05
Methylene chloride	2.40E+01	2.09E+04	1.15E-03
~~Tetrachloroethene~~ PCE	5.20E+00	1.39E+03	3.74E-03
Toluene	2.90E+00	1.74E+05	1.67E-05
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	8.20E+03	1.04E+06	7.88~~6~~E-03
1,1,1-Trichloroethane	3.60E+00	1.74E+05	2.07E-05
~~Trichloroethylene~~ TCE	~~5.38~~7.40E+02~~[34]~~	6.95E+01	**1.06E+01~~7.74E+00~~**~~[6]~~
Freon-11 (~~F~~Trichlorofluoromethane)	1.40E+03	2.43E+04	5.76~~5~~E-02
m,p-Xylene	2.90E+00	3.48E+03	8.33E-04
o-Xylene	1.10E+00	3.48E+03	3.16E-04
1,2,4-Trimethylbenzene[3]	9.20E-01	~~2.10~~6.30E+01	~~4.38~~1.46E-02
2-Hexanone[3]	1.00E+00	3.10E+01~~[5]~~	3.23E-02
2-Propanol (Isopropyl alcohol or Isopropanol)[3]	4.30E+00	2.10E+02~~[5]~~	2.05E-02
Ethanol	9.60E+00	NE~~2.10E+04~~~~[6]~~	NA~~4.57E-04~~
~~Freon 123a (1,2-Dichloro-1,1,2-trifluoroethane)~~	~~2.00E+03~~	~~1.04E+06~~~~[7]~~	~~1.92E-03~~
Freon 21 (Dichlorofluoromethane)	1.00E+01	NE~~3.48E+03~~~~[8]~~	NA~~2.87E-03~~
Tetrahydrofuran[3]	8.50E-01	2.10E+03~~[5]~~	4.05E-04
Total 600 Area Residential Soil Vapor Hazard Index			**1.08E+01~~7.9E+00~~**

Notes:

[1] Hazard =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Residential Vapor Intrusion Screening Levels (VISLs; NMED, 20~~19~~22c~~b~~), unless otherwise noted.

~~[3] No screening level available for this constituent.~~

~~[4] These entries are UCL95 values calculated using ProUCL software.~~

[3~~5~~] EPA Regional Screening Level Residential Air used when NMED screening levels are unavailable.

~~[6] No NMED or EPA screening level for Ethanol is available, so Methanol EPA screening level was used.~~

~~[7] No NMED or EPA screening level for Freon 123a is available, so Freon 113 NMED screening level was used.~~

~~[8] No NMED or EPA screening level for Freon 21 is available, so Freon 12 NMED screening level was used.~~

Bold values indicate an exceedance of ~~NMED~~ screening levels.

NA = Not applicable

NE – Not Established

Table 6.26 600 Area Soil Vapor: Industrial (Noncancer) Hazard Index (VISLs)

Constituent	**Maximum Concentration ($\mu g/m^3$)**	**VISLs[2] ($\mu g/m^3$)**	**Hazard Quotient[1]**
Acetone	2.70E+01	5.08E+06	5.31E-06
Benzene	3.20E+00	4.92E+03	6.50E-04
2-Butanone (Methyl ethyl ketone)	1.20E+01	8.19E+05	1.47E-05
Carbon disulfide	8.60E+01	1.15E+05	7.48E-04
Chloroform	4.10E+01	1.61E+04	2.55E-03
Chloromethane	1.50E+00	1.47E+04	1.02E-04
cis-1,2-dichloroethene[3]	8.20E-01	1.80E+02	4.56E-03
1,2-Dichloroethane	7.30E-01	1.15E+03	6.35E-04
1,4-Dichlorobenzene	1.90E+00	1.31E+05	1.45E-05
Ethylbenzene	1.60E+00	1.64E+05	9.76E-06
Freon-12 (Dichlorodifluoromethane)	2.40E+00	1.64E+04	1.46E-04
Ethyl chloride (Chloroethane)	2.00E+00	1.64E+06	1.22E-06
n-Hexane	1.50E+00	1.15E+05	1.30E-05
Methylene chloride	2.40E+01	9.83E+04	2.44E-04
PCE	5.20E+00	6.55E+03	7.94E-04
Toluene	2.90E+00	8.19E+05	3.54E-06
Freon-113 (1,1,2-Trichloro-1,2,2-trifluorooethane)	8.20E+03	4.92E+06	1.67E-03
1,1,1-Trichloroethane	3.60E+00	8.19E+05	4.40E-06
TCE	7.40E+02	3.28E+02	**2.26E+00**
Freon-11 (Trichlorofluoromethane)	1.40E+03	1.15E+05	1.22E-02
m,p-Xylene	2.90E+00	1.64E+04	1.77E-04
o-Xylene	1.10E+00	1.64E+04	6.71E-05
1,2,4-Trimethylbenzene[3]	9.20E-01	2.60E+02	3.54E-03
2-Hexanone[3]	1.00E+00	1.30E+02	7.69E-03
2-Propanol (Isopropyl alcohol or Isopropanol)[3]	4.30E+00	8.80E+02	4.89E-03
Ethanol	9.60E+00	NE	NA
Freon 21 (Dichlorofluoromethane)	1.00E+01	NE	NA
Tetrahydrofuran[3]	8.50E-01	8.80E+03	9.66E-05
Total 600 Area Industrial Soil Vapor Hazard Index			**2.30E+00**

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Industrial Vapor Intrusion Screening Levels (VISLs; NMED, 2022c), unless otherwise noted.

[3] EPA Regional Screening Level Industrial Air used when NMED screening levels are unavailable.

Bold values indicate an exceedance of screening levels.

NA - Not Applicable

NE - Not Established

Table 6.27~~13~~ 600 Area Soil Vapor: Residential ~~Cumulative~~ (Noncancer) Hazard Index ~~Assessment~~ (RBCs)

Constituent	Maximum Concentration ~~Or UCL95~~ (µg/m³)	Depth Maximum Detected (ft bgs)	RBC[2] (µg/m³)	RBC Depth Used (ft bgs)	Hazard Quotient[1]
Acetone	2.70E+01	7.5	1.90E+07	5	1.42E-06
Benzene	3.20E+00	12.5	2.90E+04	10	1.10E-04
2-Butanone (Methyl ethyl ketone)	1.20E+01	12.5	4.80E+06	10	2.50E-06
Carbon disulfide	8.60E+01	12.5	6.10E+05	10	1.41E-04
Chloroform	4.10E+01	12.5	1.00E+05	10	4.10E-04
Chloromethane	1.50E+00	12.5	7.20E+04	10	2.08E-05
Cis-1,2-dichloroethene[4]	8.20E-01	12.5	4.20E+01~~NA[2]~~	10	1.95E-02~~NA~~
1,2-Dichloroethane[3]	7.30E-01	12.5	2.43E+02	10	3.00E-03
1,4-Dichlorobenzene[3]	1.90E+00	12.5	2.78E+04	10	6.83E-05
Ethylbenzene[3]	1.60E+00	12.5	3.48E+04	10	4.60E-05
Freon-12 (Dichloro-difluoromethane)	2.40E+00	7.5	7.00E+04	5	3.43E-05
Ethyl chloride (Chloroethane)	2.00E+00	12.5	8.90E+06	10	2.25E-07
n-Hexane	1.50E+00	12.5	7.80E+05	10	1.92E-06
Methylene chloride	2.40E+01	12.5	5.50E+05	10	4.36E-05
~~Tetrachloroethene~~ PCE	5.20E+00	12.5	5.80E+04	10	8.97E-05
Toluene[3]	2.90E+00	12.5	1.74E+05[3]	10	1.67E-05
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	8.20E+03	12.5	5.50E+07	10	1.49E-04
1,1,1-Trichloroethane	3.60E+00	12.5	6.10E+06	10	5.90E-07
~~Trichloroethylene~~ TCE	7.40E+02~~5.38E+02[3]~~	12.5	2.30E+03	10	~~2.34~~3.22E-01
Freon-11 (Trichlorofluoromethane)	1.40E+03	12.5	8.40E+05	10	1.67E-03
m,p-Xylene[3]	2.90E+00	12.5	3.48E+03[4]	10	8.33E-04
o-Xylene[3]	1.10E+00	12.5	3.48E+03[4]	10	3.16E-04
1,2,4-Trimethylbenzene[4]	9.20E-01	12.5	6.30E+01[5]	10	1.46E-02
2-Hexanone	1.00E+00	7.5	2.20E+04	5	4.55E-05
2-Propanol (Isopropyl alcohol)	4.30E+00	12.5	1.80E+05	10	2.39E-05
Ethanol	9.60E+00	12.5	1.50E+07	10	6.40E-07
~~Freon 123a (1,2-Dichloro-1,1,2-trifluoroethane)~~	~~2.00E+03~~		~~3.20E+07~~		~~6.25E-05~~
Freon 21 (Dichlorofluoromethane)	1.00E+01	12.5	1.20E+05	10	8.33E-05
Tetrahydrofuran	8.50E-01	12.5	1.80E+06	10	4.72E-07
Total 600 Area Residential Soil Vapor Hazard Index					~~2.5~~3.63E-01

Notes:
[1] Hazard =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E+00.
[2] Table 2a, Derivation of Vapor Risk-Based Concentrations: Resident (NASA, 2022).
~~[2] No screening level available for this constituent.~~ ~~[3] These entries are UCL95 values calculated using ProUCL software.~~ [~~3~~4] NMED screening level (Table A-4 VISLs; NMED, 2022c) used when WSTF RBC screening levels are unavailable.
[~~4~~5] EPA screening level used when WSTF RBC and NMED screening level are unavailable.
RBC – WSTF Risk Based Concentration~~NA = Not applicable~~

Table 6.28 600 Area Soil Vapor: Industrial (Noncancer) Hazard Index (RBCs)

Constituent	Maximum Concentration ($\mu g/m^3$)	Depth Maximum Detected (ft bgs)	RBC[2] ($\mu g/m^3$)	RBC Depth Used (ft bgs)	Hazard Quotient[1]
Acetone	2.70E+01	7.5	2.00E+08	5	1.35E-07
Benzene	3.20E+00	12.5	4.00E+05	10	8.00E-06
2-Butanone (Methyl ethyl ketone)	1.20E+01	12.5	6.60E+07	10	1.82E-07
Carbon disulfide	8.60E+01	12.5	8.10E+06	10	1.06E-05
Chloroform	4.10E+01	12.5	1.50E+06	10	2.73E-05
Chloromethane	1.50E+00	12.5	9.00E+05	10	1.67E-06
cis-1,2-dichloroethene[4]	8.20E-01	12.5	1.80E+02	10	4.56E-03
1,2-Dichloroethane[3]	7.30E-01	12.5	1.15E+03	10	6.35E-04
1,4-Dichlorobenzene[3]	1.90E+00	12.5	1.31E+05	10	1.45E-05
Ethylbenzene[3]	1.60E+00	12.5	1.64E+05	10	9.76E-06
Freon-12 (Dichlorodifluoromethane)	2.40E+00	7.5	8.10E+05	5	2.96E-06
Ethyl chloride (Chloroethane)	2.00E+00	12.5	1.20E+08	10	1.67E-08
n-Hexane	1.50E+00	12.5	1.10E+07	10	1.36E-07
Methylene chloride	2.40E+01	12.5	7.40E+06	10	3.24E-06
PCE	5.20E+00	12.5	9.10E+05	10	5.71E-06
Toluene[3]	2.90E+00	12.5	8.19E+05	10	3.54E-06
Freon-113 (1,1,2-Trichloro-1,2,2-trifluorooethane)	8.20E+03	12.5	9.00E+08	10	9.11E-06
1,1,1-Trichloroethane	3.60E+00	12.5	9.00E+07	10	4.00E-08
TCE	7.40E+02	12.5	3.40E+04	10	2.18E-02
Freon-11 (Trichlorofluoromethane)	1.40E+03	12.5	8.40E+05	10	1.67E-03
m,p-Xylene[3]	2.90E+00	12.5	1.64E+04	10	1.77E-04
o-Xylene[3]	1.10E+00	12.5	1.64E+04	10	6.71E-05
1,2,4-Trimethylbenzene[4]	9.20E-01	12.5	2.60E+02	10	3.54E-03
2-Hexanone	1.00E+00	7.5	2.50E+05	5	4.00E-06
2-Propanol (Isopropyl alcohol)	4.30E+00	12.5	2.40E+06	10	1.79E-06
Ethanol	9.60E+00	12.5	1.70E+08	10	5.65E-08
Freon 21 (Dichlorofluoromethane)	1.00E+01	12.5	1.80E+06	10	5.56E-06
Tetrahydrofuran	8.50E-01	12.5	2.40E+07	10	3.54E-08
Total 600 Area Industrial Soil Vapor Hazard Index					3.25E-02

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.
[2] Table 3a, Derivation of Vapor Risk-Based Concentrations: Commercial Worker (NASA, 2022).
[3] NMED screening level (Table A-4 VISLs; NMED, 2022c) used when WSTF RBC screening levels are unavailable.
[4] EPA screening level used when WSTF RBC and NMED screening level are unavailable.
RBC – WSTF Risk Based Concentration

Table 6.29~~14~~ 600 Area Indoor Air: Residential ~~Cumulative~~ Cancer Risk (VISLs) ~~Assessment~~

Constituent	Maximum Concentration (µg/m^3)	VISLs~~Screening Level~~[2] (µg/m^3)	Cancer Risk[1]
Benzene	4.00E-01	3.60E+00	1.11E-06
Carbon tetrachloride	4.50E-01	4.68E+00	9.62E-07
Chloromethane	6.50E-01	1.56E+01	4.17E-07
Methylene chloride	5.50E-01	1.01E+03	5.45E-09
Total 600 Area Residential Indoor Air Cancer Risk			2.49~~3~~E-06

Notes:

[1] Cancer Risk =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Residential Indoor Air Screening Levels (NMED, 20~~19~~22c~~b~~).

Table 6.30 600 Area Indoor Air: Industrial Cancer Risk (VISLs)

Constituent	Maximum Concentration (µg/m^3)	VISLs[2] (µg/m^3)	Cancer Risk[1]
Benzene	4.00E-01	1.76E+01	2.27E-07
Carbon tetrachloride	4.50E-01	2.29E+01	1.97E-07
Chloromethane	6.50E-01	7.65E+01	8.50E-08
Methylene chloride	5.50E-01	1.38E+04	3.99E-10
Total 600 Area Industrial Indoor Air Cancer Risk			5.09E-07

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-4, NMED Industrial Indoor Air Screening Levels (NMED, 2022c).

Table 6.31~~15~~ 600 Area Indoor Air: Residential~~ Cumulative~~ (Noncancer) Hazard Index (VISLs)~~Assessment~~

Constituent	Maximum Concentration ($\mu g/m^3$)	VISLs~~Screening Level~~[2] ($\mu g/m^3$)	Hazard Quotient[1]
Acetone	2.80E+01	3.23E+04	8.67E-04
Benzene	4.00E-01	3.13E+01	1.28E-02
2-Butanone (Methyl ethyl ketone)	5.30E+00	5.21E+03	1.02E-03
Carbon tetrachloride	4.50E-01	1.04E+02	4.33E-03
Chloromethane	6.50E-01	9.39E+01	6.92E-03
Freon-12 (Dichlorodifluoromethane)	2.30E+00	1.04E+02	2.21E-02
n-Hexane	7.90E-01	7.30E+02	1.08E-03
4-Methyl-2-pentanone (Methyl isobutyl ketone)	5.00E-01	3.13E+03	1.60E-04
Methylene chloride	5.50E-01	6.26E+02	8.79E-04
Toluene	6.00E-01	5.21E+03	1.15E-04
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	5.90E-01	3.13E+04	1.88E-05
Freon-11 (Trichlorofluoromethane)	1.40E+00	7.30E+02	1.92E-03
2-Hexanone[3]	1.10E+00	3.10E+01~~[3]~~	3.55E-02
2-Propanol[3]	3.40E+00	2.10E+02~~[3]~~	1.62E-02
Ethanol[4]	2.00E+01	NE~~2.10E+04~~[4]	NA~~9.52E-04~~
Heptane[3]	3.00E-01	4.20E+02~~[3]~~	7.14E-04
Total 600 Area Residential Indoor Air Hazard Index			1.05~~8.2~~E-01~~2~~

Notes:

[1] Hazard =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Residential Indoor Air Screening Levels (NMED, 20~~19~~22c~~b~~), unless otherwise noted.

[3] EPA Regional Screening Level (EPA, 2022) used when NMED screening levels and WSTF RBCs are unavailable.

NA – Not Applicable

NE – Not Established[4]~~ No NMED or EPA screening level for Ethanol is available, so Methanol EPA screening level was used.~~

Table 6.32 600 Area Indoor Air: Industrial (Noncancer) Hazard Index (VISLs)

Constituent	Maximum Concentration (µg/m³)	VISLs[2] (µg/m³)	Hazard Quotient[1]
Acetone	2.80E+01	1.52E+05	1.84E-04
Benzene	4.00E-01	1.76E+01	2.27E-02
2-Butanone (Methyl ethyl ketone)	5.30E+00	2.46E+04	2.15E-04
Carbon tetrachloride	4.50E-01	2.29E+01	1.97E-02
Chloromethane	6.50E-01	7.65E+01	8.50E-03
Freon-12 (Dichlorodifluoromethane)	2.30E+00	4.92E+02	4.67E-03
n-Hexane	7.90E-01	3.44E+03	2.30E-04
4-Methyl-2pentanone (Methyl isobutyl ketone)	5.00E-01	1.47E+04	3.40E-05
Methylene chloride	5.50E-01	2.95E+03	1.86E-04
Toluene	6.00E-01	2.46E+04	2.44E-05
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	5.90E-01	1.47E+05	4.01E-06
Freon-11 (Trichlorofluoroethane)	1.40E+00	3.44E+03	4.07E-04
2-Hexanone[3]	1.10E+00	3.10E+02	3.55E-03
2-Propanol[3]	3.40E+00	8.80E+02	3.86E-03
Ethanol	2.00E+01	NE	NA
Heptane[3]	3.00E-01	1.80E+03	1.67E-04
Total 600 Area Industrial Indoor Air Hazard Index			6.44E-02

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-4, NMED Industrial Indoor Air Screening Levels (NMED, 2022c), unless otherwise noted.

[3] EPA Regional Screening Level (EPA, 2022) used when NMED screening levels and WSTF RBCs are unavailable.

NA – Not Applicable
NE - Not Established

Table 6.33~~16~~ 600 Area Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	600 Area Max. Detected Concentration (mg/kg)	Soil Background Area 4 BTV (95% UTL) (mg/kg)	Conclusion
Aluminum, Total	0-4	9,480	17,681	Below background
	4-8	11,600	12,154	
	8-10	4,650	13,653	
Antimony, Total	0-4	<0.5~~ND~~[1]	NE[2]	**Include as COPC**
	4-8	<0.5~~ND~~[1]	NE[2]	
	8-10	**0.4**	NE[2]	
Arsenic, Total	0-4	8.3	11.1	Below background
	4-8	10.1	12.6	
	8-10	6.76	11.9	
Barium, Total	0-4	191	215	**Compare Populations**
	4-8	240	398	
	8-10	**338**	310	
Beryllium, Total	0-4	0.56	1.1	**Compare Populations**
	4-8	**0.72**	0.713	
	8-10	0.37	0.814	
Boron, Total	0-4	**3**	NE[2]	**Include as COPC**
	4-8	<2~~ND~~[1]	NE[2]	
	8-10	**4**	NE[2]	
Cadmium, Total	0-4	0.2	0.696	**Include as COPC~~Compare Populations~~**
	4-8	**0.36**	NE[2]	
	8-10	**0.27**	NE[2]	
Chromium, Hex	0-4	0.4	1.2	Below background
	4-8	0.21	6.94	
	8-10	<0.21~~ND~~[1]	1.23	
Chromium, Total	0-4	**16.7**	11.1	**Compare Populations**
	4-8	**15.4**	11.7	
	8-10	7.2	11.3	
Cobalt, Total	0-4	**6.8**	5.35	**Compare Populations**
	4-8	**5.4**	5.35	
	8-10	2.2	5.28	
Copper, Total	0-4	7.7	11.7	**Compare Populations**
	4-8	**10.4**	9.2	
	8-10	6.8	13.5	
Iron, Total	0-4	13,800	39,911	Below background
	4-8	12,600	15,794	
	8-10	8,140	18,759	
Lead, Total	0-4	8.8	15.9	Below background
	4-8	9.5	10.3	
	8-10	5.7	15.6	
Manganese, Total	0-4	187	444	**Compare Populations**
	4-8	**325**	296	
	8-10	253	393	

Table 6.33~~16~~ 600 Area Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	600 Area Max. Detected Concentration (mg/kg)	Soil Background Area 4 BTV (95% UTL) (mg/kg)	Conclusion
Mercury, Total	0-4	0.012	0.0709	**Compare Populations**
	4-8	**0.099**	0.0576	
	8-10	0.005	0.0302	
Molybdenum, Total	0-4	**3.2**	1.33	**Compare Populations**
	4-8	1.8	2.85	
	8-10	1.4	1.98	
Nickel, Total	0-4	14.9	15.4	Below background
	4-8	11.4	12.3	
	8-10	7.2	14.1	
NO_2/NO_3	0-4	**54.6**	6.39	**Compare Populations**
	4-8	55.4	2.84	
	8-10	14.9	4.82	
Perchlorate	0-4	0.00086	0.011~~.~~2	**Include as COPC**~~Below background~~
	4-8	<0.0005^{1}~~0.03~~	0.004~~.~~95	
	8-10	**0.03**~~ND^{1}~~	0.003~~.~~37	
Selenium, Total	0-4	0.4	1.96	Below background
	4-8	<0.4~~ND~~^{1}	1.7	
	8-10	0.5	2.45	
Thallium, Total	0-4	5.9	NE^{2}	**Include as COPC**
	4-8	7.1~~6~~	NE^{2}	
	8-10	7.6~~4.6~~	NE^{2}	
Tin, Total	0-4	7	NE^{2}	**Include as COPC**
	4-8	10	NE^{2}	
	8-10	6	NE^{2}	
Titanium, Total	0-4	211	359	Below background
	4-8	213	352	
	8-10	130	330	
Vanadium, Total	0-4	26	33.9	Below background
	4-8	32.6	56.3	
	8-10	19.7	42.4	
Zinc, Total	0-4	38.6	59.7	**Compare Populations**
	4-8	**43.7**	40.8	
	8-10	23.2	52.9	

Notes:[1] Not Detected above laboratory detection limit

[2] Not Established

Bold font indicates concentration exceeds BTV.

Table 6.34~~17~~ 600 Area Essential Nutrients Soil Maximum Concentrations vs. Background Threshold Value (BTV) Comparison

Constituent	Depth Range (ft)	600 Area Max. Detected Concentration (mg/kg)	Soil Background Area 4 BTV (95% UTL) (mg/kg)	Conclusion
Calcium, Total	0-4	177,000	302,460	Below background
	4-8	200,000	214,770	
	8-10	145,000	332,558	
Magnesium, Total	0-4	**19,800**	14,149	**Compare Populations**
	4-8	21,800	31,298	
	8-10	15,600	33,658	
Potassium, Total	0-4	2,020	4,151	**Compare Populations**
	4-8	**3,130**	3,038	
	8-10	1,090	3,125	
Sodium	0-4	280	643	**Compare Populations**
	4-8	**12,900**	1,242	
	8-10	1,260	1,297	

Bold font indicates maximum concentration exceeds BTV.

Table 6.35~~18~~ Population Comparison of Background and 600 Area Soil Data

Constituent	Area 4	Conclusion
Barium	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Beryllium	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
~~**Cadmium**~~	~~**BG < 600 Area**~~	~~**600 Area soil data exceeds Background data. Retain as COPC.**~~
Chromium	**BG < 600 Area**	**600 Area soil data exceeds Background data. Retain as COPC.**
Cobalt	BG ~~<~~>= 600 Area	600 Area soil data ~~may exceed~~is no more than Background data. ~~Retain~~Delete as COPC.
Copper	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Manganese	BG ~~<~~>= 600 Area	600 Area soil data ~~may exceed~~is no more than Background data. ~~Retain~~Delete as COPC.
Mercury	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Molybdenum	BG ~~<~~>= 600 Area	600 Area soil data ~~exceeds~~is no more than Background data. ~~Retain~~Delete as COPC.
NO_2/NO_3	**BG < 600 Area**	**600 Area soil data exceeds Background data. Retain as COPC.**
Zinc	BG >= 600 Area	600 Area soil data is no more than Background data. Delete as COPC.
Essential Nutrients		
Magnesium	BG ~~<~~>= 600 Area	600 Area soil data ~~exceeds~~is no more than Background data. ~~Retain~~Delete nutrient.
Potassium	BG >= 600 Area	600 Area soil data is no more than Background data. Delete nutrient.
Sodium	**BG < 600 Area**	**600 Area soil data may exceed Background data. Retain nutrient.**

Table 6.36~~19~~ 600 Area Soil: Residential~~ Cumulative~~ Cancer Risk~~ Assessment~~

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Cancer Risk[1]
Benzo(a)anthracene	4.80E-03	1.53E+00	3.14E-08
Bis(2-ethylhexyl)phthalate	1.40E+00	3.80E+02	3.68E-08
Cadmium	3.60E-01	8.59E+04	4.19E-11
Chromium (Total)	1.67E+01	9.66E+01	1.73E-06
Chrysene	4.40E-03	1.53E+02	2.88~~7~~E-10
~~Cobalt~~	~~4.25E+00[3]~~	~~1.72E+04~~	~~2.47E-09~~
Trichloroethylene	4.90E-04	1.55E+01	3.16~~7~~E-10
Total 600 Area Residential Soil Cancer Risk			1.80~~2~~E-06

Notes:

[1] Cancer Risk =~~calculated by~~ (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-1, NMED Residential Soil Screening Levels (NMED, 20~~19~~22c~~b~~).

~~[3] These entries are UCL95 values calculated using ProUCL software.~~

Table 6.37 600 Area Soil: Industrial Cancer Risk

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Cancer Risk[1]
Benzo(a)anthracene	4.80E-03	3.23E+01	1.49E-09
Bis(2-ethylhexyl)phthalate	1.40E+00	1.83E+03	7.65E-09
Cadmium	3.60E-01	4.17E+05	8.63E-12
Chromium (Total)	1.67E+01	5.05E+02	3.31E-07
Chrysene	4.40E-03	3.23E+03	1.36E-11
Trichloroethylene	4.90E-04	1.12E+02	4.38E-11
Total 600 Area Industrial Soil Cancer Risk			3.40E-07

Notes:

[1] Cancer Risk = (Maximum Concentration/Screening Level) * 1E-05.

[2] Table A-1, NMED Industrial Soil Screening Levels (NMED, 2022c).

Table 6.38~~20~~ 600 Area Soil: Residential ~~Cumulative~~ (Noncancer) Hazard Index ~~Assessment~~

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Hazard Quotient[1]
Acetone	8.70E-02	6.63E+04	1.31E-06
Antimony	4.00E-01	3.13E+01	1.28E-02
Benzyl Alcohol[3]	3.20E-01	6.30E+03[3]	5.08E-05
Bis(2-ethylhexyl)phthalate	1.40E+00	1.23E+03	1.14E-03
Boron	4.00E+00	1.56E+04	2.56E-04
2-Butanone (Methyl ethyl ketone)	7.00E-03	3.74E+04	1.87E-07
Cadmium	3.60E-01	7.05E+01	5.11~~0~~E-03
Carbon disulfide	8.10E-04	1.55E+03	5.23~~1~~E-07
Chromium (Total)	1.67E+01	4.52E+04	3.69~~70~~E-04
~~Cobalt~~	~~4.25E+00[4]~~	~~2.34E+01~~	~~1.81E-01~~
~~Manganese~~	~~3.25E+02~~	~~1.05E+04~~	~~3.08E-02~~
~~Mercury~~	~~9.90E-02~~	~~2.38E+01~~	~~4.16E-03~~
Methyl isobutyl ketone	1.10E-03	5.81E+03	1.89E-07
~~Molybdenum~~	~~3.20E+00~~	~~3.91E+02~~	~~8.18E-03~~
Nitrite	5.54E+01	7.82E+03	7.08E-03
Perchlorate	3.00E-02	5.48E+01	5.47E-04
Thallium[4]	~~5.41~~5.19E+00[4]	7.82E-01	**~~9.72~~6.63E+00**
Toluene	6.00E-04	5.23E+03	1.15E-07
Freon-113	1.40E-01	5.08E+04	2.76E-06
~~Trichloroethylene~~TCE	4.90E-04	6.77E+00	7.24~~3~~E-05
Tetrahydrofuran[3]	1.70E-03	1.80E+04~~[3]~~	9.44E-08
Tin, Total[3,4]	1.00E+01	4.70E+04~~[3]~~	2.13E-04
2-Propanol[3]	1.80E-02	5.60E+03~~[3]~~	3.21E-06
~~Zinc~~	~~4.37E+01~~	~~2.35E+04~~	~~1.86E-03~~
Total 600 Area Residential Soil Hazard Index			**6.66~~1.0~~E+00**
Essential Nutrients			
~~Magnesium~~	~~2.18E+04~~	~~1.56E+07~~	
Sodium	1.29E+04	7.82E+06	

Notes:

[1] Hazard = ~~calculated by~~ (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-1, NMED Residential Soil Screening Levels (NMED, 20~~19~~22c~~b~~), unless otherwise noted.

[3] EPA screening level~~,~~ (EPA, 2022) used when NMED screening levels are unavailable.

[4] These entries are UCL95 values calculated using ProUCL software.

Bold values indicate an exceedance of ~~NMED~~ screening levels.

Table 6.39 600 Area Soil: Industrial (Noncancer) Hazard Index

Constituent	Maximum Concentration (mg/kg)	Soil Screening Level[2] (mg/kg)	Hazard Quotient[1]
Acetone	8.70E-02	9.60E+05	9.06E-08
Antimony	4.00E-01	5.19E+02	7.71E-04
Benzyl Alcohol[3]	3.20E-01	8.20E+04	3.90E-06
Bis(2-ethylhexyl)phthalate	1.40E+00	1.83E+04	7.65E-05
Boron	4.00E+00	2.59E+05	1.54E-05
2-Butanone (Methyl ethyl ketone)	7.00E-03	4.11E+05	1.70E-08
Cadmium	3.60E-01	1.11E+03	3.24E-04
Carbon disulfide	8.10E-04	8.54E+03	9.48E-08
Chromium (Total)	1.67E+01	3.14E+05	5.32E-05
Methyl isobutyl ketone	1.10E-03	8.16E+04	1.35E-08
Nitrite	5.54E+01	1.30E+05	4.26E-04
Perchlorate	3.00E-02	9.08E+02	3.30E-05
Thallium[4]	5.19E+00	1.30E+01	3.99E-01
Toluene	6.00E-04	6.13E+04	9.79E-09
Freon-113	1.40E-01	2.43E+05	5.76E-07
TCE	4.90E-04	3.65E+01	1.34E-05
Tetrahydrofuran[3]	1.70E-03	9.50E+04	1.79E-08
Tin, Total[3]	1.00E+01	7.00E+05	1.43E-05
2-Propanol[3]	1.80E-02	2.40E+04	7.50E-07
Total 600 Area Industrial Soil Hazard Index			4.01E-01

Notes:

[1] Hazard = (Maximum Concentration/Screening Level) * 1E+00.

[2] Table A-1, NMED Industrial Soil Screening Levels (NMED, 2022c), unless otherwise noted.

[3] EPA screening level (EPA, 2022) used when NMED screening levels are unavailable.

[4] These entries are UCL95 values calculated using ProUCL software.

~~Table 6.21 200 Area Cumulative Residential Risk and Hazard Assessment; All Pathways~~**~~Pathway~~**	**~~Cancer Risk~~**	**~~Hazard~~**
~~Soil Vapor~~	~~7E-06~~	**~~8.0E+01~~**~~[1]~~
~~Soil~~	~~6E-08~~	~~6.7E-03~~
~~Total~~	~~7E-06~~	**~~8.0E+01~~**

~~Notes:~~

~~[1] Value from Table 6.3: cumulative risk using RBCs~~

~~Bold~~ ~~values indicate exceedance of NMED target.~~

Table 6.40~~22~~ 600 Area Cumulative Residential Risk and Hazard ~~Assessment~~; All Pathways

Pathway	**Cancer Risk**	**Hazard**	**Source Risk / Hazard**
Soil Vapor	~~9~~2.20E-06	3.63E-01~~7.9E+00~~~~[1]~~	Table 6.24 (RBCs) / Table 6.27 (RBCs)
Soil	~~2~~1.80E-06	**6.66E+00**~~7.1E+00~~	Table 6.36 / Table 6.38
Total	~~1~~4.00E-06~~5~~	**7.02E+00**~~**1.5E+01**~~	

Notes:

~~[1] Value from Table 6.13: cumulative risk using RBCs~~

Bold value indicates exceedance of NMED target.

Table 6.41 600 Area Cumulative Industrial Risk and Hazard; All Pathways

Pathway	**Cancer Risk**	**Hazard**	**Source Risk / Hazard**
Soil Vapor	8.90E-06	3.25E-02	Table 6.23 (VISLs) / Table 6.28 (RBCs)
Soil	3.40E-07	4.01E-01	Table 6.37 / Table 6.39
Total	9.24E-06	4.34E-01	

Table 6.42~~23~~ Summary of F113 and TCE Vertical Concentration Profiles for Select 200 and 600 Area Wells

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – 2018[#&] (µg/m^3)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
MSVGM Well 200-SG-2						
Freon 113	F113 in soil non-detect (<11.0 µg/kg) for soil sample at 80 ft bgs. Vadose zone soil porosity not reported (insufficient sample for geotechnical analysis[@]).	Increasing F113 in soil vapor with depth by one order of magnitude from shallow port (30 ft) to middle port (60 ft). Deep port submerged in aquifer. Significant concentration increase with depth by one order of magnitude.	Steadily decreasing trend for F113 in deep soil vapor port over time for historical sampling events from 169,000 µg/m^3 to 110,000 µg/m^3.	Latest equivalent soil vapor in equilibrium with groundwater is 2,592,000 µg/m^3 on 10/22/14.	Soil vapor concentration in middle port (deep port submerged) at 110,000 µg/m^3 is one order of magnitude below equivalent soil vapor in equilibrium with groundwater.	The increasing F113 in soil vapor with depth is coincident with proximity to the local confined groundwater aquifer. The deep port is located 23 ft above groundwater Decreasing F113 soil vapor concentrations over time are coincident with declining F113 groundwater concentrations (Appendix E~~D~~ and NASA, 2019b).*
TCE	TCE in soil non-detect (<5.3 µg/kg) for soil sample at 80 bgs. Vadose zone porosity not reported (insufficient sample for geotechnical analyses[@]).	Generally increasing TCE in soil vapor with depth (within the same order of magnitude) from shallow (30 ft) to middle (60 ft) port located. Deep port submerged in aquifer.	Irregular TCE trend in deep soil vapor port over time for relatively low concentrations within the same order of magnitude for historical sampling events.	Latest equivalent soil vapor in equilibrium with groundwater is 485 µg/m^3 on 10/22/14.	Soil vapor concentration in middle port at 800 µg/m^3 is within the same order of magnitude as equivalent soil vapor in equilibrium with groundwater.	The increasing TCE in soil vapor with port depth is coincident with proximity to groundwater. The deep port is located 23 ft above groundwater. Fluctuating TCE soil vapor concentrations over time are within the same order of magnitude and are consistent with the relatively stable low level groundwater concentrations of between

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – 2018$^{\#\&}$ (µg/m^3)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
						1.2 µg/L and 1.6 µg/L (Appendix E~~D~~ and NASA, 2019b).*
			MSVGM Well 200-SG-3			
Freon 113	F113 in soil non-detect (<11.0 µg/kg) for soil samples at 30 ft, 50 ft, and 60 ft bgs. Vadose zone soil porosity reported as between 24% and 46% at the same sampling intervals.[@]	Increasing F113 in soil vapor with port depth by one order of magnitude for the upper 3 ports located at 30 ft, 60 ft, and 90 ft within vadose zone alluvium and shallow bedrock. Concentrations subsequently decline within the deep bedrock port at 154 ft.	Steadily decreasing trend for F113 in soil vapor ports over time for historical sampling events.	Equivalent soil vapor in equilibrium with groundwater is 1,922,400 µg/m^3 on 10/21/14.	Soil vapor for the deep port (110,000 µg/m^3) is one order of magnitude lower than equivalent soil vapor in equilibrium with groundwater.	Increasing F113 in soil vapor with depth for the ports at 30 ft, 60 ft, & 90 ft located within either permeable alluvium or shallow bedrock. Decreasing F113 soil vapor concentrations occur within the port at depth (154 ft) located 10 ft above groundwater within a sedimentary bedrock sequence with irregular permeability. Decreasing F113 trend in soil vapor over time is coincident with declining groundwater concentrations in the local 200 Area aquifer (Appendix E~~D~~ and NASA, 2019b).*

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – 2018[#&] (µg/m^3)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
TCE	TCE in soil non-detect (<5.3 µg/kg) for soil samples at 30 ft, 50 ft, and 60 ft bgs. Vadose zone soil porosity reported as between 24% to 46% at the same sampling intervals.[@]	Increasing TCE in soil vapor with port depth within the same order of magnitude for the upper 3 ports located at 30 ft, 60 ft, and 90 ft within vadose zone alluvium and shallow bedrock. Concentrations subsequently decline within deep port at 154 ft.	Decreasing TCE in soil vapor ports over time for historical sampling events.	Equivalent soil vapor in equilibrium with groundwater is 1,697 µg/m^3 on 10/21/14.	Soil vapor for the deep port (4,200 µg/m^3) is within the same order of magnitude as equivalent soil vapor in equilibrium with groundwater.	Increasing TCE in soil vapor with depth for the ports at 30 ft, 60 ft, & 90 ft) located within relatively permeable alluvium or shallow bedrock. Decreasing TCE soil vapor concentrations within the accessible port at depth (154 ft) located 10 ft above groundwater within a sedimentary bedrock sequence with irregular permeability. Decreasing TCE trend in soil vapor over time is consistent with declining groundwater concentrations in the local 200 Area aquifer (Appendix E~~D~~ and NASA, 2019b).*
MSVM Well 600-SGW-1						
F113	F113 in soil 140 and non-detect (<0.76 µg/kg) at 10 - 12 ft, and non-detect (<0.79 µg/kg) for the soil sample at	Steadily increasing F113 in soil vapor with depth in ports located at 12.5 ft, 57.5 ft, and 117.5 ft. Concentrations remain within the	Steadily decreasing F113 in soil vapor ports over time for all historical sampling events 2010 - 2014. The shallow port at 12.5 ft sampled for the	No groundwater sample available for this well.	No direct comparison performed.	The increasing F113 trend in soil vapor with port depth is coincident with proximity to the projected fractured bedrock depth at 160 ft) and projected groundwater aquifer depth at 170 ft. Although no groundwater

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – 2018[#&] (μg/m^3)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
	72.5 - 75 ft. vadose zone soil porosity reported as 32% at 10 – 12 ft and 47% at 72.5 – 75 ft.[#]	same order of magnitude.	vapor intrusion assessment display continuation of this declining trend.			sample is available for this well, decreasing F113 soil vapor concentrations over time correspond to declining F113 concentrations in the local 600 Area groundwater aquifer (Appendix E~~D~~ and NASA, 2019b).*
TCE	TCE in soil 0.49 and non-detect (<0.41 μg/kg) at 10 – 12 ft, and non-detect (<0.43 μg/kg) for the soil sample at 72.5 – 75 ft. Vadose zone soil porosity reported as 32% at 10 – 12 ft and 47% at 72.5 – 75 ft.[#]	Steadily increasing TCE in soil vapor with depth in ports located at 12.5 ft, 57.5 ft, and 117.5 ft. Concentrations remain within the same order of magnitude.	Steadily decreasing TCE in all soil vapor ports over time for all historical sampling events 2010 - 2014. Shallow port at 12.5 ft sampled for VI assessment events continued the declining vapor concentration trend.	No groundwater sample available for this well.	No direct comparison performed.	Increasing TCE trend in soil vapor with port depth coincident with proximity to projected fractured bedrock (depth 160 ft) and projected groundwater aquifer (depth 170 ft). Although no groundwater sample is available for this well, decreasing TCE soil vapor concentrations over time are coincident with declines for TCE concentrations in local 600 Area groundwater aquifer (Appendix E~~D~~ and NASA, 2019b).*
MSVM Well 600-SGW-5 (Twinned with Monitoring Well 600-G-138)						
Freon 113	F113 in soil non-detect for the soil	Increasing F113 in soil vapor with port depth by two orders	Decreasing F113 in all soil vapor ports over time for	Latest equivalent soil vapor concentration in	Soil vapor concentration in the lower port	Increasing F113 in soil vapor with depth and significant increase in deep port at

COPC	Soil Analytical Data (Drilling Phase) and Soil Porosity (Geotechnical Samples)	Soil Vapor Vertical Concentration Trends with Depth	Soil Vapor Sampling Event Trends Over Timeframe 2010 – $2018^{\#\&}$ (µg/m^3)	Soil Vapor (Deep Port) Equivalent Concentration in Equilibrium with Groundwater	Relationship Between Soil Vapor (Deep Port) and Groundwater	Comments
	samples at 4 ft (<0.71 µg/kg) and 77 (<0.65 µg/kg) ft. Vadose zone soil porosity reported as 34% at 4 – 6 ft.#	of magnitude. Significant increase in deep port at 137.5 ft.	historical sampling events 2010 – 2014.	equilibrium with groundwater from twinned well 600-G-138 is 280,800 µg/m^3 on 11/20/14.	(280,000 µg/m^3 on 10/9/14) is within the same order of magnitude and has excellent correlation to the equivalent soil vapor in equilibrium with groundwater.	137.5 ft located 7 ft above perched groundwater on top of bedrock. Irregular F113 soil vapor concentrations over time within the deep port are associated with irregularly fluctuating F113 concentrations in perched groundwater at 600 Area well 600-G-136 (Appendix E~~D~~ and NASA, 2019b).*
TCE	TCE in soil non-detect for soil samples at 4 ft (<0.39 µg/kg) and 77 (<0.35 µg/kg) ft. Vadose zone soil porosity reported as 34% at 4 – 6 ft.#	Increasing TCE in soil vapor with port depth by two orders of magnitude. Significant increase in deep port at 137.5 ft.	Decreasing TCE in upper 3 soil vapor ports over time for historical sampling events. Deep port relatively consistent at between 13,800 and 16,000 µg/m^3.	Latest equivalent soil vapor concentration in equilibrium with groundwater from twinned well 600-G-138 is 26,260 µg/m^3 on 11/20/14.	Soil vapor concentration in the lower port (15,000 µg/m^3 on 10/9/14) is within the same order of magnitude and has strong correlation to the equivalent soil vapor in equilibrium with groundwater.	Increasing TCE in soil vapor with depth and significant increase in deep port at 137.5 ft located 7 ft above perched groundwater on top of bedrock. Irregular TCE soil vapor concentrations over time within the deep port are associated with irregularly fluctuating TCE concentrations in perched groundwater at twinned 600 Area well 600-G-136 (Appendix E~~D~~ and NASA, 2019b).*

Notes:

@ = Soil analytical data from NASA, 2004.

[#] = Soil and soil vapor analytical data (August 2010) from NASA, 2010.
[&] = Soil vapor data sets: March 2013 (NASA, 2013c); October 2014 (NASA, 2015c~~4~~); and the VI assessment (August 2017 and February 2018).
* = Vertical concentration profiles (Appendix E~~D~~) and Periodic Monitoring Report Time-Concentration maps and table (Appendix E of NASA, 2019b).

Appendix A
Pre-Sampling Building Inspection Forms

Complete This Form For Each Building Involved In Indoor Air Testing/Sampling 200 AREA B.200

Preparer's Name: GEOFF GILES
Date/Time Prepared: 6/21/17 1200 HRS
Preparer's Affiliation: NAVARRO RESEARCH & ENGINEERING
Work Phone: 575-524-5352
Purpose of Investigation: COMPONENT OF 200 AREA AND 600 AREA VAPOR INTRUSION ASSESSMENT WORK PLAN

1. **OCCUPANT:**
Interviewed: [✓ **Yes**] **or No**

Last Name: PINA ARPIN
First Name: CHRISTINA
Address: 12600 NASA ROAD, B.200, LAS CRUCES, NM 88012
County: DOÑA ANA
Work Phone: 575-524-5195
Alternate Phone:
Number of occupants at location: ≃20
Age of occupants: 20-60 YEARS

2. **OWNER OR LANDLORD:** (Check if same as occupant) ✓
Interviewed: [✓ **Y**] **/N**

Last Name:
First Name:
Address:
County:
Work Phone:
Alternate Phone:

3. **BUILDING CHARACTERISTICS:**

Type of Building: (Circle appropriate response)

Residential	School	Commercial/Multi-use
[✓ Industrial]	Church	Other: WSTF B.200 AREA

If the property is residential, type? (Circle appropriate response)

Ranch	2-Family	3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouse/Condos
Modular	Log Home	Other:

NOTE: JIM MCCULLOUGH @ 575-524-5287 (200 AREA ENGINEER) PROVIDED ASSISTANCE WITH THE COMPLETION OF THIS FORM

If multiple units, how many? —

If the property is commercial, type?

Business Type(s) LABORATORY - PHOTOLAB, MACHINE SHOPS, TECHNICAL FACILITY

Does it include residences (i.e., multi-use)? Yes or [✓ No] If yes, how many? ________

Other characteristics:

Number of floors: 1 Building Age: 53 YEARS

Is the building insulated? [✓ Yes] or No How air tight? Tight / [✓ Average] / Not Tight

4. **AIRFLOW**

Use air current tubes or tracer smoke to evaluate airflow patterns & qualitatively describe:

Airflow between floors:

SINGLE FLOOR

Airflow near source:

FORCED REFRIDGERATED AIR (USING WATER-FILLED COOLING COILS)

Outdoor air infiltration:

THROUGH DOOR THRESHOLDS, CRACKS, OPEN DOORS ETC.

Infiltration into air ducts:

DUCT LEAKAGE THROUGH AIR DUCTS IN ROOF

5. **BASEMENT & CONSTRUCTION CHARACTERISTICS (Circle all that apply)**

Above grade construction: wood frame [✓ concrete] stone brick (SOME METAL SHEET PANELING IN THE NORTH HIGHBAY).

Basement type: full crawlspace slab other: ________

Basement floor: concrete dirt stone other: ________

Basement floor: unsealed sealed

Covered with: ________

Concrete floor: unsealed [✓ sealed]

Sealed with: CONCRETE SEALANT COVERED WITH 9"x9" VINYL TILE.

Foundation walls: [✓ poured block] stone other: POURED CONCRETE FOOTING

Foundation walls: unsealed [✓ sealed]

Sealed with: CONCRETE SEALANT COVERED WITH PAINT

The basement is: wet damp dry moldy [✓ N/A]

The basement is: finished unfinished partially finished [✓ N/A]

Sump present? Yes or No

Basement/Lowest level depth below grade: ____________ feet

Water in sump? Yes No Not Applicable

Identify potential soil vapor entry points & approximate size (e.g., cracks, utility ports, drains).

---

6. HEATING, VENTING & AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

[✓ Hot air circulation] Heat pump Hot water baseboard

Space heaters Steam radiation Radiant floor

Electric baseboard Wood stove Outdoor wood boiler

Other: ____________

The primary type of fuel used is:

[✓ Natural gas] Fuel oil Kerosene

Electric Propane Solar

Wood Coal

Domestic hot water tank fueled by: NATURAL GAS BOILER

Boiler/furnace located in: Basement Outdoors [✓ Main Floor] (NORTH HIGHBAY)

Other: ____________

Air conditioning: [✓ Central air] Window units Open windows (LOCALIZED EXCEPTIONS 1) SMALL REFRIGERATED UNIT @ PHOTOLAB ROOMS 203 AND 204. 2) SMALL REFRIGERATED UNIT FOR ROOM 206B*)

Are there air distribution ducts present? [✓ Yes] or No

[✓ Heat Pump] None

Describe the supply & cold air return ductwork & its condition where visible, including whether there is a cold air return & tightness of duct joints. Indicate the locations on the floor plan diagram.

HVAC SYSTEM RUNS 24 x 7 DUE TO LABORATORY ENVIRONMENT

*NOTE: ROOM 206B WAS BUILT OVER THE FENCED-IN YARD THAT WAS THE LOCATION FOR THE CLEAN ROOM TANKS IN THE 1960'S.

7. OCCUPANCY

Is basement/lowest lever occupied?

Full-time [✓ Occasionally] Seldom Almost never

Level General use of each floor (e.g., family room, bedroom, laundry, workshop, storage)

Basement: N/A

1st Floor: PHOTOGRAPHY LAB, MACHINE SHOPS, EQUIPMENT /MATERIAL STORAGE, GARAGE, UTILITY ROOMS.

2nd Floor: N/A

3rd Floor: N/A

4th Floor: N/A

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

Is there an attached garage? Yes or [✓ No]

Does the garage have a separate heating unit? Yes , No or [✓ Not Applicable]

Are petroleum-powered machines or vehicles stored in the garage? (e.g., lawnmower, ATV, car)

Yes or No. Please specify:

Has the building ever had a fire? Yes or [✓ No] When?

Is a kerosene or unvented gas space heater present? Yes or [✓ No]

Where & Type?

Is there a workshop or hobby/craft area? [✓ Yes] or No

Where & Type? MACHINE SHOP WITH DRILL, LATHE, LUBRICATING OILS

Is there smoking in the building? Yes or [✓ No] Frequency?

Have cleaning products been used recently? [✓ Yes] or No

When and What Type? JANITOR CLEANS BUILDING AS REQUIRED (DAILY), CLEANING ROOM OPERATIONS.

Have cosmetic products been used recently? [✓ Yes] or No

When and What Type? COSMETIC PRODUCTS USED DAILY BY PERSONNEL

Has painting/staining been done in the last 6 months? Yes or [✓ No]

Where and When?

Is there new carpet, drapes or other textiles? Yes or [✓ No]

Where and When?

Have air fresheners been used recently? [✓ Yes] or No

When and What Type? FEBREEZE IN BATHROOMS

Is there a kitchen exhaust fan? [✓ Yes] or No

If yes, where vented? SEVERAL FLUME HOODS VENTED ON ADJACENT WALL TO OUTSIDE

Is there a bathroom exhaust fan? [✓ Yes] or No

If yes, where vented? ADJACENT WALL TO ROOF AREA.

Is there a clothes dryer? [✓ Yes] or No If yes, is it vented outside? [✓ Yes] or No (VALVE SHOP AREA)

Has there been a pesticide application? [✓ Yes] or No

When and Type? ON A QUARTERLY SCHEDULE - POTENTIALLY TODAY (6/21/17).

Are there odors in the building? [✓ Yes] or No

If yes, please describe: BUILDING PART OF CHEMISTRY LAB - EACH ROOM HAS A DIFFERENT ODOR RELATED TO SUPPLIES.

Do any of the building occupants use solvents or volatile chemicals at work? [✓ Yes] or No (e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)

If yes, what type of solvents are used? CHEMICAL MANUFACTURING, LABORATORY SOLVENTS, OILS & LUBRICANTS IN MACHINE SHOP, PAINTS, ADHESIVES, ETC.

If yes, are their clothes washed at work? [✓ Yes] or No

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle one)

Yes, use dry-cleaning regularly (weekly) [✓ Yes, use dry-cleaning infrequently (monthly or less)]

Yes, work at a dry-cleaning service No

Unknown

Is there a radon mitigation system for the building/structure? Yes or [✓ No]

Date of Installation:

Is the system active or passive? Active or Passive

9. WATER & SEWAGE

Water Supply: Public water [✓ Drilled well] Driven well Dug well

Other: WATER SUPPLIED FROM DRILLED WELLS LOCATED 5 MILES TO THE WEST

Sewage Disposal: [✓ Public sewer] Septic tank Leach field Dry well

Other: CITY OF LAS CRUCES PUBLIC SANITARY SYSTEM

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. **Provide reasons why relocation is recommended:**

b. **Residents choose to:** remain in home relocate to friends/family relocate to hotel/motel

c. **Responsibility for costs associated with reimbursement explained?** Yes or No

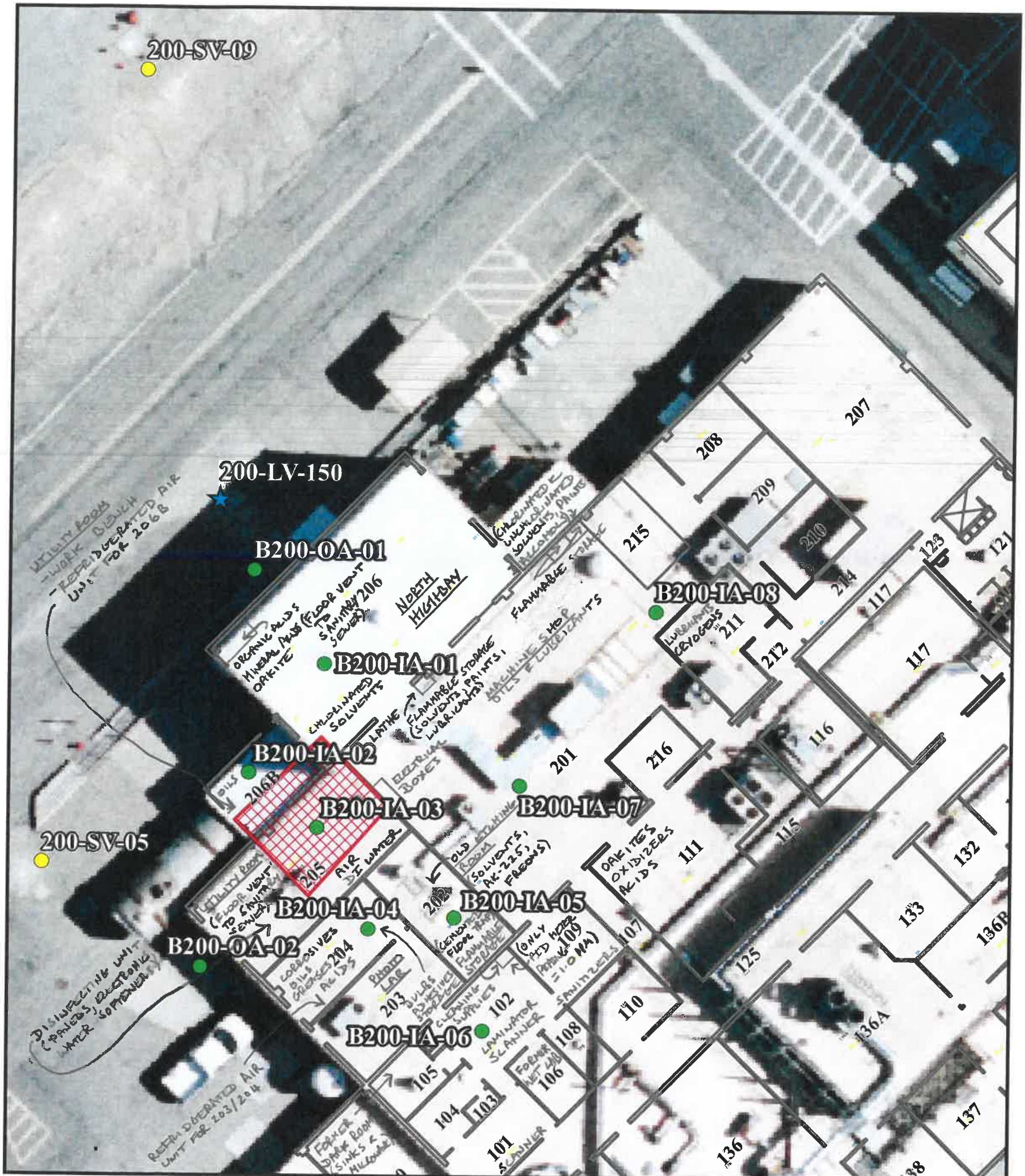
d. Relocation package provided & explained to residents? Yes or No

11. FLOOR PLANS

Draw a plan view sketch of the basement & first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement: N/A

First Floor: SEE ATTACHED SHEET (WEST BUILDING 200)



West Building 200 Soil Vapor and Air Sampling Locations

● Air Sample Location

★ MSVGM Well Sample

▨ HWMU

● MSVM Sample

N
W E
S

0 10 20 40 Feet

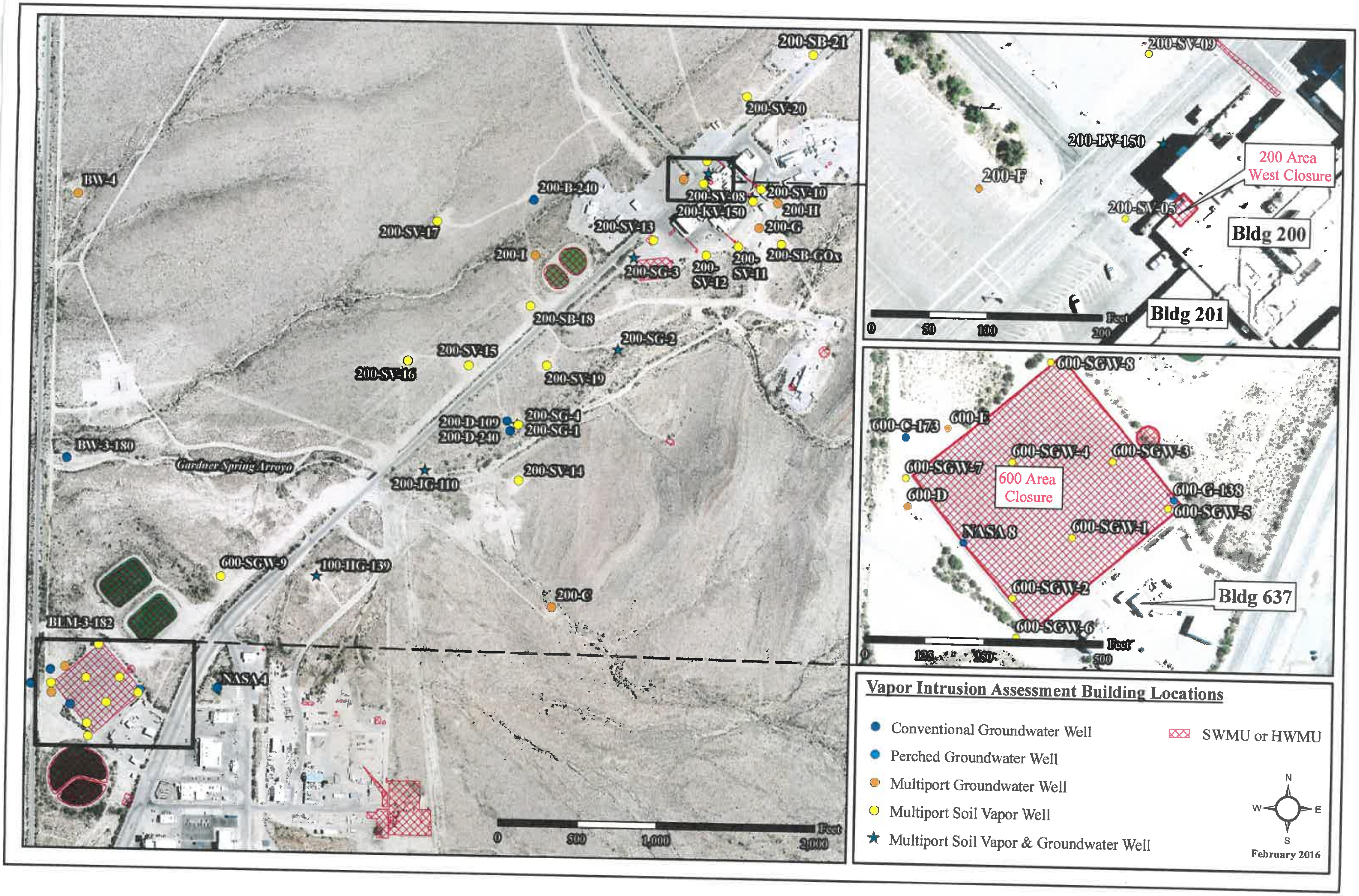
February 2016

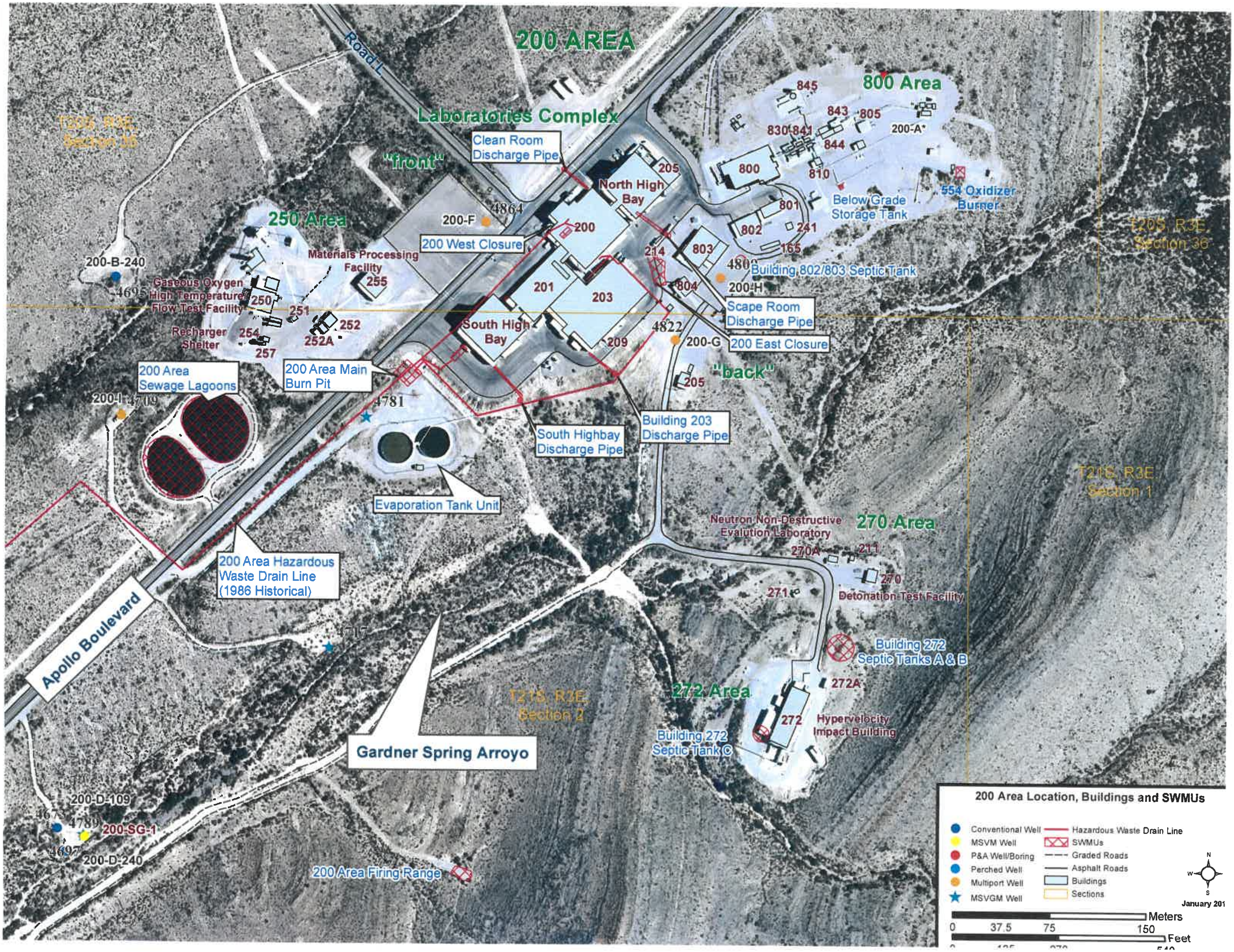
Second Floor: N/A

12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc), outdoor air sampling location(s) & PID meter readings.

Also indicate compass direction, wind direction & speed during sampling, the locations of the well & septic system, if applicable, & a qualifying statement to help locate the site on a topographic map.


200-SB-21
200-SV-20
BW-4
200-B-240
200-SV-08
200-SV-10
200-KV-150
200-H
200-SV-17
200-SV-13
200-G
200-I
200-SG-3
200-SV-12
200-SV-11
200-SB-GOx
200-SB-18
200-SG-2
200-SV-15
200-SV-16
200-SV-19
200-D-109
200-D-240
200-SG-4
200-SG-1
BW-3-180
Gardner Spring Arroyo
200-JG-110
200-SV-14
600-SGW-9
100-HG-139
200-C
BLM-3-182
NASA 4
0
500
1,000
2,000
Feet
200-SV-09
200-LV-150
200-F
200 Area West Closure
200-SV-05
Bldg 200
Bldg 201
0
50
100
200
Feet
600-SGW-8
600-C-173
600-E
600-SGW-4
600-SGW-3
600-SGW-7
600 Area Closure
600-D
600-G-138
600-SGW-5
NASA 8
600-SGW-1
600-SGW-2
Bldg 637
600-SGW-6
0
125
250
500
Feet
Vapor Intrusion Assessment Building Locations
Conventional Groundwater Well
Perched Groundwater Well
Multiport Groundwater Well
Multiport Soil Vapor Well
Multiport Soil Vapor & Groundwater Well
SWMU or HWMU
N
W
E
S
February 2016


200 AREA
Road L
800 Area
845
843
805
830
841
844
200-A*
Laboratories Complex
Clean Room Discharge Pipe
"front"
205
North High Bay
800
810
554 Oxidizer Burner
Below Grade Storage Tank
801
T20S, R3E, Section 35
T20S, R3E, Section 36
250 Area
200-F
4864
200
200 West Closure
802
241
165
Materials Processing Facility
214
803
4808
Building 802/803 Septic Tank
200-B-240
4695
255
Gaseous Oxygen High Temperature Flow Test Facility
250
251
201
203
804
200-H
Scape Room Discharge Pipe
Recharger Shelter
254
257
252
252A
South High Bay
209
4822
200-G
200 East Closure
200 Area Sewage Lagoons
200 Area Main Burn Pit
"back"
205
200-I
4709
4781
South Highbay Discharge Pipe
Building 203 Discharge Pipe
Evaporation Tank Unit
T21S, R3E, Section 1
Neutron Non-Destructive Evalution Laboratory
270 Area
270A
211
270
200 Area Hazardous Waste Drain Line (1986 Historical)
271
Detonation Test Facility
Apollo Boulevard
4717
Building 272 Septic Tanks A & B
272A
272 Area
T21S, R3E, Section 2
272
Hypervelocity Impact Building
Building 272 Septic Tank C
Gardner Spring Arroyo
200-D-109
4673
4789
200-SG-1
4697
200-D-240
200 Area Firing Range
200 Area Location, Buildings and SWMUs
Conventional Well
MSVM Well
P&A Well/Boring
Perched Well
Multiport Well
MSVGM Well
Hazardous Waste Drain Line
SWMUs
Graded Roads
Asphalt Roads
Buildings
Sections
N
W
S
January 201
Meters
0
37.5
75
150
Feet

13. PRODUCT INVENTORY FORM

Preliminary walk-through conducted on 6/21/2017
P. Egan and G. Giles, Navarro

Make & Model of field instrument used: MSA Altair 5X PID

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (ppm)	Photo** Y / N
Photo Lab Rm 102 B200-IA-06	Glue Paper		In Use	Heat-activated Adhesive	0	Y
	Flammables Cabinet	~3ft^3	In Use	Various chemicals	1	
	Fire Extinguisher		Unopened	Possible fluorocarbon propelling agent	0	
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
	Hand Sanitizer	2 liters	In Use	Ethyl Alcohol	0	
Photo Lab Room 203	Fire Extinguisher		Ready to Use	Possible fluorocarbon propelling agent	0	Y
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
	Gator Board		In Use	Adhesive Backing	0	
Photo Lab Room 204 (Storage (Shelves) B200-IA-04	Adhesive Tape	50' roll	Open & Unopened	Adhesive Backing	0	Y
	Dry Erase Markers		Unopened	Solvent (ethanol ?)	0	
	Kodak Lens Cleaner		Unopened		0	
Room 202 B200-IA-05	Sure Coat	5 gal buckets	Unopened & Used	Epoxy	0	Y
	Freon	Steel canisters	Unopened	Freon	0	
Room 201	FilterMate Vapor Extractor	machine	In Use	?	0	Y
	Hydraulic Drill Press	machine	In Use	Lubes/Oils	0	
Room 111	Cleaners	Open Vats	In Use	Oakite, oxidizers, sulfuric acids	0	Y
Room 201 B200-IA-08	drain to sanitary sewer (outside room 111)	Utility Sink	In Use	?	0	Y
B200-IA-07	Flammable Cabinets #2 & #3	1 large, 1 small	In Use	Alcohols, chlorinated solvents, Rustoleum spray paints, WD-40	0	
	Flammable Cabinet #1	small	In Use	Paints, solvents, lubes	0	

Room 216 Assembly Room	Krytox		In Use	?	0	Y
Room 206 (CSS HiBay) B200-IA-01	Several products		In Use	Oakite, IPA, Acids, Sat Accum Area, full of stuff!	0	Y
Room 206B Workbench Area B200-IA-02	Marker Pens Oils used for assembly	small	In Use	?	0	Y
Room 205 Utility Room B200-IA-03	Active Drain to Sewer Bags of water softening pellets		In Use	Citric acid anhydrous	0	Y
Room 204	Various		In Use	Full of petrochemicals, acids, corrosives, vacuum pump oils.	0	Y

***Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D)**
****Photographs of the front & back of the product containers can replace the hand written list of chemical ingredients. However, the photographs must be of good quality & ingredient labels must be legible.**

Complete This Form For Each Building Involved In Indoor Air Testing/Sampling 600 AREA B.637

Preparer's Name: GEOFF GILES Date/Time Prepared: 6/26/17 1400 HRS

Preparer's Affiliation: NAVARRO RESEARCH & ENGINEERING Work Phone: 575-524-5352

Purpose of Investigation: COMPONENT OF 200 AREA AND 600 AREA VAPOR INTRUSION ASSESSMENT WORK PLAN

1. **OCCUPANT:**
Interviewed: [✓ **Yes**] **or No**

Last Name: DEL FERRARO First Name: CRAIG

Address: 12600 NASA ROAD, B.637, LAS CRUCES, NM 88012

County: DOÑA ANA

Work Phone: 575-524-5699 Alternate Phone:

Number of occupants at location: ≃ 8

Age of occupants: ≃ 20-60 YEARS

2. **OWNER OR LANDLORD:** (Check if same as occupant) ✓
Interviewed: Y/N

Last Name: First Name:

Address:

County:

Work Phone: Alternate Phone:

3. **BUILDING CHARACTERISTICS:**

Type of Building: (Circle appropriate response)

Residential School Commercial/Multi-use

[✓ Industrial] Church Other: WSTF B.637 AREA (1200 SQFT BUILDING)

If the property is residential, type? (Circle appropriate response)

Ranch 2-Family 3-Family

Raised Ranch Split Level Colonial

Cape Cod Contemporary Mobile Home

Duplex Apartment House Townhouse/Condos

Modular Log Home Other:

If multiple units, how many? —

If the property is commercial, type?

Business Type(s) GROUND WATER ASSESSMENT BUILDING - SAMPLING EQUIPMENT

Does it include residences (i.e., multi-use)? Yes or [✓ No] If yes, how many?

Other characteristics:

Number of floors: 1 Building Age: 26 YEARS

Is the building insulated? [✓ Yes] or No How air tight? Tight / [✓ Average] / Not Tight

4. AIRFLOW

Use air current tubes or tracer smoke to evaluate airflow patterns & qualitatively describe:

Airflow between floors:

SINGLE FLOOR

Airflow near source:

FORCED AIR THROUGH SWAMP COOLER

Outdoor air infiltration:

THROUGH DOOR THRESHOLDS, OPEN DOORS (NO WINDOWS)

Infiltration into air ducts:

VIA SWAMP COOLER LOCATED ON GROUND ON NORTH SIDE OF B,637

5. BASEMENT & CONSTRUCTION CHARACTERISTICS (Circle all that apply)

Above grade construction: wood frame [✓ concrete] stone brick [✓ CORRUGATED METAL SIDING]

Basement type: full crawlspace slab other:

Basement floor: concrete dirt stone other:

Basement floor: unsealed sealed

Covered with:

Concrete floor: unsealed [✓ sealed]

Sealed with: CONCRETE SEALANT

Foundation walls: poured block stone other: POURED CONCRETE FOOTING

Foundation walls: unsealed [✓ sealed] CORRUGATED METAL SIDING

Sealed with: PAINT

The basement is: wet damp dry moldy [✓ N/A]

The basement is: finished unfinished partially finished [✓ N/A]

Sump present? Yes or No

Basement/Lowest level depth below grade: ____________________ feet

Water in sump? Yes No Not Applicable

Identify potential soil vapor entry points & approximate size (e.g., cracks, utility ports, drains).

____

6. HEATING, VENTING & AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

[✓ Hot air circulation] Heat pump Hot water baseboard

Space heaters Steam radiation Radiant floor

Electric baseboard Wood stove Outdoor wood boiler

Other: ____

The primary type of fuel used is:

[✓ Natural gas] Fuel oil Kerosene

Electric Propane Solar

Wood Coal

Domestic hot water tank fueled by: N/A

Boiler/furnace located in: Basement Outdoors Main Floor

Other: ____

Air conditioning: [✓ Central air] Window units Open windows

Are there air distribution ducts present? [✓ Yes] or No

Heat Pump None

Describe the supply & cold air return ductwork & its condition where visible, including whether there is a cold air return & tightness of duct joints. Indicate the locations on the floor plan diagram.

SWAMP COOLER USUALLY SHUT DOWN AT WEEKEND WHEN BUILDING IS UNOCCUPIED

7. OCCUPANCY

Is basement/lowest lever occupied?

Full-time [✓ Occasionally] Seldom Almost never

Level General use of each floor (e.g., family room, bedroom, laundry, workshop, storage)

Basement: N/A

1st Floor: SAMPLE EQUIPMENT STORAGE AND SAMPLE MANAGEMENT IN SINGLE ROOM WAREHOUSE.

2nd Floor: N/A

3rd Floor: N/A

4th Floor: N/A

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

Is there an attached garage? Yes or [✓ No]

NEARBY (10 FT) MORGAN BUILDING (T-637A) ON SOUTHWEST CORNER, CONTAINS GENERATORS, STEAM CLEANERS, FLAMMABLES – SILICONE SPRAY, ISOPROPYL ALCOHOL, GASOLINE, CORROSIVES – SODIUM HYDROXIDE, OILS.

Does the garage have a separate heating unit? Yes , No or [✓ Not Applicable]

Are petroleum-powered machines or vehicles stored in the garage? (e.g., lawnmower, ATV, car)

Yes or No. Please specify:

Has the building ever had a fire? Yes or [✓ No] When?

Is a kerosene or unvented gas space heater present? Yes or [✓ No]

Where & Type?

Is there a workshop or hobby/craft area? [✓ Yes] or No

Where & Type? WORKBENCH WITH TOOLS & LUBRICANTS IN SOUTHWEST CORNER OF BUILDING.

Is there smoking in the building? Yes or [✓ No]? Frequency?

Have cleaning products been used recently? [✓ Yes] or No

When and What Type? TECHNICIANS CLEAN WORK SURFACES W/CHLORINATED WIPES WHEN REQUIRED.

Have cosmetic products been used recently? Yes or [✓ No]

When and What Type?

Has painting/staining been done in the last 6 months? Yes or [✓ No]

Where and When?

Is there new carpet, drapes or other textiles? Yes or [✓ No]

Where and When?

Have air fresheners been used recently? Yes or [✓ No]

When and What Type?

Is there a kitchen exhaust fan? Yes or [✓ No]

If yes, where vented? ______________________________

Is there a bathroom exhaust fan? Yes or [✓ No]

If yes, where vented? ______________________________

Is there a clothes dryer? Yes or [✓ No] If yes, is it vented outside? Yes or No

Has there been a pesticide application? [✓ Yes] or No

When and Type? WITHIN LAST MONTH FOR INSECTS & RODENTS.

Are there odors in the building? [✓ Yes] or No

If yes, please describe: CHEMICAL PRESERVATIVES FOR WATER SAMPLES (DILUTE ACIDS)

Do any of the building occupants use solvents or volatile chemicals at work? [✓ Yes] or No (e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)

If yes, what type of solvents are used? LABORATORY PRESERVATIVES, CLEANING FLUIDS.

If yes, are their clothes washed at work? Yes or [✓ No]

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle one)

Yes, use dry-cleaning regularly (weekly) Yes, use dry-cleaning infrequently (monthly or less)

Yes, work at a dry-cleaning service [✓ No]

Unknown

Is there a radon mitigation system for the building/structure? Yes or [✓ No]

Date of Installation: ______________________________

Is the system active or passive? Active or Passive

9. WATER & SEWAGE

Water Supply: Public water [✓ Drilled well] Driven well Dug well

Other: WATER SUPPLIED FROM DRILLED WELLS LOCATED 4 MILES TO THE WEST

Sewage Disposal: [✓ Public sewer] Septic tank Leach field Dry well

Other: ______________________________

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended:

____

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? Yes or No

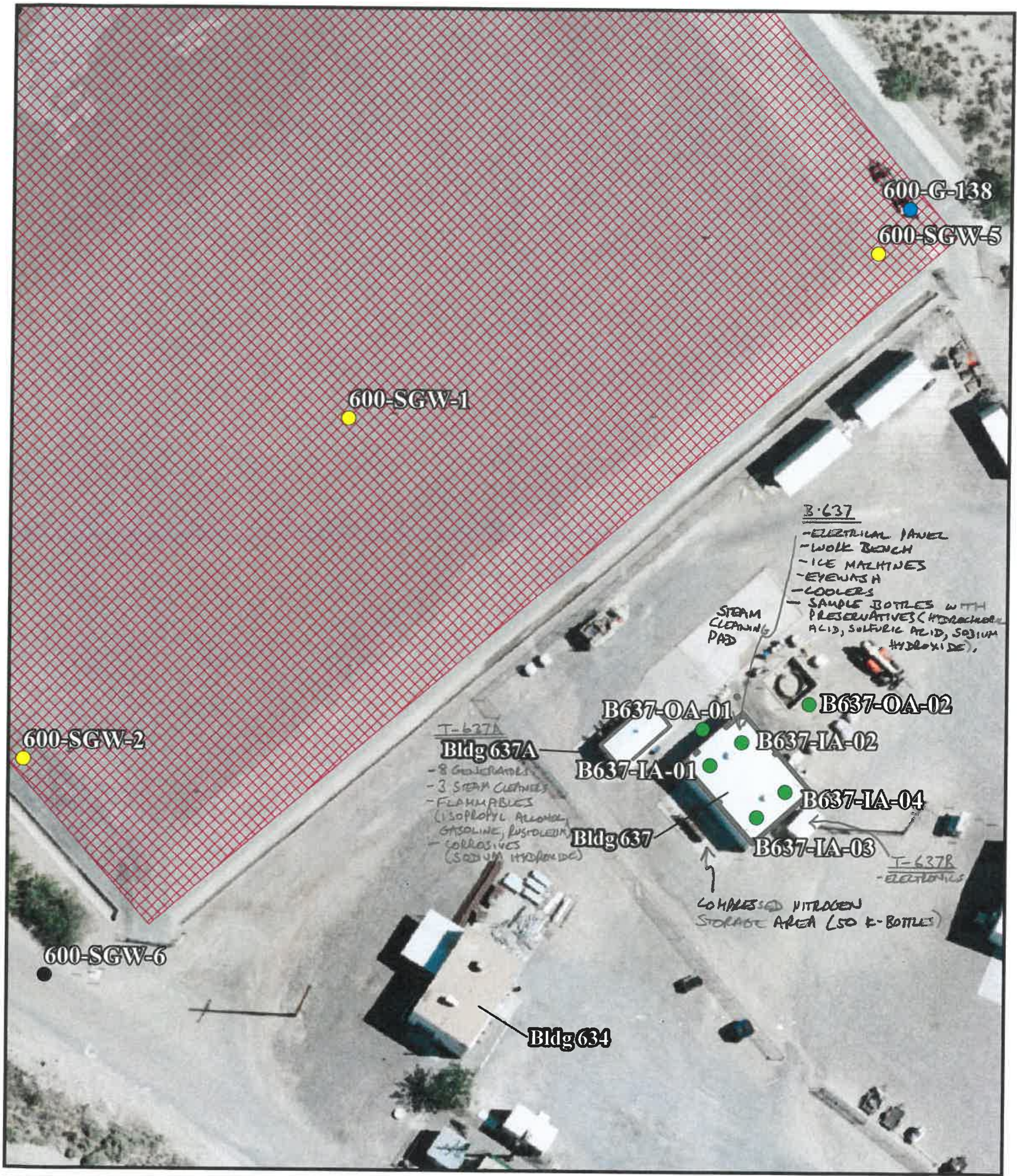
d. Relocation package provided & explained to residents? Yes or No

11. FLOOR PLANS

Draw a plan view sketch of the basement & first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement: N/A

First Floor: SEE ATTACHED SHEET (BUILDING 637)



Building 637 Soil Vapor and Air Sampling Locations

🟢	Air Sample Location	●	MGVM Well
🟡	MGMV Well Sample	🔵	Perched GW Monitoring Well

▨ SWMU

0 15 30 60 Feet

N
W E
S

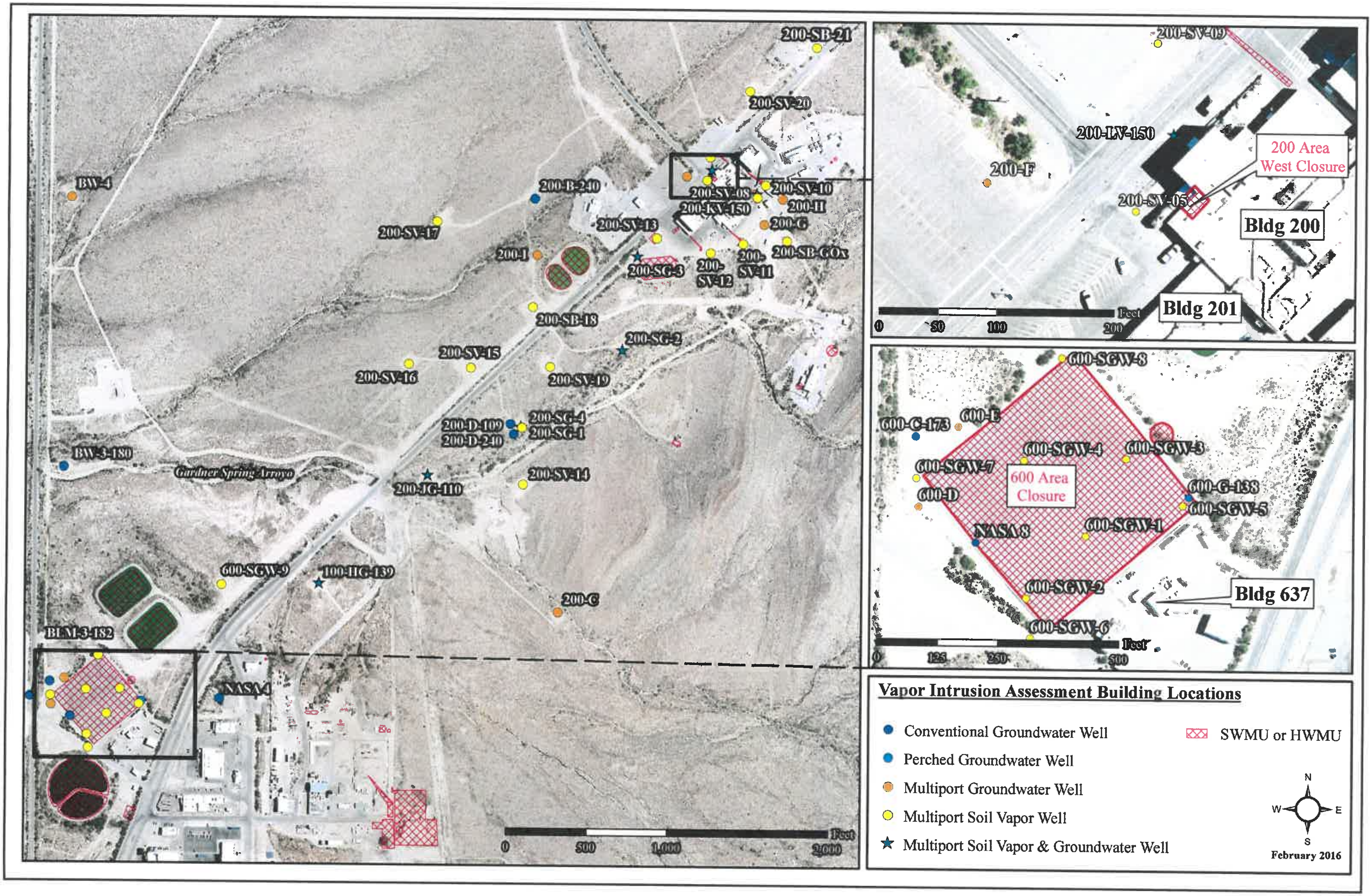
February 2016

Second Floor: N/A

12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc), outdoor air sampling location(s) & PID meter readings.

Also indicate compass direction, wind direction & speed during sampling, the locations of the well & septic system, if applicable, & a qualifying statement to help locate the site on a topographic map.



Vapor Intrusion Assessment Building Locations

February 2016

13. PRODUCT INVENTORY FORM

Preliminary walk-through conducted on 6/26/2017
G. Giles, Navarro

Make & Model of field instrument used: MSA Altair 5X PID

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (ppm)	Photo** Y / N
Building 637	Sample Bottles (with Preservative)	40 mL – 1 Liter	Unopened	Dilute hydrochloric acid, sulfuric acid, sodium hydrozide	0	Y
	Fire Extinguisher	0.5 cuft	Unopened	Possible fluorocarbon propelling agent	0	
	Hand Sanitizer	1 Liter	In Use	Ethyl Alcohol	0	
Building T-637A	Flammables Cabinet	0.25L – 1 Liter	In Use	Silicone spray, isopropyl alcohol, gasoline, Rustoleum products	0	Y
	Corrosives Cabinet	14 oz	In Use	Sodium hydroxide	0	
	Generators	8 cuft	In Use	Gasoline and oil	0	
	Steam Cleaners	8 cuft	In Use	Gasoline and oil	0	
	Oils/Lubricants	1 Liter	Unopened	Various motor oils and lubricants (WD40)	0	
	Aero Duster	14 oz	In Use	1,1,1,2,tetrafuoroethane	0	
Building T-637B	Groundwater Sampling Equipment Electronics	50’ – 500’ reels	In Use		0	Y
Compressed Nitrogen Storage Area Adjacent to B. 637	Compressed Gas Cylinders	1.5 cuft	In Use	Nitrogen	0	N

***Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D)**
****Photographs of the front & back of the product containers can replace the hand written list of chemical ingredients. However, the photographs must be of good quality & ingredient labels must be legible.**

Appendix B
Pre-Sampling Building Walkthrough Photographs

Photograph 1 **Building 200, Room 102 (Photographic Laboratory) – 06/28/2017**

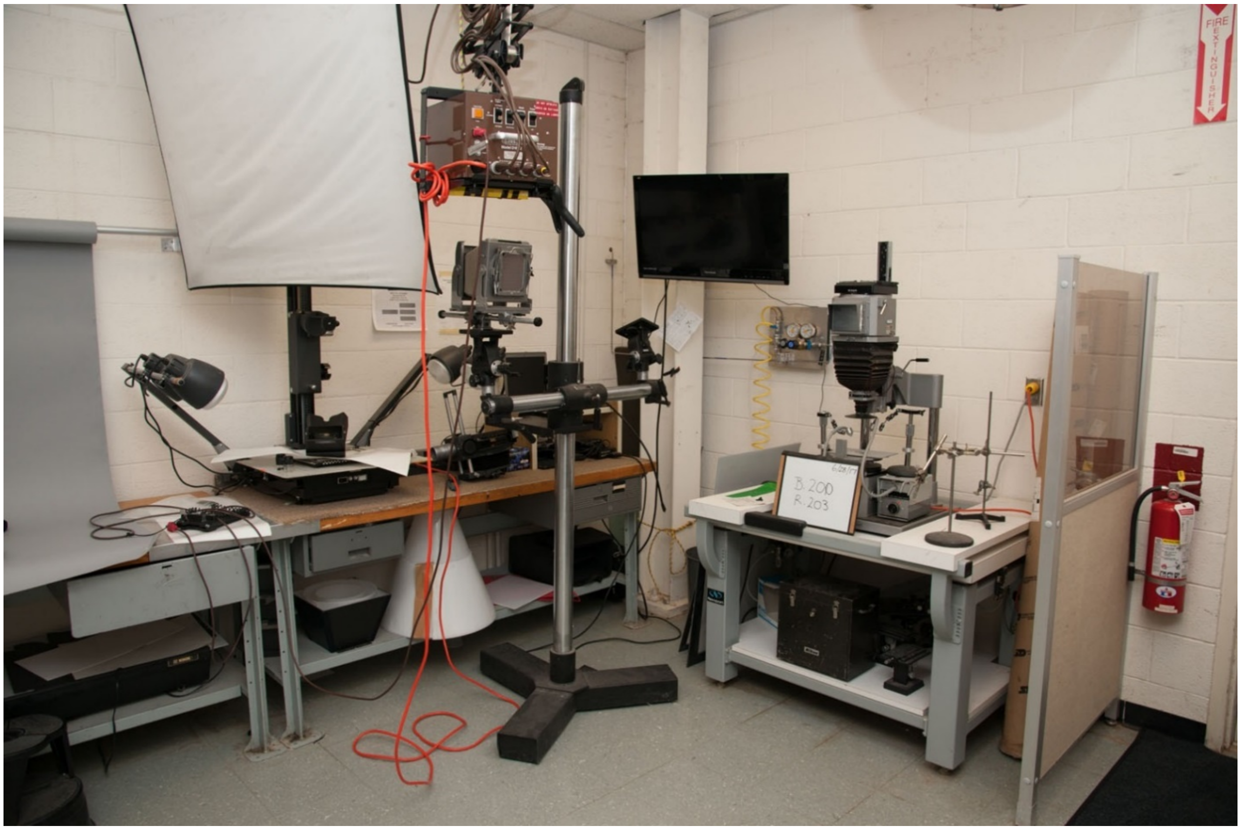
Photograph 2 **Building 200, Room 102 (Photographic Laboratory) – 06/28/2017**

Photograph 3 **Building 200, Room 106 (Photographic Laboratory Office) – 06/28/2017**

Photograph 4 **Building 200, Room 108 (Photographic Laboratory Office) – 06/28/2017**

Photograph 5 **Building 200, Room 105 (Photographic Laboratory Store Room) – 06/28/2017**

Photograph 6 **Building 200, Room 203 (Photographic Laboratory) – 06/28/2017**



Photograph 7 **Building 200, Room 204 (Photographic Laboratory Store Room) – 06/28/2017**

Photograph 8 **Building 200, Room 201 (Technical Facility Store Room) – 06/28/2017**

Photograph 9 **Building 200, Room 201 (Machine Shop) – 06/28/2017**

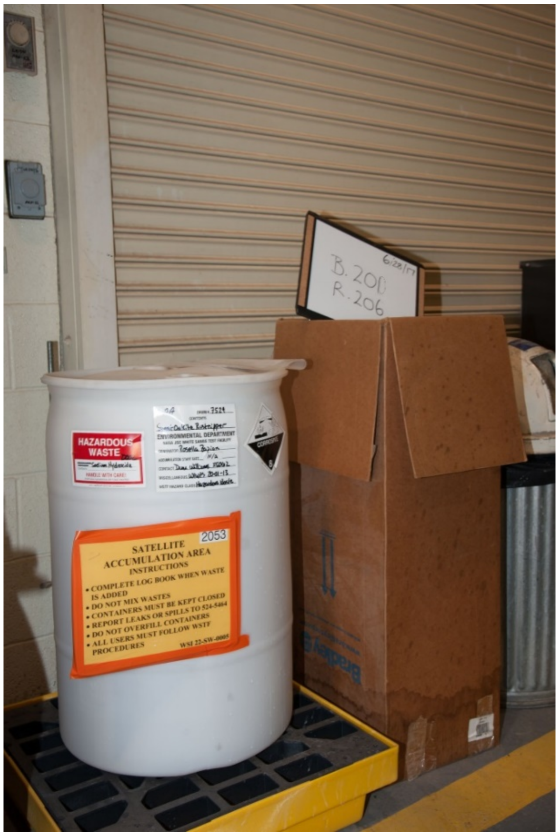
Photograph 10 **Building 200, Room 201 (Machine Shop) – 06/28/2017**

Photograph 11 **Building 200, Room 206 (Technical Facility Chemical Storage) – 06/28/2017**

Photograph 12 **Building 200, Room 206 (Technical Facility Chemical Storage) – 06/28/2017**

Photograph 13 **Building 200, Room 206 (Technical Facility Chemical Storage) – 06/28/2017**

Photograph 14 **Building 200, Room 206 (Technical Facility Chemical Storage) – 06/28/2017**



Photograph 15 **Building 200, Room 206B (Workshop) – 06/28/2017**

Photograph 16 **Building 200, Room 205 (Equipment Room) – 06/28/2017**

Photograph 17 **Building 200, Room 205 (Equipment Room Storage) – 06/28/2017**

Photograph 18 **Building 200, Room 204 (Equipment Room Storage) – 06/28/2017**

Photograph 19 Building 637 Northeast Corner (Groundwater Assessment Building) – 06/28/2017

Photograph 20 Building 637 Northwest Corner (Groundwater Assessment Building) – 06/28/2017

Photograph 21 **Building 637 Southwest Corner (Groundwater Assessment Building) – 06/28/2017**

Photograph 22 **Building 637 Southeast Corner (Groundwater Assessment Building) – 06/28/2017**

Photograph 23 **Building T-637A (Morgan Building for Flammable Storage) – 06/28/2017**

Photograph 24 **Building T-637A (Morgan Building for Flammable Storage) – 06/28/2017**

Photograph 25 Building T-637B (Morgan Building for Miscellaneous Equipment Storage) – 06/28/2017

Photograph 26 Building T-637B (Morgan Building for Miscellaneous Equipment Storage) – 06/28/2017

Photograph 27 **Outside, South West Side of Building 200 (1L Soil Vapor Sample with Duplicate) – 02/25/2018**

Photograph 28 **Building 200, Room 102 (6L Indoor Air Sample) – 02/25/2018**

Photograph 29 Outside on South Side of Building 200 (6L Outdoor Air Sample) – 02/25/2018

Appendix C
Quality Assurance Reports

National Aeronautics and Space Administration

Quality Assurance Report for White Sands Test Facility 200 and 600 Area Vapor Intrusion Assessment Report Soils Analytical Data

April 2023

NM 8800019434

Report Submitted:
Report Prepared by: Will Teas
Navarro Research and Engineering, Inc.

1.0 Introduction

The 200 and 600 Area Vapor Intrusion Assessment Work Plan requires the preparation of an investigation report that includes soil analytical data reported. The Quality Assurance Report (QAR) prepared and reviewed by responsible environmental contractor data management personnel provides the following information:

- A summary of notable anomalies.
- A summary of notable data quality issues by analytical method, if any.
- A list of the sample events for which soil samples were collected in April and October 2017.
- The quantity and type of quality control samples collected or prepared in April and October 2017.
- Definitions of data qualifiers used in WSTF analytical data reporting.
- The quantity and type of data qualifiers applied to individual analytical results.
- A list of duplicate samples and their relative percent differences (RPD)
- A summary table of blank sample detections.

2.0 Data Quality

2.1 Notable Anomalies

Soil analytical data from samples collected for the 200 Area Phase II Investigation Report and the 600 Area Closure Investigation Report were used to perform a cumulative risk screening assessment. The soil data includes equipment blanks, field blanks, duplicates, trip blanks, in accordance with the approved work plan.

3.0 Data Tables

Table 1 summarizes the soil sample events in September 2009, November 2009, December 2009, January 2010, June 2014, and July 2014. This report is based on data quality issues related to the sample events listed in Table 1.

Table 2 through Table 5 contain information related to the sample events identified in Table 1. As specified by the Vapor Intrusion Assessment Work Plan, Section 5.4, specific quality control samples are utilized to assess the quality of analytical data. Table 2 presents the quantity of quality control samples collected for each analytical method. Table 3 compares the quality control sample percentages collected to the requirements in the respective investigation work plan. When data quality criteria are not met, data qualifiers are applied to the data. Definitions of data qualifiers used for WSTF chemical analytical data are listed in Table 4. Table 5 presents the total number of individual result records and summarize the quantity of field and laboratory data qualifiers assigned to individual analyte result records in the WSTF analytical database. Table 6 provides the RPD between duplicate samples. Samples associated with qualified data are identified by bold text in Table 6. Table 7 provides all detections found in trip blank and field blank samples. All data affected by blank sample detections are appropriately qualified.

4.0 Usability Assessment

The goal of the usability assessment is to determine the quality of each data point and to identify data that are not acceptable to support project quality objectives. This QAR qualifies as the completed assessment for the soil data from samples collected for the 200 Area Phase II Investigation Report and the 600 Area Closure Investigation Report in addition to the August 2017 and February 2018 sample events performed for the 200 and 600 Area Vapor Intrusion Assessment Report. No data was rejected (R) based on established quality review protocols.

Table 1 – Soil Sample Events

Location Sample ID	Sample Matrix	Event Date
200-SB-5 (8 ft bgs)	Soil	6/15/2014
200-SB-6 (8 ft bgs)	Soil	6/14/2014
200-SB-7 (8 ft bgs)	Soil	6/11/2014
200-SB-7 (18 ft bgs)	Soil	6/11/2014
200-SB-7 (38 ft bgs)	Soil	6/12/2014
200-SB-8 (8 ft bgs)	Soil	7/13/2014
200-SB-8 (28 ft bgs)	Soil	6/13/2014
200-SB-8 (43 ft bgs)	Soil	6/13/2014
200-SB-9 (8 ft bgs)	Soil	6/30/2014
200-SB-10 (16 ft bgs)	Soil	6/28/2014
200-SB-10 (26 ft bgs)	Soil	6/28/2014
200-SB-10 (36 ft bgs)	Soil	6/28/2014
200-SB-11 (8 ft bgs)	Soil	7/1/2014
200-SB-11 (28 ft bgs)	Soil	7/1/2014
200-SB-13 (8 ft bgs)	Soil	6/16/2014
200-SB-13 (28 ft bgs)	Soil	6/16/2014
600-SB-01 (6 ft bgs)	Soil	11/13/2009
600-SB-01 (72 ft bgs)	Soil	11/16/2009
600-SB-02 (3 ft bgs)	Soil	1/26/2010
600-SB-02 (8 ft bgs)	Soil	1/26/2010
600-SB-02 (75 ft bgs)	Soil	1/27/2010
600-SB-02A (3 ft bgs)	Soil	11/19/2009
600-SB-02A (8 ft bgs)	Soil	11/19/2009
600-SB-03 (6 ft bgs)	Soil	11/19/2009
600-SB-03 (10 ft bgs)	Soil	11/19/2009
600-SB-03 (75 ft bgs)	Soil	1/13/2010
600-SB-04 (6 ft bgs)	Soil	11/20/2009
600-SB-04 (10 ft bgs)	Soil	11/20/2009
600-SB-04 (75 ft bgs)	Soil	1/20/2010
600-SB-05 (4 ft bgs)	Soil	11/23/2009
600-SB-05 (77 ft bgs)	Soil	12/17/2009
600-SB-05 (144 ft bgs)	Soil	12/21/2009
600-SB-06 (4 ft bgs)	Soil	11/23/2009
600-SB-06 (75 ft bgs)	Soil	1/6/2010
600-SB-07 (6 ft bgs)	Soil	11/20/2009
600-SB-07 (78 ft bgs)	Soil	12/2/2009
600-SB-07 (158 ft bgs)	Soil	12/2/2009
600-SB-08 (6 ft bgs)	Soil	11/20/2009
600-SB-08 (85 ft bgs)	Soil	12/10/2009
600-SB-08 (150 ft bgs)	Soil	12/14/2009
600-SB-10 (01 ft bgs)	Soil	9/18/2009
600-SB-10 (10 ft bgs)	Soil	9/21/2009
600-SB-10 (20 ft bgs)	Soil	9/22/2009

Table 2 Quantity of Quality Control Samples

Matrix	Method	Total Samples	Non-QA Samples	Equipment Blanks	Field Blanks	Duplicates	Trip Blanks
Soil	353.2M	44	23	16		5	
Soil	607M	72	41	25		6	
Soil	6010	3	3				
Soil	6010B	46	23	17	1	5	
Soil	6010C	26	16	8		2	
Soil	6011C		0				
Soil	6020A		0				
Soil	6056A		0				
Soil	6850	47	35	8		4	
Soil	7196a	10	1	8		1	
Soil	7199	37	21	13		3	
Soil	8260B	65	26	20	1	5	13
Soil	8260C	34	16	8		2	8
Soil	8270C	44	23	16		5	
Soil	8270D	25	15	8		2	
Soil	8290A	26	16	8		2	
Total		**479**	**259**	**155**	**2**	**42**	**21**

Table 3 – Quality Control Sample Percentages (Soil)

Method	Quality Control Requirement	Sample Quantity	QC Quantity	QC %
353.2M	Equipment Blanks	60	16	27
	Field Blanks	44	0	0
	Duplicates	49	5	10
	Trip Blanks	44	0	0
607M	Equipment Blanks	97	25	26
	Field Blanks	72	0	0
	Duplicates	78	6	8
	Trip Blanks	72	0	0
6010	Equipment Blanks	3	0	0
	Field Blanks	3	0	0
	Duplicates	3	0	0
	Trip Blanks	3	0	0
6010B	Equipment Blanks	63	17	27
	Field Blanks	47	1	2
	Duplicates	51	5	10
	Trip Blanks	46	0	0
6010C	Equipment Blanks	34	8	24
	Field Blanks	26	0	0
	Duplicates	28	2	7
	Trip Blanks	26	0	0
6850	Equipment Blanks	55	8	15
	Field Blanks	47	0	0
	Duplicates	51	4	8
	Trip Blanks	47	0	0
7196a	Equipment Blanks	18	8	44
	Field Blanks	10	0	0
	Duplicates	11	1	9
	Trip Blanks	10	0	0

Method	Quality Control Requirement	Sample Quantity	QC Quantity	QC %
7199	Equipment Blanks	50	13	26
	Field Blanks	37	0	0
	Duplicates	40	3	8
	Trip Blanks	37	0	0
8260B	Equipment Blanks	85	20	24
	Field Blanks	66	1	2
	Duplicates	70	5	7
	Trip Blanks	78	13	17
8260C	Equipment Blanks	42	8	19
	Field Blanks	34	0	0
	Duplicates	36	2	6
	Trip Blanks	42	8	19
8270C	Equipment Blanks	60	16	27
	Field Blanks	44	0	0
	Duplicates	49	5	10
	Trip Blanks	44	0	0
8270D	Equipment Blanks	33	8	24
	Field Blanks	25	0	0
	Duplicates	27	2	7
	Trip Blanks	25	0	0
8290D	Equipment Blanks	34	8	24
	Field Blanks	26	0	0
	Duplicates	28	2	7
	Trip Blanks	26	0	0

Table 4 – Definitions of Data Qualifiers

Qualifier	Definition
*	User defined qualifier. See quality assurance narrative.
A	The result of an analyte for a laboratory control sample (LCS), initial calibration verification (ICV) or continuing calibration verification (CCV) was outside standard limits.
AD	Relative percent difference for analyst (laboratory) duplicates was outside standard limits.
D	The reported result is from a dilution.
EB	The analyte was detected in the equipment blank.
FB	The analyte was detected in the field blank.
G	The result is an estimated value greater than the upper calibration limit.
i	The result, quantitation limit, and/or detection limit may have been affected by matrix interference.
J	The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA	The value/result was either not analyzed for or not applicable.
ND	The analyte was not detected above the detection limit.
Q	The result for a blind control sample was outside standard limits.
QD	The relative percent difference for a field duplicate was outside standard limits.
R	The result is rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
RB	The analyte was detected in the method blank.
S	The result was determined by the method of standard addition.
SP	The matrix spike recovery and/or the relative percent difference for matrix spike duplicates was outside standard limits.
T	The sample was analyzed outside the specified holding time or temperature.
TB	The analyte was detected in the trip blank.
TIC	The analyte was tentatively identified by a GC/MS library search and the amount reported is an estimated value.

Table 5 – Quantity of Field Based Data Qualifiers Assigned to Individual Result Records (Soil)

COPC	FB	EB	TB	Q	QD	SP	R	*	A	AD	G	RB	T	D	i	J	TIC
2-Butanone (Methyl ethyl ketone)												2				19	
2-Propanol		1														2	
Acetone		9	1									13				16	
Antimony						1						18				19	
Benzo(a)anthracene																	
Benzyl Alcohol												12				14	
Bis(2-ethylhexyl)phthalate									2								
Boron																3	
Cadmium																38	
Carbon disulfide						1										2	
Chromium (Total)					2	1											
Chrysene																1	
Cobalt						1										18	
Freon-113																	
Manganese					2	3											
Mercury												2				22	
Methyl isobutyl ketone																1	
Molybdenum									8			3				31	
Nitrate+Nitrite as Nitrogen					5							3				27	
Tetrahydrofuran												8				11	
Thallium																1	
Tin, Total																19	
Toluene									3							10	
Trichloroethylene																4	
Zinc					2												

Table 6 – Duplicate Sample Relative Percent Difference

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
200-SB-5-8	**6/15/2014**	**Antimony**	**10.5**		**J RB**
200-SB-5-8	**6/15/2014**	**Cadmium**	**31.6**		**J**
200-SB-5-8	6/15/2014	Chromium	8.0		
200-SB-5-8	6/15/2014	Cobalt	1.3		
200-SB-5-8	6/15/2014	Manganese	10.3		
200-SB-5-8	**6/15/2014**	**Molybdenum**	**11.8**		**J**
200-SB-5-8	**6/15/2014**	**Nitrate+Nitrite as Nitrogen**	**13.3**		**J**
200-SB-5-8	6/15/2014	Zinc	0.3		
200-SB-8-8	**7/13/2014**	**Antimony**	**18.2**		**J RB**
200-SB-8-8	**7/13/2014**	**Cadmium**	**18.2**		**J**
200-SB-8-8	7/13/2014	Chromium	5.6		
200-SB-8-8	7/13/2014	Cobalt	20.8		
200-SB-8-8	7/13/2014	Manganese	8.8		
200-SB-8-8	**7/13/2014**	**Molybdenum**	**24.0**		**J**
200-SB-8-8	**7/13/2014**	**Nitrate+Nitrite as Nitrogen**	**0.0**		**J**
200-SB-8-8	7/13/2014	Zinc	14.7		
600-SB-01-006	11/13/2009	Freon 113	24.0		

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
600-SB-01-006	**11/13/2009**	**2-Butanone (MEK)**	**33.3**		**J**
600-SB-01-006	11/13/2009	Acetone	27.6		
600-SB-01-006	11/13/2009	Benz(a)anthracene	NA*		
600-SB-01-006	**11/13/2009**	**Bis(2-ethylhexyl) Phthalate**	**17.6**		**A**
600-SB-01-006	**11/13/2009**	**Cadmium**	**2.8**		**J**
600-SB-01-006	**11/13/2009**	**Carbon Disulfide**	**NA***		**J**
600-SB-01-006	11/13/2009	Chromium	3.6		
600-SB-01-006	11/13/2009	Chrysene	NA*		
600-SB-01-006	**11/13/2009**	**Cobalt**	**16.0**		**J**
600-SB-01-006	11/13/2009	Manganese	17.0		
600-SB-01-006	**11/13/2009**	**Mercury**	**11.1**		**J**
600-SB-01-006	**11/13/2009**	**Nitrate+Nitrite as Nitrogen**	**15.4**		**J**
600-SB-01-006	11/13/2009	Thallium	70.0		
600-SB-01-006	**11/13/2009**	**Tin, Total**	**22.2**		**J**
600-SB-01-006	**11/13/2009**	**Trichloroethene (TCE)**	**4.2**		**J**
600-SB-01-006	11/13/2009	Zinc	11.6		
600-SB-02A-003	**11/19/2009**	**2-Butanone (MEK)**	**24.0**		**J**
600-SB-02A-003	**11/19/2009**	**Benzyl Alcohol**	**32.7**		**J RB**
600-SB-02A-003	**11/19/2009**	**Cadmium**	**0.0**	**25**	**J**
600-SB-02A-003	**11/19/2009**	**Chromium**	**25.7**	**25**	**QD**
600-SB-02A-003	11/19/2009	Cobalt	34.5	**25**	
600-SB-02A-003	11/19/2009	Manganese	13.3	**25**	
600-SB-02A-003	**11/19/2009**	**Mercury**	**18.2**	**25**	**J**
600-SB-02A-003	**11/19/2009**	**Molybdenum**	**37.0**	**25**	**A**
600-SB-02A-003	**11/19/2009**	**Nitrate+Nitrite as Nitrogen**	**93.2**	**25**	**QD**
600-SB-02A-003	**11/19/2009**	**Thallium**	**56.0**	**25**	**J**
600-SB-02A-003	**11/19/2009**	**Zinc**	**35.4**	**25**	**QD**
600-SB-05-004	**11/23/2009**	**2-Butanone (MEK)**	**11.6**	**25**	**J**
600-SB-05-004	**11/23/2009**	**2-Propanol**	**NA***	**25**	**J EB**
600-SB-05-004	**11/23/2009**	**Acetone**	**14.1**	**25**	**J RB**
600-SB-05-004	**11/23/2009**	**Benzyl Alcohol**	**33.3**	**25**	**J RB**
600-SB-05-004	**11/23/2009**	**Cadmium**	**66.7**	**25**	**J**
600-SB-05-004	11/23/2009	Chromium	17.1	**25**	
600-SB-05-004	**11/23/2009**	**Cobalt**	**27.5**	**25**	**J**
600-SB-05-004	**11/23/2009**	**Manganese**	**50.3**	**25**	**QD**
600-SB-05-004	**11/23/2009**	**Mercury**	**28.6**	**25**	**J**
600-SB-05-004	**11/23/2009**	**Nitrate+Nitrite as Nitrogen**	**85.9**	**25**	**QD**
600-SB-05-004	11/23/2009	Tetrahydrofuran	NA*	**25**	
600-SB-05-004	11/23/2009	Thallium	18.5	**25**	
600-SB-05-004	**11/23/2009**	**Tin**	**0.0**	**25**	**J**
600-SB-05-004	11/23/2009	Zinc	20.8	**25**	

[1] RPD could not be calculated due to one of the duplicate samples being non-detect

Table 7 – Blank Sample Detections

Sample Location*	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
200-SB-11-8	7/1/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	9.40E-01	µg/L	J EB
200-SB-11-8	7/1/2014	Equipment Blank	Chromium, Total	2.00E-03	mg/L	J EB
200-SB-11-8	7/1/2014	Equipment Blank	Manganese	3.00E-03	mg/L	J EB
200-SB-11-8	7/1/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	3.00E-02	mg/L	J EB
200-SB-11-8	7/1/2014	Equipment Blank	Zinc	8.00E-03	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Chromium, Total	2.00E-03	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Manganese	5.00E-03	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Mercury	1.00E-04	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.90E-02	mg/L	J EB
200-SB-13-8	6/16/2014	Equipment Blank	Zinc	6.00E-03	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Acetone	2.60E+00	µg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.30E+00	µg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Chromium, Total	3.00E-03	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Manganese	6.00E-03	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Molybdenum	2.00E-03	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	2.90E-02	mg/L	J EB
200-SB-5-8	6/15/2014	Equipment Blank	Zinc	6.00E-03	mg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Acetone	2.00E+00	µg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Antimony	3.00E-04	mg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.50E+01	µg/L	EB
200-SB-6-8	6/14/2014	Equipment Blank	Chromium, Total	1.10E-02	mg/L	EB
200-SB-6-8	6/14/2014	Equipment Blank	Manganese	1.70E-02	mg/L	EB
200-SB-6-8	6/14/2014	Equipment Blank	Molybdenum	5.00E-03	mg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.40E-02	mg/L	J EB
200-SB-6-8	6/14/2014	Equipment Blank	Zinc	1.40E-02	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Acetone	1.60E+00	µg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Antimony	2.00E-04	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Carbon Disulfide	6.80E-01	µg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Chromium, Total	3.00E-03	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Manganese	6.00E-03	mg/L	J RB EB
200-SB-7-8	6/11/2014	Equipment Blank	Molybdenum	2.00E-03	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	4.30E-02	mg/L	J EB
200-SB-7-8	6/11/2014	Equipment Blank	Zinc	9.00E-03	mg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Acetone	1.50E+00	µg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Antimony	2.00E-04	mg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.10E+01	µg/L	EB
200-SB-8-8	7/13/2014	Equipment Blank	Chromium, Total	1.00E-02	mg/L	EB
200-SB-8-8	7/13/2014	Equipment Blank	Manganese	1.70E-02	mg/L	EB

Sample Location*	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
200-SB-8-8	7/13/2014	Equipment Blank	Molybdenum	7.00E-03	mg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.10E-02	mg/L	J EB
200-SB-8-8	7/13/2014	Equipment Blank	Zinc	1.00E-02	mg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Acetone	1.60E+00	µg/L	J RB EB A
200-SB-9-8	6/30/2014	Equipment Blank	Bis(2-ethylhexyl) Phthalate	3.80E+00	µg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Chromium, Total	3.00E-03	mg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Manganese	7.00E-03	mg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Molybdenum	2.00E-03	mg/L	J EB
200-SB-9-8	6/30/2014	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.90E-02	mg/L	J EB
600-SB-01-072	11/16/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.40E+00	µg/L	J RB EB
600-SB-01-072	11/16/2009	Equipment Blank	Thallium	5.00E-04	mg/L	J EB
600-SB-02-003	1/26/2010	Equipment Blank	Bis(2-ethylhexyl) Phthalate	2.00E+00	µg/L	J EB
600-SB-02-003	1/26/2010	Equipment Blank	Boron	6.00E-02	mg/L	J EB
600-SB-02-003	1/26/2010	Equipment Blank	Mercury	2.00E-05	mg/L	J EB
600-SB-02-003	1/26/2010	Equipment Blank	Zinc	4.00E-03	mg/L	J EB
600-SB-02-075	1/27/2010	Equipment Blank	Bis(2-ethylhexyl) Phthalate	6.70E-01	µg/L	J
600-SB-02-075	1/27/2010	Equipment Blank	Chromium, Total	5.00E-03	mg/L	J EB
600-SB-02-075	1/27/2010	Equipment Blank	Manganese	1.60E-02	mg/L	EB
600-SB-02-075	1/27/2010	Equipment Blank	Zinc	1.00E-02	mg/L	J EB
600-SB-02A-003	11/19/2009	Equipment Blank	Mercury	2.00E-05	mg/L	J EB
600-SB-03-006	11/19/2009	Equipment Blank	Acetone	3.40E+00	µg/L	J EB
600-SB-03-006	11/19/2009	Equipment Blank	Chromium, Total	3.00E-03	mg/L	J EB
600-SB-03-006	11/19/2009	Equipment Blank	Manganese	5.00E-03	mg/L	J EB
600-SB-03-006	11/19/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.00E-02	mg/L	J EB
600-SB-03-075	1/13/2010	Equipment Blank	Acetone	1.70E+00	µg/L	J EB
600-SB-03-075	1/13/2010	Equipment Blank	Manganese	1.00E-03	mg/L	J EB
600-SB-03-075	1/13/2010	Equipment Blank	Nitrate+Nitrite as Nitrogen	7.00E-03	mg/L	J RB EB
600-SB-03-075	1/13/2010	Equipment Blank	Zinc	4.00E-03	mg/L	J EB
600-SB-04-006	11/20/2009	Equipment Blank	Acetone	2.40E+00	µg/L	J EB
600-SB-04-006	11/20/2009	Equipment Blank	Manganese	2.00E-03	mg/L	J EB
600-SB-04-006	11/20/2009	Equipment Blank	Mercury	2.00E-05	mg/L	J EB
600-SB-04-006	11/20/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	9.00E-03	mg/L	J EB
600-SB-04-075	1/20/2010	Equipment Blank	Acetone	1.90E+00	µg/L	J TB EB
600-SB-05-004	11/23/2009	Equipment Blank	2-Propanol	1.40E+01	µg/L	J EB
600-SB-05-004	11/23/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	2.10E+00	µg/L	J EB
600-SB-05-004	11/23/2009	Equipment Blank	Manganese	4.00E-03	mg/L	J EB
600-SB-05-004	11/23/2009	Equipment Blank	Molybdenum	4.00E-03	mg/L	J EB
600-SB-05-004	11/23/2009	Equipment Blank	Thallium	1.30E-03	mg/L	J EB

Sample Location*	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
600-SB-05-077	12/17/2009	Equipment Blank	Acetone	2.80E+00	µg/L	J TB EB
600-SB-06-075	1/6/2010	Equipment Blank	Acetone	2.90E+00	µg/L	J TB EB
600-SB-07-006	11/20/2009	Equipment Blank	Acetone	2.80E+00	µg/L	J EB
600-SB-07-006	11/20/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	2.50E-01	µg/L	J RB EB
600-SB-07-006	11/20/2009	Equipment Blank	Manganese	3.00E-03	mg/L	J EB
600-SB-07-006	11/20/2009	Equipment Blank	Mercury	2.00E-05	mg/L	J EB
600-SB-07-006	11/20/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	3.00E-03	mg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	2-Propanol	3.60E+01	µg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	Acetone	5.50E+00	µg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	3.30E-01	µg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	Manganese	7.00E-03	mg/L	J RB EB
600-SB-07-078	12/2/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.40E-02	mg/L	J EB
600-SB-07-078	12/2/2009	Equipment Blank	Zinc	5.00E-03	mg/L	J EB
600-SB-07-158	12/2/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	3.00E-01	µg/L	J EB
600-SB-07-158	12/2/2009	Equipment Blank	Manganese	3.00E-03	mg/L	J RB EB
600-SB-07-158	12/2/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.70E-02	mg/L	J RB EB
600-SB-07-158	12/2/2009	Equipment Blank	Zinc	3.00E-03	mg/L	J EB
600-SB-08-006	11/20/2009	Equipment Blank	Acetone	3.30E+00	µg/L	J EB
600-SB-08-006	11/20/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	4.30E-01	µg/L	J EB RB
600-SB-08-006	11/20/2009	Equipment Blank	Manganese	2.00E-03	mg/L	J EB
600-SB-08-006	11/20/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	5.00E-03	mg/L	J EB
600-SB-08-085	12/10/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	4.60E+00	µg/L	J EB
600-SB-08-085	12/10/2009	Equipment Blank	Manganese	2.00E-03	mg/L	J EB
600-SB-08-085	12/10/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	1.80E-02	mg/L	J RB EB
600-SB-08-085	12/10/2009	Equipment Blank	Zinc	4.00E-03	mg/L	J EB
600-SB-10-001	9/18/2009	Equipment Blank	Acetone	2.20E+00	µg/L	J EB
600-SB-10-001	9/18/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.30E+00	µg/L	J EB
600-SB-10-001	9/18/2009	Equipment Blank	Manganese	2.20E-02	mg/L	EB
600-SB-10-001	9/18/2009	Equipment Blank	Zinc	1.30E-02	mg/L	J RB EB
600-SB-10-010	9/21/2009	Equipment Blank	Bis(2-ethylhexyl) Phthalate	1.60E+00	µg/L	J EB
600-SB-10-010	9/21/2009	Equipment Blank	Manganese	5.00E-03	mg/L	J EB FB
600-SB-10-010	9/21/2009	Equipment Blank	Nitrate+Nitrite as Nitrogen	6.00E-03	mg/L	J EB
600-SB-10-010	9/21/2009	Equipment Blank	Zinc	4.00E-03	mg/L	J EB FB
600-SB-10-020	9/22/2009	Equipment Blank	Acetone	2.70E+01	µg/L	J EB
600-SB-10-020	9/22/2009	Equipment Blank	Antimony	9.00E-04	mg/L	J RB EB
600-SB-10-020	9/22/2009	Equipment Blank	Cadmium	3.00E-04	mg/L	J EB
600-SB-10-020	9/22/2009	Equipment Blank	Chromium, Total	2.68E-01	mg/L	EB

Sample Location*	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
600-SB-10-020	9/22/2009	Equipment Blank	Cobalt	5.00E-03	mg/L	J EB
600-SB-10-020	9/22/2009	Equipment Blank	Manganese	3.68E-01	mg/L	EB
600-SB-10-020	9/22/2009	Equipment Blank	Molybdenum	6.00E-03	mg/L	J EB
600-SB-10-020	9/22/2009	Equipment Blank	Zinc	1.21E-01	mg/L	EB
600-SB-10-010	9/21/2009	Field Blank	Antimony	4.00E-04	mg/L	J RB FB
600-SB-10-010	9/21/2009	Field Blank	Chromium, Total	2.60E-02	mg/L	FB
600-SB-10-010	9/21/2009	Field Blank	Manganese	4.00E-02	mg/L	EB FB
600-SB-10-010	9/21/2009	Field Blank	Zinc	1.45E-01	mg/L	FB
600-SB-01-072	11/16/2009	Trip Blank	Acetone	1.90E+00	µg/L	J TB
600-SB-04-006	11/20/2009	Trip Blank	Carbon Disulfide	1.20E+00	µg/L	TB
600-SB-04-075	1/20/2010	Trip Blank	2-Propanol	2.30E+01	µg/L	J TB
600-SB-04-075	1/20/2010	Trip Blank	Acetone	3.60E+00	µg/L	J TB EB
600-SB-05-077	12/17/2009	Trip Blank	Acetone	5.30E+00	µg/L	J TB EB
600-SB-06-075	1/6/2010	Trip Blank	Acetone	2.00E+00	µg/L	J TB EB
600-SB-10-001	9/18/2009	Trip Blank	Carbon Disulfide	1.80E+00	µg/L	TB
600-SB-10-010	9/21/2009	Trip Blank	Acetone	1.80E+00	µg/L	J TB

National Aeronautics and Space Administration

Quality Assurance Report for White Sands Test Facility
200 and 600 Area Vapor Intrusion Assessment Report Vapor Analytical Data

April 2023

NM 8800019434

Report Submitted:
Report Prepared by: Will Teas
Navarro Research and Engineering, Inc.

1.0 Introduction

The 200 and 600 Area Vapor Intrusion Assessment Work Plan requires the preparation of an investigation report that includes soil analytical data reported. The Quality Assurance Report (QAR) prepared and reviewed by responsible environmental contractor data management personnel provides the following information:

- A summary of notable anomalies.
- A summary of notable data quality issues by analytical method, if any.
- A list of the sample events for which soil samples were collected in April and October 2017.
- The quantity and type of quality control samples collected or prepared in April and October 2017.
- Definitions of data qualifiers used in WSTF analytical data reporting.
- The quantity and type of data qualifiers applied to individual analytical results.
- A list of duplicate samples and their relative percent differences (RPD)
- A summary table of blank sample detections.

2.0 Data Quality

2.1 Notable Anomalies

In the 200 and 600 areas, samples collected during this investigation include soil vapor samples, indoor air samples, and outdoor air samples. These sample sets include field blanks, duplicates, trip blanks, and matrix spikes in accordance with the approved work plan.

3.0 Data Tables

Table 1 summarizes the soil vapor, indoor air, and outdoor air sample events in August 2017 and February 2018. This report is based on data quality issues related to the sample events listed in Table 1.

Table 2 through Table 6 contain information related to the sample events identified in Table 1. As specified by the Vapor Intrusion Assessment Work Plan Section 5.4, specific quality control samples are utilized to assess the quality of analytical data. Table 2 presents the quantity of quality control samples collected for each analytical method. Table 3 compares the quality control sample percentages collected to the requirements in the respective investigation work plan. When data quality criteria are not met, data qualifiers are applied to the data. Definitions of data qualifiers used for WSTF chemical analytical data are listed in Table 4. Table 5 presents the total number of individual result records and summarize the quantity of field and laboratory data qualifiers assigned to individual analyte result records in the WSTF analytical database. Table 6 provides the RPD between duplicate samples. Samples associated with qualified data are identified by bold text in Table 6. Table 7 provides all detections found in trip blank and field blank samples. All data affected by blank sample detections are appropriately qualified.

4.0 Usability Assessment

The goal of the usability assessment is to determine the quality of each data point and to identify data that are not acceptable to support project quality objectives. This QAR qualifies as the completed assessment for the soil data from samples collected for the 200 Area Phase II Investigation Report and the 600 Area Closure Investigation Report in addition to the August 2017 and February 2018 sample events performed for the 200 and 600 Area Vapor Intrusion Assessment Report. There were ten Freon 123a soil vapor detections that included a tentatively identified compound (TIC) QA flag which were excluded from the dataset. No data was rejected (R) based on established quality review protocols.

5.0 References

Table 1 – Soil Vapor, Indoor Air, and Outdoor Air Sample Events

Location Sample ID	Sample Matrix	Event Date
200-IA-1	Air	8/27/2017
		2/25/2018
200-IA-2	Air	8/27/2017
		2/25/2018
200-IA-3	Air	8/27/2017
		2/25/2018
200-IA-4	Air	8/27/2017
		2/25/2018
200-IA-5	Air	8/27/2017
		2/25/2018
200-IA-6	Air	8/27/2017
		2/25/2018
200-IA-7	Air	8/27/2017
		2/25/2018
200-IA-8	Air	8/27/2017
		2/25/2018
200-OA-1	Air	8/27/2017
		2/25/2018
200-OA-2	Air	8/27/2017
		2/25/2018
600-IA-1	Air	8/26/2017
		2/24/2018
600-IA-2	Air	8/26/2017
		2/24/2018
600-IA-3	Air	8/26/2017
		2/24/2018
600-IA-4	Air	8/26/2017
		2/24/2018
600-OA-1	Air	8/26/2017
		2/24/2018
600-OA-2	Air	8/26/2017
		2/24/2018
200-LV-150 (34 ft bgs)	Soil Vapor	8/27/2017
		2/25/2018
200-SV-05 (9 ft bgs)	Soil Vapor	8/27/2017
		2/25/2018
200-SV-09 (19 ft bgs)	Soil Vapor	8/27/2017
		2/25/2018
600-SGW-1 (12.5 ft bgs)	Soil Vapor	8/26/2017
		2/24/2018
600-SGW-2 (12.5 ft bgs)	Soil Vapor	8/26/2017
		2/24/2018

Location Sample ID	Sample Matrix	Event Date
600-SGW-5 (7.5 ft bgs)	Soil Vapor	8/26/2017
		2/24/2018

Table 2 – Quantity of Quality Control Samples (Soil Vapor, Indoor Air, and Outdoor Air)

Matrix	Method	Total Samples	Non-QA Samples	Field Blanks	Duplicates	Trip Blanks	Matrix Spikes
Indoor/Outdoor Air	TO-15	74	32	4	4	2	32
Soil Vapor	TO-15	32	12	4	4	0	12
Total		106	44	8	8	2	44

Table 3 – Quality Control Sample Percentages (Soil Vapor, Indoor Air, and Outdoor Air)

Quality Control Requirement	IWP Requirement	Sample Quantity	QC Quantity	QC %
Air, Field Blanks	4	40	8	20
Air, Trip Blanks	1 per shipment	34	2	6
Air, Duplicates	10%	40	8	20
Air, Matrix Spikes		64	32	50
Soil Vapor, Field Blanks	4	12	4	33
Soil Vapor, Trip Blanks	1 per shipment	12		0
Soil Vapor, Duplicates	10%	12	4	33
Soil Vapor, Matrix Spikes		24	12	50

Table 4 – Definitions of Data Qualifiers

Qualifier	Definition
*	User defined qualifier. See quality assurance narrative.
A	The result of an analyte for a laboratory control sample (LCS), initial calibration verification (ICV) or continuing calibration verification (CCV) was outside standard limits.
AD	Relative percent difference for analyst (laboratory) duplicates was outside standard limits.
D	The reported result is from a dilution.
EB	The analyte was detected in the equipment blank.
FB	The analyte was detected in the field blank.
G	The result is an estimated value greater than the upper calibration limit.
i	The result, quantitation limit, and/or detection limit may have been affected by matrix interference.
J	The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA	The value/result was either not analyzed for or not applicable.
ND	The analyte was not detected above the detection limit.
Q	The result for a blind control sample was outside standard limits.
QD	The relative percent difference for a field duplicate was outside standard limits.
R	The result is rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
RB	The analyte was detected in the method blank.
S	The result was determined by the method of standard addition.
SP	The matrix spike recovery and/or the relative percent difference for matrix spike duplicates was outside standard limits.
T	The sample was analyzed outside the specified holding time or temperature.
TB	The analyte was detected in the trip blank.
TIC	The analyte was tentatively identified by a GC/MS library search and the amount reported is an estimated value.

Table 5 – Quantity of Field Based Data Qualifiers Assigned to Individual Result Records (Soil Vapor, Indoor Air, and Outdoor Air)

COPC	Method	Total Records	FB	EB	TB	Q	QD	SP	R	*	A	AD	G	RB	T	D	i	J	TIC
1,1,1-Trichloroethane	TO-15	52																2	
1,1-Dichloroethene	TO-15	52																	
1,2,4-Trimethylbenzene	TO-15	52																4	
1,2-Dichloroethane	TO-15	52																1	
1,4-Dichlorobenzene	TO-15	52																1	
2,2,4-Trimethylpentane	TO-15	52																2	
2-Butanone (Methyl Ethyl Ketone)	TO-15	52	9		2													39	
2-Hexanone	TO-15	52	2															7	
2-Propanol	TO-15	52	2		1		2											7	
4-Methyl-2-pentanone	TO-15	52					2											4	
Acetone	TO-15	52	12		2		4			1								23	
Benzene	TO-15	52	2															22	
Bromodichloromethane	TO-15	52																2	
Carbon Disulfide	TO-15	52	2		1						6							7	
Carbon Tetrachloride	TO-15	52	2															36	
Chloroethane	TO-15	52																2	
Chloroform	TO-15	52	4															10	
Chloromethane	TO-15	52	8		2													37	
cis-1,2-Dichloroethene	TO-15	52																1	
Ethanol	TO-15	52	7		1		2											21	
Ethyl Benzene	TO-15	52																4	
Freon 11	TO-15	52	9				2				22								
Freon 113	TO-15	52	7		2		4									4		21	
Freon 12	TO-15	52	12		2														
Freon 123a	TO-15	52	4							26									10
Freon 21	TO-15	52																1	
Heptane	TO-15	52																4	
Hexane	TO-15	52	1		1													14	
m,p-Xylene	TO-15	52	1															4	
Methylene Chloride	TO-15	52	4		1													21	
o-Xylene	TO-15	52																4	
Styrene	TO-15	52																	
Tetrachloroethene	TO-15	52	1															2	
Tetrahydrofuran	TO-15	52																3	
Toluene	TO-15	52	5		1													17	
trans-1,2-Dichloroethene	TO-15	52	2															4	
Trichloroethene	TO-15	52	4													4		7	

Table 6 – Duplicate Sample Relative Percent Difference

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
200-IA-3	8/27/2017	1,2,4-Trimethylbenzene	104.1	25	
200-IA-3	8/27/2017	2,2,4-Trimethylpentane	NA[1]	25	
200-IA-3	8/27/2017	2-Butanone (Methyl Ethyl Ketone)	43.4	25	
200-IA-3	**8/27/2017**	**2-Hexanone**	**89.5**	**25**	**J**
200-IA-3	**8/27/2017**	**2-Propanol**	**120.0**	**25**	**QD**
200-IA-3	**8/27/2017**	**4-Methyl-2-pentanone**	**193.1**	**25**	**QD**
200-IA-3	**8/27/2017**	**Acetone**	**63.6**	**25**	**QD**
200-IA-3	**8/27/2017**	**Benzene**	**20.2**	**25**	**J**
200-IA-3	**8/27/2017**	**Carbon Tetrachloride**	**2.4**	**25**	**J**
200-IA-3	**8/27/2017**	**Chloroform**	**NA[1]**	**25**	**J**
200-IA-3	**8/27/2017**	**Chloromethane**	**8.7**	**25**	**J**
200-IA-3	**8/27/2017**	**Ethanol**	**48.6**	**25**	**QD**
200-IA-3	**8/27/2017**	**Ethyl Benzene**	**NA[1]**	**25**	**J**
200-IA-3	**8/27/2017**	**Freon 11**	**58.8**	**25**	**A QD**
200-IA-3	**8/27/2017**	**Freon 113**	**33.0**	**25**	**QD**
200-IA-3	8/27/2017	Freon 12	4.1	25	
200-IA-3	8/27/2017	Freon 21	74.5	25	
200-IA-3	**8/27/2017**	**Heptane**	**NA[1]**	**25**	**J**
200-IA-3	8/27/2017	Hexane	23.3	25	
200-IA-3	8/27/2017	m,p-Xylene	69.1	25	
200-IA-3	**8/27/2017**	**Methylene Chloride**	**NA[1]**	**25**	**J**
200-IA-3	**8/27/2017**	**o-Xylene**	**55.3**	**25**	**J**
200-IA-3	8/27/2017	Styrene	NA[1]	25	
200-IA-3	**8/27/2017**	**Tetrahydrofuran**	**NA[1]**	**25**	**J**
200-IA-3	8/27/2017	Toluene	26.7	25	
200-IA-3	**8/27/2017**	**trans-1,2-Dichloroethene**	**24.8**	**25**	**J**
200-IA-3	**8/27/2017**	**Trichloroethene**	**2.5**	**25**	**J**
200-SV-05-9	8/27/2017	1,1-Dichloroethene	2.3	25	
200-SV-05-9	**8/27/2017**	**Freon 11**	**NA[1]**	**25**	**A**
200-SV-05-9	8/27/2017	Freon 113	0.0	25	

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
200-SV-05-9	8/27/2017	Tetrachloroethene	3.2	25	
200-SV-05-9	8/27/2017	Trichloroethene	2.5	25	
600-IA-4	**8/26/2017**	**2-Butanone (Methyl Ethyl Ketone)**	**33.0**	**25**	**J**
600-IA-4	8/26/2017	2-Hexanone	11.5	25	
600-IA-4	8/26/2017	2-Propanol	30.5	25	
600-IA-4	**8/26/2017**	**4-Methyl-2-pentanone**	**0.0**	**25**	**J**
600-IA-4	**8/26/2017**	**Acetone**	**43.5**	**25**	**QD**
600-IA-4	**8/26/2017**	**Benzene**	**NA[1]**	**25**	**J**
600-IA-4	**8/26/2017**	**Carbon Tetrachloride**	**15.8**	**25**	**J**
600-IA-4	**8/26/2017**	**Chloromethane**	**3.1**	**25**	**J**
600-IA-4	**8/26/2017**	**Ethanol**	**121.3**	**25**	**J**
600-IA-4	**8/26/2017**	**Freon 11**	**0.0**	**25**	**A**
600-IA-4	**8/26/2017**	**Freon 113**	**4.3**	**25**	**J**
600-IA-4	8/26/2017	Freon 12	4.4	25	
600-IA-4	**8/26/2017**	**Heptane**	**NA[1]**	**25**	**J**
600-IA-4	**8/26/2017**	**Hexane**	**5.2**	**25**	**J**
600-IA-4	**8/26/2017**	**Toluene**	**47.4**	**25**	**J**
600-SGW-5-7.5	**8/26/2017**	**2-Butanone (Methyl Ethyl Ketone)**	**51.9**	**25**	**J FB**
600-SGW-5-7.5	**8/26/2017**	**Acetone**	**31.6**	**25**	**J FB**
600-SGW-5-7.5	**8/26/2017**	**Carbon Disulfide**	**NA[1]**	**25**	**J A FB**
600-SGW-5-7.5	**8/26/2017**	**Chloroform**	**12.5**	**25**	**J FB**
600-SGW-5-7.5	8/26/2017	Ethanol	NA[1]	25	
600-SGW-5-7.5	**8/26/2017**	**Freon 11**	**177.7**	**25**	**A FB**
600-SGW-5-7.5	**8/26/2017**	**Freon 113**	**26.5**	**25**	**QD FB**
600-SGW-5-7.5	**8/26/2017**	**Freon 12**	**4.3**	**25**	**FB**
600-SGW-5-7.5	8/26/2017	Methylene Chloride	NA[1]	25	
600-SGW-5-7.5	8/26/2017	Toluene	NA[1]	25	
600-SGW-5-7.5	**8/26/2017**	**Trichloroethene**	**9.5**	**25**	**FB**
200-IA-3	**2/25/2018**	**2-Butanone (Methyl Ethyl Ketone)**	**106.0**	**25**	**J**
200-IA-3	2/25/2018	2-Propanol	13.3	25	

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
200-IA-3	**2/25/2018**	**Acetone**	**61.5**	**25**	**J**
200-IA-3	**2/25/2018**	**Benzene**	**2.7**	**25**	**J**
200-IA-3	**2/25/2018**	**Carbon Tetrachloride**	**7.6**	**25**	**J**
200-IA-3	**2/25/2018**	**Chloroform**	**13.7**	**25**	**J**
200-IA-3	**2/25/2018**	**Chloromethane**	**5.1**	**25**	**J**
200-IA-3	**2/25/2018**	**Ethanol**	**7.4**	**25**	**J**
200-IA-3	2/25/2018	Freon 11	2.3	25	
200-IA-3	2/25/2018	Freon 113	13.3	25	
200-IA-3	2/25/2018	Freon 12	7.7	25	
200-IA-3	2/25/2018	Hexane	9.5	25	
200-IA-3	**2/25/2018**	**Methylene Chloride**	**4.8**	**25**	**J**
200-IA-3	2/25/2018	Toluene	0.0	25	
200-IA-3	**2/25/2018**	**Trichloroethene**	**20.7**	**25**	**J**
200-SV-05-9	2/25/2018	1,1-Dichloroethene	3.8	25	
200-SV-05-9	2/25/2018	Freon 113	3.6	25	
200-SV-05-9	2/25/2018	Tetrachloroethene	1.9	25	
200-SV-05-9	2/25/2018	Trichloroethene	3.9	25	
600-IA-1	**2/24/2018**	**2-Butanone (Methyl Ethyl Ketone)**	**18.9**	**25**	**J FB**
600-IA-1	**2/24/2018**	**Acetone**	**13.6**	**25**	**J FB**
600-IA-1	**2/24/2018**	**Benzene**	**5.1**	**25**	**J**
600-IA-1	**2/24/2018**	**Carbon Tetrachloride**	**6.9**	**25**	**J**
600-IA-1	**2/24/2018**	**Chloromethane**	**12.2**	**25**	**J FB**
600-IA-1	**2/24/2018**	**Ethanol**	**54.5**	**25**	**J FB**
600-IA-1	**2/24/2018**	**Freon 11**	**7.4**	**25**	**FB**
600-IA-1	**2/24/2018**	**Freon 113**	**1.8**	**25**	**J**
600-IA-1	**2/24/2018**	**Freon 12**	**4.4**	**25**	**FB**
600-IA-1	**2/24/2018**	**Methylene Chloride**	**3.7**	**25**	**J FB**
600-IA-1	2/24/2018	Toluene	NA[1]	25	
600-SGW-5-7.5	**2/24/2018**	**2-Butanone (Methyl Ethyl Ketone)**	**77.8**	**25**	**J FB**
600-SGW-5-7.5	**2/24/2018**	**2-Hexanone**	**NA[1]**	**25**	**J FB**

Sample Location	Sample Date	Analyte	RPD (%)	RPD Upper Acceptance Limit (%)	QA Flag
600-SGW-5-7.5	**2/24/2018**	**Acetone**	**34.8**	**25**	**FB**
600-SGW-5-7.5	**2/24/2018**	**Chloroform**	**0.0**	**25**	**J FB**
600-SGW-5-7.5	**2/24/2018**	**Freon 11**	**3.8**	**25**	**FB**
600-SGW-5-7.5	**2/24/2018**	**Freon 113**	**0.0**	**25**	**FB**
600-SGW-5-7.5	**2/24/2018**	**Freon 12**	**0.0**	**25**	**FB**
600-SGW-5-7.5	**2/24/2018**	**Tetrachloroethene**	**NA[1]**	**25**	**J FB**
600-SGW-5-7.5	**2/24/2018**	**Trichloroethene**	**2.4**	**25**	**FB**

[1]RPD could not be calculated due to one of the duplicate samples being non-detect

Table 7 – Blank Sample Detections

Sample Location[1]	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
200-IA-7	8/27/2017	Field Blank	2-Butanone (Methyl Ethyl Ketone)	1.9	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	2-Propanol	14.0	UG/M3	FB
200-IA-7	8/27/2017	Field Blank	Acetone	17.0	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Chloromethane	0.6	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Ethanol	15.0	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Freon 11	3.9	UG/M3	A FB
200-IA-7	8/27/2017	Field Blank	Freon 113	25.0	UG/M3	FB
200-IA-7	8/27/2017	Field Blank	Freon 12	2.8	UG/M3	FB
200-IA-7	8/27/2017	Field Blank	Tetrachloroethene	0.6	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Tetrahydrofuran	45.0	UG/M3	FB
200-IA-7	8/27/2017	Field Blank	Toluene	1.0	UG/M3	J FB
200-IA-7	8/27/2017	Field Blank	Trichloroethene	2.7	UG/M3	FB
200-SV-09-19	8/27/2017	Field Blank	2-Butanone (Methyl Ethyl Ketone)	2.3	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	2-Propanol	0.8	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Acetone	12.0	UG/M3	FB
200-SV-09-19	8/27/2017	Field Blank	Benzene	0.4	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Carbon Tetrachloride	0.4	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Ethanol	1.6	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Freon 11	1.0	UG/M3	A FB
200-SV-09-19	8/27/2017	Field Blank	Freon 113	0.5	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Freon 12	2.0	UG/M3	FB
200-SV-09-19	8/27/2017	Field Blank	Hexane	0.4	UG/M3	J FB
200-SV-09-19	8/27/2017	Field Blank	Tetrahydrofuran	3.9	UG/M3	FB
600-IA-1	8/26/2017	Field Blank	1,4-Dioxane	1.5	UG/M3	J FB
600-IA-1	8/26/2017	Field Blank	2-Butanone (Methyl Ethyl Ketone)	5.9	UG/M3	J FB
600-IA-1	8/26/2017	Field Blank	2-Hexanone	0.9	UG/M3	J FB

Sample Location[1]	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
600-IA-1	8/26/2017	Field Blank	Acetone	62.0	UG/M3	FB
600-IA-1	8/26/2017	Field Blank	Carbon Disulfide	130.0	UG/M3	A FB
600-IA-1	8/26/2017	Field Blank	Chloromethane	0.8	UG/M3	J FB
600-IA-1	8/26/2017	Field Blank	Ethanol	9.1	UG/M3	J FB
600-IA-1	8/26/2017	Field Blank	Freon 11	1.2	UG/M3	J A FB
600-IA-1	8/26/2017	Field Blank	Freon 12	2.3	UG/M3	FB
600-IA-1	8/26/2017	Field Blank	Tetrahydrofuran	0.9	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	2-Butanone (Methyl Ethyl Ketone)	4.2	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Acetone	23.0	UG/M3	FB
600-SGW-1-12.5	8/26/2017	Field Blank	Benzene	1.0	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Carbon Disulfide	13.0	UG/M3	J A FB
600-SGW-1-12.5	8/26/2017	Field Blank	Chloromethane	0.7	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Cyclohexane	2.1	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Ethanol	4.6	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Freon 11	1.2	UG/M3	J A FB
600-SGW-1-12.5	8/26/2017	Field Blank	Freon 113	0.8	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Freon 12	2.3	UG/M3	FB
600-SGW-1-12.5	8/26/2017	Field Blank	Hexane	1.4	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	m,p-Xylene	1.9	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Styrene	0.8	UG/M3	J FB
600-SGW-1-12.5	8/26/2017	Field Blank	Toluene	6.2	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	2-Propanol	2.7	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Acetone	5.9	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Carbon Tetrachloride	0.4	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Chloromethane	0.6	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Ethanol	1.8	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Freon 11	1.9	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Freon 113	12.0	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Freon 12	2.4	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Methylene Chloride	0.4	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	Toluene	0.5	UG/M3	J FB
200-IA-8	2/25/2018	Field Blank	trans-1,2-Dichloroethene	1.6	UG/M3	FB
200-IA-8	2/25/2018	Field Blank	Trichloroethene	0.4	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Acetone	8.1	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Chloromethane	1.1	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Freon 11	1.2	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Freon 113	6.9	UG/M3	FB
200-SV-09-19	2/25/2018	Field Blank	Freon 12	2.4	UG/M3	FB
200-SV-09-19	2/25/2018	Field Blank	Methylene Chloride	0.7	UG/M3	J FB
200-SV-09-19	2/25/2018	Field Blank	Tetrachloroethene	2.7	UG/M3	FB
200-SV-09-19	2/25/2018	Field Blank	Trichloroethene	15.0	UG/M3	FB

Sample Location[1]	Sample Date	QA Sample Type	Analyte Detected	Concentration	Units	QA Flag
600-IA-1	2/24/2018	Field Blank	2-Butanone (Methyl Ethyl Ketone)	0.9	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Acetone	14.0	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Carbon Disulfide	2.6	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Chloromethane	1.1	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Ethanol	5.1	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Freon 11	1.4	UG/M3	J FB
600-IA-1	2/24/2018	Field Blank	Freon 12	2.3	UG/M3	FB
600-IA-1	2/24/2018	Field Blank	Methylene Chloride	0.9	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	2-Butanone (Methyl Ethyl Ketone)	3.6	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	2-Propanol	9.1	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Acetone	14.0	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Benzene	2.6	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Carbon Disulfide	6.3	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Chloromethane	1.0	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Cyclohexane	9.5	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Ethanol	9.1	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Freon 11	1.2	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Freon 113	0.9	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Freon 12	2.3	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Heptane	2.1	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Hexane	5.9	UG/M3	FB
600-SGW-1-12.5	2/24/2018	Field Blank	Methylene Chloride	1.3	UG/M3	J FB
600-SGW-1-12.5	2/24/2018	Field Blank	Toluene	20.0	UG/M3	FB
200-OA-1	2/25/2018	Trip Blank	2-Propanol	15.0	UG/M3	TB
200-OA-1	2/25/2018	Trip Blank	Freon 113	2.4	UG/M3	J TB
200-OA-1	2/25/2018	Trip Blank	Freon 12	2.4	UG/M3	J TB
200-OA-1	2/25/2018	Trip Blank	o-Xylene	1.4	UG/M3	J TB

[1] There were no detections in the Trip Blank (200-IA-7) collected on August 27, 2017.

~~Appendix C~~Appendix D

UCL95 Results for Cumulative Risk Assessment

1		**Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects**
2	**User Selected Options**	
3	Date/Time of Computation	ProUCL 5.2 4/2/2023 10:03:59 PM
4	From File	UCL95_input_Revised.xls
5	Full Precision	OFF
6	Confidence Coefficient	0.95
7		
8		
9	**200_Soil_NO2/NO3**	
10		
11	**Raw Statistics**	
12	Number of Valid Observations	8
13	Number of Distinct Observations	8
14	Minimum	0.6
15	Maximum	7.4
16	Mean of Raw Data	2.9
17	Standard Deviation of Raw Data	2.479
18	Khat	1.594
19	Theta hat	1.82
20	Kstar	1.079
21	Theta star	2.687
22	Mean of Log Transformed Data	0.719
23	Standard Deviation of Log Transformed Data	0.909
24		
25	**Normal GOF Test Results**	
26		
27	Correlation Coefficient R	0.925
28	Shapiro Wilk Test Statistic	0.847
29	Shapiro Wilk Critical (0.05) Value	0.818
30	Approximate Shapiro Wilk P Value	0.11
31	Lilliefors Test Statistic	0.296
32	Lilliefors Critical (0.05) Value	0.283
33	**Data appear Approximate Normal at (0.05) Significance Level**	
34		
35	**Gamma GOF Test Results**	
36		
37	Correlation Coefficient R	0.972
38	A-D Test Statistic	0.421
39	A-D Critical (0.05) Value	0.728
40	K-S Test Statistic	0.236
41	K-S Critical(0.05) Value	0.299
42	**Data appear Gamma Distributed at (0.05) Significance Level**	
43		

44	**Lognormal GOF Test Results**	
45		
46	Correlation Coefficient R	0.974
47	Shapiro Wilk Test Statistic	0.932
48	Shapiro Wilk Critical (0.05) Value	0.818
49	Approximate Shapiro Wilk P Value	0.677
50	Lilliefors Test Statistic	0.194
51	Lilliefors Critical (0.05) Value	0.283
52	**Data appear Lognormal at (0.05) Significance Level**	
53		
54	200_BG2_NO2/NO3	
55		
56	**Raw Statistics**	
57	Number of Valid Observations	36
58	Number of Distinct Observations	15
59	Minimum	0.5
60	Maximum	3.1
61	Mean of Raw Data	1.225
62	Standard Deviation of Raw Data	0.533
63	Khat	7.222
64	Theta hat	0.17
65	Kstar	6.638
66	Theta star	0.185
67	Mean of Log Transformed Data	0.132
68	Standard Deviation of Log Transformed Data	0.364
69		
70	**Normal GOF Test Results**	
71		
72	Correlation Coefficient R	0.882
73	Shapiro Wilk Test Statistic	0.792
74	Shapiro Wilk Critical (0.05) Value	0.935
75	Approximate Shapiro Wilk P Value	2.2301E-6
76	Lilliefors Test Statistic	0.191
77	Lilliefors Critical (0.05) Value	0.145
78	**Data not Normal at (0.05) Significance Level**	
79		
80	**Gamma GOF Test Results**	
81		
82	Correlation Coefficient R	0.938
83	A-D Test Statistic	1.244
84	A-D Critical (0.05) Value	0.749
85	K-S Test Statistic	0.184
86	K-S Critical(0.05) Value	0.147
87	**Data not Gamma Distributed at (0.05) Significance Level**	
88		

	A	B	C	D	E	F	G	H	I	J	K	L
89	**Lognormal GOF Test Results**											
90												
91	Correlation Coefficient R					0.964						
92	Shapiro Wilk Test Statistic					0.941						
93	Shapiro Wilk Critical (0.05) Value					0.935						
94	Approximate Shapiro Wilk P Value					0.0699						
95	Lilliefors Test Statistic					0.169						
96	Lilliefors Critical (0.05) Value					0.145						
97	**Data appear Approximate_Lognormal at (0.05) Significance Level**											

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:49:38 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 200_Soil_NO2/NO3

Sample 2 Data: 200_BG2_NO2/NO3

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	8	36
Number of Non-Detects	1	0
Number of Detect Data	7	36
Minimum Non-Detect	0.6	N/A
Maximum Non-Detect	0.6	N/A
Percent Non-detects	12.50%	0.00%
Minimum Detect	0.8	0.5
Maximum Detect	7.4	3.1
Mean of Detects	3.229	1.225
Median of Detects	1.8	1
SD of Detects	2.482	0.533
KM Mean	2.9	1.225
KM SD	2.319	0.533

Sample 1 vs Sample 2 Gehan Test

H0: Mean/Median of Sample 1 <= Mean/Median of background

Gehan z Test Value	1.628
Critical z (0.05)	1.645
P-Value	0.0518

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Tarone-Ware Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:50:46 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 200_Soil_NO2/NO3

Sample 2 Data: 200_BG2_NO2/NO3

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	8	36
Number of Non-Detects	1	0
Number of Detects	7	36
Minimum Non-Detect	0.6	N/A
Maximum Non-Detect	0.6	N/A
Percent Non-detects	12.50%	0.00%
Minimum Detect	0.8	0.5
Maximum Detect	7.4	3.1
Mean of Detects	3.229	1.225
Median of Detects	1.8	1
SD of Detects	2.482	0.533
KM Mean	2.9	1.225
KM SD	2.319	0.533

Sample 1 vs Sample 2 Tarone-Ware Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

TW Statistic	1.539
TW Critical Value (0.05)	1.645
P-Value	0.0619

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:18:04 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean <= Sample 2 Mean (Form 1)
Alternative Hypothesis	Sample 1 Mean > the Sample 2 Mean

Sample 1 Data: 600 Barium 0-10

Sample 2 Data: 600 BG4 Barium 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	15	33
Minimum	36.4	42.2
Maximum	338	383
Mean	142.4	114.1
Median	151	94.85
SD	77.81	67.71
SE of Mean	20.09	11.28

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 - Mean of Sample 2 <= 0

Method	DF	t-Test Value	Critical t (0.05)	P-Value
Pooled (Equal Variance)	49	1.299	1.677	0.100
Welch-Satterthwaite (Unequal Varian	23.3	1.226	1.714	0.116

Pooled SD 70.743

Conclusion with Alpha = 0.050

Student t (Pooled) Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Welch-Satterthwaite Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

	A	B	C	D	E	F	G	H	I	J	K	L
41	**Test of Equality of Variances**											
42												
43	Variance of Sample 1				6055							
44	Variance of Sample 2				4584							
45												
46	Numerator DF		Denominator DF		F-Test Value		P-Value					
47	14		35		1.321		0.490					
48	Conclusion with Alpha = 0.05											
49	Two variances appear to be equal											
50												

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:21:18 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Barium 0-10

Sample 2 Data: 600 BG4 Barium 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	15	33
Minimum	36.4	42.2
Maximum	338	383
Mean	142.4	114.1
Median	151	94.85
SD	77.81	67.71
SE of Mean	20.09	11.28

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	457
Standardized WMW U-Stat	1.375
Mean (U)	270
SD(U) - Adj ties	48.37
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.0846

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

1		**Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects**
2	**User Selected Options**	
3	Date/Time of Computation	ProUCL 5.2 3/6/2023 12:09:56 AM
4	From File	UCL95_input_Revised.xls
5	Full Precision	OFF
6	Confidence Coefficient	0.95
7		
8		
9	**600 Barium 0-10**	
10		
11	**Raw Statistics**	
12	Number of Valid Observations	15
13	Number of Distinct Observations	15
14	Minimum	36.4
15	Maximum	338
16	Mean of Raw Data	142.4
17	Standard Deviation of Raw Data	77.81
18	Khat	3.575
19	Theta hat	39.82
20	Kstar	2.904
21	Theta star	49.01
22	Mean of Log Transformed Data	4.812
23	Standard Deviation of Log Transformed Data	0.582
24		
25	**Normal GOF Test Results**	
26		
27	Correlation Coefficient R	0.951
28	Shapiro Wilk Test Statistic	0.914
29	Shapiro Wilk Critical (0.05) Value	0.881
30	Approximate Shapiro Wilk P Value	0.14
31	Lilliefors Test Statistic	0.166
32	Lilliefors Critical (0.05) Value	0.22
33	**Data appear Normal at (0.05) Significance Level**	
34		
35	**Gamma GOF Test Results**	
36		
37	Correlation Coefficient R	0.979
38	A-D Test Statistic	0.366
39	A-D Critical (0.05) Value	0.742
40	K-S Test Statistic	0.184
41	K-S Critical(0.05) Value	0.223
42	**Data appear Gamma Distributed at (0.05) Significance Level**	
43		

	A	B	C	D	E	F	G	H	I	J	K	L
44	**Lognormal GOF Test Results**											
45												
46	Correlation Coefficient R					0.976						
47	Shapiro Wilk Test Statistic					0.957						
48	Shapiro Wilk Critical (0.05) Value					0.881						
49	Approximate Shapiro Wilk P Value					0.597						
50	Lilliefors Test Statistic					0.211						
51	Lilliefors Critical (0.05) Value					0.22						
52	**Data appear Lognormal at (0.05) Significance Level**											
53												
54	**600 BG4 Barium 0-12**											
55												
56	**Raw Statistics**											
57	Number of Valid Observations					36						
58	Number of Distinct Observations					33						
59	Minimum					42.2						
60	Maximum					383						
61	Mean of Raw Data					114.1						
62	Standard Deviation of Raw Data					67.71						
63	Khat					4.383						
64	Theta hat					26.04						
65	Kstar					4.036						
66	Theta star					28.27						
67	Mean of Log Transformed Data					4.619						
68	Standard Deviation of Log Transformed Data					0.465						
69												
70	**Normal GOF Test Results**											
71												
72	Correlation Coefficient R					0.847						
73	Shapiro Wilk Test Statistic					0.736						
74	Shapiro Wilk Critical (0.05) Value					0.935						
75	Approximate Shapiro Wilk P Value					8.1232E-8						
76	Lilliefors Test Statistic					0.219						
77	Lilliefors Critical (0.05) Value					0.145						
78	**Data not Normal at (0.05) Significance Level**											
79												
80	**Gamma GOF Test Results**											
81												
82	Correlation Coefficient R					0.924						
83	A-D Test Statistic					1.012						
84	A-D Critical (0.05) Value					0.752						
85	K-S Test Statistic					0.143						
86	K-S Critical(0.05) Value					0.147						
87	**Data follow Appr. Gamma Distribution at (0.05) Significance Level**											
88												

89	**Lognormal GOF Test Results**	
90		
91	Correlation Coefficient R	0.973
92	Shapiro Wilk Test Statistic	0.952
93	Shapiro Wilk Critical (0.05) Value	0.935
94	Approximate Shapiro Wilk P Value	0.159
95	Lilliefors Test Statistic	0.108
96	Lilliefors Critical (0.05) Value	0.145
97	**Data appear Lognormal at (0.05) Significance Level**	
98		
99	**600 Beryllium 0-10**	
100		
101	**Raw Statistics**	
102	Number of Valid Observations	15
103	Number of Distinct Observations	13
104	Minimum	0.34
105	Maximum	0.72
106	Mean of Raw Data	0.45
107	Standard Deviation of Raw Data	0.103
108	Khat	23.3
109	Theta hat	0.0193
110	Kstar	18.69
111	Theta star	0.0241
112	Mean of Log Transformed Data	-0.82
113	Standard Deviation of Log Transformed Data	0.21
114		
115	**Normal GOF Test Results**	
116		
117	Correlation Coefficient R	0.937
118	Shapiro Wilk Test Statistic	0.882
119	Shapiro Wilk Critical (0.05) Value	0.881
120	Approximate Shapiro Wilk P Value	0.0495
121	Lilliefors Test Statistic	0.167
122	Lilliefors Critical (0.05) Value	0.22
123	**Data appear Normal at (0.05) Significance Level**	
124		
125	**Gamma GOF Test Results**	
126		
127	Correlation Coefficient R	0.962
128	A-D Test Statistic	0.382
129	A-D Critical (0.05) Value	0.735
130	K-S Test Statistic	0.139
131	K-S Critical(0.05) Value	0.221
132	**Data appear Gamma Distributed at (0.05) Significance Level**	
133		

	A	B	C	D	E	F	G	H	I	J	K	L
134	**Lognormal GOF Test Results**											
135												
136	Correlation Coefficient R					0.969						
137	Shapiro Wilk Test Statistic					0.937						
138	Shapiro Wilk Critical (0.05) Value					0.881						
139	Approximate Shapiro Wilk P Value					0.36						
140	Lilliefors Test Statistic					0.126						
141	Lilliefors Critical (0.05) Value					0.22						
142	**Data appear Lognormal at (0.05) Significance Level**											
143												
144	**600 BG4 Beryllium 0-12**											
145												
146	**Raw Statistics**											
147	Number of Valid Observations					36						
148	Number of Distinct Observations					27						
149	Minimum					0.17						
150	Maximum					0.72						
151	Mean of Raw Data					0.471						
152	Standard Deviation of Raw Data					0.119						
153	Khat					13.66						
154	Theta hat					0.0345						
155	Kstar					12.54						
156	Theta star					0.0376						
157	Mean of Log Transformed Data					-0.789						
158	Standard Deviation of Log Transformed Data					0.292						
159												
160	**Normal GOF Test Results**											
161												
162	Correlation Coefficient R					0.992						
163	Shapiro Wilk Test Statistic					0.986						
164	Shapiro Wilk Critical (0.05) Value					0.935						
165	Approximate Shapiro Wilk P Value					0.943						
166	Lilliefors Test Statistic					0.106						
167	Lilliefors Critical (0.05) Value					0.145						
168	**Data appear Normal at (0.05) Significance Level**											
169												
170	**Gamma GOF Test Results**											
171												
172	Correlation Coefficient R					0.975						
173	A-D Test Statistic					0.529						
174	A-D Critical (0.05) Value					0.748						
175	K-S Test Statistic					0.116						
176	K-S Critical(0.05) Value					0.147						
177	**Data appear Gamma Distributed at (0.05) Significance Level**											
178												

179	**Lognormal GOF Test Results**	
180		
181	Correlation Coefficient R	0.953
182	Shapiro Wilk Test Statistic	0.919
183	Shapiro Wilk Critical (0.05) Value	0.935
184	Approximate Shapiro Wilk P Value	0.0138
185	Lilliefors Test Statistic	0.112
186	Lilliefors Critical (0.05) Value	0.145
187	**Data appear Approximate_Lognormal at (0.05) Significance Level**	
188		
189	**600 Cadmium 0-10**	
190		
191	**Raw Statistics**	
192	Number of Valid Observations	15
193	Number of Distinct Observations	13
194	Minimum	0.09
195	Maximum	0.36
196	Mean of Raw Data	0.187
197	Standard Deviation of Raw Data	0.0727
198	Khat	7.519
199	Theta hat	0.0248
200	Kstar	6.059
201	Theta star	0.0308
202	Mean of Log Transformed Data	-1.746
203	Standard Deviation of Log Transformed Data	0.381
204		
205	**Normal GOF Test Results**	
206		
207	Correlation Coefficient R	0.968
208	Shapiro Wilk Test Statistic	0.939
209	Shapiro Wilk Critical (0.05) Value	0.881
210	Approximate Shapiro Wilk P Value	0.363
211	Lilliefors Test Statistic	0.124
212	Lilliefors Critical (0.05) Value	0.22
213	**Data appear Normal at (0.05) Significance Level**	
214		
215	**Gamma GOF Test Results**	
216		
217	Correlation Coefficient R	0.991
218	A-D Test Statistic	0.187
219	A-D Critical (0.05) Value	0.738
220	K-S Test Statistic	0.124
221	K-S Critical(0.05) Value	0.222
222	**Data appear Gamma Distributed at (0.05) Significance Level**	
223		

	A	B	C	D	E	F	G	H	I	J	K	L
224	**Lognormal GOF Test Results**											
225												
226	Correlation Coefficient R					0.994						
227	Shapiro Wilk Test Statistic					0.985						
228	Shapiro Wilk Critical (0.05) Value					0.881						
229	Approximate Shapiro Wilk P Value					0.989						
230	Lilliefors Test Statistic					0.113						
231	Lilliefors Critical (0.05) Value					0.22						
232	**Data appear Lognormal at (0.05) Significance Level**											
233												
234	**600 BG4 Cadmium 0-12**											
235												
236	**Raw Statistics**											
237	Number of Valid Observations					36						
238	Number of Distinct Observations					10						
239	Minimum					0.06						
240	Maximum					0.21						
241	Mean of Raw Data					0.0847						
242	Standard Deviation of Raw Data					0.0365						
243	Khat					8.066						
244	Theta hat					0.0105						
245	Kstar					7.413						
246	Theta star					0.0114						
247	Mean of Log Transformed Data					-2.532						
248	Standard Deviation of Log Transformed Data					0.331						
249												
250	**Normal GOF Test Results**											
251												
252	Correlation Coefficient R					0.779						
253	Shapiro Wilk Test Statistic					0.615						
254	Shapiro Wilk Critical (0.05) Value					0.935						
255	Approximate Shapiro Wilk P Value					1.578E-10						
256	Lilliefors Test Statistic					0.434						
257	Lilliefors Critical (0.05) Value					0.145						
258	**Data not Normal at (0.05) Significance Level**											
259												
260	**Gamma GOF Test Results**											
261												
262	Correlation Coefficient R					0.855						
263	A-D Test Statistic					5.712						
264	A-D Critical (0.05) Value					0.749						
265	K-S Test Statistic					0.435						
266	K-S Critical(0.05) Value					0.147						
267	**Data not Gamma Distributed at (0.05) Significance Level**											
268												

	A	B	C	D	E	F	G	H	I	J	K	L
269	**Lognormal GOF Test Results**											
270												
271	Correlation Coefficient R					0.824						
272	Shapiro Wilk Test Statistic					0.679						
273	Shapiro Wilk Critical (0.05) Value					0.935						
274	Approximate Shapiro Wilk P Value					3.7477E-9						
275	Lilliefors Test Statistic					0.428						
276	Lilliefors Critical (0.05) Value					0.145						
277	**Data not Lognormal at (0.05) Significance Level**											
278												
279	**Non-parametric GOF Test Results**											
280												
281	**Data do not follow a discernible distribution at (0.05) Level of Significanc**											
282												
283	**600 Chromium 0-10**											
284												
285	**Raw Statistics**											
286	Number of Valid Observations					15						
287	Number of Distinct Observations					14						
288	Minimum					4.88						
289	Maximum					16.7						
290	Mean of Raw Data					8.633						
291	Standard Deviation of Raw Data					3.716						
292	Khat					7.17						
293	Theta hat					1.204						
294	Kstar					5.78						
295	Theta star					1.493						
296	Mean of Log Transformed Data					2.084						
297	Standard Deviation of Log Transformed Data					0.373						
298												
299	**Normal GOF Test Results**											
300												
301	Correlation Coefficient R					0.884						
302	Shapiro Wilk Test Statistic					0.779						
303	Shapiro Wilk Critical (0.05) Value					0.881						
304	Approximate Shapiro Wilk P Value					0.00173						
305	Lilliefors Test Statistic					0.28						
306	Lilliefors Critical (0.05) Value					0.22						
307	**Data not Normal at (0.05) Significance Level**											
308												

	A	B	C	D	E	F	G	H	I	J	K	L
309	**Gamma GOF Test Results**											
310												
311	Correlation Coefficient R					0.93						
312	A-D Test Statistic					1.101						
313	A-D Critical (0.05) Value					0.738						
314	K-S Test Statistic					0.238						
315	K-S Critical(0.05) Value					0.222						
316	**Data not Gamma Distributed at (0.05) Significance Level**											
317												
318	**Lognormal GOF Test Results**											
319												
320	Correlation Coefficient R					0.937						
321	Shapiro Wilk Test Statistic					0.873						
322	Shapiro Wilk Critical (0.05) Value					0.881						
323	Approximate Shapiro Wilk P Value					0.0408						
324	Lilliefors Test Statistic					0.212						
325	Lilliefors Critical (0.05) Value					0.22						
326	**Data appear Approximate_Lognormal at (0.05) Significance Level**											
327												
328	**600 BG4 Chromium 0-12**											
329												
330	**Raw Statistics**											
331	Number of Valid Observations					36						
332	Number of Distinct Observations					36						
333	Minimum					3.44						
334	Maximum					9.8						
335	Mean of Raw Data					6.296						
336	Standard Deviation of Raw Data					1.607						
337	Khat					15.1						
338	Theta hat					0.417						
339	Kstar					13.86						
340	Theta star					0.454						
341	Mean of Log Transformed Data					1.806						
342	Standard Deviation of Log Transformed Data					0.267						
343												
344	**Normal GOF Test Results**											
345												
346	Correlation Coefficient R					0.986						
347	Shapiro Wilk Test Statistic					0.962						
348	Shapiro Wilk Critical (0.05) Value					0.935						
349	Approximate Shapiro Wilk P Value					0.315						
350	Lilliefors Test Statistic					0.113						
351	Lilliefors Critical (0.05) Value					0.145						
352	**Data appear Normal at (0.05) Significance Level**											
353												

Gamma GOF Test Results

Correlation Coefficient R	0.983
A-D Test Statistic	0.614
A-D Critical (0.05) Value	0.747
K-S Test Statistic	0.129
K-S Critical(0.05) Value	0.147

Data appear Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.981
Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Critical (0.05) Value	0.935
Approximate Shapiro Wilk P Value	0.161
Lilliefors Test Statistic	0.143
Lilliefors Critical (0.05) Value	0.145

Data appear Lognormal at (0.05) Significance Level

600 Cobalt 0-10

Raw Statistics

Number of Valid Observations	15
Number of Distinct Observations	14
Minimum	1.8
Maximum	6.8
Mean of Raw Data	3.58
Standard Deviation of Raw Data	1.472
Khat	6.759
Theta hat	0.53
Kstar	5.451
Theta star	0.657
Mean of Log Transformed Data	1.2
Standard Deviation of Log Transformed Data	0.401

Normal GOF Test Results

Correlation Coefficient R	0.962
Shapiro Wilk Test Statistic	0.92
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	0.215
Lilliefors Test Statistic	0.174
Lilliefors Critical (0.05) Value	0.22

Data appear Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.987
A-D Test Statistic	0.306
A-D Critical (0.05) Value	0.738
K-S Test Statistic	0.121
K-S Critical(0.05) Value	0.222

Data appear Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.986
Shapiro Wilk Test Statistic	0.96
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	0.757
Lilliefors Test Statistic	0.114
Lilliefors Critical (0.05) Value	0.22

Data appear Lognormal at (0.05) Significance Level

600 BG4 Cobalt 0-12

Raw Statistics

Number of Valid Observations	37
Number of Distinct Observations	34
Minimum	2.12
Maximum	4.6
Mean of Raw Data	3.329
Standard Deviation of Raw Data	0.727
Khat	20.88
Theta hat	0.159
Kstar	19.2
Theta star	0.173
Mean of Log Transformed Data	1.179
Standard Deviation of Log Transformed Data	0.225

Normal GOF Test Results

Correlation Coefficient R	0.978
Shapiro Wilk Test Statistic	0.935
Shapiro Wilk Critical (0.05) Value	0.936
Approximate Shapiro Wilk P Value	0.0428
Lilliefors Test Statistic	0.106
Lilliefors Critical (0.05) Value	0.144

Data appear Approximate Normal at (0.05) Significance Level

444	**Gamma GOF Test Results**	
445		
446	Correlation Coefficient R	0.971
447	A-D Test Statistic	0.736
448	A-D Critical (0.05) Value	0.747
449	K-S Test Statistic	0.117
450	K-S Critical(0.05) Value	0.145
451	**Data appear Gamma Distributed at (0.05) Significance Level**	
452		
453	**Lognormal GOF Test Results**	
454		
455	Correlation Coefficient R	0.976
456	Shapiro Wilk Test Statistic	0.932
457	Shapiro Wilk Critical (0.05) Value	0.936
458	Approximate Shapiro Wilk P Value	0.0338
459	Lilliefors Test Statistic	0.128
460	Lilliefors Critical (0.05) Value	0.144
461	**Data appear Approximate_Lognormal at (0.05) Significance Level**	
462		
463	**600 Copper 0-10**	
464		
465	**Raw Statistics**	
466	Number of Valid Observations	15
467	Number of Distinct Observations	15
468	Minimum	2.2
469	Maximum	10.4
470	Mean of Raw Data	4.84
471	Standard Deviation of Raw Data	2.546
472	Khat	4.258
473	Theta hat	1.137
474	Kstar	3.451
475	Theta star	1.402
476	Mean of Log Transformed Data	1.455
477	Standard Deviation of Log Transformed Data	0.505
478		
479	**Normal GOF Test Results**	
480		
481	Correlation Coefficient R	0.939
482	Shapiro Wilk Test Statistic	0.872
483	Shapiro Wilk Critical (0.05) Value	0.881
484	Approximate Shapiro Wilk P Value	0.0422
485	Lilliefors Test Statistic	0.22
486	Lilliefors Critical (0.05) Value	0.22
487	**Data not Normal at (0.05) Significance Level**	
488		

	A	B	C	D	E	F	G	H	I	J	K	L
489	**Gamma GOF Test Results**											
490												
491	Correlation Coefficient R					0.974						
492	A-D Test Statistic					0.585						
493	A-D Critical (0.05) Value					0.74						
494	K-S Test Statistic					0.167						
495	K-S Critical(0.05) Value					0.222						
496	**Data appear Gamma Distributed at (0.05) Significance Level**											
497												
498	**Lognormal GOF Test Results**											
499												
500	Correlation Coefficient R					0.97						
501	Shapiro Wilk Test Statistic					0.924						
502	Shapiro Wilk Critical (0.05) Value					0.881						
503	Approximate Shapiro Wilk P Value					0.283						
504	Lilliefors Test Statistic					0.153						
505	Lilliefors Critical (0.05) Value					0.22						
506	**Data appear Lognormal at (0.05) Significance Level**											
507												
508	**600 BG4 Copper 0-12**											
509												
510	**Raw Statistics**											
511	Number of Valid Observations					36						
512	Number of Distinct Observations					35						
513	Minimum					3.73						
514	Maximum					9.53						
515	Mean of Raw Data					5.859						
516	Standard Deviation of Raw Data					1.641						
517	Khat					13.9						
518	Theta hat					0.422						
519	Kstar					12.76						
520	Theta star					0.459						
521	Mean of Log Transformed Data					1.732						
522	Standard Deviation of Log Transformed Data					0.271						
523												
524	**Normal GOF Test Results**											
525												
526	Correlation Coefficient R					0.964						
527	Shapiro Wilk Test Statistic					0.913						
528	Shapiro Wilk Critical (0.05) Value					0.935						
529	Approximate Shapiro Wilk P Value					0.00897						
530	Lilliefors Test Statistic					0.133						
531	Lilliefors Critical (0.05) Value					0.145						
532	**Data appear Approximate Normal at (0.05) Significance Level**											
533												

	A	B	C	D	E	F	G	H	I	J	K	L
534	**Gamma GOF Test Results**											
535												
536	Correlation Coefficient R					0.98						
537	A-D Test Statistic					0.712						
538	A-D Critical (0.05) Value					0.748						
539	K-S Test Statistic					0.123						
540	K-S Critical(0.05) Value					0.147						
541	**Data appear Gamma Distributed at (0.05) Significance Level**											
542												
543	**Lognormal GOF Test Results**											
544												
545	Correlation Coefficient R					0.979						
546	Shapiro Wilk Test Statistic					0.939						
547	Shapiro Wilk Critical (0.05) Value					0.935						
548	Approximate Shapiro Wilk P Value					0.062						
549	Lilliefors Test Statistic					0.112						
550	Lilliefors Critical (0.05) Value					0.145						
551	**Data appear Lognormal at (0.05) Significance Level**											
552												
553	**600 Manganese 0-10**											
554												
555	**Raw Statistics**											
556	Number of Valid Observations					15						
557	Number of Distinct Observations					13						
558	Minimum					102						
559	Maximum					325						
560	Mean of Raw Data					175.9						
561	Standard Deviation of Raw Data					65.42						
562	Khat					8.6						
563	Theta hat					20.45						
564	Kstar					6.924						
565	Theta star					25.4						
566	Mean of Log Transformed Data					5.11						
567	Standard Deviation of Log Transformed Data					0.35						
568												
569	**Normal GOF Test Results**											
570												
571	Correlation Coefficient R					0.943						
572	Shapiro Wilk Test Statistic					0.884						
573	Shapiro Wilk Critical (0.05) Value					0.881						
574	Approximate Shapiro Wilk P Value					0.0611						
575	Lilliefors Test Statistic					0.231						
576	Lilliefors Critical (0.05) Value					0.22						
577	**Data appear Approximate Normal at (0.05) Significance Level**											
578												

	A	B	C	D	E	F	G	H	I	J	K	L
579	**Gamma GOF Test Results**											
580												
581					Correlation Coefficient R	0.973						
582					A-D Test Statistic	0.579						
583					A-D Critical (0.05) Value	0.738						
584					K-S Test Statistic	0.221						
585					K-S Critical(0.05) Value	0.222						
586	**Data appear Gamma Distributed at (0.05) Significance Level**											
587												
588	**Lognormal GOF Test Results**											
589												
590					Correlation Coefficient R	0.969						
591					Shapiro Wilk Test Statistic	0.929						
592					Shapiro Wilk Critical (0.05) Value	0.881						
593					Approximate Shapiro Wilk P Value	0.312						
594					Lilliefors Test Statistic	0.204						
595					Lilliefors Critical (0.05) Value	0.22						
596	**Data appear Lognormal at (0.05) Significance Level**											
597												
598	**600 BG4 Manganese 0-12**											
599												
600	**Raw Statistics**											
601					Number of Valid Observations	36						
602					Number of Distinct Observations	33						
603					Minimum	74						
604					Maximum	320						
605					Mean of Raw Data	178.2						
606					Standard Deviation of Raw Data	61.62						
607					Khat	8.503						
608					Theta hat	20.96						
609					Kstar	7.813						
610					Theta star	22.81						
611					Mean of Log Transformed Data	5.123						
612					Standard Deviation of Log Transformed Data	0.358						
613												
614	**Normal GOF Test Results**											
615												
616					Correlation Coefficient R	0.98						
617					Shapiro Wilk Test Statistic	0.951						
618					Shapiro Wilk Critical (0.05) Value	0.935						
619					Approximate Shapiro Wilk P Value	0.148						
620					Lilliefors Test Statistic	0.166						
621					Lilliefors Critical (0.05) Value	0.145						
622	**Data appear Approximate Normal at (0.05) Significance Level**											
623												

	A	B	C	D	E	F	G	H	I	J	K	L
624	**Gamma GOF Test Results**											
625												
626	Correlation Coefficient R					0.988						
627	A-D Test Statistic					0.425						
628	A-D Critical (0.05) Value					0.749						
629	K-S Test Statistic					0.125						
630	K-S Critical(0.05) Value					0.147						
631	**Data appear Gamma Distributed at (0.05) Significance Level**											
632												
633	**Lognormal GOF Test Results**											
634												
635	Correlation Coefficient R					0.985						
636	Shapiro Wilk Test Statistic					0.962						
637	Shapiro Wilk Critical (0.05) Value					0.935						
638	Approximate Shapiro Wilk P Value					0.326						
639	Lilliefors Test Statistic					0.102						
640	Lilliefors Critical (0.05) Value					0.145						
641	**Data appear Lognormal at (0.05) Significance Level**											
642												
643	**600 Mercury 0-10**											
644												
645	**Raw Statistics**											
646	Number of Valid Observations					15						
647	Number of Distinct Observations					11						
648	Minimum					0.001						
649	Maximum					0.099						
650	Mean of Raw Data					0.0155						
651	Standard Deviation of Raw Data					0.0268						
652	Khat					0.764						
653	Theta hat					0.0202						
654	Kstar					0.656						
655	Theta star					0.0236						
656	Mean of Log Transformed Data					-4.951						
657	Standard Deviation of Log Transformed Data					1.152						
658												
659	**Normal GOF Test Results**											
660												
661	Correlation Coefficient R					0.71						
662	Shapiro Wilk Test Statistic					0.527						
663	Shapiro Wilk Critical (0.05) Value					0.881						
664	Approximate Shapiro Wilk P Value					1.4244E-6						
665	Lilliefors Test Statistic					0.418						
666	Lilliefors Critical (0.05) Value					0.22						
667	**Data not Normal at (0.05) Significance Level**											
668												

	A	B	C	D	E	F	G	H	I	J	K	L
669	**Gamma GOF Test Results**											
670												
671					Correlation Coefficient R	0.92						
672					A-D Test Statistic	1.576						
673					A-D Critical (0.05) Value	0.774						
674					K-S Test Statistic	0.314						
675					K-S Critical(0.05) Value	0.23						
676	**Data not Gamma Distributed at (0.05) Significance Level**											
677												
678	**Lognormal GOF Test Results**											
679												
680					Correlation Coefficient R	0.944						
681					Shapiro Wilk Test Statistic	0.904						
682					Shapiro Wilk Critical (0.05) Value	0.881						
683					Approximate Shapiro Wilk P Value	0.0914						
684					Lilliefors Test Statistic	0.217						
685					Lilliefors Critical (0.05) Value	0.22						
686	**Data appear Lognormal at (0.05) Significance Level**											
687												
688	**600 BG4 Mercury 0-12**											
689												
690	**Raw Statistics**											
691					Number of Valid Observations	36						
692					Number of Distinct Observations	11						
693					Minimum	0.006						
694					Maximum	0.025						
695					Mean of Raw Data	0.00897						
696					Standard Deviation of Raw Data	0.00517						
697					Khat	4.787						
698					Theta hat	0.00187						
699					Kstar	4.406						
700					Theta star	0.00204						
701					Mean of Log Transformed Data	-4.822						
702					Standard Deviation of Log Transformed Data	0.427						
703												
704	**Normal GOF Test Results**											
705												
706					Correlation Coefficient R	0.792						
707					Shapiro Wilk Test Statistic	0.628						
708					Shapiro Wilk Critical (0.05) Value	0.935						
709					Approximate Shapiro Wilk P Value	2.947E-10						
710					Lilliefors Test Statistic	0.303						
711					Lilliefors Critical (0.05) Value	0.145						
712	**Data not Normal at (0.05) Significance Level**											
713												

Gamma GOF Test Results

Correlation Coefficient R	0.887
A-D Test Statistic	4.493
A-D Critical (0.05) Value	0.751
K-S Test Statistic	0.259
K-S Critical(0.05) Value	0.147

Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.851
Shapiro Wilk Test Statistic	0.716
Shapiro Wilk Critical (0.05) Value	0.935
Approximate Shapiro Wilk P Value	2.7161E-8
Lilliefors Test Statistic	0.245
Lilliefors Critical (0.05) Value	0.145

Data not Lognormal at (0.05) Significance Level

Non-parametric GOF Test Results

Data do not follow a discernible distribution at (0.05) Level of Significanc

600 Molybdenum 0-10

Raw Statistics

Number of Valid Observations	15
Number of Distinct Observations	7
Minimum	0.4
Maximum	3.2
Mean of Raw Data	0.887
Standard Deviation of Raw Data	0.784
Khat	2.054
Theta hat	0.432
Kstar	1.688
Theta star	0.525
Mean of Log Transformed Data	-0.383
Standard Deviation of Log Transformed Data	0.698

Normal GOF Test Results

Correlation Coefficient R	0.824
Shapiro Wilk Test Statistic	0.691
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	1.1009E-4
Lilliefors Test Statistic	0.289
Lilliefors Critical (0.05) Value	0.22

Data not Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.947
A-D Test Statistic	1.573
A-D Critical (0.05) Value	0.747
K-S Test Statistic	0.31
K-S Critical(0.05) Value	0.224

Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.885
Shapiro Wilk Test Statistic	0.774
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	0.00163
Lilliefors Test Statistic	0.311
Lilliefors Critical (0.05) Value	0.22

Data not Lognormal at (0.05) Significance Level

Non-parametric GOF Test Results

Data do not follow a discernible distribution at (0.05) Level of Significanc

600 BG4 Molybdenum 0-12

Raw Statistics

Number of Valid Observations	36
Number of Distinct Observations	11
Minimum	0.2
Maximum	1.9
Mean of Raw Data	0.661
Standard Deviation of Raw Data	0.428
Khat	2.862
Theta hat	0.231
Kstar	2.642
Theta star	0.25
Mean of Log Transformed Data	-0.599
Standard Deviation of Log Transformed Data	0.614

Normal GOF Test Results

Correlation Coefficient R	0.926
Shapiro Wilk Test Statistic	0.853
Shapiro Wilk Critical (0.05) Value	0.935
Approximate Shapiro Wilk P Value	1.1553E-4
Lilliefors Test Statistic	0.178
Lilliefors Critical (0.05) Value	0.145

Data not Normal at (0.05) Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
812	**Gamma GOF Test Results**											
813												
814	Correlation Coefficient R					0.983						
815	A-D Test Statistic					0.675						
816	A-D Critical (0.05) Value					0.755						
817	K-S Test Statistic					0.14						
818	K-S Critical(0.05) Value					0.148						
819	**Data appear Gamma Distributed at (0.05) Significance Level**											
820												
821	**Lognormal GOF Test Results**											
822												
823	Correlation Coefficient R					0.983						
824	Shapiro Wilk Test Statistic					0.95						
825	Shapiro Wilk Critical (0.05) Value					0.935						
826	Approximate Shapiro Wilk P Value					0.135						
827	Lilliefors Test Statistic					0.143						
828	Lilliefors Critical (0.05) Value					0.145						
829	**Data appear Lognormal at (0.05) Significance Level**											
830												
831	**600 NO2/NO3 0-10**											
832												
833	**Raw Statistics**											
834	Number of Valid Observations					15						
835	Number of Distinct Observations					15						
836	Minimum					0.7						
837	Maximum					55.4						
838	Mean of Raw Data					16.21						
839	Standard Deviation of Raw Data					20.26						
840	Khat					0.72						
841	Theta hat					22.53						
842	Kstar					0.62						
843	Theta star					26.14						
844	Mean of Log Transformed Data					1.949						
845	Standard Deviation of Log Transformed Data					1.407						
846												
847	**Normal GOF Test Results**											
848												
849	Correlation Coefficient R					0.856						
850	Shapiro Wilk Test Statistic					0.721						
851	Shapiro Wilk Critical (0.05) Value					0.881						
852	Approximate Shapiro Wilk P Value					3.3924E-4						
853	Lilliefors Test Statistic					0.342						
854	Lilliefors Critical (0.05) Value					0.22						
855	**Data not Normal at (0.05) Significance Level**											
856												

857	**Gamma GOF Test Results**	
858		
859	Correlation Coefficient R	0.933
860	A-D Test Statistic	0.819
861	A-D Critical (0.05) Value	0.777
862	K-S Test Statistic	0.25
863	K-S Critical(0.05) Value	0.231
864	**Data not Gamma Distributed at (0.05) Significance Level**	
865		
866	**Lognormal GOF Test Results**	
867		
868	Correlation Coefficient R	0.973
869	Shapiro Wilk Test Statistic	0.932
870	Shapiro Wilk Critical (0.05) Value	0.881
871	Approximate Shapiro Wilk P Value	0.356
872	Lilliefors Test Statistic	0.168
873	Lilliefors Critical (0.05) Value	0.22
874	**Data appear Lognormal at (0.05) Significance Level**	
875		
876	**600 BG4 NO2/NO3 0-12**	
877		
878	**Raw Statistics**	
879	Number of Valid Observations	40
880	Number of Distinct Observations	18
881	Minimum	0.3
882	Maximum	3.3
883	Mean of Raw Data	0.95
884	Standard Deviation of Raw Data	0.784
885	Khat	1.891
886	Theta hat	0.502
887	Kstar	1.766
888	Theta star	0.538
889	Mean of Log Transformed Data	-0.338
890	Standard Deviation of Log Transformed Data	0.75
891		
892	**Normal GOF Test Results**	
893		
894	Correlation Coefficient R	0.897
895	Shapiro Wilk Test Statistic	0.799
896	Shapiro Wilk Critical (0.05) Value	0.94
897	Approximate Shapiro Wilk P Value	6.9488E-7
898	Lilliefors Test Statistic	0.204
899	Lilliefors Critical (0.05) Value	0.139
900	**Data not Normal at (0.05) Significance Level**	
901		

902	**Gamma GOF Test Results**	
903		
904	Correlation Coefficient R	0.982
905	A-D Test Statistic	1.429
906	A-D Critical (0.05) Value	0.76
907	K-S Test Statistic	0.156
908	K-S Critical(0.05) Value	0.141
909	**Data not Gamma Distributed at (0.05) Significance Level**	
910		
911	**Lognormal GOF Test Results**	
912		
913	Correlation Coefficient R	0.961
914	Shapiro Wilk Test Statistic	0.899
915	Shapiro Wilk Critical (0.05) Value	0.94
916	Approximate Shapiro Wilk P Value	0.00153
917	Lilliefors Test Statistic	0.151
918	Lilliefors Critical (0.05) Value	0.139
919	**Data not Lognormal at (0.05) Significance Level**	
920		
921	**Non-parametric GOF Test Results**	
922		
923	**Data do not follow a discernible distribution at (0.05) Level of Significanc**	
924		
925	**600 Zinc 0-10**	
926		
927	**Raw Statistics**	
928	Number of Valid Observations	15
929	Number of Distinct Observations	15
930	Minimum	15.8
931	Maximum	43.7
932	Mean of Raw Data	23.89
933	Standard Deviation of Raw Data	8.72
934	Khat	9.577
935	Theta hat	2.494
936	Kstar	7.706
937	Theta star	3.1
938	Mean of Log Transformed Data	3.12
939	Standard Deviation of Log Transformed Data	0.325
940		
941	**Normal GOF Test Results**	
942		
943	Correlation Coefficient R	0.907
944	Shapiro Wilk Test Statistic	0.817
945	Shapiro Wilk Critical (0.05) Value	0.881
946	Approximate Shapiro Wilk P Value	0.00615
947	Lilliefors Test Statistic	0.265
948	Lilliefors Critical (0.05) Value	0.22
949	**Data not Normal at (0.05) Significance Level**	
950		

	A	B	C	D	E	F	G	H	I	J	K	L
951	**Gamma GOF Test Results**											
952												
953	Correlation Coefficient R					0.948						
954	A-D Test Statistic					0.839						
955	A-D Critical (0.05) Value					0.737						
956	K-S Test Statistic					0.226						
957	K-S Critical(0.05) Value					0.222						
958	**Data not Gamma Distributed at (0.05) Significance Level**											
959												
960	**Lognormal GOF Test Results**											
961												
962	Correlation Coefficient R					0.945						
963	Shapiro Wilk Test Statistic					0.882						
964	Shapiro Wilk Critical (0.05) Value					0.881						
965	Approximate Shapiro Wilk P Value					0.0613						
966	Lilliefors Test Statistic					0.204						
967	Lilliefors Critical (0.05) Value					0.22						
968	**Data appear Lognormal at (0.05) Significance Level**											
969												
970	**600 BG4 Zinc 0-12**											
971												
972	**Raw Statistics**											
973	Number of Valid Observations					36						
974	Number of Distinct Observations					32						
975	Minimum					12.7						
976	Maximum					44.8						
977	Mean of Raw Data					27.5						
978	Standard Deviation of Raw Data					7.299						
979	Khat					13.57						
980	Theta hat					2.027						
981	Kstar					12.46						
982	Theta star					2.208						
983	Mean of Log Transformed Data					3.277						
984	Standard Deviation of Log Transformed Data					0.285						
985												
986	**Normal GOF Test Results**											
987												
988	Correlation Coefficient R					0.992						
989	Shapiro Wilk Test Statistic					0.981						
990	Shapiro Wilk Critical (0.05) Value					0.935						
991	Approximate Shapiro Wilk P Value					0.834						
992	Lilliefors Test Statistic					0.0865						
993	Lilliefors Critical (0.05) Value					0.145						
994	**Data appear Normal at (0.05) Significance Level**											
995												

	A	B	C	D	E	F	G	H	I	J	K	L
996	**Gamma GOF Test Results**											
997												
998	Correlation Coefficient R					0.987						
999	A-D Test Statistic					0.346						
1000	A-D Critical (0.05) Value					0.748						
1001	K-S Test Statistic					0.0982						
1002	K-S Critical(0.05) Value					0.147						
1003	**Data appear Gamma Distributed at (0.05) Significance Level**											
1004												
1005	**Lognormal GOF Test Results**											
1006												
1007	Correlation Coefficient R					0.979						
1008	Shapiro Wilk Test Statistic					0.956						
1009	Shapiro Wilk Critical (0.05) Value					0.935						
1010	Approximate Shapiro Wilk P Value					0.219						
1011	Lilliefors Test Statistic					0.0973						
1012	Lilliefors Critical (0.05) Value					0.145						
1013	**Data appear Lognormal at (0.05) Significance Level**											
1014												
1015	**600 Magnesium 0-10**											
1016												
1017	**Raw Statistics**											
1018	Number of Valid Observations					15						
1019	Number of Distinct Observations					15						
1020	Minimum					3460						
1021	Maximum					21800						
1022	Mean of Raw Data					11429						
1023	Standard Deviation of Raw Data					5270						
1024	Khat					4.567						
1025	Theta hat					2503						
1026	Kstar					3.698						
1027	Theta star					3091						
1028	Mean of Log Transformed Data					9.23						
1029	Standard Deviation of Log Transformed Data					0.519						
1030												
1031	**Normal GOF Test Results**											
1032												
1033	Correlation Coefficient R					0.985						
1034	Shapiro Wilk Test Statistic					0.964						
1035	Shapiro Wilk Critical (0.05) Value					0.881						
1036	Approximate Shapiro Wilk P Value					0.78						
1037	Lilliefors Test Statistic					0.124						
1038	Lilliefors Critical (0.05) Value					0.22						
1039	**Data appear Normal at (0.05) Significance Level**											
1040												

	A	B	C	D	E	F	G	H	I	J	K	L
1041	**Gamma GOF Test Results**											
1042												
1043	Correlation Coefficient R					0.988						
1044	A-D Test Statistic					0.207						
1045	A-D Critical (0.05) Value					0.739						
1046	K-S Test Statistic					0.116						
1047	K-S Critical(0.05) Value					0.222						
1048	**Data appear Gamma Distributed at (0.05) Significance Level**											
1049												
1050	**Lognormal GOF Test Results**											
1051												
1052	Correlation Coefficient R					0.978						
1053	Shapiro Wilk Test Statistic					0.954						
1054	Shapiro Wilk Critical (0.05) Value					0.881						
1055	Approximate Shapiro Wilk P Value					0.585						
1056	Lilliefors Test Statistic					0.149						
1057	Lilliefors Critical (0.05) Value					0.22						
1058	**Data appear Lognormal at (0.05) Significance Level**											
1059												
1060	**600 BG4 Magnesium 0-12**											
1061												
1062	**Raw Statistics**											
1063	Number of Valid Observations					36						
1064	Number of Distinct Observations					35						
1065	Minimum					4000						
1066	Maximum					18000						
1067	Mean of Raw Data					8765						
1068	Standard Deviation of Raw Data					4012						
1069	Khat					5.165						
1070	Theta hat					1697						
1071	Kstar					4.753						
1072	Theta star					1844						
1073	Mean of Log Transformed Data					8.979						
1074	Standard Deviation of Log Transformed Data					0.453						
1075												
1076	**Normal GOF Test Results**											
1077												
1078	Correlation Coefficient R					0.954						
1079	Shapiro Wilk Test Statistic					0.894						
1080	Shapiro Wilk Critical (0.05) Value					0.935						
1081	Approximate Shapiro Wilk P Value					0.00218						
1082	Lilliefors Test Statistic					0.2						
1083	Lilliefors Critical (0.05) Value					0.145						
1084	**Data not Normal at (0.05) Significance Level**											
1085												

Gamma GOF Test Results

Correlation Coefficient R	0.978
A-D Test Statistic	1.012
A-D Critical (0.05) Value	0.75
K-S Test Statistic	0.181
K-S Critical(0.05) Value	0.147

Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.973
Shapiro Wilk Test Statistic	0.925
Shapiro Wilk Critical (0.05) Value	0.935
Approximate Shapiro Wilk P Value	0.0213
Lilliefors Test Statistic	0.163
Lilliefors Critical (0.05) Value	0.145

Data not Lognormal at (0.05) Significance Level

Non-parametric GOF Test Results

Data do not follow a discernible distribution at (0.05) Level of Significanc

600 Potassium 0-10

Raw Statistics

Number of Valid Observations	15
Number of Distinct Observations	14
Minimum	830
Maximum	3130
Mean of Raw Data	1371
Standard Deviation of Raw Data	614.5
Khat	7.247
Theta hat	189.1
Kstar	5.842
Theta star	234.6
Mean of Log Transformed Data	7.152
Standard Deviation of Log Transformed Data	0.364

Normal GOF Test Results

Correlation Coefficient R	0.858
Shapiro Wilk Test Statistic	0.75
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	5.9501E-4
Lilliefors Test Statistic	0.282
Lilliefors Critical (0.05) Value	0.22

Data not Normal at (0.05) Significance Level

1135	**Gamma GOF Test Results**	
1136		
1137	Correlation Coefficient R	0.925
1138	A-D Test Statistic	1.094
1139	A-D Critical (0.05) Value	0.738
1140	K-S Test Statistic	0.264
1141	K-S Critical(0.05) Value	0.222
1142	**Data not Gamma Distributed at (0.05) Significance Level**	
1143		
1144	**Lognormal GOF Test Results**	
1145		
1146	Correlation Coefficient R	0.926
1147	Shapiro Wilk Test Statistic	0.862
1148	Shapiro Wilk Critical (0.05) Value	0.881
1149	Approximate Shapiro Wilk P Value	0.0242
1150	Lilliefors Test Statistic	0.244
1151	Lilliefors Critical (0.05) Value	0.22
1152	**Data not Lognormal at (0.05) Significance Level**	
1153		
1154	**Non-parametric GOF Test Results**	
1155		
1156	**Data do not follow a discernible distribution at (0.05) Level of Significanc**	
1157		
1158	**600 BG4 Potassium 0-12**	
1159		
1160	**Raw Statistics**	
1161	Number of Valid Observations	36
1162	Number of Distinct Observations	34
1163	Minimum	920
1164	Maximum	2770
1165	Mean of Raw Data	1801
1166	Standard Deviation of Raw Data	539.8
1167	Khat	10.73
1168	Theta hat	167.9
1169	Kstar	9.854
1170	Theta star	182.8
1171	Mean of Log Transformed Data	7.449
1172	Standard Deviation of Log Transformed Data	0.32
1173		
1174	**Normal GOF Test Results**	
1175		
1176	Correlation Coefficient R	0.988
1177	Shapiro Wilk Test Statistic	0.955
1178	Shapiro Wilk Critical (0.05) Value	0.935
1179	Approximate Shapiro Wilk P Value	0.198
1180	Lilliefors Test Statistic	0.109
1181	Lilliefors Critical (0.05) Value	0.145
1182	**Data appear Normal at (0.05) Significance Level**	
1183		

	A	B	C	D	E	F	G	H	I	J	K	L
1184	**Gamma GOF Test Results**											
1185												
1186					Correlation Coefficient R	0.979						
1187					A-D Test Statistic	0.409						
1188					A-D Critical (0.05) Value	0.748						
1189					K-S Test Statistic	0.0904						
1190					K-S Critical(0.05) Value	0.147						
1191	**Data appear Gamma Distributed at (0.05) Significance Level**											
1192												
1193	**Lognormal GOF Test Results**											
1194												
1195					Correlation Coefficient R	0.981						
1196					Shapiro Wilk Test Statistic	0.943						
1197					Shapiro Wilk Critical (0.05) Value	0.935						
1198					Approximate Shapiro Wilk P Value	0.0833						
1199					Lilliefors Test Statistic	0.0996						
1200					Lilliefors Critical (0.05) Value	0.145						
1201	**Data appear Lognormal at (0.05) Significance Level**											
1202												
1203	**600 Sodium 0-10**											
1204												
1205	**Raw Statistics**											
1206					Number of Valid Observations	15						
1207					Number of Distinct Observations	14						
1208					Minimum	140						
1209					Maximum	12900						
1210					Mean of Raw Data	1615						
1211					Standard Deviation of Raw Data	3352						
1212					Khat	0.585						
1213					Theta hat	2761						
1214					Kstar	0.512						
1215					Theta star	3152						
1216					Mean of Log Transformed Data	6.327						
1217					Standard Deviation of Log Transformed Data	1.309						
1218												
1219	**Normal GOF Test Results**											
1220												
1221					Correlation Coefficient R	0.677						
1222					Shapiro Wilk Test Statistic	0.484						
1223					Shapiro Wilk Critical (0.05) Value	0.881						
1224					Approximate Shapiro Wilk P Value	5.1804E-7						
1225					Lilliefors Test Statistic	0.409						
1226					Lilliefors Critical (0.05) Value	0.22						
1227	**Data not Normal at (0.05) Significance Level**											
1228												

	A	B	C	D	E	F	G	H	I	J	K	L
1229	**Gamma GOF Test Results**											
1230												
1231	Correlation Coefficient R					0.924						
1232	A-D Test Statistic					1.538						
1233	A-D Critical (0.05) Value					0.787						
1234	K-S Test Statistic					0.276						
1235	K-S Critical(0.05) Value					0.233						
1236	**Data not Gamma Distributed at (0.05) Significance Level**											
1237												
1238	**Lognormal GOF Test Results**											
1239												
1240	Correlation Coefficient R					0.938						
1241	Shapiro Wilk Test Statistic					0.878						
1242	Shapiro Wilk Critical (0.05) Value					0.881						
1243	Approximate Shapiro Wilk P Value					0.0461						
1244	Lilliefors Test Statistic					0.152						
1245	Lilliefors Critical (0.05) Value					0.22						
1246	**Data appear Approximate_Lognormal at (0.05) Significance Level**											
1247												
1248	**600 BG4 Sodium 0-12**											
1249												
1250	**Raw Statistics**											
1251	Number of Valid Observations					36						
1252	Number of Distinct Observations					32						
1253	Minimum					30						
1254	Maximum					800						
1255	Mean of Raw Data					286.6						
1256	Standard Deviation of Raw Data					210.5						
1257	Khat					1.732						
1258	Theta hat					165.4						
1259	Kstar					1.606						
1260	Theta star					178.4						
1261	Mean of Log Transformed Data					5.342						
1262	Standard Deviation of Log Transformed Data					0.875						
1263												
1264	**Normal GOF Test Results**											
1265												
1266	Correlation Coefficient R					0.959						
1267	Shapiro Wilk Test Statistic					0.907						
1268	Shapiro Wilk Critical (0.05) Value					0.935						
1269	Approximate Shapiro Wilk P Value					0.00554						
1270	Lilliefors Test Statistic					0.155						
1271	Lilliefors Critical (0.05) Value					0.145						
1272	**Data not Normal at (0.05) Significance Level**											
1273												

	A	B	C	D	E	F	G	H	I	J	K	L
1274	**Gamma GOF Test Results**											
1275												
1276	Correlation Coefficient R					0.985						
1277	A-D Test Statistic					0.252						
1278	A-D Critical (0.05) Value					0.763						
1279	K-S Test Statistic					0.0893						
1280	K-S Critical(0.05) Value					0.149						
1281	**Data appear Gamma Distributed at (0.05) Significance Level**											
1282												
1283	**Lognormal GOF Test Results**											
1284												
1285	Correlation Coefficient R					0.983						
1286	Shapiro Wilk Test Statistic					0.953						
1287	Shapiro Wilk Critical (0.05) Value					0.935						
1288	Approximate Shapiro Wilk P Value					0.172						
1289	Lilliefors Test Statistic					0.093						
1290	Lilliefors Critical (0.05) Value					0.145						
1291	**Data appear Lognormal at (0.05) Significance Level**											

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:28:23 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean <= Sample 2 Mean (Form 1)
Alternative Hypothesis	Sample 1 Mean > the Sample 2 Mean

Sample 1 Data: 600 Beryllium 0-10

Sample 2 Data: 600 BG4 Beryllium 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	13	27
Minimum	0.34	0.17
Maximum	0.72	0.72
Mean	0.45	0.471
Median	0.43	0.48
SD	0.103	0.119
SE of Mean	0.0265	0.0199

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 - Mean of Sample 2 <= 0

		t-Test	Critical	
Method	DF	Value	t (0.05)	P-Value
Pooled (Equal Variance)	49	-0.607	1.677	0.727
Welch-Satterthwaite (Unequal Varian	30.3	-0.646	1.697	0.738

Pooled SD 0.115

Conclusion with Alpha = 0.050

Student t (Pooled) Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Welch-Satterthwaite Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Test of Equality of Variances

Variance of Sample 1	0.0105
Variance of Sample 2	0.0142

Numerator DF	Denominator DF	F-Test Value	P-Value
35	14	1.350	0.559

Conclusion with Alpha = 0.05

Two variances appear to be equal

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:14:02 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean <= Sample 2 Mean (Form 1)
Alternative Hypothesis	Sample 1 Mean > the Sample 2 Mean

Sample 1 Data: 600 Cobalt 0-10

Sample 2 Data: 600 BG4 Cobalt 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	37
Number of Distinct Observations	14	34
Minimum	1.8	2.12
Maximum	6.8	4.6
Mean	3.58	3.329
Median	3.5	3.47
SD	1.472	0.727
SE of Mean	0.38	0.12

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 - Mean of Sample 2 <= 0

Method	DF	t-Test Value	Critical t (0.05)	P-Value
Pooled (Equal Variance)	50	0.825	1.676	0.207
Welch-Satterthwaite (Unequal Varian	16.8	0.629	1.740	0.269

Pooled SD 0.994

Conclusion with Alpha = 0.050

Student t (Pooled) Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Welch-Satterthwaite Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Test of Equality of Variances

Variance of Sample 1	2.167
Variance of Sample 2	0.529

Numerator DF	Denominator DF	F-Test Value	P-Value
14	36	4.101	0.001

Conclusion with Alpha = 0.05

Two variances are not equal

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:15:08 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Cobalt 0-10

Sample 2 Data: 600 BG4 Cobalt 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	37
Number of Distinct Observations	14	34
Minimum	1.8	2.12
Maximum	6.8	4.6
Mean	3.58	3.329
Median	3.5	3.47
SD	1.472	0.727
SE of Mean	0.38	0.12

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	398.5
Standardized WMW U-Stat	0.0101
Mean (U)	277.5
SD(U) - Adj ties	49.5
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.496

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

```
          Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

                User Selected Options
            Date/Time of Computation  ProUCL 5.2 3/6/2023 12:33:49 AM
                           From File  UCL95_input_Revised.xls
                      Full Precision  OFF
             Confidence Coefficient   95%
             Substantial Difference   0.000
            Selected Null Hypothesis  Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
             Alternative Hypothesis   Sample 1 Mean/Median > Sample 2 Mean/Median


Sample 1 Data: 600 Chromium 0-10
Sample 2 Data: 600 BG4 Chromium 0-12

                              Raw Statistics
                                             Sample 1   Sample 2
            Number of Valid Observations      15         36
         Number of Distinct Observations      14         36
                                 Minimum       4.88       3.44
                                 Maximum      16.7        9.8
                                    Mean       8.633      6.296
                                  Median      7.2        6.6
                                      SD       3.716      1.607
                              SE of Mean       0.959      0.268

                     Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

                   Sample 1 Rank Sum W-Stat   492
                    Standardized WMW U-Stat     2.098
                                   Mean (U)   270
                            SD(U) - Adj ties   48.37
      Approximate U-Stat Critical Value (0.05)    1.645
                   P-Value (Adjusted for Ties)   0.0179

Conclusion with Alpha = 0.05
  Reject H0, Conclude Sample 1 > Sample 2
  P-Value < alpha (0.05)
```

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 12:35:27 AM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Substantial Difference			0.000								
9	Selected Null Hypothesis			Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)								
10	Alternative Hypothesis			Sample 1 Mean/Median > Sample 2 Mean/Median								
11												
12												
13	**Sample 1 Data: 600 Copper 0-10**											
14	**Sample 2 Data: 600 BG4 Copper 0-12**											
15												
16	**Raw Statistics**											
17					Sample 1	Sample 2						
18	Number of Valid Observations				15	36						
19	Number of Distinct Observations				15	35						
20	Minimum				2.2	3.73						
21	Maximum				10.4	9.53						
22	Mean				4.84	5.859						
23	Median				4	5.675						
24	SD				2.546	1.641						
25	SE of Mean				0.657	0.274						
26												
27	**Wilcoxon-Mann-Whitney (WMW) Test**											
28												
29	**H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2**											
30												
31	Sample 1 Rank Sum W-Stat				287							
32	Standardized WMW U-Stat				-2.14							
33	Mean (U)				270							
34	SD(U) - Adj ties				48.37							
35	Approximate U-Stat Critical Value (0.05)				1.645							
36	P-Value (Adjusted for Ties)				0.984							
37												
38	**Conclusion with Alpha = 0.05**											
39	**Do Not Reject H0, Conclude Sample 1 <= Sample 2**											
40	**P-Value >= alpha (0.05)**											
41												

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:38:15 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Mercury 0-10

Sample 2 Data: 600 BG4 Mercury 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	1	17
Number of Detect Data	14	19
Minimum Non-Detect	0.001	0.006
Maximum Non-Detect	0.001	0.006
Percent Non-detects	6.67%	47.22%
Minimum Detect	0.002	0.007
Maximum Detect	0.099	0.025
Mean of Detects	0.0165	0.0116
Median of Detects	0.007	0.009
SD of Detects	0.0274	0.00602
KM Mean	0.0155	0.00897
KM SD	0.0258	0.0051

Sample 1 vs Sample 2 Gehan Test

H0: Mean/Median of Sample 1 <= Mean/Median of background

Gehan z Test Value	0.0109
Critical z (0.05)	1.645
P-Value	0.496

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Tarone-Ware Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:00:42 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Mercury 0-10

Sample 2 Data: 600 BG4 Mercury 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	1	17
Number of Detects	14	19
Minimum Non-Detect	0.001	0.006
Maximum Non-Detect	0.001	0.006
Percent Non-detects	6.67%	47.22%
Minimum Detect	0.002	0.007
Maximum Detect	0.099	0.025
Mean of Detects	0.0165	0.0116
Median of Detects	0.007	0.009
SD of Detects	0.0274	0.00602
KM Mean	0.0155	0.00897
KM SD	0.0258	0.0051

Sample 1 vs Sample 2 Tarone-Ware Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

TW Statistic	0.148
TW Critical Value (0.05)	1.645
P-Value	0.441

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:48:02 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Potassium 0-10

Sample 2 Data: 600 BG4 Potassium 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	14	34
Minimum	830	920
Maximum	3130	2770
Mean	1371	1801
Median	1110	1795
SD	614.5	539.8
SE of Mean	158.7	89.96

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	259
Standardized WMW U-Stat	-2.719
Mean (U)	270
SD(U) - Adj ties	48.37
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.997

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

	A	B	C	D	E	F	G	H	I	J	K	L
1	Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.2 3/6/2023 12:46:32 AM								
5			From File	UCL95_input_Revised.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Substantial Difference	0.000								
9			Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)								
10			Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median								
11												
12												
13	**Sample 1 Data: 600 Magnesium 0-10**											
14	**Sample 2 Data: 600 BG4 Magnesium 0-12**											
15												
16				**Raw Statistics**								
17					Sample 1	Sample 2						
18				Number of Valid Observations	15	36						
19				Number of Distinct Observations	15	35						
20				Minimum	3460	4000						
21				Maximum	21800	18000						
22				Mean	11429	8765						
23				Median	11000	7160						
24				SD	5270	4012						
25				SE of Mean	1361	668.6						
26												
27				**Wilcoxon-Mann-Whitney (WMW) Test**								
28												
29	**H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2**											
30												
31				Sample 1 Rank Sum W-Stat	469.5							
32				Standardized WMW U-Stat	1.633							
33				Mean (U)	270							
34				SD(U) - Adj ties	48.37							
35				Approximate U-Stat Critical Value (0.05)	1.645							
36				P-Value (Adjusted for Ties)	0.0512							
37												
38	**Conclusion with Alpha = 0.05**											
39	**Do Not Reject H0, Conclude Sample 1 <= Sample 2**											
40	**P-Value >= alpha (0.05)**											
41												

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:36:55 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean <= Sample 2 Mean (Form 1)
Alternative Hypothesis	Sample 1 Mean > the Sample 2 Mean

Sample 1 Data: 600 Manganese 0-10

Sample 2 Data: 600 BG4 Manganese 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	13	33
Minimum	102	74
Maximum	325	320
Mean	175.9	178.2
Median	142	156.5
SD	65.42	61.62
SE of Mean	16.89	10.27

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 - Mean of Sample 2 <= 0

Method	DF	t-Test Value	Critical t (0.05)	P-Value
Pooled (Equal Variance)	49	-0.122	1.677	0.548
Welch-Satterthwaite (Unequal Varian	24.9	-0.119	1.708	0.547

Pooled SD 62.728

Conclusion with Alpha = 0.050

Student t (Pooled) Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Welch-Satterthwaite Test: Do Not Reject H0, Conclude Sample 1 <= Sample 2

Test of Equality of Variances

Variance of Sample 1	4280
Variance of Sample 2	3797

Numerator DF	Denominator DF	F-Test Value	P-Value
14	35	1.127	0.740

Conclusion with Alpha = 0.05

Two variances appear to be equal

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:37:34 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Manganese 0-10

Sample 2 Data: 600 BG4 Manganese 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	13	33
Minimum	102	74
Maximum	325	320
Mean	175.9	178.2
Median	142	156.5
SD	65.42	61.62
SE of Mean	16.89	10.27

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	366.5
Standardized WMW U-Stat	-0.496
Mean (U)	270
SD(U) - Adj ties	48.37
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.69

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Gehan Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:39:50 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Molybdenum 0-10

Sample 2 Data: 600 BG4 Molybdenum 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	7	0
Number of Detect Data	8	36
Minimum Non-Detect	0.4	N/A
Maximum Non-Detect	0.4	N/A
Percent Non-detects	46.67%	0.00%
Minimum Detect	0.4	0.2
Maximum Detect	3.2	1.9
Mean of Detects	1.313	0.661
Median of Detects	1.1	0.55
SD of Detects	0.885	0.428
KM Mean	0.887	0.661
KM SD	0.757	0.428

Sample 1 vs Sample 2 Gehan Test

H0: Mean/Median of Sample 1 <= Mean/Median of background

Gehan z Test Value	-0.242
Critical z (0.05)	1.645
P-Value	0.596

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Tarone-Ware Sample 1 vs Sample 2 Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:08:42 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Molybdenum 0-10

Sample 2 Data: 600 BG4 Molybdenum 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	7	0
Number of Detects	8	36
Minimum Non-Detect	0.4	N/A
Maximum Non-Detect	0.4	N/A
Percent Non-detects	46.67%	0.00%
Minimum Detect	0.4	0.2
Maximum Detect	3.2	1.9
Mean of Detects	1.313	0.661
Median of Detects	1.1	0.55
SD of Detects	0.885	0.428
KM Mean	0.887	0.661
KM SD	0.757	0.428

Sample 1 vs Sample 2 Tarone-Ware Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

TW Statistic	-0.375
TW Critical Value (0.05)	1.645
P-Value	0.646

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:40:28 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Molybdenum 0-10

Sample 2 Data: 600 BG4 Molybdenum 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	36
Number of Non-Detects	7	0
Number of Detect Data	8	36
Minimum Non-Detect	0.4	N/A
Maximum Non-Detect	0.4	N/A
Percent Non-detects	46.67%	0.00%
Minimum Detect	0.4	0.2
Maximum Detect	3.2	1.9
Mean of Detects	1.313	0.661
Median of Detects	1.1	0.55
SD of Detects	0.885	0.428

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	388.5
Standardized WMW U-Stat	-0.0432
Mean (U)	270
SD(U) - Adj ties	48.3
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.517

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

1	**Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs**		
2			
3	User Selected Options		
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 12:49:32 AM	
5	From File	UCL95_input_Revised.xls	
6	Full Precision	OFF	
7	Confidence Coefficient	95%	
8	Substantial Difference	0.000	
9	Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)	
10	Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median	
11			
12			
13	**Sample 1 Data: 600 Sodium 0-10**		
14	**Sample 2 Data: 600 BG4 Sodium 0-12**		
15			
16	**Raw Statistics**		
17		Sample 1	Sample 2
18	Number of Valid Observations	15	36
19	Number of Distinct Observations	14	32
20	Minimum	140	30
21	Maximum	12900	800
22	Mean	1615	286.6
23	Median	580	217.5
24	SD	3352	210.5
25	SE of Mean	865.5	35.09
26			
27	**Wilcoxon-Mann-Whitney (WMW) Test**		
28			
29	**H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2**		
30			
31	Sample 1 Rank Sum W-Stat	510.5	
32	Standardized WMW U-Stat	2.482	
33	Mean (U)	270	
34	SD(U) - Adj ties	48.36	
35	Approximate U-Stat Critical Value (0.05)	1.645	
36	P-Value (Adjusted for Ties)	0.00654	
37			
38	**Conclusion with Alpha = 0.05**		
39	**Reject H0, Conclude Sample 1 > Sample 2**		
40	**P-Value < alpha (0.05)**		
41			

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:42:41 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 NO2/NO3 0-10

Sample 2 Data: 600 BG4 NO2/NO3 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Data	15	40
Number of Non-Detects	0	7
Number of Detect Data	15	33
Minimum Non-Detect	N/A	0.3
Maximum Non-Detect	N/A	0.3
Percent Non-detects	0.00%	17.50%
Minimum Detect	0.7	0.3
Maximum Detect	55.4	3.3
Mean of Detects	16.21	1.088
Median of Detects	5.5	0.8
SD of Detects	20.26	0.799

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	683
Standardized WMW U-Stat	4.984
Mean (U)	300
SD(U) - Adj ties	52.88
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	3.1107E-7

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 > Sample 2

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 12:44:58 AM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median <= Sample 2 Mean/Median (Form 1)
Alternative Hypothesis	Sample 1 Mean/Median > Sample 2 Mean/Median

Sample 1 Data: 600 Zinc 0-10

Sample 2 Data: 600 BG4 Zinc 0-12

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	15	36
Number of Distinct Observations	15	32
Minimum	15.8	12.7
Maximum	43.7	44.8
Mean	23.89	27.5
Median	22.7	27.05
SD	8.72	7.299
SE of Mean	2.251	1.217

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 <= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	300
Standardized WMW U-Stat	-1.871
Mean (U)	270
SD(U) - Adj ties	48.37
Approximate U-Stat Critical Value (0.05)	1.645
P-Value (Adjusted for Ties)	0.969

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 <= Sample 2

P-Value >= alpha (0.05)

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:43:03 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200 IA Trans-1,2-Dichloroethene**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	14
14	Number of Detects	5	Number of Non-Detects	11
15	Number of Distinct Detects	5	Number of Distinct Non-Detects	9
16	Minimum Detect	0.51	Minimum Non-Detect	0.27
17	Maximum Detect	2.2	Maximum Non-Detect	7.3
18	Variance Detects	0.592	Percent Non-Detects	68.75%
19	Mean Detects	1.18	SD Detects	0.769
20	Median Detects	0.8	CV Detects	0.652
21	Skewness Detects	0.676	Kurtosis Detects	-2.378
22	Mean of Logged Detects	-0.00958	SD of Logged Detects	0.661
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.846	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.686	Detected Data appear Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.289	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.396	Detected Data appear Normal at 1% Significance Level	
29	**Detected Data appear Normal at 1% Significance Level**			
30	**Note GOF tests may be unreliable for small sample sizes**			
31				
32	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
33	KM Mean	0.573	KM Standard Error of Mean	0.169
34	90KM SD	0.585	95% KM (BCA) UCL	0.869
35	95% KM (t) UCL	0.869	95% KM (Percentile Bootstrap) UCL	0.849
36	95% KM (z) UCL	0.851	95% KM Bootstrap t UCL	1.046
37	90% KM Chebyshev UCL	1.08	95% KM Chebyshev UCL	1.309
38	97.5% KM Chebyshev UCL	1.627	99% KM Chebyshev UCL	2.252
39				
40	**Gamma GOF Tests on Detected Observations Only**			
41	A-D Test Statistic	0.45	**Anderson-Darling GOF Test**	
42	5% A-D Critical Value	0.683	Detected data appear Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.268	**Kolmogorov-Smirnov GOF**	
44	5% K-S Critical Value	0.359	Detected data appear Gamma Distributed at 5% Significance Level	
45	**Detected data appear Gamma Distributed at 5% Significance Level**			
46	**Note GOF tests may be unreliable for small sample sizes**			
47				

Calculation of Toxicity Equivalents (TEQ)[1] for Dioxins/Furans

Boring Number	Depth bgs (ft)	Sample Number	Analyte	Result	Original Units	Concentration (mg/kg)	TEF	Concentration x TEF	TEQ
200-SB-05	8	1406151129	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.0729	ng/Kg	7.29E-08	0.1	7.29E-09	
			Octachlorodibenzo-p-dioxin (OCDD)	0.643	ng/Kg	6.43E-07	0.0003	1.93E-10	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.159	ng/Kg	1.59E-07	0.01	1.59E-09	9.07E-09
		1406151145	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.157	ng/Kg	1.57E-07	0.1	1.57E-08	
			1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	2.35	ng/Kg	2.35E-06	0.01	2.35E-08	
			Octachlorodibenzo-p-dioxin (OCDD)	23.7	ng/Kg	2.37E-05	0.0003	7.11E-09	
			1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.133	ng/Kg	1.33E-07	0.1	1.33E-08	
			1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.123	ng/Kg	1.23E-07	0.1	1.23E-08	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.309	ng/Kg	3.09E-07	0.01	3.09E-09	
			Octachlorodibenzofuran (OCDF)	0.534	ng/Kg	5.34E-07	0.0003	1.60E-10	7.52E-08
200-SB-6	8	1406141704	Octachlorodibenzo-p-dioxin (OCDD)	0.8	ng/Kg	8.00E-07	0.0003	2.40E-10	
			1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.182	ng/Kg	1.82E-07	0.01	1.82E-09	2.06E-09
200-SB-7	8	1406111503	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	1.37	ng/Kg	1.37E-06	0.01	1.37E-08	
			Octachlorodibenzo-p-dioxin (OCDD)	17.1	ng/Kg	1.71E-05	0.0003	5.13E-09	1.88E-08
200-SB-8	8	1406130804	Octachlorodibenzo-p-dioxin (OCDD)	1.46	ng/Kg	1.46E-06	0.0003	4.38E-10	4.38E-10
		1406130814	Octachlorodibenzo-p-dioxin (OCDD)	1.24	ng/Kg	1.24E-06	0.0003	3.72E-10	3.72E-10
200-SB-09	8	1406301549	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.0476	ng/Kg	4.76E-08	0.1	4.76E-09	
			1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.0653	ng/Kg	6.53E-08	0.01	6.53E-10	
			Octachlorodibenzo-p-dioxin (OCDD)	0.475	ng/Kg	4.75E-07	0.0003	1.43E-10	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.0413	ng/Kg	4.13E-08	0.01	4.13E-10	5.97E-09
200-SB-10	16	1406281022	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxins (HpCDD)	0.263	ng/Kg	2.63E-07	0.01	2.63E-09	
			Octachlorodibenzo-p-dioxin (OCDD)	1.75	ng/Kg	1.75E-06	0.0003	5.25E-10	3.16E-09
200-SB-11	8	1407011414	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	0.282	ng/Kg	2.82E-07	1	2.82E-07	
			1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.192	ng/Kg	1.92E-07	0.01	1.92E-09	
			Octachlorodibenzo-p-dioxin (OCDD)	0.843	ng/Kg	8.43E-07	0.0003	2.53E-10	
			1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.0392	ng/Kg	3.92E-08	0.1	3.92E-09	
			1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.0418	ng/Kg	4.18E-08	0.1	4.18E-09	
			1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.0479	ng/Kg	4.79E-08	0.1	4.79E-09	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.201	ng/Kg	2.01E-07	0.01	2.01E-09	
			Octachlorodibenzofuran (OCDF)	0.23	ng/Kg	2.30E-07	0.0003	6.90E-11	2.99E-07
200-SB-13	8	1406161404	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.105	ng/Kg	1.05E-07	0.1	1.05E-08	
			1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.107	ng/Kg	1.07E-07	0.1	1.07E-08	
			1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.202	ng/Kg	2.02E-07	0.01	2.02E-09	
			Octachlorodibenzo-p-dioxin (OCDD)	10	ng/Kg	1.00E-05	0.0003	3.00E-09	
			1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.0506	ng/Kg	5.06E-08	0.1	5.06E-09	
			1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.0843	ng/Kg	8.43E-08	0.1	8.43E-09	
			1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.0604	ng/Kg	6.04E-08	0.01	6.04E-10	
			1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.0664	ng/Kg	6.64E-08	0.01	6.64E-10	4.10E-08

Calculation of Toxicity Equivalents (TEQ)[1] for Dioxins/Furans

Boring Number	Depth bgs (ft)	Sample Number	Analyte	Result	Original Units	Concentration (mg/kg)	TEF	Concentration x TEF	TEQ

[1] = TEQs calculated per NMED RA Guidance (June 2019) Section 2.1. Dioxin and furan congeners were assessed using the 2005 World Health Organization’s (WHO) toxicity equivalency factors (TEF) applied to the analytical results and summed for each sample location. The sum, or toxicity equivalent (TEQ), is compared to the NMED SSL for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) in the risk screening evaluation for carcinogens and noncarcinogens.

bgs = below ground surface

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Gamma Statistics on Detected Data Only**											
49	k hat (MLE)					3.012	k star (bias corrected MLE)					1.338
50	Theta hat (MLE)					0.392	Theta star (bias corrected MLE)					0.882
51	nu hat (MLE)					30.12	nu star (bias corrected)					13.38
52	Mean (detects)					1.18						
53												
54	**Gamma ROS Statistics using Imputed Non-Detects**											
55	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
56	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
57	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
58	This is especially true when the sample size is small.											
59	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
60	Minimum					0.01	Mean					0.376
61	Maximum					2.2	Median					0.01
62	SD					0.687	CV					1.828
63	k hat (MLE)					0.313	k star (bias corrected MLE)					0.296
64	Theta hat (MLE)					1.201	Theta star (bias corrected MLE)					1.27
65	nu hat (MLE)					10.01	nu star (bias corrected)					9.465
66	Adjusted Level of Significance (β)					0.0335						
67	Approximate Chi Square Value (9.46, α)					3.61	Adjusted Chi Square Value (9.46, β)					3.209
68	95% Gamma Approximate UCL					0.985	95% Gamma Adjusted UCL					1.108
69												
70	**Estimates of Gamma Parameters using KM Estimates**											
71	Mean (KM)					0.573	SD (KM)					0.585
72	Variance (KM)					0.342	SE of Mean (KM)					0.169
73	k hat (KM)					0.962	k star (KM)					0.823
74	nu hat (KM)					30.78	nu star (KM)					26.34
75	theta hat (KM)					0.596	theta star (KM)					0.697
76	80% gamma percentile (KM)					0.935	90% gamma percentile (KM)					1.385
77	95% gamma percentile (KM)					1.841	99% gamma percentile (KM)					2.916
78												
79	**Gamma Kaplan-Meier (KM) Statistics**											
80	Approximate Chi Square Value (26.34, α)					15.64	Adjusted Chi Square Value (26.34, β)					14.71
81	95% KM Approximate Gamma UCL					0.965	95% KM Adjusted Gamma UCL					1.027
82												
83	**Lognormal GOF Test on Detected Observations Only**											
84	Shapiro Wilk Test Statistic					0.88	**Shapiro Wilk GOF Test**					
85	10% Shapiro Wilk Critical Value					0.806	Detected Data appear Lognormal at 10% Significance Level					
86	Lilliefors Test Statistic					0.227	**Lilliefors GOF Test**					
87	10% Lilliefors Critical Value					0.319	Detected Data appear Lognormal at 10% Significance Level					
88	**Detected Data appear Lognormal at 10% Significance Level**											
89	**Note GOF tests may be unreliable for small sample sizes**											
90												

	A	B	C	D	E	F	G	H	I	J	K	L
91	**Lognormal ROS Statistics Using Imputed Non-Detects**											
92					Mean in Original Scale	0.441					Mean in Log Scale	-1.597
93					SD in Original Scale	0.651					SD in Log Scale	1.199
94					95% t UCL (assumes normality of ROS data)	0.726					95% Percentile Bootstrap UCL	0.731
95					95% BCA Bootstrap UCL	0.808					95% Bootstrap t UCL	1.147
96					95% H-UCL (Log ROS)	1.059						
97												
98	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
99					KM Mean (logged)	-0.876					KM Geo Mean	0.416
100					KM SD (logged)	0.701					95% Critical H Value (KM-Log)	2.282
101					KM Standard Error of Mean (logged)	0.202					95% H-UCL (KM -Log)	0.805
102					KM SD (logged)	0.701					95% Critical H Value (KM-Log)	2.282
103					KM Standard Error of Mean (logged)	0.202						
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107					Mean in Original Scale	0.698					Mean in Log Scale	-1.068
108					SD in Original Scale	1.004					SD in Log Scale	1.124
109					95% t UCL (Assumes normality)	1.138					95% H-Stat UCL	1.498
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Detected Data appear Normal Distributed at 1% Significance Level**											
114												
115	**Suggested UCL to Use**											
116					95% KM (t) UCL	0.869						
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:33:24 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA 2-Butanone (MEK)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	13
Number of Detects	15	Number of Non-Detects	1
Number of Distinct Detects	12	Number of Distinct Non-Detects	1
Minimum Detect	0.36	Minimum Non-Detect	8.1
Maximum Detect	8.7	Maximum Non-Detect	8.1
Variance Detects	4.008	Percent Non-Detects	6.25%
Mean Detects	1.921	SD Detects	2.002
Median Detects	1.8	CV Detects	1.042
Skewness Detects	3.048	Kurtosis Detects	10.84
Mean of Logged Detects	0.292	SD of Logged Detects	0.892

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.589	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.398	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.89	KM Standard Error of Mean	0.49
90KM SD	1.884	95% KM (BCA) UCL	2.848
95% KM (t) UCL	2.749	95% KM (Percentile Bootstrap) UCL	2.727
95% KM (z) UCL	2.696	95% KM Bootstrap t UCL	3.549
90% KM Chebyshev UCL	3.36	95% KM Chebyshev UCL	4.026
97.5% KM Chebyshev UCL	4.95	99% KM Chebyshev UCL	6.765

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.236	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.284	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.225	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

46	Gamma Statistics on Detected Data Only			
47	k hat (MLE)	1.531	k star (bias corrected MLE)	1.269
48	Theta hat (MLE)	1.254	Theta star (bias corrected MLE)	1.513
49	nu hat (MLE)	45.93	nu star (bias corrected)	38.08
50	Mean (detects)	1.921		
51				
52	Gamma ROS Statistics using Imputed Non-Detects			
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
56	This is especially true when the sample size is small.			
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
58	Minimum	0.36	Mean	1.886
59	Maximum	8.7	Median	1.75
60	SD	1.939	CV	1.028
61	k hat (MLE)	1.611	k star (bias corrected MLE)	1.351
62	Theta hat (MLE)	1.171	Theta star (bias corrected MLE)	1.396
63	nu hat (MLE)	51.55	nu star (bias corrected)	43.22
64	Adjusted Level of Significance (β)	0.0335		
65	Approximate Chi Square Value (43.22, α)	29.15	Adjusted Chi Square Value (43.22, β)	27.83
66	95% Gamma Approximate UCL	2.796	95% Gamma Adjusted UCL	2.928
67				
68	Estimates of Gamma Parameters using KM Estimates			
69	Mean (KM)	1.89	SD (KM)	1.884
70	Variance (KM)	3.551	SE of Mean (KM)	0.49
71	k hat (KM)	1.006	k star (KM)	0.859
72	nu hat (KM)	32.2	nu star (KM)	27.5
73	theta hat (KM)	1.878	theta star (KM)	2.2
74	80% gamma percentile (KM)	3.076	90% gamma percentile (KM)	4.518
75	95% gamma percentile (KM)	5.977	99% gamma percentile (KM)	9.404
76				
77	Gamma Kaplan-Meier (KM) Statistics			
78	Approximate Chi Square Value (27.50, α)	16.54	Adjusted Chi Square Value (27.50, β)	15.58
79	95% KM Approximate Gamma UCL	3.143	95% KM Adjusted Gamma UCL	3.338
80				
81	Lognormal GOF Test on Detected Observations Only			
82	Shapiro Wilk Test Statistic	0.825	Shapiro Wilk GOF Test	
83	10% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 10% Significance Level	
84	Lilliefors Test Statistic	0.253	Lilliefors GOF Test	
85	10% Lilliefors Critical Value	0.202	Detected Data Not Lognormal at 10% Significance Level	
86	Detected Data Not Lognormal at 10% Significance Level			
87				

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89	Mean in Original Scale					1.877	Mean in Log Scale					0.286
90	SD in Original Scale					1.942	SD in Log Scale					0.862
91	95% t UCL (assumes normality of ROS data)					2.728	95% Percentile Bootstrap UCL					2.698
92	95% BCA Bootstrap UCL					3.249	95% Bootstrap t UCL					3.585
93	95% H-UCL (Log ROS)					3.367						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96	KM Mean (logged)					0.284	KM Geo Mean					1.328
97	KM SD (logged)					0.855	95% Critical H Value (KM-Log)					2.488
98	KM Standard Error of Mean (logged)					0.226	95% H-UCL (KM -Log)					3.312
99	KM SD (logged)					0.855	95% Critical H Value (KM-Log)					2.488
100	KM Standard Error of Mean (logged)					0.226						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104	Mean in Original Scale					2.054	Mean in Log Scale					0.361
105	SD in Original Scale					2.006	SD in Log Scale					0.905
106	95% t UCL (Assumes normality)					2.933	95% H-Stat UCL					3.932
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Data do not follow a Discernible Distribution**											
111												
112	**Suggested UCL to Use**											
113	95% KM (t) UCL					2.749						
114												
115	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
116	**Please verify the data were collected from random locations.**											
117	**If the data were collected using judgmental or other non-random methods,**											
118	**then contact a statistician to correctly calculate UCLs.**											
119												
120	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
121	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
122	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
123												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Uncensored Full Data Sets**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 1:30:01 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	**200 IA 2-Propanol**											
12												
13	**General Statistics**											
14					Total Number of Observations	16					Number of Distinct Observations	15
15											Number of Missing Observations	0
16					Minimum	0.95					Mean	17.48
17					Maximum	68					Median	7.65
18					SD	20.08					Std. Error of Mean	5.021
19					Coefficient of Variation	1.149					Skewness	1.292
20												
21	**Normal GOF Test**											
22					Shapiro Wilk Test Statistic	0.813	**Shapiro Wilk GOF Test**					
23					1% Shapiro Wilk Critical Value	0.844	Data Not Normal at 1% Significance Level					
24					Lilliefors Test Statistic	0.244	**Lilliefors GOF Test**					
25					1% Lilliefors Critical Value	0.248	Data appear Normal at 1% Significance Level					
26	**Data appear Approximate Normal at 1% Significance Level**											
27												
28	**Assuming Normal Distribution**											
29	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
30					95% Student's-t UCL	26.28					95% Adjusted-CLT UCL (Chen-1995)	27.47
31											95% Modified-t UCL (Johnson-1978)	26.55
32												
33	**Gamma GOF Test**											
34					A-D Test Statistic	0.685	**Anderson-Darling Gamma GOF Test**					
35					5% A-D Critical Value	0.776	Detected data appear Gamma Distributed at 5% Significance Level					
36					K-S Test Statistic	0.221	**Kolmogorov-Smirnov Gamma GOF Test**					
37					5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance Level					
38	**Detected data appear Gamma Distributed at 5% Significance Level**											
39												
40	**Gamma Statistics**											
41					k hat (MLE)	0.732					k star (bias corrected MLE)	0.637
42					Theta hat (MLE)	23.87					Theta star (bias corrected MLE)	27.45
43					nu hat (MLE)	23.43					nu star (bias corrected)	20.37
44					MLE Mean (bias corrected)	17.48					MLE Sd (bias corrected)	21.91
45											Approximate Chi Square Value (0.05)	11.13
46					Adjusted Level of Significance	0.0335					Adjusted Chi Square Value	10.35
47												

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Assuming Gamma Distribution**											
49					95% Approximate Gamma UCL	32					95% Adjusted Gamma UCL	34.39
50												
51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk Lognormal GOF Test**					
53					10% Shapiro Wilk Critical Value	0.906	Data appear Lognormal at 10% Significance Level					
54					Lilliefors Test Statistic	0.196	**Lilliefors Lognormal GOF Test**					
55					10% Lilliefors Critical Value	0.196	Data Not Lognormal at 10% Significance Level					
56	**Data appear Approximate Lognormal at 10% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	-0.0513					Mean of logged Data	2.041
60					Maximum of Logged Data	4.22					SD of logged Data	1.442
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	78.32					90% Chebyshev (MVUE) UCL	43.53
64					95% Chebyshev (MVUE) UCL	54.46					97.5% Chebyshev (MVUE) UCL	69.62
65					99% Chebyshev (MVUE) UCL	99.41						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	25.74					95% BCA Bootstrap UCL	26.85
72					95% Standard Bootstrap UCL	25.4					95% Bootstrap-t UCL	30.33
73					95% Hall's Bootstrap UCL	29.27					95% Percentile Bootstrap UCL	25.42
74					90% Chebyshev(Mean, Sd) UCL	32.54					95% Chebyshev(Mean, Sd) UCL	39.36
75					97.5% Chebyshev(Mean, Sd) UCL	48.84					99% Chebyshev(Mean, Sd) UCL	67.44
76												
77	**Suggested UCL to Use**											
78					95% Student's-t UCL	26.28						
79												
80	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
81	**Please verify the data were collected from random locations.**											
82	**If the data were collected using judgmental or other non-random methods,**											
83	**then contact a statistician to correctly calculate UCLs.**											
84												
85	When a data set follows an approximate distribution passing only one of the GOF tests,											
86	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
87												
88	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
89	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
90	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
91												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Uncensored Full Data Sets**											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.2 3/6/2023 1:32:42 PM								
5			From File	UCL95_input_Revised.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Number of Bootstrap Operations	2000								
9												
10												
11	**200 IA Acetone**											
12												
13	**General Statistics**											
14					Total Number of Observations	16					Number of Distinct Observations	14
15											Number of Missing Observations	0
16					Minimum	2.4					Mean	10.48
17					Maximum	30					Median	9.35
18					SD	8.196					Std. Error of Mean	2.049
19					Coefficient of Variation	0.782					Skewness	1.652
20												
21	**Normal GOF Test**											
22					Shapiro Wilk Test Statistic	0.785	**Shapiro Wilk GOF Test**					
23					1% Shapiro Wilk Critical Value	0.844	Data Not Normal at 1% Significance Level					
24					Lilliefors Test Statistic	0.254	**Lilliefors GOF Test**					
25					1% Lilliefors Critical Value	0.248	Data Not Normal at 1% Significance Level					
26	**Data Not Normal at 1% Significance Level**											
27												
28	**Assuming Normal Distribution**											
29	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
30					95% Student's-t UCL	14.07					95% Adjusted-CLT UCL (Chen-1995)	14.75
31											95% Modified-t UCL (Johnson-1978)	14.21
32												
33	**Gamma GOF Test**											
34					A-D Test Statistic	0.477	**Anderson-Darling Gamma GOF Test**					
35					5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level					
36					K-S Test Statistic	0.165	**Kolmogorov-Smirnov Gamma GOF Test**					
37					5% K-S Critical Value	0.218	Detected data appear Gamma Distributed at 5% Significance Level					
38	**Detected data appear Gamma Distributed at 5% Significance Level**											
39												
40	**Gamma Statistics**											
41					k hat (MLE)	2.104					k star (bias corrected MLE)	1.751
42					Theta hat (MLE)	4.979					Theta star (bias corrected MLE)	5.982
43					nu hat (MLE)	67.33					nu star (bias corrected)	56.04
44					MLE Mean (bias corrected)	10.48					MLE Sd (bias corrected)	7.916
45											Approximate Chi Square Value (0.05)	39.83
46					Adjusted Level of Significance	0.0335					Adjusted Chi Square Value	38.28
47												

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Assuming Gamma Distribution**											
49	95% Approximate Gamma UCL					14.74	95% Adjusted Gamma UCL					15.33
50												
51	**Lognormal GOF Test**											
52	Shapiro Wilk Test Statistic					0.944	**Shapiro Wilk Lognormal GOF Test**					
53	10% Shapiro Wilk Critical Value					0.906	Data appear Lognormal at 10% Significance Level					
54	Lilliefors Test Statistic					0.138	**Lilliefors Lognormal GOF Test**					
55	10% Lilliefors Critical Value					0.196	Data appear Lognormal at 10% Significance Level					
56	**Data appear Lognormal at 10% Significance Level**											
57												
58	**Lognormal Statistics**											
59	Minimum of Logged Data					0.875	Mean of logged Data					2.093
60	Maximum of Logged Data					3.401	SD of logged Data					0.746
61												
62	**Assuming Lognormal Distribution**											
63	95% H-UCL					16.79	90% Chebyshev (MVUE) UCL					16.71
64	95% Chebyshev (MVUE) UCL					19.54	97.5% Chebyshev (MVUE) UCL					23.46
65	99% Chebyshev (MVUE) UCL					31.15						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution**											
69												
70	**Nonparametric Distribution Free UCLs**											
71	95% CLT UCL					13.85	95% BCA Bootstrap UCL					14.63
72	95% Standard Bootstrap UCL					13.73	95% Bootstrap-t UCL					17.39
73	95% Hall's Bootstrap UCL					36.36	95% Percentile Bootstrap UCL					13.89
74	90% Chebyshev(Mean, Sd) UCL					16.62	95% Chebyshev(Mean, Sd) UCL					19.41
75	97.5% Chebyshev(Mean, Sd) UCL					23.27	99% Chebyshev(Mean, Sd) UCL					30.86
76												
77	**Suggested UCL to Use**											
78	95% Adjusted Gamma UCL					15.33						
79												
80	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
81	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
82	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
83												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:34:36 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA Acetone

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14
Number of Detects	15	Number of Non-Detects	1
Number of Distinct Detects	13	Number of Distinct Non-Detects	1
Minimum Detect	2.4	Minimum Non-Detect	30
Maximum Detect	29	Maximum Non-Detect	30
Variance Detects	42.93	Percent Non-Detects	6.25%
Mean Detects	9.173	SD Detects	6.552
Median Detects	8.7	CV Detects	0.714
Skewness Detects	2.015	Kurtosis Detects	5.829
Mean of Logged Detects	2.006	SD of Logged Detects	0.682

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.796	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.213	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level

Detected Data appear Approximate Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	9.173	KM Standard Error of Mean	1.692
90KM SD	6.33	95% KM (BCA) UCL	12.21
95% KM (t) UCL	12.14	95% KM (Percentile Bootstrap) UCL	11.99
95% KM (z) UCL	11.96	95% KM Bootstrap t UCL	13.62
90% KM Chebyshev UCL	14.25	95% KM Chebyshev UCL	16.55
97.5% KM Chebyshev UCL	19.74	99% KM Chebyshev UCL	26.01

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.411	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.147	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47					k hat (MLE)	2.528					k star (bias corrected MLE)	2.067
48					Theta hat (MLE)	3.628					Theta star (bias corrected MLE)	4.438
49					nu hat (MLE)	75.85					nu star (bias corrected)	62.01
50					Mean (detects)	9.173						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	2.4					Mean	9.108
59					Maximum	29					Median	8.413
60					SD	6.335					CV	0.696
61					k hat (MLE)	2.682					k star (bias corrected MLE)	2.221
62					Theta hat (MLE)	3.396					Theta star (bias corrected MLE)	4.101
63					nu hat (MLE)	85.82					nu star (bias corrected)	71.06
64					Adjusted Level of Significance (β)	0.0335						
65					Approximate Chi Square Value (71.06, α)	52.65					Adjusted Chi Square Value (71.06, β)	50.85
66					95% Gamma Approximate UCL	12.29					95% Gamma Adjusted UCL	12.73
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	9.173					SD (KM)	6.33
70					Variance (KM)	40.07					SE of Mean (KM)	1.692
71					k hat (KM)	2.1					k star (KM)	1.748
72					nu hat (KM)	67.2					nu star (KM)	55.94
73					theta hat (KM)	4.368					theta star (KM)	5.248
74					80% gamma percentile (KM)	13.95					90% gamma percentile (KM)	18.42
75					95% gamma percentile (KM)	22.72					99% gamma percentile (KM)	32.33
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (55.94, α)	39.75					Adjusted Chi Square Value (55.94, β)	38.2
79					95% KM Approximate Gamma UCL	12.91					95% KM Adjusted Gamma UCL	13.43
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk GOF Test**					
83					10% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 10% Significance Level					
84					Lilliefors Test Statistic	0.139	**Lilliefors GOF Test**					
85					10% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 10% Significance Level					
86	**Detected Data appear Lognormal at 10% Significance Level**											
87												

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89	Mean in Original Scale					9.064	Mean in Log Scale					2.006
90	SD in Original Scale					6.345	SD in Log Scale					0.659
91	95% t UCL (assumes normality of ROS data)					11.85	95% Percentile Bootstrap UCL					11.86
92	95% BCA Bootstrap UCL					12.63	95% Bootstrap t UCL					13.26
93	95% H-UCL (Log ROS)					13.49						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96	KM Mean (logged)					2.006	KM Geo Mean					7.431
97	KM SD (logged)					0.659	95% Critical H Value (KM-Log)					2.229
98	KM Standard Error of Mean (logged)					0.176	95% H-UCL (KM -Log)					13.49
99	KM SD (logged)					0.659	95% Critical H Value (KM-Log)					2.229
100	KM Standard Error of Mean (logged)					0.176						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104	Mean in Original Scale					9.538	Mean in Log Scale					2.05
105	SD in Original Scale					6.495	SD in Log Scale					0.682
106	95% t UCL (Assumes normality)					12.38	95% H-Stat UCL					14.58
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Detected Data appear Approximate Normal Distributed at 1% Significance Level**											
111												
112	**Suggested UCL to Use**											
113	95% KM (t) UCL					12.14						
114												
115	When a data set follows an approximate distribution passing only one of the GOF tests,											
116	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:35:23 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200 IA Benzene**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	12
14	Number of Detects	9	Number of Non-Detects	7
15	Number of Distinct Detects	8	Number of Distinct Non-Detects	6
16	Minimum Detect	0.23	Minimum Non-Detect	0.25
17	Maximum Detect	1.6	Maximum Non-Detect	6.2
18	Variance Detects	0.227	Percent Non-Detects	43.75%
19	Mean Detects	0.55	SD Detects	0.477
20	Median Detects	0.31	CV Detects	0.867
21	Skewness Detects	1.796	Kurtosis Detects	2.368
22	Mean of Logged Detects	-0.844	SD of Logged Detects	0.684
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.703	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.764	Detected Data Not Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.328	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.316	Detected Data Not Normal at 1% Significance Level	
29	**Detected Data Not Normal at 1% Significance Level**			
30				
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
32	KM Mean	0.427	KM Standard Error of Mean	0.104
33	90KM SD	0.38	95% KM (BCA) UCL	0.605
34	95% KM (t) UCL	0.609	95% KM (Percentile Bootstrap) UCL	0.604
35	95% KM (z) UCL	0.598	95% KM Bootstrap t UCL	1.224
36	90% KM Chebyshev UCL	0.739	95% KM Chebyshev UCL	0.88
37	97.5% KM Chebyshev UCL	1.077	99% KM Chebyshev UCL	1.462
38				
39	**Gamma GOF Tests on Detected Observations Only**			
40	A-D Test Statistic	0.966	**Anderson-Darling GOF Test**	
41	5% A-D Critical Value	0.729	Detected Data Not Gamma Distributed at 5% Significance Level	
42	K-S Test Statistic	0.278	**Kolmogorov-Smirnov GOF**	
43	5% K-S Critical Value	0.282	Detected data appear Gamma Distributed at 5% Significance Level	
44	**Detected data follow Appr. Gamma Distribution at 5% Significance Level**			
45	**Note GOF tests may be unreliable for small sample sizes**			
46				

	A	B	C	D	E	F	G	H	I	J	K	L
47	**Gamma Statistics on Detected Data Only**											
48					k hat (MLE)	2.187					k star (bias corrected MLE)	1.532
49					Theta hat (MLE)	0.251					Theta star (bias corrected MLE)	0.359
50					nu hat (MLE)	39.37					nu star (bias corrected)	27.58
51					Mean (detects)	0.55						
52												
53	**Gamma ROS Statistics using Imputed Non-Detects**											
54	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
55	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
56	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
57	This is especially true when the sample size is small.											
58	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
59					Minimum	0.01					Mean	0.353
60					Maximum	1.6					Median	0.255
61					SD	0.422					CV	1.196
62					k hat (MLE)	0.909					k star (bias corrected MLE)	0.781
63					Theta hat (MLE)	0.388					Theta star (bias corrected MLE)	0.452
64					nu hat (MLE)	29.1					nu star (bias corrected)	24.98
65					Adjusted Level of Significance (β)	0.0335						
66					Approximate Chi Square Value (24.98, α)	14.6					Adjusted Chi Square Value (24.98, β)	13.7
67					95% Gamma Approximate UCL	0.604					95% Gamma Adjusted UCL	0.643
68												
69	**Estimates of Gamma Parameters using KM Estimates**											
70					Mean (KM)	0.427					SD (KM)	0.38
71					Variance (KM)	0.144					SE of Mean (KM)	0.104
72					k hat (KM)	1.261					k star (KM)	1.066
73					nu hat (KM)	40.36					nu star (KM)	34.13
74					theta hat (KM)	0.338					theta star (KM)	0.4
75					80% gamma percentile (KM)	0.683					90% gamma percentile (KM)	0.967
76					95% gamma percentile (KM)	1.249					99% gamma percentile (KM)	1.902
77												
78	**Gamma Kaplan-Meier (KM) Statistics**											
79					Approximate Chi Square Value (34.13, α)	21.77					Adjusted Chi Square Value (34.13, β)	20.65
80					95% KM Approximate Gamma UCL	0.669					95% KM Adjusted Gamma UCL	0.705
81												
82	**Lognormal GOF Test on Detected Observations Only**											
83					Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**					
84					10% Shapiro Wilk Critical Value	0.859	Detected Data Not Lognormal at 10% Significance Level					
85					Lilliefors Test Statistic	0.24	**Lilliefors GOF Test**					
86					10% Lilliefors Critical Value	0.252	Detected Data appear Lognormal at 10% Significance Level					
87	**Detected Data appear Approximate Lognormal at 10% Significance Level**											
88	**Note GOF tests may be unreliable for small sample sizes**											
89												

	A	B	C	D	E	F	G	H	I	J	K	L
90	**Lognormal ROS Statistics Using Imputed Non-Detects**											
91					Mean in Original Scale	0.405					Mean in Log Scale	-1.15
92					SD in Original Scale	0.389					SD in Log Scale	0.631
93					95% t UCL (assumes normality of ROS data)	0.575					95% Percentile Bootstrap UCL	0.581
94					95% BCA Bootstrap UCL	0.639					95% Bootstrap t UCL	1.08
95					95% H-UCL (Log ROS)	0.553						
96												
97	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
98					KM Mean (logged)	-1.076					KM Geo Mean	0.341
99					KM SD (logged)	0.577					95% Critical H Value (KM-Log)	2.133
100					KM Standard Error of Mean (logged)	0.159					95% H-UCL (KM -Log)	0.553
101					KM SD (logged)	0.577					95% Critical H Value (KM-Log)	2.133
102					KM Standard Error of Mean (logged)	0.159						
103	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107					Mean in Original Scale	0.558					Mean in Log Scale	-1.131
108					SD in Original Scale	0.788					SD in Log Scale	0.952
109					95% t UCL (Assumes normality)	0.903					95% H-Stat UCL	0.97
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Detected Data appear Approximate Gamma Distributed at 5% Significance Level**											
114												
115	**Suggested UCL to Use**											
116					95% KM Adjusted Gamma UCL	0.705					95% GROS Adjusted Gamma UCL	0.643
117												
118	When a data set follows an approximate distribution passing only one of the GOF tests,											
119	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
120												
121	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
122	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
123	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
124												

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:36:19 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200 IA Carbon Tetrachloride**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	8
14	Number of Detects	15	Number of Non-Detects	1
15	Number of Distinct Detects	7	Number of Distinct Non-Detects	1
16	Minimum Detect	0.37	Minimum Non-Detect	5.8
17	Maximum Detect	0.45	Maximum Non-Detect	5.8
18	Variance Detects	6.2857E-4	Percent Non-Detects	6.25%
19	Mean Detects	0.4	SD Detects	0.0251
20	Median Detects	0.39	CV Detects	0.0627
21	Skewness Detects	0.628	Kurtosis Detects	-0.587
22	Mean of Logged Detects	-0.918	SD of Logged Detects	0.0618
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.908	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.835	Detected Data appear Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level	
29	**Detected Data appear Normal at 1% Significance Level**			
30				
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
32	KM Mean	0.4	KM Standard Error of Mean	0.00647
33	90KM SD	0.0242	95% KM (BCA) UCL	0.411
34	95% KM (t) UCL	0.411	95% KM (Percentile Bootstrap) UCL	0.41
35	95% KM (z) UCL	0.411	95% KM Bootstrap t UCL	0.413
36	90% KM Chebyshev UCL	0.419	95% KM Chebyshev UCL	0.428
37	97.5% KM Chebyshev UCL	0.44	99% KM Chebyshev UCL	0.464
38	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**			
39				
40	**Gamma GOF Tests on Detected Observations Only**			
41	A-D Test Statistic	0.581	**Anderson-Darling GOF Test**	
42	5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.196	**Kolmogorov-Smirnov GOF**	
44	5% K-S Critical Value	0.221	Detected data appear Gamma Distributed at 5% Significance Level	
45	**Detected data appear Gamma Distributed at 5% Significance Level**			
46				

	A	B	C	D	E	F	G	H	I	J	K	L
47	**Gamma Statistics on Detected Data Only**											
48					k hat (MLE)	278.1					k star (bias corrected MLE)	222.6
49					Theta hat (MLE)	0.00144					Theta star (bias corrected MLE)	0.0018
50					nu hat (MLE)	8344					nu star (bias corrected)	6677
51					Mean (detects)	0.4						
52												
53	**Gamma ROS Statistics using Imputed Non-Detects**											
54	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
55	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
56	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
57	This is especially true when the sample size is small.											
58	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
59					Minimum	0.37					Mean	0.4
60					Maximum	0.45					Median	0.395
61					SD	0.0242					CV	0.0606
62					k hat (MLE)	296.7					k star (bias corrected MLE)	241.1
63					Theta hat (MLE)	0.00135					Theta star (bias corrected MLE)	0.00166
64					nu hat (MLE)	9494					nu star (bias corrected)	7715
65					Adjusted Level of Significance (β)	0.0335						
66					Approximate Chi Square Value (N/A, α)	7512					Adjusted Chi Square Value (N/A, β)	7489
67					95% Gamma Approximate UCL	0.411					95% Gamma Adjusted UCL	0.412
68												
69	**Estimates of Gamma Parameters using KM Estimates**											
70					Mean (KM)	0.4					SD (KM)	0.0242
71					Variance (KM)	5.8667E-4					SE of Mean (KM)	0.00647
72					k hat (KM)	272.7					k star (KM)	221.6
73					nu hat (KM)	8727					nu star (KM)	7092
74					theta hat (KM)	0.00147					theta star (KM)	0.0018
75					80% gamma percentile (KM)	0.422					90% gamma percentile (KM)	0.435
76					95% gamma percentile (KM)	0.445					99% gamma percentile (KM)	0.465
77												
78	**Gamma Kaplan-Meier (KM) Statistics**											
79					Approximate Chi Square Value (N/A, α)	6897					Adjusted Chi Square Value (N/A, β)	6876
80					95% KM Approximate Gamma UCL	0.411					95% KM Adjusted Gamma UCL	0.413
81	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
82												
83	**Lognormal GOF Test on Detected Observations Only**											
84					Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**					
85					10% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 10% Significance Level					
86					Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**					
87					10% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 10% Significance Level					
88	**Detected Data appear Lognormal at 10% Significance Level**											
89												

	A	B	C	D	E	F	G	H	I	J	K	L
90	**Lognormal ROS Statistics Using Imputed Non-Detects**											
91	Mean in Original Scale					0.4	Mean in Log Scale					-0.918
92	SD in Original Scale					0.0242	SD in Log Scale					0.0597
93	95% t UCL (assumes normality of ROS data)					0.411	95% Percentile Bootstrap UCL					0.41
94	95% BCA Bootstrap UCL					0.411	95% Bootstrap t UCL					0.412
95	95% H-UCL (Log ROS)					N/A						
96												
97	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
98	KM Mean (logged)					-0.918	KM Geo Mean					0.399
99	KM SD (logged)					0.0597	95% Critical H Value (KM-Log)					N/A
100	KM Standard Error of Mean (logged)					0.016	95% H-UCL (KM -Log)					N/A
101	KM SD (logged)					0.0597	95% Critical H Value (KM-Log)					N/A
102	KM Standard Error of Mean (logged)					0.016						
103												
104	**DL/2 Statistics**											
105	**DL/2 Normal**						**DL/2 Log-Transformed**					
106	Mean in Original Scale					0.556	Mean in Log Scale					-0.794
107	SD in Original Scale					0.625	SD in Log Scale					0.499
108	95% t UCL (Assumes normality)					0.83	95% H-Stat UCL					0.667
109	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
110												
111	**Nonparametric Distribution Free UCL Statistics**											
112	**Detected Data appear Normal Distributed at 1% Significance Level**											
113												
114	**Suggested UCL to Use**											
115	95% KM (t) UCL					0.411						
116												
117	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
118	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
119	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
120												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 1:37:22 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

200 IA Chloromethane

General Statistics

Total Number of Observations	16	Number of Distinct Observations	11
Number of Detects	15	Number of Non-Detects	1
Number of Distinct Detects	10	Number of Distinct Non-Detects	1
Minimum Detect	0.29	Minimum Non-Detect	5.8
Maximum Detect	0.6	Maximum Non-Detect	5.8
Variance Detects	0.0164	Percent Non-Detects	6.25%
Mean Detects	0.469	SD Detects	0.128
Median Detects	0.56	CV Detects	0.273
Skewness Detects	-0.213	Kurtosis Detects	-2.077
Mean of Logged Detects	-0.796	SD of Logged Detects	0.29

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.781	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.295	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.469	KM Standard Error of Mean	0.0331
90KM SD	0.124	95% KM (BCA) UCL	0.518
95% KM (t) UCL	0.527	95% KM (Percentile Bootstrap) UCL	0.519
95% KM (z) UCL	0.523	95% KM Bootstrap t UCL	0.524
90% KM Chebyshev UCL	0.568	95% KM Chebyshev UCL	0.613
97.5% KM Chebyshev UCL	0.675	99% KM Chebyshev UCL	0.798

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.547	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.736	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.31	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.221	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
47	**Gamma Statistics on Detected Data Only**											
48	k hat (MLE)					13.41	k star (bias corrected MLE)					10.78
49	Theta hat (MLE)					0.0349	Theta star (bias corrected MLE)					0.0435
50	nu hat (MLE)					402.4	nu star (bias corrected)					323.3
51	Mean (detects)					0.469						
52												
53	**Gamma ROS Statistics using Imputed Non-Detects**											
54	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
55	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
56	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
57	This is especially true when the sample size is small.											
58	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
59	Minimum					0.29	Mean					0.468
60	Maximum					0.6	Median					0.51
61	SD					0.124	CV					0.264
62	k hat (MLE)					14.29	k star (bias corrected MLE)					11.65
63	Theta hat (MLE)					0.0328	Theta star (bias corrected MLE)					0.0402
64	nu hat (MLE)					457.4	nu star (bias corrected)					372.9
65	Adjusted Level of Significance (β)					0.0335						
66	Approximate Chi Square Value (372.95, α)					329.2	Adjusted Chi Square Value (372.95, β)					324.5
67	95% Gamma Approximate UCL					0.53	95% Gamma Adjusted UCL					0.538
68												
69	**Estimates of Gamma Parameters using KM Estimates**											
70	Mean (KM)					0.469	SD (KM)					0.124
71	Variance (KM)					0.0153	SE of Mean (KM)					0.0331
72	k hat (KM)					14.34	k star (KM)					11.69
73	nu hat (KM)					458.8	nu star (KM)					374.1
74	theta hat (KM)					0.0327	theta star (KM)					0.0401
75	80% gamma percentile (KM)					0.578	90% gamma percentile (KM)					0.651
76	95% gamma percentile (KM)					0.715	99% gamma percentile (KM)					0.845
77												
78	**Gamma Kaplan-Meier (KM) Statistics**											
79	Approximate Chi Square Value (374.15, α)					330.3	Adjusted Chi Square Value (374.15, β)					325.6
80	95% KM Approximate Gamma UCL					0.531	95% KM Adjusted Gamma UCL					0.538
81	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
82												
83	**Lognormal GOF Test on Detected Observations Only**											
84	Shapiro Wilk Test Statistic					0.791	**Shapiro Wilk GOF Test**					
85	10% Shapiro Wilk Critical Value					0.901	Detected Data Not Lognormal at 10% Significance Level					
86	Lilliefors Test Statistic					0.305	**Lilliefors GOF Test**					
87	10% Lilliefors Critical Value					0.202	Detected Data Not Lognormal at 10% Significance Level					
88	**Detected Data Not Lognormal at 10% Significance Level**											
89												

	A	B	C	D	E	F	G	H	I	J	K	L
90	**Lognormal ROS Statistics Using Imputed Non-Detects**											
91	Mean in Original Scale					0.468	Mean in Log Scale					-0.796
92	SD in Original Scale					0.124	SD in Log Scale					0.28
93	95% t UCL (assumes normality of ROS data)					0.522	95% Percentile Bootstrap UCL					0.517
94	95% BCA Bootstrap UCL					0.514	95% Bootstrap t UCL					0.523
95	95% H-UCL (Log ROS)					0.537						
96												
97	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
98	KM Mean (logged)					-0.796	KM Geo Mean					0.451
99	KM SD (logged)					0.28	95% Critical H Value (KM-Log)					1.855
100	KM Standard Error of Mean (logged)					0.0748	95% H-UCL (KM -Log)					0.537
101	KM SD (logged)					0.28	95% Critical H Value (KM-Log)					1.855
102	KM Standard Error of Mean (logged)					0.0748						
103	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107	Mean in Original Scale					0.621	Mean in Log Scale					-0.679
108	SD in Original Scale					0.62	SD in Log Scale					0.543
109	95% t UCL (Assumes normality)					0.892	95% H-Stat UCL					0.788
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Data do not follow a Discernible Distribution**											
114												
115	**Suggested UCL to Use**											
116	95% KM (t) UCL					0.527						
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:38:05 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200 IA Ethanol**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	15
14	Number of Detects	12	Number of Non-Detects	4
15	Number of Distinct Detects	12	Number of Distinct Non-Detects	4
16	Minimum Detect	1.5	Minimum Non-Detect	1.4
17	Maximum Detect	23	Maximum Non-Detect	31
18	Variance Detects	33.14	Percent Non-Detects	25%
19	Mean Detects	7.225	SD Detects	5.756
20	Median Detects	6.1	CV Detects	0.797
21	Skewness Detects	2.025	Kurtosis Detects	5.237
22	Mean of Logged Detects	1.719	SD of Logged Detects	0.771
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.798	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.805	Detected Data Not Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.259	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.281	Detected Data appear Normal at 1% Significance Level	
29	**Detected Data appear Approximate Normal at 1% Significance Level**			
30				
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
32	KM Mean	6.067	KM Standard Error of Mean	1.469
33	90KM SD	5.447	95% KM (BCA) UCL	8.65
34	95% KM (t) UCL	8.642	95% KM (Percentile Bootstrap) UCL	8.447
35	95% KM (z) UCL	8.483	95% KM Bootstrap t UCL	10.02
36	90% KM Chebyshev UCL	10.47	95% KM Chebyshev UCL	12.47
37	97.5% KM Chebyshev UCL	15.24	99% KM Chebyshev UCL	20.68
38				
39	**Gamma GOF Tests on Detected Observations Only**			
40	A-D Test Statistic	0.323	**Anderson-Darling GOF Test**	
41	5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level	
42	K-S Test Statistic	0.168	**Kolmogorov-Smirnov GOF**	
43	5% K-S Critical Value	0.248	Detected data appear Gamma Distributed at 5% Significance Level	
44	**Detected data appear Gamma Distributed at 5% Significance Level**			
45				

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47	k hat (MLE)					2.086	k star (bias corrected MLE)					1.62
48	Theta hat (MLE)					3.464	Theta star (bias corrected MLE)					4.461
49	nu hat (MLE)					50.05	nu star (bias corrected)					38.87
50	Mean (detects)					7.225						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58	Minimum					0.01	Mean					5.694
59	Maximum					23	Median					5.15
60	SD					5.723	CV					1.005
61	k hat (MLE)					0.517	k star (bias corrected MLE)					0.462
62	Theta hat (MLE)					11.01	Theta star (bias corrected MLE)					12.33
63	nu hat (MLE)					16.55	nu star (bias corrected)					14.78
64	Adjusted Level of Significance (β)					0.0335						
65	Approximate Chi Square Value (14.78, α)					7.112	Adjusted Chi Square Value (14.78, β)					6.513
66	95% Gamma Approximate UCL					11.84	95% Gamma Adjusted UCL					12.92
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69	Mean (KM)					6.067	SD (KM)					5.447
70	Variance (KM)					29.67	SE of Mean (KM)					1.469
71	k hat (KM)					1.241	k star (KM)					1.05
72	nu hat (KM)					39.7	nu star (KM)					33.59
73	theta hat (KM)					4.89	theta star (KM)					5.78
74	80% gamma percentile (KM)					9.725	90% gamma percentile (KM)					13.8
75	95% gamma percentile (KM)					17.87	99% gamma percentile (KM)					27.27
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78	Approximate Chi Square Value (33.59, α)					21.33	Adjusted Chi Square Value (33.59, β)					20.23
79	95% KM Approximate Gamma UCL					9.551	95% KM Adjusted Gamma UCL					10.07
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82	Shapiro Wilk Test Statistic					0.953	**Shapiro Wilk GOF Test**					
83	10% Shapiro Wilk Critical Value					0.883	Detected Data appear Lognormal at 10% Significance Level					
84	Lilliefors Test Statistic					0.169	**Lilliefors GOF Test**					
85	10% Lilliefors Critical Value					0.223	Detected Data appear Lognormal at 10% Significance Level					
86	**Detected Data appear Lognormal at 10% Significance Level**											
87												

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89	Mean in Original Scale					5.874	Mean in Log Scale					1.388
90	SD in Original Scale					5.53	SD in Log Scale					0.94
91	95% t UCL (assumes normality of ROS data)					8.298	95% Percentile Bootstrap UCL					8.325
92	95% BCA Bootstrap UCL					8.902	95% Bootstrap t UCL					9.72
93	95% H-UCL (Log ROS)					11.74						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96	KM Mean (logged)					1.447	KM Geo Mean					4.25
97	KM SD (logged)					0.856	95% Critical H Value (KM-Log)					2.49
98	KM Standard Error of Mean (logged)					0.231	95% H-UCL (KM -Log)					10.62
99	KM SD (logged)					0.856	95% Critical H Value (KM-Log)					2.49
100	KM Standard Error of Mean (logged)					0.231						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104	Mean in Original Scale					6.534	Mean in Log Scale					1.414
105	SD in Original Scale					6.054	SD in Log Scale					1.088
106	95% t UCL (Assumes normality)					9.188	95% H-Stat UCL					16.5
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Detected Data appear Approximate Normal Distributed at 1% Significance Level**											
111												
112	**Suggested UCL to Use**											
113	95% KM (t) UCL					8.642						
114												
115	When a data set follows an approximate distribution passing only one of the GOF tests,											
116	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 1:39:03 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10	**200 IA Freon 11**											
11												
12	**General Statistics**											
13	Total Number of Observations					16	Number of Distinct Observations					12
14	Number of Detects					15	Number of Non-Detects					1
15	Number of Distinct Detects					11	Number of Distinct Non-Detects					1
16	Minimum Detect					1.3	Minimum Non-Detect					6.6
17	Maximum Detect					22	Maximum Non-Detect					6.6
18	Variance Detects					45.44	Percent Non-Detects					6.25%
19	Mean Detects					4.84	SD Detects					6.741
20	Median Detects					1.6	CV Detects					1.393
21	Skewness Detects					2.199	Kurtosis Detects					3.725
22	Mean of Logged Detects					1.004	SD of Logged Detects					0.975
23												
24	**Normal GOF Test on Detects Only**											
25	Shapiro Wilk Test Statistic					0.578	**Shapiro Wilk GOF Test**					
26	1% Shapiro Wilk Critical Value					0.835	Detected Data Not Normal at 1% Significance Level					
27	Lilliefors Test Statistic					0.326	**Lilliefors GOF Test**					
28	1% Lilliefors Critical Value					0.255	Detected Data Not Normal at 1% Significance Level					
29	**Detected Data Not Normal at 1% Significance Level**											
30												
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
32	KM Mean					4.685	KM Standard Error of Mean					1.645
33	90KM SD					6.346	95% KM (BCA) UCL					7.475
34	95% KM (t) UCL					7.569	95% KM (Percentile Bootstrap) UCL					7.412
35	95% KM (z) UCL					7.391	95% KM Bootstrap t UCL					14.48
36	90% KM Chebyshev UCL					9.621	95% KM Chebyshev UCL					11.86
37	97.5% KM Chebyshev UCL					14.96	99% KM Chebyshev UCL					21.06
38												
39	**Gamma GOF Tests on Detected Observations Only**											
40	A-D Test Statistic					1.928	**Anderson-Darling GOF Test**					
41	5% A-D Critical Value					0.763	Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic					0.305	**Kolmogorov-Smirnov GOF**					
43	5% K-S Critical Value					0.228	Detected Data Not Gamma Distributed at 5% Significance Level					
44	**Detected Data Not Gamma Distributed at 5% Significance Level**											
45												

46	**Gamma Statistics on Detected Data Only**			
47	k hat (MLE)	1.007	k star (bias corrected MLE)	0.85
48	Theta hat (MLE)	4.806	Theta star (bias corrected MLE)	5.693
49	nu hat (MLE)	30.21	nu star (bias corrected)	25.5
50	Mean (detects)	4.84		
51				
52	**Gamma ROS Statistics using Imputed Non-Detects**			
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
56	This is especially true when the sample size is small.			
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
58	Minimum	1.3	Mean	4.669
59	Maximum	22	Median	1.65
60	SD	6.548	CV	1.402
61	k hat (MLE)	1.039	k star (bias corrected MLE)	0.886
62	Theta hat (MLE)	4.493	Theta star (bias corrected MLE)	5.27
63	nu hat (MLE)	33.25	nu star (bias corrected)	28.35
64	Adjusted Level of Significance (β)	0.0335		
65	Approximate Chi Square Value (28.35, α)	17.2	Adjusted Chi Square Value (28.35, β)	16.22
66	95% Gamma Approximate UCL	7.695	95% Gamma Adjusted UCL	8.162
67				
68	**Estimates of Gamma Parameters using KM Estimates**			
69	Mean (KM)	4.685	SD (KM)	6.346
70	Variance (KM)	40.27	SE of Mean (KM)	1.645
71	k hat (KM)	0.545	k star (KM)	0.484
72	nu hat (KM)	17.44	nu star (KM)	15.5
73	theta hat (KM)	8.596	theta star (KM)	9.67
74	80% gamma percentile (KM)	7.682	90% gamma percentile (KM)	12.76
75	95% gamma percentile (KM)	18.2	99% gamma percentile (KM)	31.62
76				
77	**Gamma Kaplan-Meier (KM) Statistics**			
78	Approximate Chi Square Value (15.50, α)	7.612	Adjusted Chi Square Value (15.50, β)	6.99
79	95% KM Approximate Gamma UCL	9.54	95% KM Adjusted Gamma UCL	10.39
80				
81	**Lognormal GOF Test on Detected Observations Only**			
82	Shapiro Wilk Test Statistic	0.762	**Shapiro Wilk GOF Test**	
83	10% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 10% Significance Level	
84	Lilliefors Test Statistic	0.286	**Lilliefors GOF Test**	
85	10% Lilliefors Critical Value	0.202	Detected Data Not Lognormal at 10% Significance Level	
86	**Detected Data Not Lognormal at 10% Significance Level**			
87				

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89					Mean in Original Scale	4.68					Mean in Log Scale	0.993
90					SD in Original Scale	6.543					SD in Log Scale	0.943
91					95% t UCL (assumes normality of ROS data)	7.548					95% Percentile Bootstrap UCL	7.397
92					95% BCA Bootstrap UCL	8.299					95% Bootstrap t UCL	15.21
93					95% H-UCL (Log ROS)	7.966						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96					KM Mean (logged)	0.985					KM Geo Mean	2.677
97					KM SD (logged)	0.925					95% Critical H Value (KM-Log)	2.591
98					KM Standard Error of Mean (logged)	0.242					95% H-UCL (KM -Log)	7.623
99					KM SD (logged)	0.925					95% Critical H Value (KM-Log)	2.591
100					KM Standard Error of Mean (logged)	0.242						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104					Mean in Original Scale	4.744					Mean in Log Scale	1.016
105					SD in Original Scale	6.523					SD in Log Scale	0.943
106					95% t UCL (Assumes normality)	7.603					95% H-Stat UCL	8.154
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Data do not follow a Discernible Distribution**											
111												
112	**Suggested UCL to Use**											
113					95% KM (t) UCL	7.569						
114												
115	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
116	**Please verify the data were collected from random locations.**											
117	**If the data were collected using judgmental or other non-random methods,**											
118	**then contact a statistician to correctly calculate UCLs.**											
119												
120	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
121	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
122	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
123												

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:40:06 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200 IA Freon 12**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	5
14	Number of Detects	15	Number of Non-Detects	1
15	Number of Distinct Detects	4	Number of Distinct Non-Detects	1
16	Minimum Detect	2.3	Minimum Non-Detect	6.6
17	Maximum Detect	2.7	Maximum Non-Detect	6.6
18	Variance Detects	0.0155	Percent Non-Detects	6.25%
19	Mean Detects	2.447	SD Detects	0.125
20	Median Detects	2.4	CV Detects	0.0509
21	Skewness Detects	0.982	Kurtosis Detects	0.648
22	Mean of Logged Detects	0.894	SD of Logged Detects	0.05
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.848	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.835	Detected Data appear Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.246	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level	
29	**Detected Data appear Normal at 1% Significance Level**			
30				
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
32	KM Mean	2.447	KM Standard Error of Mean	0.0322
33	90KM SD	0.12	95% KM (BCA) UCL	N/A
34	95% KM (t) UCL	2.503	95% KM (Percentile Bootstrap) UCL	N/A
35	95% KM (z) UCL	2.5	95% KM Bootstrap t UCL	N/A
36	90% KM Chebyshev UCL	2.543	95% KM Chebyshev UCL	2.587
37	97.5% KM Chebyshev UCL	2.648	99% KM Chebyshev UCL	2.767
38				
39	**Gamma GOF Tests on Detected Observations Only**			
40	A-D Test Statistic	0.915	**Anderson-Darling GOF Test**	
41	5% A-D Critical Value	0.734	Detected Data Not Gamma Distributed at 5% Significance Level	
42	K-S Test Statistic	0.248	**Kolmogorov-Smirnov GOF**	
43	5% K-S Critical Value	0.221	Detected Data Not Gamma Distributed at 5% Significance Level	
44	**Detected Data Not Gamma Distributed at 5% Significance Level**			
45				

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47					k hat (MLE)	424.1					k star (bias corrected MLE)	339.3
48					Theta hat (MLE)	0.00577					Theta star (bias corrected MLE)	0.00721
49					nu hat (MLE)	12723					nu star (bias corrected)	10179
50					Mean (detects)	2.447						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	2.3					Mean	2.447
59					Maximum	2.7					Median	2.4
60					SD	0.12					CV	0.0492
61					k hat (MLE)	452.3					k star (bias corrected MLE)	367.6
62					Theta hat (MLE)	0.00541					Theta star (bias corrected MLE)	0.00666
63					nu hat (MLE)	14475					nu star (bias corrected)	11762
64					Adjusted Level of Significance (β)	0.0335						
65					Approximate Chi Square Value (N/A, α)	11511					Adjusted Chi Square Value (N/A, β)	11483
66					95% Gamma Approximate UCL	2.5					95% Gamma Adjusted UCL	2.506
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	2.447					SD (KM)	0.12
70					Variance (KM)	0.0145					SE of Mean (KM)	0.0322
71					k hat (KM)	413.2					k star (KM)	335.7
72					nu hat (KM)	13221					nu star (KM)	10743
73					theta hat (KM)	0.00592					theta star (KM)	0.00729
74					80% gamma percentile (KM)	2.558					90% gamma percentile (KM)	2.619
75					95% gamma percentile (KM)	2.67					99% gamma percentile (KM)	2.768
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (N/A, α)	10503					Adjusted Chi Square Value (N/A, β)	10476
79					95% KM Approximate Gamma UCL	2.503					95% KM Adjusted Gamma UCL	2.509
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk GOF Test**					
83					10% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 10% Significance Level					
84					Lilliefors Test Statistic	0.241	**Lilliefors GOF Test**					
85					10% Lilliefors Critical Value	0.202	Detected Data Not Lognormal at 10% Significance Level					
86	**Detected Data Not Lognormal at 10% Significance Level**											
87												

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89	Mean in Original Scale					2.446	Mean in Log Scale					0.894
90	SD in Original Scale					0.12	SD in Log Scale					0.0483
91	95% t UCL (assumes normality of ROS data)					2.499	95% Percentile Bootstrap UCL					2.499
92	95% BCA Bootstrap UCL					2.505	95% Bootstrap t UCL					2.515
93	95% H-UCL (Log ROS)					N/A						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96	KM Mean (logged)					0.894	KM Geo Mean					2.444
97	KM SD (logged)					0.0483	95% Critical H Value (KM-Log)					N/A
98	KM Standard Error of Mean (logged)					0.0129	95% H-UCL (KM -Log)					N/A
99	KM SD (logged)					0.0483	95% Critical H Value (KM-Log)					N/A
100	KM Standard Error of Mean (logged)					0.0129						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104	Mean in Original Scale					2.5	Mean in Log Scale					0.912
105	SD in Original Scale					0.245	SD in Log Scale					0.0893
106	95% t UCL (Assumes normality)					2.607	95% H-Stat UCL					N/A
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Detected Data appear Normal Distributed at 1% Significance Level**											
111												
112	**Suggested UCL to Use**											
113	95% KM (t) UCL					2.503						
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
117	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
118												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Uncensored Full Data Sets**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 1:39:34 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	**200 IA Freon 113**											
12												
13	**General Statistics**											
14	Total Number of Observations					16	Number of Distinct Observations					15
15							Number of Missing Observations					0
16	Minimum					0.53	Mean					267.5
17	Maximum					3200	Median					17.5
18	SD					802.3	Std. Error of Mean					200.6
19	Coefficient of Variation					2.999	Skewness					3.704
20												
21	**Normal GOF Test**											
22	Shapiro Wilk Test Statistic					0.38	**Shapiro Wilk GOF Test**					
23	1% Shapiro Wilk Critical Value					0.844	Data Not Normal at 1% Significance Level					
24	Lilliefors Test Statistic					0.448	**Lilliefors GOF Test**					
25	1% Lilliefors Critical Value					0.248	Data Not Normal at 1% Significance Level					
26	**Data Not Normal at 1% Significance Level**											
27												
28	**Assuming Normal Distribution**											
29	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
30	95% Student's-t UCL					619.2	95% Adjusted-CLT UCL (Chen-1995)					795.9
31							95% Modified-t UCL (Johnson-1978)					650.1
32												
33	**Gamma GOF Test**											
34	A-D Test Statistic					1.49	**Anderson-Darling Gamma GOF Test**					
35	5% A-D Critical Value					0.866	Data Not Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic					0.285	**Kolmogorov-Smirnov Gamma GOF Test**					
37	5% K-S Critical Value					0.236	Data Not Gamma Distributed at 5% Significance Level					
38	**Data Not Gamma Distributed at 5% Significance Level**											
39												
40	**Gamma Statistics**											
41	k hat (MLE)					0.238	k star (bias corrected MLE)					0.235
42	Theta hat (MLE)					1123	Theta star (bias corrected MLE)					1138
43	nu hat (MLE)					7.621	nu star (bias corrected)					7.525
44	MLE Mean (bias corrected)					267.5	MLE Sd (bias corrected)					551.7
45							Approximate Chi Square Value (0.05)					2.463
46	Adjusted Level of Significance					0.0335	Adjusted Chi Square Value					2.146
47												

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Assuming Gamma Distribution**											
49	95% Approximate Gamma UCL					817.3	95% Adjusted Gamma UCL					938.1
50												
51	**Lognormal GOF Test**											
52	Shapiro Wilk Test Statistic					0.922	**Shapiro Wilk Lognormal GOF Test**					
53	10% Shapiro Wilk Critical Value					0.906	Data appear Lognormal at 10% Significance Level					
54	Lilliefors Test Statistic					0.182	**Lilliefors Lognormal GOF Test**					
55	10% Lilliefors Critical Value					0.196	Data appear Lognormal at 10% Significance Level					
56	**Data appear Lognormal at 10% Significance Level**											
57												
58	**Lognormal Statistics**											
59	Minimum of Logged Data					-0.635	Mean of logged Data					2.583
60	Maximum of Logged Data					8.071	SD of logged Data					2.591
61												
62	**Assuming Lognormal Distribution**											
63	95% H-UCL					16209	90% Chebyshev (MVUE) UCL					650.8
64	95% Chebyshev (MVUE) UCL					853.5	97.5% Chebyshev (MVUE) UCL					1135
65	99% Chebyshev (MVUE) UCL					1688						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution**											
69												
70	**Nonparametric Distribution Free UCLs**											
71	95% CLT UCL					597.5	95% BCA Bootstrap UCL					900.9
72	95% Standard Bootstrap UCL					588.3	95% Bootstrap-t UCL					5866
73	95% Hall's Bootstrap UCL					4024	95% Percentile Bootstrap UCL					651
74	90% Chebyshev(Mean, Sd) UCL					869.3	95% Chebyshev(Mean, Sd) UCL					1142
75	97.5% Chebyshev(Mean, Sd) UCL					1520	99% Chebyshev(Mean, Sd) UCL					2263
76												
77	**Suggested UCL to Use**											
78	95% Student's-t UCL					619.2						
79												
80	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
81	**Please verify the data were collected from random locations.**											
82	**If the data were collected using judgmental or other non-random methods,**											
83	**then contact a statistician to correctly calculate UCLs.**											
84												
85	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
86	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
87	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
88												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 1:41:03 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10	**200 IA Hexane**											
11												
12	**General Statistics**											
13	Total Number of Observations					16	Number of Distinct Observations					14
14	Number of Detects					8	Number of Non-Detects					8
15	Number of Distinct Detects					7	Number of Distinct Non-Detects					7
16	Minimum Detect					0.3	Minimum Non-Detect					0.22
17	Maximum Detect					1.2	Maximum Non-Detect					5.8
18	Variance Detects					0.159	Percent Non-Detects					50%
19	Mean Detects					0.659	SD Detects					0.399
20	Median Detects					0.46	CV Detects					0.606
21	Skewness Detects					0.574	Kurtosis Detects					-2.107
22	Mean of Logged Detects					-0.58	SD of Logged Detects					0.607
23												
24	**Normal GOF Test on Detects Only**											
25	Shapiro Wilk Test Statistic					0.777	**Shapiro Wilk GOF Test**					
26	1% Shapiro Wilk Critical Value					0.749	Detected Data appear Normal at 1% Significance Level					
27	Lilliefors Test Statistic					0.28	**Lilliefors GOF Test**					
28	1% Lilliefors Critical Value					0.333	Detected Data appear Normal at 1% Significance Level					
29	**Detected Data appear Normal at 1% Significance Level**											
30	**Note GOF tests may be unreliable for small sample sizes**											
31												
32	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
33	KM Mean					0.455	KM Standard Error of Mean					0.0964
34	90KM SD					0.349	95% KM (BCA) UCL					0.618
35	95% KM (t) UCL					0.624	95% KM (Percentile Bootstrap) UCL					0.617
36	95% KM (z) UCL					0.614	95% KM Bootstrap t UCL					0.662
37	90% KM Chebyshev UCL					0.745	95% KM Chebyshev UCL					0.875
38	97.5% KM Chebyshev UCL					1.057	99% KM Chebyshev UCL					1.414
39												
40	**Gamma GOF Tests on Detected Observations Only**											
41	A-D Test Statistic					0.789	**Anderson-Darling GOF Test**					
42	5% A-D Critical Value					0.721	Detected Data Not Gamma Distributed at 5% Significance Level					
43	K-S Test Statistic					0.257	**Kolmogorov-Smirnov GOF**					
44	5% K-S Critical Value					0.296	Detected data appear Gamma Distributed at 5% Significance Level					
45	**Detected data follow Appr. Gamma Distribution at 5% Significance Level**											
46	**Note GOF tests may be unreliable for small sample sizes**											
47												

48	**Gamma Statistics on Detected Data Only**			
49	k hat (MLE)	3.228	k star (bias corrected MLE)	2.101
50	Theta hat (MLE)	0.204	Theta star (bias corrected MLE)	0.314
51	nu hat (MLE)	51.65	nu star (bias corrected)	33.62
52	Mean (detects)	0.659		
53				
54	**Gamma ROS Statistics using Imputed Non-Detects**			
55	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
56	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
57	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
58	This is especially true when the sample size is small.			
59	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
60	Minimum	0.01	Mean	0.347
61	Maximum	1.2	Median	0.26
62	SD	0.425	CV	1.222
63	k hat (MLE)	0.477	k star (bias corrected MLE)	0.429
64	Theta hat (MLE)	0.729	Theta star (bias corrected MLE)	0.81
65	nu hat (MLE)	15.25	nu star (bias corrected)	13.73
66	Adjusted Level of Significance (β)	0.0335		
67	Approximate Chi Square Value (13.73, α)	6.384	Adjusted Chi Square Value (13.73, β)	5.822
68	95% Gamma Approximate UCL	0.747	95% Gamma Adjusted UCL	0.819
69				
70	**Estimates of Gamma Parameters using KM Estimates**			
71	Mean (KM)	0.455	SD (KM)	0.349
72	Variance (KM)	0.122	SE of Mean (KM)	0.0964
73	k hat (KM)	1.703	k star (KM)	1.425
74	nu hat (KM)	54.49	nu star (KM)	45.61
75	theta hat (KM)	0.267	theta star (KM)	0.32
76	80% gamma percentile (KM)	0.709	90% gamma percentile (KM)	0.961
77	95% gamma percentile (KM)	1.207	99% gamma percentile (KM)	1.764
78				
79	**Gamma Kaplan-Meier (KM) Statistics**			
80	Approximate Chi Square Value (45.61, α)	31.11	Adjusted Chi Square Value (45.61, β)	29.75
81	95% KM Approximate Gamma UCL	0.668	95% KM Adjusted Gamma UCL	0.698
82				
83	**Lognormal GOF Test on Detected Observations Only**			
84	Shapiro Wilk Test Statistic	0.821	**Shapiro Wilk GOF Test**	
85	10% Shapiro Wilk Critical Value	0.851	Detected Data Not Lognormal at 10% Significance Level	
86	Lilliefors Test Statistic	0.242	**Lilliefors GOF Test**	
87	10% Lilliefors Critical Value	0.265	Detected Data appear Lognormal at 10% Significance Level	
88	**Detected Data appear Approximate Lognormal at 10% Significance Level**			
89	**Note GOF tests may be unreliable for small sample sizes**			
90				

	A	B	C	D	E	F	G	H	I	J	K	L
91	**Lognormal ROS Statistics Using Imputed Non-Detects**											
92	Mean in Original Scale					0.401	Mean in Log Scale					-1.287
93	SD in Original Scale					0.383	SD in Log Scale					0.868
94	95% t UCL (assumes normality of ROS data)					0.569	95% Percentile Bootstrap UCL					0.564
95	95% BCA Bootstrap UCL					0.591	95% Bootstrap t UCL					0.621
96	95% H-UCL (Log ROS)					0.706						
97												
98	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
99	KM Mean (logged)					-1.011	KM Geo Mean					0.364
100	KM SD (logged)					0.621	95% Critical H Value (KM-Log)					2.184
101	KM Standard Error of Mean (logged)					0.172	95% H-UCL (KM -Log)					0.626
102	KM SD (logged)					0.621	95% Critical H Value (KM-Log)					2.184
103	KM Standard Error of Mean (logged)					0.172						
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107	Mean in Original Scale					0.565	Mean in Log Scale					-1.137
108	SD in Original Scale					0.73	SD in Log Scale					1.044
109	95% t UCL (Assumes normality)					0.885	95% H-Stat UCL					1.169
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Detected Data appear Normal Distributed at 1% Significance Level**											
114												
115	**Suggested UCL to Use**											
116	95% KM (t) UCL					0.624						
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 1:41:36 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10	**200 IA Methylene Chloride**											
11												
12	**General Statistics**											
13	Total Number of Observations					16	Number of Distinct Observations					12
14	Number of Detects					10	Number of Non-Detects					6
15	Number of Distinct Detects					7	Number of Distinct Non-Detects					5
16	Minimum Detect					0.26	Minimum Non-Detect					0.3
17	Maximum Detect					1.6	Maximum Non-Detect					6.6
18	Variance Detects					0.148	Percent Non-Detects					37.5%
19	Mean Detects					0.516	SD Detects					0.384
20	Median Detects					0.41	CV Detects					0.744
21	Skewness Detects					3.059	Kurtosis Detects					9.562
22	Mean of Logged Detects					-0.797	SD of Logged Detects					0.469
23												
24	**Normal GOF Test on Detects Only**											
25	Shapiro Wilk Test Statistic					0.47	**Shapiro Wilk GOF Test**					
26	1% Shapiro Wilk Critical Value					0.781	Detected Data Not Normal at 1% Significance Level					
27	Lilliefors Test Statistic					0.489	**Lilliefors GOF Test**					
28	1% Lilliefors Critical Value					0.304	Detected Data Not Normal at 1% Significance Level					
29	**Detected Data Not Normal at 1% Significance Level**											
30												
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
32	KM Mean					0.431	KM Standard Error of Mean					0.0874
33	90KM SD					0.321	95% KM (BCA) UCL					0.665
34	95% KM (t) UCL					0.584	95% KM (Percentile Bootstrap) UCL					0.597
35	95% KM (z) UCL					0.574	95% KM Bootstrap t UCL					0.87
36	90% KM Chebyshev UCL					0.693	95% KM Chebyshev UCL					0.812
37	97.5% KM Chebyshev UCL					0.976	99% KM Chebyshev UCL					1.3
38												
39	**Gamma GOF Tests on Detected Observations Only**											
40	A-D Test Statistic					2.232	**Anderson-Darling GOF Test**					
41	5% A-D Critical Value					0.73	Detected Data Not Gamma Distributed at 5% Significance Level					
42	K-S Test Statistic					0.469	**Kolmogorov-Smirnov GOF**					
43	5% K-S Critical Value					0.268	Detected Data Not Gamma Distributed at 5% Significance Level					
44	**Detected Data Not Gamma Distributed at 5% Significance Level**											
45												

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47					k hat (MLE)	3.866					k star (bias corrected MLE)	2.773
48					Theta hat (MLE)	0.133					Theta star (bias corrected MLE)	0.186
49					nu hat (MLE)	77.32					nu star (bias corrected)	55.46
50					Mean (detects)	0.516						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01					Mean	0.364
59					Maximum	1.6					Median	0.395
60					SD	0.365					CV	1.003
61					k hat (MLE)	1.196					k star (bias corrected MLE)	1.013
62					Theta hat (MLE)	0.305					Theta star (bias corrected MLE)	0.36
63					nu hat (MLE)	38.26					nu star (bias corrected)	32.42
64					Adjusted Level of Significance (β)	0.0335						
65					Approximate Chi Square Value (32.42, α)	20.4					Adjusted Chi Square Value (32.42, β)	19.32
66					95% Gamma Approximate UCL	0.579					95% Gamma Adjusted UCL	0.611
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	0.431					SD (KM)	0.321
70					Variance (KM)	0.103					SE of Mean (KM)	0.0874
71					k hat (KM)	1.799					k star (KM)	1.504
72					nu hat (KM)	57.58					nu star (KM)	48.12
73					theta hat (KM)	0.239					theta star (KM)	0.286
74					80% gamma percentile (KM)	0.666					90% gamma percentile (KM)	0.897
75					95% gamma percentile (KM)	1.121					99% gamma percentile (KM)	1.627
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (48.12, α)	33.2					Adjusted Chi Square Value (48.12, β)	31.79
79					95% KM Approximate Gamma UCL	0.624					95% KM Adjusted Gamma UCL	0.652
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.604	**Shapiro Wilk GOF Test**					
83					10% Shapiro Wilk Critical Value	0.869	Detected Data Not Lognormal at 10% Significance Level					
84					Lilliefors Test Statistic	0.44	**Lilliefors GOF Test**					
85					10% Lilliefors Critical Value	0.241	Detected Data Not Lognormal at 10% Significance Level					
86	**Detected Data Not Lognormal at 10% Significance Level**											
87												

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89	Mean in Original Scale					0.417	Mean in Log Scale					-1.022
90	SD in Original Scale					0.327	SD in Log Scale					0.485
91	95% t UCL (assumes normality of ROS data)					0.56	95% Percentile Bootstrap UCL					0.571
92	95% BCA Bootstrap UCL					0.652	95% Bootstrap t UCL					0.796
93	95% H-UCL (Log ROS)					0.522						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96	KM Mean (logged)					-0.98	KM Geo Mean					0.375
97	KM SD (logged)					0.446	95% Critical H Value (KM-Log)					1.997
98	KM Standard Error of Mean (logged)					0.122	95% H-UCL (KM -Log)					0.522
99	KM SD (logged)					0.446	95% Critical H Value (KM-Log)					1.997
100	KM Standard Error of Mean (logged)					0.122						
101	**Note: KM UCLs may be biased low with this dataset. Other substitution method recommended**											
102												
103	**DL/2 Statistics**											
104	**DL/2 Normal**						**DL/2 Log-Transformed**					
105	Mean in Original Scale					0.58	Mean in Log Scale					-0.987
106	SD in Original Scale					0.801	SD in Log Scale					0.836
107	95% t UCL (Assumes normality)					0.931	95% H-Stat UCL					0.899
108	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
109												
110	**Nonparametric Distribution Free UCL Statistics**											
111	**Data do not follow a Discernible Distribution**											
112												
113	**Suggested UCL to Use**											
114	95% KM (t) UCL					0.584						
115												
116	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
117	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

	A–E	F	G–K	L
1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:44:08 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200_IA_TCE**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	13
14	Number of Detects	6	Number of Non-Detects	10
15	Number of Distinct Detects	6	Number of Distinct Non-Detects	7
16	Minimum Detect	0.33	Minimum Non-Detect	0.2
17	Maximum Detect	1.3	Maximum Non-Detect	5.4
18	Variance Detects	0.145	Percent Non-Detects	62.5%
19	Mean Detects	0.627	SD Detects	0.381
20	Median Detects	0.44	CV Detects	0.608
21	Skewness Detects	1.434	Kurtosis Detects	1.163
22	Mean of Logged Detects	-0.598	SD of Logged Detects	0.536
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.803	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.713	Detected Data appear Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.317	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.373	Detected Data appear Normal at 1% Significance Level	
29	**Detected Data appear Normal at 1% Significance Level**			
30	**Note GOF tests may be unreliable for small sample sizes**			
31				
32	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
33	KM Mean	0.371	KM Standard Error of Mean	0.0858
34	90KM SD	0.303	95% KM (BCA) UCL	0.548
35	95% KM (t) UCL	0.521	95% KM (Percentile Bootstrap) UCL	0.522
36	95% KM (z) UCL	0.512	95% KM Bootstrap t UCL	0.651
37	90% KM Chebyshev UCL	0.628	95% KM Chebyshev UCL	0.745
38	97.5% KM Chebyshev UCL	0.906	99% KM Chebyshev UCL	1.224
39				
40	**Gamma GOF Tests on Detected Observations Only**			
41	A-D Test Statistic	0.548	**Anderson-Darling GOF Test**	
42	5% A-D Critical Value	0.7	Detected data appear Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.299	**Kolmogorov-Smirnov GOF**	
44	5% K-S Critical Value	0.334	Detected data appear Gamma Distributed at 5% Significance Level	
45	**Detected data appear Gamma Distributed at 5% Significance Level**			
46	**Note GOF tests may be unreliable for small sample sizes**			
47				

48	**Gamma Statistics on Detected Data Only**			
49	k hat (MLE)	3.981	k star (bias corrected MLE)	2.102
50	Theta hat (MLE)	0.157	Theta star (bias corrected MLE)	0.298
51	nu hat (MLE)	47.77	nu star (bias corrected)	25.22
52	Mean (detects)	0.627		
53				
54	**Gamma ROS Statistics using Imputed Non-Detects**			
55	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
56	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
57	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
58	This is especially true when the sample size is small.			
59	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
60	Minimum	0.01	Mean	0.241
61	Maximum	1.3	Median	0.01
62	SD	0.379	CV	1.57
63	k hat (MLE)	0.393	k star (bias corrected MLE)	0.361
64	Theta hat (MLE)	0.614	Theta star (bias corrected MLE)	0.669
65	nu hat (MLE)	12.57	nu star (bias corrected)	11.54
66	Adjusted Level of Significance (β)	0.0335		
67	Approximate Chi Square Value (11.54, α)	4.928	Adjusted Chi Square Value (11.54, β)	4.445
68	95% Gamma Approximate UCL	0.565	95% Gamma Adjusted UCL	0.627
69				
70	**Estimates of Gamma Parameters using KM Estimates**			
71	Mean (KM)	0.371	SD (KM)	0.303
72	Variance (KM)	0.092	SE of Mean (KM)	0.0858
73	k hat (KM)	1.493	k star (KM)	1.255
74	nu hat (KM)	47.79	nu star (KM)	40.16
75	theta hat (KM)	0.248	theta star (KM)	0.295
76	80% gamma percentile (KM)	0.584	90% gamma percentile (KM)	0.807
77	95% gamma percentile (KM)	1.026	99% gamma percentile (KM)	1.526
78				
79	**Gamma Kaplan-Meier (KM) Statistics**			
80	Approximate Chi Square Value (40.16, α)	26.64	Adjusted Chi Square Value (40.16, β)	25.39
81	95% KM Approximate Gamma UCL	0.559	95% KM Adjusted Gamma UCL	0.586
82				
83	**Lognormal GOF Test on Detected Observations Only**			
84	Shapiro Wilk Test Statistic	0.871	**Shapiro Wilk GOF Test**	
85	10% Shapiro Wilk Critical Value	0.826	Detected Data appear Lognormal at 10% Significance Level	
86	Lilliefors Test Statistic	0.267	**Lilliefors GOF Test**	
87	10% Lilliefors Critical Value	0.298	Detected Data appear Lognormal at 10% Significance Level	
88	**Detected Data appear Lognormal at 10% Significance Level**			
89	**Note GOF tests may be unreliable for small sample sizes**			
90				

	A	B	C	D	E	F	G	H	I	J	K	L
91	**Lognormal ROS Statistics Using Imputed Non-Detects**											
92	Mean in Original Scale					0.303	Mean in Log Scale					-1.651
93	SD in Original Scale					0.341	SD in Log Scale					0.943
94	95% t UCL (assumes normality of ROS data)					0.452	95% Percentile Bootstrap UCL					0.455
95	95% BCA Bootstrap UCL					0.491	95% Bootstrap t UCL					0.601
96	95% H-UCL (Log ROS)					0.566						
97												
98	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
99	KM Mean (logged)					-1.205	KM Geo Mean					0.3
100	KM SD (logged)					0.584	95% Critical H Value (KM-Log)					2.142
101	KM Standard Error of Mean (logged)					0.165	95% H-UCL (KM -Log)					0.491
102	KM SD (logged)					0.584	95% Critical H Value (KM-Log)					2.142
103	KM Standard Error of Mean (logged)					0.165						
104												
105	**DL/2 Statistics**											
106	**DL/2 Normal**						**DL/2 Log-Transformed**					
107	Mean in Original Scale					0.473	Mean in Log Scale					-1.349
108	SD in Original Scale					0.68	SD in Log Scale					1.021
109	95% t UCL (Assumes normality)					0.771	95% H-Stat UCL					0.9
110	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
111												
112	**Nonparametric Distribution Free UCL Statistics**											
113	**Detected Data appear Normal Distributed at 1% Significance Level**											
114												
115	**Suggested UCL to Use**											
116	95% KM (t) UCL					0.521						
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
120	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
121												

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 1:42:22 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**200 IA Toluene**			
11				
12	**General Statistics**			
13	Total Number of Observations	16	Number of Distinct Observations	15
14	Number of Detects	13	Number of Non-Detects	3
15	Number of Distinct Detects	13	Number of Distinct Non-Detects	3
16	Minimum Detect	0.25	Minimum Non-Detect	0.29
17	Maximum Detect	7.2	Maximum Non-Detect	0.38
18	Variance Detects	3.402	Percent Non-Detects	18.75%
19	Mean Detects	1.285	SD Detects	1.844
20	Median Detects	0.64	CV Detects	1.436
21	Skewness Detects	3.18	Kurtosis Detects	10.71
22	Mean of Logged Detects	-0.238	SD of Logged Detects	0.907
23				
24	**Normal GOF Test on Detects Only**			
25	Shapiro Wilk Test Statistic	0.544	**Shapiro Wilk GOF Test**	
26	1% Shapiro Wilk Critical Value	0.814	Detected Data Not Normal at 1% Significance Level	
27	Lilliefors Test Statistic	0.313	**Lilliefors GOF Test**	
28	1% Lilliefors Critical Value	0.271	Detected Data Not Normal at 1% Significance Level	
29	**Detected Data Not Normal at 1% Significance Level**			
30				
31	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
32	KM Mean	1.092	KM Standard Error of Mean	0.429
33	90KM SD	1.647	95% KM (BCA) UCL	1.935
34	95% KM (t) UCL	1.843	95% KM (Percentile Bootstrap) UCL	1.864
35	95% KM (z) UCL	1.797	95% KM Bootstrap t UCL	3.447
36	90% KM Chebyshev UCL	2.378	95% KM Chebyshev UCL	2.96
37	97.5% KM Chebyshev UCL	3.768	99% KM Chebyshev UCL	5.356
38				
39	**Gamma GOF Tests on Detected Observations Only**			
40	A-D Test Statistic	0.907	**Anderson-Darling GOF Test**	
41	5% A-D Critical Value	0.755	Detected Data Not Gamma Distributed at 5% Significance Level	
42	K-S Test Statistic	0.208	**Kolmogorov-Smirnov GOF**	
43	5% K-S Critical Value	0.242	Detected data appear Gamma Distributed at 5% Significance Level	
44	**Detected data follow Appr. Gamma Distribution at 5% Significance Level**			
45				

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics on Detected Data Only**											
47					k hat (MLE)	1.163					k star (bias corrected MLE)	0.946
48					Theta hat (MLE)	1.105					Theta star (bias corrected MLE)	1.358
49					nu hat (MLE)	30.23					nu star (bias corrected)	24.59
50					Mean (detects)	1.285						
51												
52	**Gamma ROS Statistics using Imputed Non-Detects**											
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01					Mean	1.046
59					Maximum	7.2					Median	0.615
60					SD	1.728					CV	1.652
61					k hat (MLE)	0.566					k star (bias corrected MLE)	0.502
62					Theta hat (MLE)	1.847					Theta star (bias corrected MLE)	2.085
63					nu hat (MLE)	18.11					nu star (bias corrected)	16.05
64					Adjusted Level of Significance (β)	0.0335						
65					Approximate Chi Square Value (16.05, α)	7.998					Adjusted Chi Square Value (16.05, β)	7.358
66					95% Gamma Approximate UCL	2.098					95% Gamma Adjusted UCL	2.281
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	1.092					SD (KM)	1.647
70					Variance (KM)	2.712					SE of Mean (KM)	0.429
71					k hat (KM)	0.44					k star (KM)	0.399
72					nu hat (KM)	14.07					nu star (KM)	12.76
73					theta hat (KM)	2.484					theta star (KM)	2.738
74					80% gamma percentile (KM)	1.762					90% gamma percentile (KM)	3.086
75					95% gamma percentile (KM)	4.542					99% gamma percentile (KM)	8.203
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (12.76, α)	5.734					Adjusted Chi Square Value (12.76, β)	5.207
79					95% KM Approximate Gamma UCL	2.431					95% KM Adjusted Gamma UCL	2.677
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.92	**Shapiro Wilk GOF Test**					
83					10% Shapiro Wilk Critical Value	0.889	Detected Data appear Lognormal at 10% Significance Level					
84					Lilliefors Test Statistic	0.129	**Lilliefors GOF Test**					
85					10% Lilliefors Critical Value	0.215	Detected Data appear Lognormal at 10% Significance Level					
86	**Detected Data appear Lognormal at 10% Significance Level**											
87												

	A	B	C	D	E	F	G	H	I	J	K	L
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89					Mean in Original Scale	1.077					Mean in Log Scale	-0.522
90					SD in Original Scale	1.709					SD in Log Scale	1.019
91					95% t UCL (assumes normality of ROS data)	1.826					95% Percentile Bootstrap UCL	1.83
92					95% BCA Bootstrap UCL	2.296					95% Bootstrap t UCL	3.46
93					95% H-UCL (Log ROS)	2.046						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96					KM Mean (logged)	-0.448					KM Geo Mean	0.639
97					KM SD (logged)	0.9					95% Critical H Value (KM-Log)	2.554
98					KM Standard Error of Mean (logged)	0.234					95% H-UCL (KM -Log)	1.735
99					KM SD (logged)	0.9					95% Critical H Value (KM-Log)	2.554
100					KM Standard Error of Mean (logged)	0.234						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**						**DL/2 Log-Transformed**					
104					Mean in Original Scale	1.074					Mean in Log Scale	-0.536
105					SD in Original Scale	1.711					SD in Log Scale	1.036
106					95% t UCL (Assumes normality)	1.824					95% H-Stat UCL	2.094
107	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
108												
109	**Nonparametric Distribution Free UCL Statistics**											
110	**Detected Data appear Approximate Gamma Distributed at 5% Significance Level**											
111												
112	**Suggested UCL to Use**											
113					95% KM Adjusted Gamma UCL	2.677						
114												
115	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
116	**Please verify the data were collected from random locations.**											
117	**If the data were collected using judgmental or other non-random methods,**											
118	**then contact a statistician to correctly calculate UCLs.**											
119												
120	When a data set follows an approximate distribution passing only one of the GOF tests,											
121	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
122												
123	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
124	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
125	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
126												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Uncensored Full Data Sets**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 2:22:15 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	**600 IA 2-Butanone (MEK)**											
12												
13	**General Statistics**											
14	Total Number of Observations					8	Number of Distinct Observations					7
15							Number of Missing Observations					0
16	Minimum					0.37	Mean					2.089
17	Maximum					5.3	Median					1.41
18	SD					1.985	Std. Error of Mean					0.702
19	Coefficient of Variation					0.95	Skewness					0.677
20												
21	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**											
22	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**											
23	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**											
24	**The Chebyshev UCL often results in gross overestimates of the mean.**											
25	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**											
26												
27	**Normal GOF Test**											
28	Shapiro Wilk Test Statistic					0.836	**Shapiro Wilk GOF Test**					
29	1% Shapiro Wilk Critical Value					0.749	Data appear Normal at 1% Significance Level					
30	Lilliefors Test Statistic					0.285	**Lilliefors GOF Test**					
31	1% Lilliefors Critical Value					0.333	Data appear Normal at 1% Significance Level					
32	**Data appear Normal at 1% Significance Level**											
33	**Note GOF tests may be unreliable for small sample sizes**											
34												
35	**Assuming Normal Distribution**											
36	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
37	95% Student's-t UCL					3.418	95% Adjusted-CLT UCL (Chen-1995)					3.423
38							95% Modified-t UCL (Johnson-1978)					3.446
39												
40	**Gamma GOF Test**											
41	A-D Test Statistic					0.673	**Anderson-Darling Gamma GOF Test**					
42	5% A-D Critical Value					0.734	Detected data appear Gamma Distributed at 5% Significance Level					
43	K-S Test Statistic					0.296	**Kolmogorov-Smirnov Gamma GOF Test**					
44	5% K-S Critical Value					0.301	Detected data appear Gamma Distributed at 5% Significance Level					
45	**Detected data appear Gamma Distributed at 5% Significance Level**											
46	**Note GOF tests may be unreliable for small sample sizes**											
47												

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Gamma Statistics**											
49	k hat (MLE)					1.077	k star (bias corrected MLE)					0.756
50	Theta hat (MLE)					1.94	Theta star (bias corrected MLE)					2.762
51	nu hat (MLE)					17.23	nu star (bias corrected)					12.1
52	MLE Mean (bias corrected)					2.089	MLE Sd (bias corrected)					2.402
53							Approximate Chi Square Value (0.05)					5.293
54	Adjusted Level of Significance					0.0195	Adjusted Chi Square Value					4.211
55												
56	**Assuming Gamma Distribution**											
57	95% Approximate Gamma UCL					4.775	95% Adjusted Gamma UCL					6.001
58												
59	**Lognormal GOF Test**											
60	Shapiro Wilk Test Statistic					0.823	**Shapiro Wilk Lognormal GOF Test**					
61	10% Shapiro Wilk Critical Value					0.851	Data Not Lognormal at 10% Significance Level					
62	Lilliefors Test Statistic					0.269	**Lilliefors Lognormal GOF Test**					
63	10% Lilliefors Critical Value					0.265	Data Not Lognormal at 10% Significance Level					
64	**Data Not Lognormal at 10% Significance Level**											
65												
66	**Lognormal Statistics**											
67	Minimum of Logged Data					-0.994	Mean of logged Data					0.205
68	Maximum of Logged Data					1.668	SD of logged Data					1.17
69												
70	**Assuming Lognormal Distribution**											
71	95% H-UCL					13.4	90% Chebyshev (MVUE) UCL					4.888
72	95% Chebyshev (MVUE) UCL					6.125	97.5% Chebyshev (MVUE) UCL					7.842
73	99% Chebyshev (MVUE) UCL					11.21						
74												
75	**Nonparametric Distribution Free UCL Statistics**											
76	**Data appear to follow a Discernible Distribution**											
77												
78	**Nonparametric Distribution Free UCLs**											
79	95% CLT UCL					3.243	95% BCA Bootstrap UCL					3.396
80	95% Standard Bootstrap UCL					3.187	95% Bootstrap-t UCL					3.727
81	95% Hall's Bootstrap UCL					3.332	95% Percentile Bootstrap UCL					3.236
82	90% Chebyshev(Mean, Sd) UCL					4.194	95% Chebyshev(Mean, Sd) UCL					5.148
83	97.5% Chebyshev(Mean, Sd) UCL					6.472	99% Chebyshev(Mean, Sd) UCL					9.072
84												
85	**Suggested UCL to Use**											
86	95% Student's-t UCL					3.418						
87												
88	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
89	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
90	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
91												

1	**UCL Statistics for Uncensored Full Data Sets**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 2:26:35 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	**600 IA Acetone**			
12				
13	**General Statistics**			
14	Total Number of Observations	8	Number of Distinct Observations	7
15			Number of Missing Observations	0
16	Minimum	3.8	Mean	11.84
17	Maximum	28	Median	7.85
18	SD	9.555	Std. Error of Mean	3.378
19	Coefficient of Variation	0.807	Skewness	0.846
20				
21	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**			
22	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**			
23	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**			
24	**The Chebyshev UCL often results in gross overestimates of the mean.**			
25	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**			
26				
27	**Normal GOF Test**			
28	Shapiro Wilk Test Statistic	0.832	**Shapiro Wilk GOF Test**	
29	1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level	
30	Lilliefors Test Statistic	0.272	**Lilliefors GOF Test**	
31	1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level	
32	**Data appear Normal at 1% Significance Level**			
33	**Note GOF tests may be unreliable for small sample sizes**			
34				
35	**Assuming Normal Distribution**			
36	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
37	95% Student's-t UCL	18.24	95% Adjusted-CLT UCL (Chen-1995)	18.47
38			95% Modified-t UCL (Johnson-1978)	18.41
39				
40	**Gamma GOF Test**			
41	A-D Test Statistic	0.626	**Anderson-Darling Gamma GOF Test**	
42	5% A-D Critical Value	0.726	Detected data appear Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.291	**Kolmogorov-Smirnov Gamma GOF Test**	
44	5% K-S Critical Value	0.298	Detected data appear Gamma Distributed at 5% Significance Level	
45	**Detected data appear Gamma Distributed at 5% Significance Level**			
46	**Note GOF tests may be unreliable for small sample sizes**			
47				

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Gamma Statistics**											
49	k hat (MLE)					1.796	k star (bias corrected MLE)					1.206
50	Theta hat (MLE)					6.589	Theta star (bias corrected MLE)					9.814
51	nu hat (MLE)					28.74	nu star (bias corrected)					19.3
52	MLE Mean (bias corrected)					11.84	MLE Sd (bias corrected)					10.78
53							Approximate Chi Square Value (0.05)					10.34
54	Adjusted Level of Significance					0.0195	Adjusted Chi Square Value					8.726
55												
56	**Assuming Gamma Distribution**											
57	95% Approximate Gamma UCL					22.1	95% Adjusted Gamma UCL					26.18
58												
59	**Lognormal GOF Test**											
60	Shapiro Wilk Test Statistic					0.843	**Shapiro Wilk Lognormal GOF Test**					
61	10% Shapiro Wilk Critical Value					0.851	Data Not Lognormal at 10% Significance Level					
62	Lilliefors Test Statistic					0.27	**Lilliefors Lognormal GOF Test**					
63	10% Lilliefors Critical Value					0.265	Data Not Lognormal at 10% Significance Level					
64	**Data Not Lognormal at 10% Significance Level**											
65												
66	**Lognormal Statistics**											
67	Minimum of Logged Data					1.335	Mean of logged Data					2.168
68	Maximum of Logged Data					3.332	SD of logged Data					0.84
69												
70	**Assuming Lognormal Distribution**											
71	95% H-UCL					32.65	90% Chebyshev (MVUE) UCL					22.48
72	95% Chebyshev (MVUE) UCL					27.32	97.5% Chebyshev (MVUE) UCL					34.04
73	99% Chebyshev (MVUE) UCL					47.25						
74												
75	**Nonparametric Distribution Free UCL Statistics**											
76	**Data appear to follow a Discernible Distribution**											
77												
78	**Nonparametric Distribution Free UCLs**											
79	95% CLT UCL					17.39	95% BCA Bootstrap UCL					18.55
80	95% Standard Bootstrap UCL					17.13	95% Bootstrap-t UCL					20.09
81	95% Hall's Bootstrap UCL					18.15	95% Percentile Bootstrap UCL					17.39
82	90% Chebyshev(Mean, Sd) UCL					21.97	95% Chebyshev(Mean, Sd) UCL					26.56
83	97.5% Chebyshev(Mean, Sd) UCL					32.94	99% Chebyshev(Mean, Sd) UCL					45.45
84												
85	**Suggested UCL to Use**											
86	95% Student's-t UCL					18.24						
87												
88	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
89	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
90	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
91												

1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 2:27:19 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10	**600 IA Benzene**			
11				
12	**General Statistics**			
13	Total Number of Observations	8	Number of Distinct Observations	6
14	Number of Detects	7	Number of Non-Detects	1
15	Number of Distinct Detects	6	Number of Distinct Non-Detects	1
16	Minimum Detect	0.28	Minimum Non-Detect	0.28
17	Maximum Detect	0.4	Maximum Non-Detect	0.28
18	Variance Detects	0.00246	Percent Non-Detects	12.5%
19	Mean Detects	0.353	SD Detects	0.0496
20	Median Detects	0.37	CV Detects	0.14
21	Skewness Detects	-0.537	Kurtosis Detects	-1.68
22	Mean of Logged Detects	-1.051	SD of Logged Detects	0.146
23				
24	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**			
25	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**			
26	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**			
27	**The Chebyshev UCL often results in gross overestimates of the mean.**			
28	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**			
29				
30	**Normal GOF Test on Detects Only**			
31	Shapiro Wilk Test Statistic	0.874	**Shapiro Wilk GOF Test**	
32	1% Shapiro Wilk Critical Value	0.73	Detected Data appear Normal at 1% Significance Level	
33	Lilliefors Test Statistic	0.207	**Lilliefors GOF Test**	
34	1% Lilliefors Critical Value	0.35	Detected Data appear Normal at 1% Significance Level	
35	**Detected Data appear Normal at 1% Significance Level**			
36	**Note GOF tests may be unreliable for small sample sizes**			
37				
38	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
39	KM Mean	0.344	KM Standard Error of Mean	0.0188
40	90KM SD	0.0492	95% KM (BCA) UCL	0.373
41	95% KM (t) UCL	0.379	95% KM (Percentile Bootstrap) UCL	0.373
42	95% KM (z) UCL	0.375	95% KM Bootstrap t UCL	0.377
43	90% KM Chebyshev UCL	0.4	95% KM Chebyshev UCL	0.426
44	97.5% KM Chebyshev UCL	0.461	99% KM Chebyshev UCL	0.531
45				

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma GOF Tests on Detected Observations Only**											
47					A-D Test Statistic	0.48	**Anderson-Darling GOF Test**					
48					5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level					
49					K-S Test Statistic	0.228	**Kolmogorov-Smirnov GOF**					
50					5% K-S Critical Value	0.311	Detected data appear Gamma Distributed at 5% Significance Level					
51	**Detected data appear Gamma Distributed at 5% Significance Level**											
52	**Note GOF tests may be unreliable for small sample sizes**											
53												
54	**Gamma Statistics on Detected Data Only**											
55					k hat (MLE)	56.44					k star (bias corrected MLE)	32.34
56					Theta hat (MLE)	0.00625					Theta star (bias corrected MLE)	0.0109
57					nu hat (MLE)	790.1					nu star (bias corrected)	452.8
58					Mean (detects)	0.353						
59												
60	**Gamma ROS Statistics using Imputed Non-Detects**											
61	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
62	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
63	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
64	This is especially true when the sample size is small.											
65	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
66					Minimum	0.243					Mean	0.339
67					Maximum	0.4					Median	0.35
68					SD	0.0601					CV	0.177
69					k hat (MLE)	34.25					k star (bias corrected MLE)	21.49
70					Theta hat (MLE)	0.0099					Theta star (bias corrected MLE)	0.0158
71					nu hat (MLE)	547.9					nu star (bias corrected)	343.8
72					Adjusted Level of Significance (β)	0.0195						
73					Approximate Chi Square Value (343.80, α)	301.8					Adjusted Chi Square Value (343.80, β)	291.9
74					95% Gamma Approximate UCL	0.386					95% Gamma Adjusted UCL	0.4
75												
76	**Estimates of Gamma Parameters using KM Estimates**											
77					Mean (KM)	0.344					SD (KM)	0.0492
78					Variance (KM)	0.00242					SE of Mean (KM)	0.0188
79					k hat (KM)	48.76					k star (KM)	30.56
80					nu hat (KM)	780.1					nu star (KM)	488.9
81					theta hat (KM)	0.00705					theta star (KM)	0.0112
82					80% gamma percentile (KM)	0.395					90% gamma percentile (KM)	0.425
83					95% gamma percentile (KM)	0.452					99% gamma percentile (KM)	0.505
84												
85	**Gamma Kaplan-Meier (KM) Statistics**											
86					Approximate Chi Square Value (488.92, α)	438.6					Adjusted Chi Square Value (488.92, β)	426.5
87					95% KM Approximate Gamma UCL	0.383					95% KM Adjusted Gamma UCL	0.394
88												

	A	B	C	D	E	F	G	H	I	J	K	L
89	**Lognormal GOF Test on Detected Observations Only**											
90	Shapiro Wilk Test Statistic					0.869	**Shapiro Wilk GOF Test**					
91	10% Shapiro Wilk Critical Value					0.838	Detected Data appear Lognormal at 10% Significance Level					
92	Lilliefors Test Statistic					0.222	**Lilliefors GOF Test**					
93	10% Lilliefors Critical Value					0.28	Detected Data appear Lognormal at 10% Significance Level					
94	**Detected Data appear Lognormal at 10% Significance Level**											
95	**Note GOF tests may be unreliable for small sample sizes**											
96												
97	**Lognormal ROS Statistics Using Imputed Non-Detects**											
98	Mean in Original Scale					0.34	Mean in Log Scale					-1.094
99	SD in Original Scale					0.0592	SD in Log Scale					0.182
100	95% t UCL (assumes normality of ROS data)					0.379	95% Percentile Bootstrap UCL					0.371
101	95% BCA Bootstrap UCL					0.369	95% Bootstrap t UCL					0.378
102	95% H-UCL (Log ROS)					0.389						
103												
104	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
105	KM Mean (logged)					-1.078	KM Geo Mean					0.34
106	KM SD (logged)					0.146	95% Critical H Value (KM-Log)					1.89
107	KM Standard Error of Mean (logged)					0.0558	95% H-UCL (KM -Log)					0.382
108	KM SD (logged)					0.146	95% Critical H Value (KM-Log)					1.89
109	KM Standard Error of Mean (logged)					0.0558						
110												
111	**DL/2 Statistics**											
112	**DL/2 Normal**						**DL/2 Log-Transformed**					
113	Mean in Original Scale					0.326	Mean in Log Scale					-1.165
114	SD in Original Scale					0.0881	SD in Log Scale					0.351
115	95% t UCL (Assumes normality)					0.385	95% H-Stat UCL					0.44
116	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
117												
118	**Nonparametric Distribution Free UCL Statistics**											
119	**Detected Data appear Normal Distributed at 1% Significance Level**											
120												
121	**Suggested UCL to Use**											
122	95% KM (t) UCL					0.379						
123												
124	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
125	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
126	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
127												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:25:47 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

600 IA Carbon Tetrachloride

General Statistics

Total Number of Observations	8	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.37	Mean	0.419
Maximum	0.45	Median	0.42
SD	0.0247	Std. Error of Mean	0.00875
Coefficient of Variation	0.0591	Skewness	-0.941

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,

refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,

but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).

The Chebyshev UCL often results in gross overestimates of the mean.

Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.912	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.237	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.435	95% Adjusted-CLT UCL (Chen-1995)	0.43
		95% Modified-t UCL (Johnson-1978)	0.435

Gamma GOF Test

A-D Test Statistic	0.433	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.236	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

48	**Gamma Statistics**			
49	k hat (MLE)	317	k star (bias corrected MLE)	198.2
50	Theta hat (MLE)	0.00132	Theta star (bias corrected MLE)	0.00211
51	nu hat (MLE)	5072	nu star (bias corrected)	3171
52	MLE Mean (bias corrected)	0.419	MLE Sd (bias corrected)	0.0297
53			Approximate Chi Square Value (0.05)	3041
54	Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	3009
55				
56	**Assuming Gamma Distribution**			
57	95% Approximate Gamma UCL	0.437	95% Adjusted Gamma UCL	0.441
58				
59	**Lognormal GOF Test**			
60	Shapiro Wilk Test Statistic	0.897	**Shapiro Wilk Lognormal GOF Test**	
61	10% Shapiro Wilk Critical Value	0.851	Data appear Lognormal at 10% Significance Level	
62	Lilliefors Test Statistic	0.248	**Lilliefors Lognormal GOF Test**	
63	10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level	
64	**Data appear Lognormal at 10% Significance Level**			
65	**Note GOF tests may be unreliable for small sample sizes**			
66				
67	**Lognormal Statistics**			
68	Minimum of Logged Data	-0.994	Mean of logged Data	-0.872
69	Maximum of Logged Data	-0.799	SD of logged Data	0.0606
70				
71	**Assuming Lognormal Distribution**			
72	95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	0.446
73	95% Chebyshev (MVUE) UCL	0.458	97.5% Chebyshev (MVUE) UCL	0.475
74	99% Chebyshev (MVUE) UCL	0.508		
75				
76	**Nonparametric Distribution Free UCL Statistics**			
77	**Data appear to follow a Discernible Distribution**			
78				
79	**Nonparametric Distribution Free UCLs**			
80	95% CLT UCL	0.433	95% BCA Bootstrap UCL	0.429
81	95% Standard Bootstrap UCL	0.432	95% Bootstrap-t UCL	0.432
82	95% Hall's Bootstrap UCL	0.431	95% Percentile Bootstrap UCL	0.431
83	90% Chebyshev(Mean, Sd) UCL	0.445	95% Chebyshev(Mean, Sd) UCL	0.457
84	97.5% Chebyshev(Mean, Sd) UCL	0.473	99% Chebyshev(Mean, Sd) UCL	0.506
85				
86	**Suggested UCL to Use**			
87	95% Student's-t UCL	0.435		
88				
89	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
90	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.			
91	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
92				
93	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
94	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
95				

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Uncensored Full Data Sets**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 2:28:07 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	**600 IA Chloromethane**											
12												
13	**General Statistics**											
14	Total Number of Observations					8	Number of Distinct Observations					7
15							Number of Missing Observations					0
16	Minimum					0.31	Mean					0.471
17	Maximum					0.65	Median					0.465
18	SD					0.162	Std. Error of Mean					0.0574
19	Coefficient of Variation					0.345	Skewness					0.0261
20												
21	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**											
22	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**											
23	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**											
24	**The Chebyshev UCL often results in gross overestimates of the mean.**											
25	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**											
26												
27	**Normal GOF Test**											
28	Shapiro Wilk Test Statistic					0.739	**Shapiro Wilk GOF Test**					
29	1% Shapiro Wilk Critical Value					0.749	Data Not Normal at 1% Significance Level					
30	Lilliefors Test Statistic					0.308	**Lilliefors GOF Test**					
31	1% Lilliefors Critical Value					0.333	Data appear Normal at 1% Significance Level					
32	**Data appear Approximate Normal at 1% Significance Level**											
33	**Note GOF tests may be unreliable for small sample sizes**											
34												
35	**Assuming Normal Distribution**											
36	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
37	95% Student's-t UCL					0.58	95% Adjusted-CLT UCL (Chen-1995)					0.566
38							95% Modified-t UCL (Johnson-1978)					0.58
39												
40	**Gamma GOF Test**											
41	A-D Test Statistic					1.134	**Anderson-Darling Gamma GOF Test**					
42	5% A-D Critical Value					0.716	Data Not Gamma Distributed at 5% Significance Level					
43	K-S Test Statistic					0.319	**Kolmogorov-Smirnov Gamma GOF Test**					
44	5% K-S Critical Value					0.294	Data Not Gamma Distributed at 5% Significance Level					
45	**Data Not Gamma Distributed at 5% Significance Level**											
46												

	A	B	C	D	E	F	G	H	I	J	K	L
47	**Gamma Statistics**											
48					k hat (MLE)	9.302					k star (bias corrected MLE)	5.897
49					Theta hat (MLE)	0.0507					Theta star (bias corrected MLE)	0.0799
50					nu hat (MLE)	148.8					nu star (bias corrected)	94.35
51					MLE Mean (bias corrected)	0.471					MLE Sd (bias corrected)	0.194
52											Approximate Chi Square Value (0.05)	72.95
53					Adjusted Level of Significance	0.0195					Adjusted Chi Square Value	68.2
54												
55	**Assuming Gamma Distribution**											
56					95% Approximate Gamma UCL	0.61					95% Adjusted Gamma UCL	0.652
57												
58	**Lognormal GOF Test**											
59					Shapiro Wilk Test Statistic	0.734	**Shapiro Wilk Lognormal GOF Test**					
60					10% Shapiro Wilk Critical Value	0.851	Data Not Lognormal at 10% Significance Level					
61					Lilliefors Test Statistic	0.301	**Lilliefors Lognormal GOF Test**					
62					10% Lilliefors Critical Value	0.265	Data Not Lognormal at 10% Significance Level					
63	**Data Not Lognormal at 10% Significance Level**											
64												
65	**Lognormal Statistics**											
66					Minimum of Logged Data	-1.171					Mean of logged Data	-0.807
67					Maximum of Logged Data	-0.431					SD of logged Data	0.357
68												
69	**Assuming Lognormal Distribution**											
70					95% H-UCL	0.634					90% Chebyshev (MVUE) UCL	0.651
71					95% Chebyshev (MVUE) UCL	0.732					97.5% Chebyshev (MVUE) UCL	0.845
72					99% Chebyshev (MVUE) UCL	1.067						
73												
74	**Nonparametric Distribution Free UCL Statistics**											
75	**Data appear to follow a Discernible Distribution**											
76												
77	**Nonparametric Distribution Free UCLs**											
78					95% CLT UCL	0.566					95% BCA Bootstrap UCL	0.553
79					95% Standard Bootstrap UCL	0.56					95% Bootstrap-t UCL	0.57
80					95% Hall's Bootstrap UCL	0.535					95% Percentile Bootstrap UCL	0.554
81					90% Chebyshev(Mean, Sd) UCL	0.644					95% Chebyshev(Mean, Sd) UCL	0.722
82					97.5% Chebyshev(Mean, Sd) UCL	0.83					99% Chebyshev(Mean, Sd) UCL	1.043
83												
84	**Suggested UCL to Use**											
85					95% Student's-t UCL	0.58						
86												
87	When a data set follows an approximate distribution passing only one of the GOF tests,											
88	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
89												
90	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
91	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
92	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
93												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 2:29:00 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10	**600 IA Ethanol**											
11												
12	**General Statistics**											
13	Total Number of Observations					8	Number of Distinct Observations					8
14	Number of Detects					7	Number of Non-Detects					1
15	Number of Distinct Detects					7	Number of Distinct Non-Detects					1
16	Minimum Detect					1.6	Minimum Non-Detect					1.4
17	Maximum Detect					20	Maximum Non-Detect					1.4
18	Variance Detects					40.81	Percent Non-Detects					12.5%
19	Mean Detects					6.271	SD Detects					6.388
20	Median Detects					3.8	CV Detects					1.019
21	Skewness Detects					2.145	Kurtosis Detects					4.773
22	Mean of Logged Detects					1.507	SD of Logged Detects					0.822
23												
24	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**											
25	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**											
26	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**											
27	**The Chebyshev UCL often results in gross overestimates of the mean.**											
28	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**											
29												
30	**Normal GOF Test on Detects Only**											
31	Shapiro Wilk Test Statistic					0.715	**Shapiro Wilk GOF Test**					
32	1% Shapiro Wilk Critical Value					0.73	Detected Data Not Normal at 1% Significance Level					
33	Lilliefors Test Statistic					0.341	**Lilliefors GOF Test**					
34	1% Lilliefors Critical Value					0.35	Detected Data appear Normal at 1% Significance Level					
35	**Detected Data appear Approximate Normal at 1% Significance Level**											
36	**Note GOF tests may be unreliable for small sample sizes**											
37												
38	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
39	KM Mean					5.663	KM Standard Error of Mean					2.201
40	90KM SD					5.762	95% KM (BCA) UCL					9.538
41	95% KM (t) UCL					9.832	95% KM (Percentile Bootstrap) UCL					9.55
42	95% KM (z) UCL					9.282	95% KM Bootstrap t UCL					21.17
43	90% KM Chebyshev UCL					12.26	95% KM Chebyshev UCL					15.25
44	97.5% KM Chebyshev UCL					19.4	99% KM Chebyshev UCL					27.56
45												

46	**Gamma GOF Tests on Detected Observations Only**			
47	A-D Test Statistic	0.52	**Anderson-Darling GOF Test**	
48	5% A-D Critical Value	0.719	Detected data appear Gamma Distributed at 5% Significance Level	
49	K-S Test Statistic	0.3	**Kolmogorov-Smirnov GOF**	
50	5% K-S Critical Value	0.316	Detected data appear Gamma Distributed at 5% Significance Level	
51	**Detected data appear Gamma Distributed at 5% Significance Level**			
52	**Note GOF tests may be unreliable for small sample sizes**			
53				
54	**Gamma Statistics on Detected Data Only**			
55	k hat (MLE)	1.669	k star (bias corrected MLE)	1.049
56	Theta hat (MLE)	3.757	Theta star (bias corrected MLE)	5.978
57	nu hat (MLE)	23.37	nu star (bias corrected)	14.69
58	Mean (detects)	6.271		
59				
60	**Gamma ROS Statistics using Imputed Non-Detects**			
61	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
62	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
63	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
64	This is especially true when the sample size is small.			
65	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
66	Minimum	0.01	Mean	5.489
67	Maximum	20	Median	3.75
68	SD	6.315	CV	1.151
69	k hat (MLE)	0.638	k star (bias corrected MLE)	0.482
70	Theta hat (MLE)	8.599	Theta star (bias corrected MLE)	11.38
71	nu hat (MLE)	10.21	nu star (bias corrected)	7.716
72	Adjusted Level of Significance (β)	0.0195		
73	Approximate Chi Square Value (7.72, α)	2.572	Adjusted Chi Square Value (7.72, β)	1.885
74	95% Gamma Approximate UCL	16.47	95% Gamma Adjusted UCL	22.47
75				
76	**Estimates of Gamma Parameters using KM Estimates**			
77	Mean (KM)	5.663	SD (KM)	5.762
78	Variance (KM)	33.2	SE of Mean (KM)	2.201
79	k hat (KM)	0.966	k star (KM)	0.687
80	nu hat (KM)	15.45	nu star (KM)	10.99
81	theta hat (KM)	5.864	theta star (KM)	8.244
82	80% gamma percentile (KM)	9.313	90% gamma percentile (KM)	14.28
83	95% gamma percentile (KM)	19.41	99% gamma percentile (KM)	31.67
84				
85	**Gamma Kaplan-Meier (KM) Statistics**			
86	Approximate Chi Square Value (10.99, α)	4.569	Adjusted Chi Square Value (10.99, β)	3.581
87	95% KM Approximate Gamma UCL	13.62	95% KM Adjusted Gamma UCL	17.38
88				

	A	B	C	D	E	F	G	H	I	J	K	L
89	**Lognormal GOF Test on Detected Observations Only**											
90					Shapiro Wilk Test Statistic	0.936	**Shapiro Wilk GOF Test**					
91					10% Shapiro Wilk Critical Value	0.838	Detected Data appear Lognormal at 10% Significance Level					
92					Lilliefors Test Statistic	0.249	**Lilliefors GOF Test**					
93					10% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 10% Significance Level					
94	**Detected Data appear Lognormal at 10% Significance Level**											
95	**Note GOF tests may be unreliable for small sample sizes**											
96												
97	**Lognormal ROS Statistics Using Imputed Non-Detects**											
98					Mean in Original Scale	5.562					Mean in Log Scale	1.255
99					SD in Original Scale	6.245					SD in Log Scale	1.044
100					95% t UCL (assumes normality of ROS data)	9.746					95% Percentile Bootstrap UCL	9.462
101					95% BCA Bootstrap UCL	10.99					95% Bootstrap t UCL	19.63
102					95% H-UCL (Log ROS)	24.37						
103												
104	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
105					KM Mean (logged)	1.361					KM Geo Mean	3.9
106					KM SD (logged)	0.811					95% Critical H Value (KM-Log)	2.976
107					KM Standard Error of Mean (logged)	0.31					95% H-UCL (KM -Log)	13.48
108					KM SD (logged)	0.811					95% Critical H Value (KM-Log)	2.976
109					KM Standard Error of Mean (logged)	0.31						
110												
111	**DL/2 Statistics**											
112	**DL/2 Normal**						**DL/2 Log-Transformed**					
113					Mean in Original Scale	5.575					Mean in Log Scale	1.274
114					SD in Original Scale	6.234					SD in Log Scale	1.007
115					95% t UCL (Assumes normality)	9.751					95% H-Stat UCL	22.02
116	**DL/2 is not a recommended method, provided for comparisons and historical reasons**											
117												
118	**Nonparametric Distribution Free UCL Statistics**											
119	**Detected Data appear Approximate Normal Distributed at 1% Significance Level**											
120												
121	**Suggested UCL to Use**											
122					95% KM (t) UCL	9.832						
123												
124	**The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.**											
125	**Please verify the data were collected from random locations.**											
126	**If the data were collected using judgmental or other non-random methods,**											
127	**then contact a statistician to correctly calculate UCLs.**											
128												
129	When a data set follows an approximate distribution passing only one of the GOF tests,											
130	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL											
131												
132	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
133	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
134	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
135												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:29:41 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

600 IA Freon 11

General Statistics

Total Number of Observations	8	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	1.2	Mean	1.288
Maximum	1.4	Median	1.25
SD	0.0991	Std. Error of Mean	0.035
Coefficient of Variation	0.077	Skewness	0.312

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.735	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.311	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.354	95% Adjusted-CLT UCL (Chen-1995)	1.349
		95% Modified-t UCL (Johnson-1978)	1.355

Gamma GOF Test

A-D Test Statistic	1.061	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.328	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

47	**Gamma Statistics**			
48	k hat (MLE)	194.8	k star (bias corrected MLE)	121.8
49	Theta hat (MLE)	0.00661	Theta star (bias corrected MLE)	0.0106
50	nu hat (MLE)	3117	nu star (bias corrected)	1949
51	MLE Mean (bias corrected)	1.288	MLE Sd (bias corrected)	0.117
52			Approximate Chi Square Value (0.05)	1848
53	Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	1823
54				
55	**Assuming Gamma Distribution**			
56	95% Approximate Gamma UCL	1.358	95% Adjusted Gamma UCL	1.377
57				
58	**Lognormal GOF Test**			
59	Shapiro Wilk Test Statistic	0.735	**Shapiro Wilk Lognormal GOF Test**	
60	10% Shapiro Wilk Critical Value	0.851	Data Not Lognormal at 10% Significance Level	
61	Lilliefors Test Statistic	0.312	**Lilliefors Lognormal GOF Test**	
62	10% Lilliefors Critical Value	0.265	Data Not Lognormal at 10% Significance Level	
63	**Data Not Lognormal at 10% Significance Level**			
64				
65	**Lognormal Statistics**			
66	Minimum of Logged Data	0.182	Mean of logged Data	0.25
67	Maximum of Logged Data	0.336	SD of logged Data	0.0764
68				
69	**Assuming Lognormal Distribution**			
70	95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	1.392
71	95% Chebyshev (MVUE) UCL	1.439	97.5% Chebyshev (MVUE) UCL	1.505
72	99% Chebyshev (MVUE) UCL	1.634		
73				
74	**Nonparametric Distribution Free UCL Statistics**			
75	**Data appear to follow a Discernible Distribution**			
76				
77	**Nonparametric Distribution Free UCLs**			
78	95% CLT UCL	1.345	95% BCA Bootstrap UCL	N/A
79	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
80	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
81	90% Chebyshev(Mean, Sd) UCL	1.393	95% Chebyshev(Mean, Sd) UCL	1.44
82	97.5% Chebyshev(Mean, Sd) UCL	1.506	99% Chebyshev(Mean, Sd) UCL	1.636
83				
84	**Suggested UCL to Use**			
85	95% Student's-t UCL	1.354		
86				
87	When a data set follows an approximate distribution passing only one of the GOF tests,			
88	it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL			
89				
90	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
91	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.			
92	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
93				

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Uncensored Full Data Sets**											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.2 3/6/2023 2:30:52 PM								
5			From File	UCL95_input_Revised.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Number of Bootstrap Operations	2000								
9												
10												
11	**600 IA Freon 12**											
12												
13	**General Statistics**											
14					Total Number of Observations	8					Number of Distinct Observations	2
15											Number of Missing Observations	0
16					Minimum	2.2					Mean	2.288
17					Maximum	2.3					Median	2.3
18					SD	0.0354					Std. Error of Mean	0.0125
19					Coefficient of Variation	0.0155					Skewness	-2.828
20												
21	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**											
22	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**											
23	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**											
24	**The Chebyshev UCL often results in gross overestimates of the mean.**											
25	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**											
26												
27	**Normal GOF Test**											
28					Shapiro Wilk Test Statistic	0.419	**Shapiro Wilk GOF Test**					
29					1% Shapiro Wilk Critical Value	0.749	Data Not Normal at 1% Significance Level					
30					Lilliefors Test Statistic	0.513	**Lilliefors GOF Test**					
31					1% Lilliefors Critical Value	0.333	Data Not Normal at 1% Significance Level					
32	**Data Not Normal at 1% Significance Level**											
33												
34	**Assuming Normal Distribution**											
35	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
36					95% Student's-t UCL	2.311					95% Adjusted-CLT UCL (Chen-1995)	2.295
37											95% Modified-t UCL (Johnson-1978)	2.309
38												
39	**Gamma GOF Test**											
40					A-D Test Statistic	2.504	**Anderson-Darling Gamma GOF Test**					
41					5% A-D Critical Value	0.715	Data Not Gamma Distributed at 5% Significance Level					
42					K-S Test Statistic	0.522	**Kolmogorov-Smirnov Gamma GOF Test**					
43					5% K-S Critical Value	0.294	Data Not Gamma Distributed at 5% Significance Level					
44	**Data Not Gamma Distributed at 5% Significance Level**											
45												

	A	B	C	D	E	F	G	H	I	J	K	L
46	**Gamma Statistics**											
47	k hat (MLE)					4679	k star (bias corrected MLE)					2924
48	Theta hat (MLE)					4.8889E-4	Theta star (bias corrected MLE)					7.8221E-4
49	nu hat (MLE)					74863	nu star (bias corrected)					46791
50	MLE Mean (bias corrected)					2.288	MLE Sd (bias corrected)					0.0423
51							Approximate Chi Square Value (0.05)					46289
52	Adjusted Level of Significance					0.0195	Adjusted Chi Square Value					46161
53												
54	**Assuming Gamma Distribution**											
55	95% Approximate Gamma UCL					2.312	95% Adjusted Gamma UCL					2.319
56												
57	**Lognormal GOF Test**											
58	Shapiro Wilk Test Statistic					0.419	**Shapiro Wilk Lognormal GOF Test**					
59	10% Shapiro Wilk Critical Value					0.851	Data Not Lognormal at 10% Significance Level					
60	Lilliefors Test Statistic					0.513	**Lilliefors Lognormal GOF Test**					
61	10% Lilliefors Critical Value					0.265	Data Not Lognormal at 10% Significance Level					
62	**Data Not Lognormal at 10% Significance Level**											
63												
64	**Lognormal Statistics**											
65	Minimum of Logged Data					0.788	Mean of logged Data					0.827
66	Maximum of Logged Data					0.833	SD of logged Data					0.0157
67												
68	**Assuming Lognormal Distribution**											
69	95% H-UCL					N/A	90% Chebyshev (MVUE) UCL					2.326
70	95% Chebyshev (MVUE) UCL					2.343	97.5% Chebyshev (MVUE) UCL					2.367
71	99% Chebyshev (MVUE) UCL					2.414						
72												
73	**Nonparametric Distribution Free UCL Statistics**											
74	**Data do not follow a Discernible Distribution**											
75												
76	**Nonparametric Distribution Free UCLs**											
77	95% CLT UCL					2.308	95% BCA Bootstrap UCL					N/A
78	95% Standard Bootstrap UCL					N/A	95% Bootstrap-t UCL					N/A
79	95% Hall's Bootstrap UCL					N/A	95% Percentile Bootstrap UCL					N/A
80	90% Chebyshev(Mean, Sd) UCL					2.325	95% Chebyshev(Mean, Sd) UCL					2.342
81	97.5% Chebyshev(Mean, Sd) UCL					2.366	99% Chebyshev(Mean, Sd) UCL					2.412
82												
83	**Suggested UCL to Use**											
84	Recommendation cannot be provided											
85												
86	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
87	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
88	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
89												
90	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**											
91	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**											
92												

1	**UCL Statistics for Uncensored Full Data Sets**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 3/6/2023 2:30:17 PM		
5	From File	UCL95_input_Revised.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	**600 IA Freon 113**			
12				
13	**General Statistics**			
14	Total Number of Observations	8	Number of Distinct Observations	7
15			Number of Missing Observations	0
16	Minimum	0.47	Mean	0.524
17	Maximum	0.59	Median	0.52
18	SD	0.0484	Std. Error of Mean	0.0171
19	Coefficient of Variation	0.0924	Skewness	0.158
20				
21	**Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,**			
22	**refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,**			
23	**but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).**			
24	**The Chebyshev UCL often results in gross overestimates of the mean.**			
25	**Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.**			
26				
27	**Normal GOF Test**			
28	Shapiro Wilk Test Statistic	0.856	**Shapiro Wilk GOF Test**	
29	1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level	
30	Lilliefors Test Statistic	0.257	**Lilliefors GOF Test**	
31	1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level	
32	**Data appear Normal at 1% Significance Level**			
33	**Note GOF tests may be unreliable for small sample sizes**			
34				
35	**Assuming Normal Distribution**			
36	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
37	95% Student's-t UCL	0.556	95% Adjusted-CLT UCL (Chen-1995)	0.553
38			95% Modified-t UCL (Johnson-1978)	0.556
39				
40	**Gamma GOF Test**			
41	A-D Test Statistic	0.654	**Anderson-Darling Gamma GOF Test**	
42	5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level	
43	K-S Test Statistic	0.269	**Kolmogorov-Smirnov Gamma GOF Test**	
44	5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level	
45	**Detected data appear Gamma Distributed at 5% Significance Level**			
46	**Note GOF tests may be unreliable for small sample sizes**			
47				

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Gamma Statistics**											
49					k hat (MLE)	134.4					k star (bias corrected MLE)	84.1
50					Theta hat (MLE)	0.0039					Theta star (bias corrected MLE)	0.00623
51					nu hat (MLE)	2151					nu star (bias corrected)	1346
52					MLE Mean (bias corrected)	0.524					MLE Sd (bias corrected)	0.0571
53											Approximate Chi Square Value (0.05)	1261
54					Adjusted Level of Significance	0.0195					Adjusted Chi Square Value	1241
55												
56	**Assuming Gamma Distribution**											
57					95% Approximate Gamma UCL	0.559					95% Adjusted Gamma UCL	0.568
58												
59	**Lognormal GOF Test**											
60					Shapiro Wilk Test Statistic	0.854	**Shapiro Wilk Lognormal GOF Test**					
61					10% Shapiro Wilk Critical Value	0.851	Data appear Lognormal at 10% Significance Level					
62					Lilliefors Test Statistic	0.252	**Lilliefors Lognormal GOF Test**					
63					10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level					
64	**Data appear Lognormal at 10% Significance Level**											
65	**Note GOF tests may be unreliable for small sample sizes**											
66												
67	**Lognormal Statistics**											
68					Minimum of Logged Data	-0.755					Mean of logged Data	-0.65
69					Maximum of Logged Data	-0.528					SD of logged Data	0.0922
70												
71	**Assuming Lognormal Distribution**											
72					95% H-UCL	N/A					90% Chebyshev (MVUE) UCL	0.575
73					95% Chebyshev (MVUE) UCL	0.598					97.5% Chebyshev (MVUE) UCL	0.63
74					99% Chebyshev (MVUE) UCL	0.694						
75												
76	**Nonparametric Distribution Free UCL Statistics**											
77	**Data appear to follow a Discernible Distribution**											
78												
79	**Nonparametric Distribution Free UCLs**											
80					95% CLT UCL	0.552					95% BCA Bootstrap UCL	0.549
81					95% Standard Bootstrap UCL	0.55					95% Bootstrap-t UCL	0.558
82					95% Hall's Bootstrap UCL	0.545					95% Percentile Bootstrap UCL	0.55
83					90% Chebyshev(Mean, Sd) UCL	0.575					95% Chebyshev(Mean, Sd) UCL	0.598
84					97.5% Chebyshev(Mean, Sd) UCL	0.631					99% Chebyshev(Mean, Sd) UCL	0.694
85												
86	**Suggested UCL to Use**											
87					95% Student's-t UCL	0.556						
88												
89	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
90	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
91	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
92												

	A	B	C	D	E	F	G	H	I	J	K	L
1	**UCL Statistics for Uncensored Full Data Sets**											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.2 3/6/2023 2:31:55 PM								
5	From File			UCL95_input_Revised.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	**600 ResSoil Thallium**											
12												
13	**General Statistics**											
14	Total Number of Observations					15	Number of Distinct Observations					15
15							Number of Missing Observations					0
16	Minimum					0.2	Mean					4.18
17	Maximum					7.6	Median					4.6
18	SD					2.215	Std. Error of Mean					0.572
19	Coefficient of Variation					0.53	Skewness					-0.132
20												
21	**Normal GOF Test**											
22	Shapiro Wilk Test Statistic					0.962	**Shapiro Wilk GOF Test**					
23	1% Shapiro Wilk Critical Value					0.835	Data appear Normal at 1% Significance Level					
24	Lilliefors Test Statistic					0.148	**Lilliefors GOF Test**					
25	1% Lilliefors Critical Value					0.255	Data appear Normal at 1% Significance Level					
26	**Data appear Normal at 1% Significance Level**											
27												
28	**Assuming Normal Distribution**											
29	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
30	95% Student's-t UCL					5.188	95% Adjusted-CLT UCL (Chen-1995)					5.1
31							95% Modified-t UCL (Johnson-1978)					5.184
32												
33	**Gamma GOF Test**											
34	A-D Test Statistic					0.594	**Anderson-Darling Gamma GOF Test**					
35	5% A-D Critical Value					0.746	Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic					0.193	**Kolmogorov-Smirnov Gamma GOF Test**					
37	5% K-S Critical Value					0.224	Detected data appear Gamma Distributed at 5% Significance Level					
38	**Detected data appear Gamma Distributed at 5% Significance Level**											
39												
40	**Gamma Statistics**											
41	k hat (MLE)					2.193	k star (bias corrected MLE)					1.798
42	Theta hat (MLE)					1.906	Theta star (bias corrected MLE)					2.324
43	nu hat (MLE)					65.78	nu star (bias corrected)					53.95
44	MLE Mean (bias corrected)					4.18	MLE Sd (bias corrected)					3.117
45							Approximate Chi Square Value (0.05)					38.08
46	Adjusted Level of Significance					0.0324	Adjusted Chi Square Value					36.44
47												

	A	B	C	D	E	F	G	H	I	J	K	L
48	**Assuming Gamma Distribution**											
49	95% Approximate Gamma UCL					5.923	95% Adjusted Gamma UCL					6.189
50												
51	**Lognormal GOF Test**											
52	Shapiro Wilk Test Statistic					0.774	**Shapiro Wilk Lognormal GOF Test**					
53	10% Shapiro Wilk Critical Value					0.901	Data Not Lognormal at 10% Significance Level					
54	Lilliefors Test Statistic					0.207	**Lilliefors Lognormal GOF Test**					
55	10% Lilliefors Critical Value					0.202	Data Not Lognormal at 10% Significance Level					
56	**Data Not Lognormal at 10% Significance Level**											
57												
58	**Lognormal Statistics**											
59	Minimum of Logged Data					-1.609	Mean of logged Data					1.185
60	Maximum of Logged Data					2.028	SD of logged Data					0.919
61												
62	**Assuming Lognormal Distribution**											
63	95% H-UCL					9.483	90% Chebyshev (MVUE) UCL					8.506
64	95% Chebyshev (MVUE) UCL					10.18	97.5% Chebyshev (MVUE) UCL					12.51
65	99% Chebyshev (MVUE) UCL					17.08						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution**											
69												
70	**Nonparametric Distribution Free UCLs**											
71	95% CLT UCL					5.121	95% BCA Bootstrap UCL					5.043
72	95% Standard Bootstrap UCL					5.106	95% Bootstrap-t UCL					5.144
73	95% Hall's Bootstrap UCL					5.057	95% Percentile Bootstrap UCL					5.113
74	90% Chebyshev(Mean, Sd) UCL					5.896	95% Chebyshev(Mean, Sd) UCL					6.673
75	97.5% Chebyshev(Mean, Sd) UCL					7.752	99% Chebyshev(Mean, Sd) UCL					9.872
76												
77	**Suggested UCL to Use**											
78	95% Student's-t UCL					5.188						
79												
80	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
81	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
82	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
83												
84	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**											
85	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**											
86												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.2 3/6/2023 2:33:03 PM
From File	UCL95_input_Revised.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

600 ResSoil Tin

General Statistics

Total Number of Observations	15	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	3	Mean	6.2
Maximum	10	Median	6
SD	2.242	Std. Error of Mean	0.579
Coefficient of Variation	0.362	Skewness	0.151

Normal GOF Test

Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.136	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7.22	95% Adjusted-CLT UCL (Chen-1995)	7.176
		95% Modified-t UCL (Johnson-1978)	7.224

Gamma GOF Test

A-D Test Statistic	0.518	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.18	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

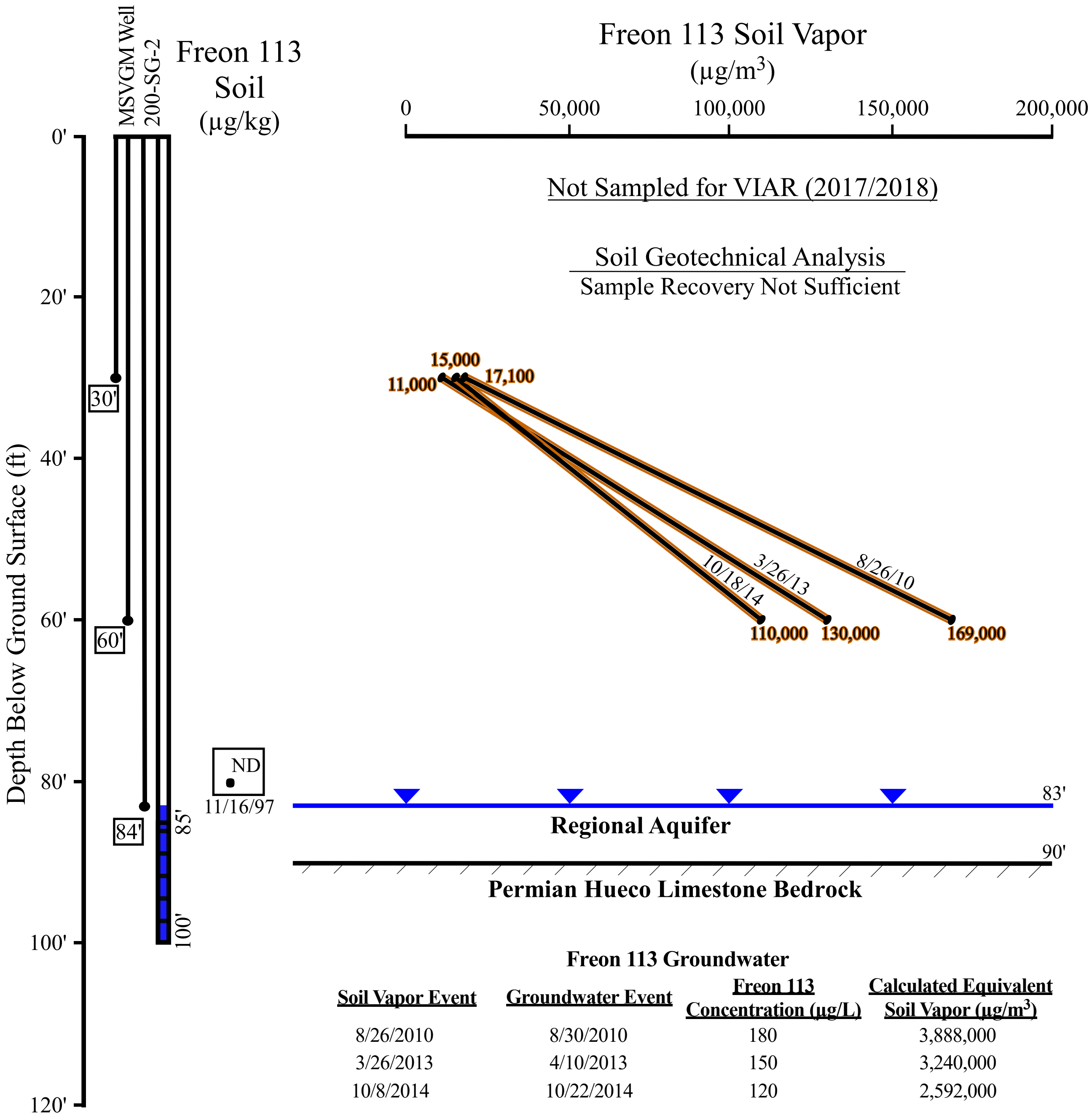
k hat (MLE)	7.44	k star (bias corrected MLE)	5.996
Theta hat (MLE)	0.833	Theta star (bias corrected MLE)	1.034
nu hat (MLE)	223.2	nu star (bias corrected)	179.9
MLE Mean (bias corrected)	6.2	MLE Sd (bias corrected)	2.532
		Approximate Chi Square Value (0.05)	149.9
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	146.5

48	**Assuming Gamma Distribution**			
49	95% Approximate Gamma UCL	7.442	95% Adjusted Gamma UCL	7.613
50				
51	**Lognormal GOF Test**			
52	Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk Lognormal GOF Test**	
53	10% Shapiro Wilk Critical Value	0.901	Data Not Lognormal at 10% Significance Level	
54	Lilliefors Test Statistic	0.203	**Lilliefors Lognormal GOF Test**	
55	10% Lilliefors Critical Value	0.202	Data Not Lognormal at 10% Significance Level	
56	**Data Not Lognormal at 10% Significance Level**			
57				
58	**Lognormal Statistics**			
59	Minimum of Logged Data	1.099	Mean of logged Data	1.756
60	Maximum of Logged Data	2.303	SD of logged Data	0.399
61				
62	**Assuming Lognormal Distribution**			
63	95% H-UCL	7.727	90% Chebyshev (MVUE) UCL	8.193
64	95% Chebyshev (MVUE) UCL	9.081	97.5% Chebyshev (MVUE) UCL	10.31
65	99% Chebyshev (MVUE) UCL	12.74		
66				
67	**Nonparametric Distribution Free UCL Statistics**			
68	**Data appear to follow a Discernible Distribution**			
69				
70	**Nonparametric Distribution Free UCLs**			
71	95% CLT UCL	7.152	95% BCA Bootstrap UCL	7
72	95% Standard Bootstrap UCL	7.134	95% Bootstrap-t UCL	7.297
73	95% Hall's Bootstrap UCL	7.258	95% Percentile Bootstrap UCL	7.133
74	90% Chebyshev(Mean, Sd) UCL	7.937	95% Chebyshev(Mean, Sd) UCL	8.724
75	97.5% Chebyshev(Mean, Sd) UCL	9.816	99% Chebyshev(Mean, Sd) UCL	11.96
76				
77	**Suggested UCL to Use**			
78	95% Student's-t UCL	7.22		
79				
80	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
81	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.			
82	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
83				

~~Appendix D~~Appendix E

Soil Vapor Vertical Concentration Profiles

MSVGM Well 200-SG-2 Vertical Concentration Profile For Freon 113

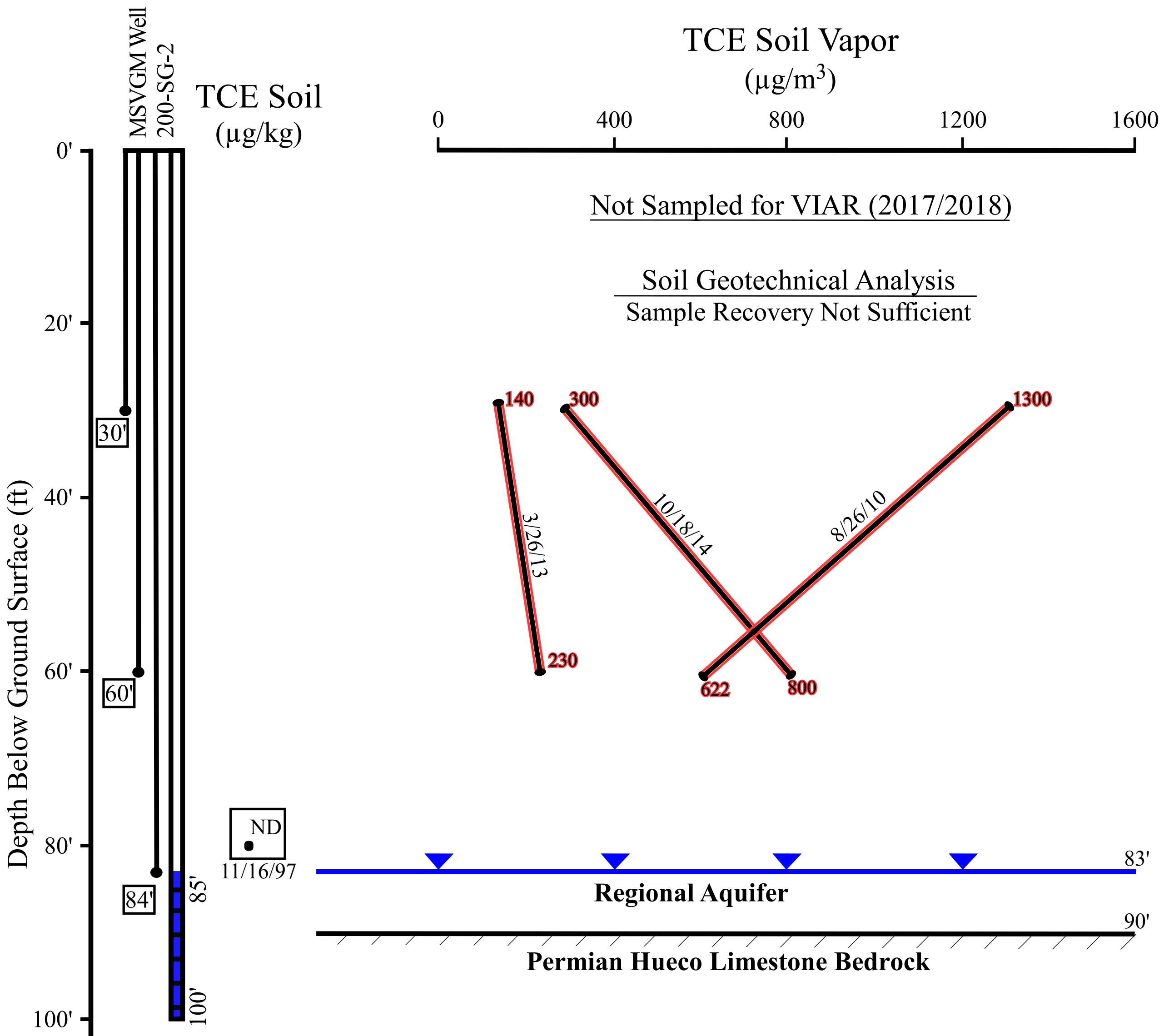


Freon 113 Groundwater

Soil Vapor Event	Groundwater Event	Freon 113 Concentration (μg/L)	Calculated Equivalent Soil Vapor (μg/m³)
8/26/2010	8/30/2010	180	3,888,000
3/26/2013	4/10/2013	150	3,240,000
10/8/2014	10/22/2014	120	2,592,000

Note:
ND - Freon 113 soil < 11.0 μg/kg

MSVGM Well 200-SG-2 Vertical Concentration Profile For TCE

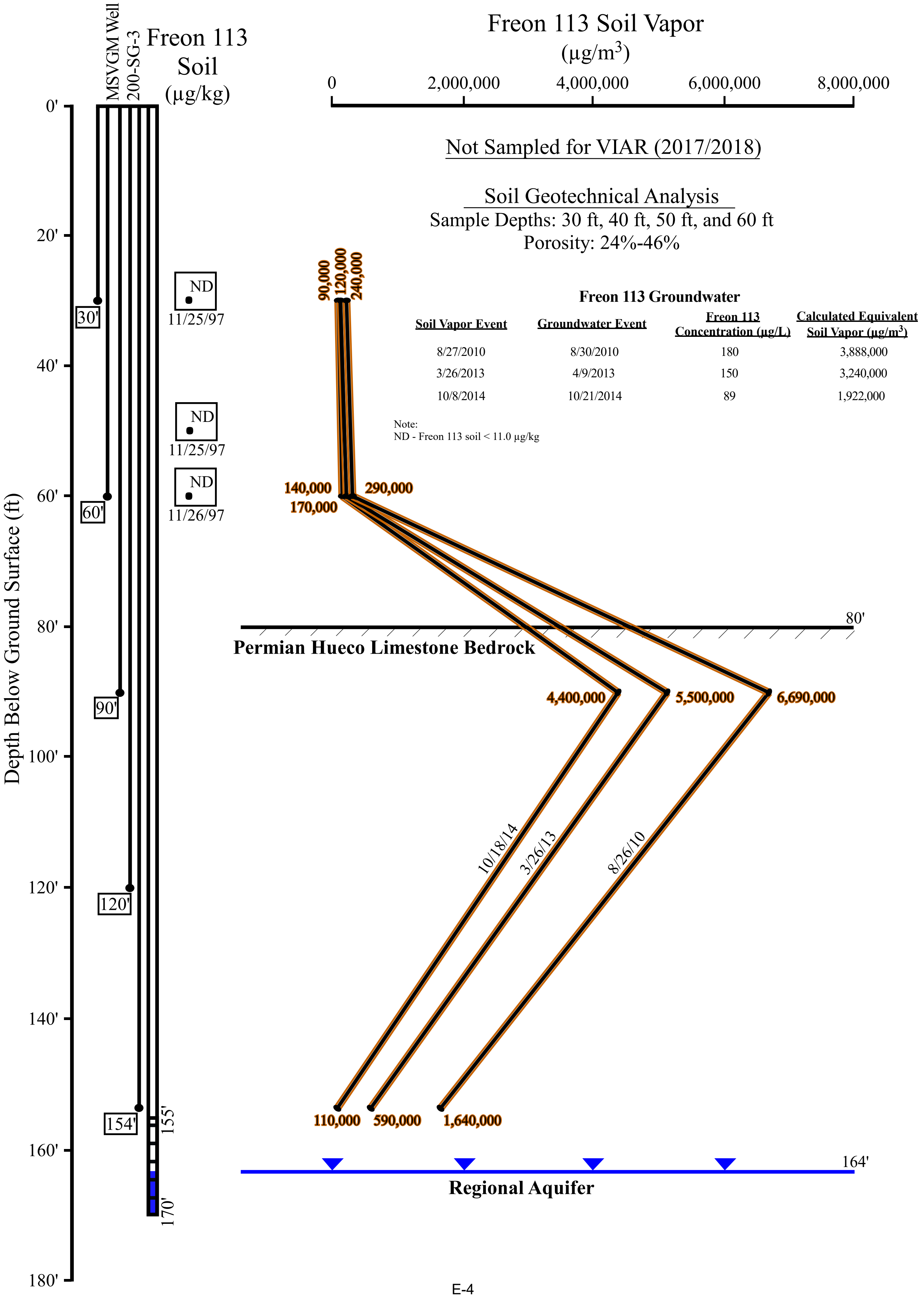


TCE Groundwater

Soil Vapor Event	Groundwater Event	TCE Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m^3)
8/26/2010	8/30/2010	1.6	646
3/26/2013	4/10/2013	1.6	646
10/8/2014	10/22/2014	1.2	485

Note:
ND - TCE soil < 5.2 µg/kg

MSVGM Well 200-SG-3 Vertical Concentration Profile For Freon 113



Not Sampled for VIAR (2017/2018)

Soil Geotechnical Analysis

Sample Depths: 30 ft, 40 ft, 50 ft, and 60 ft

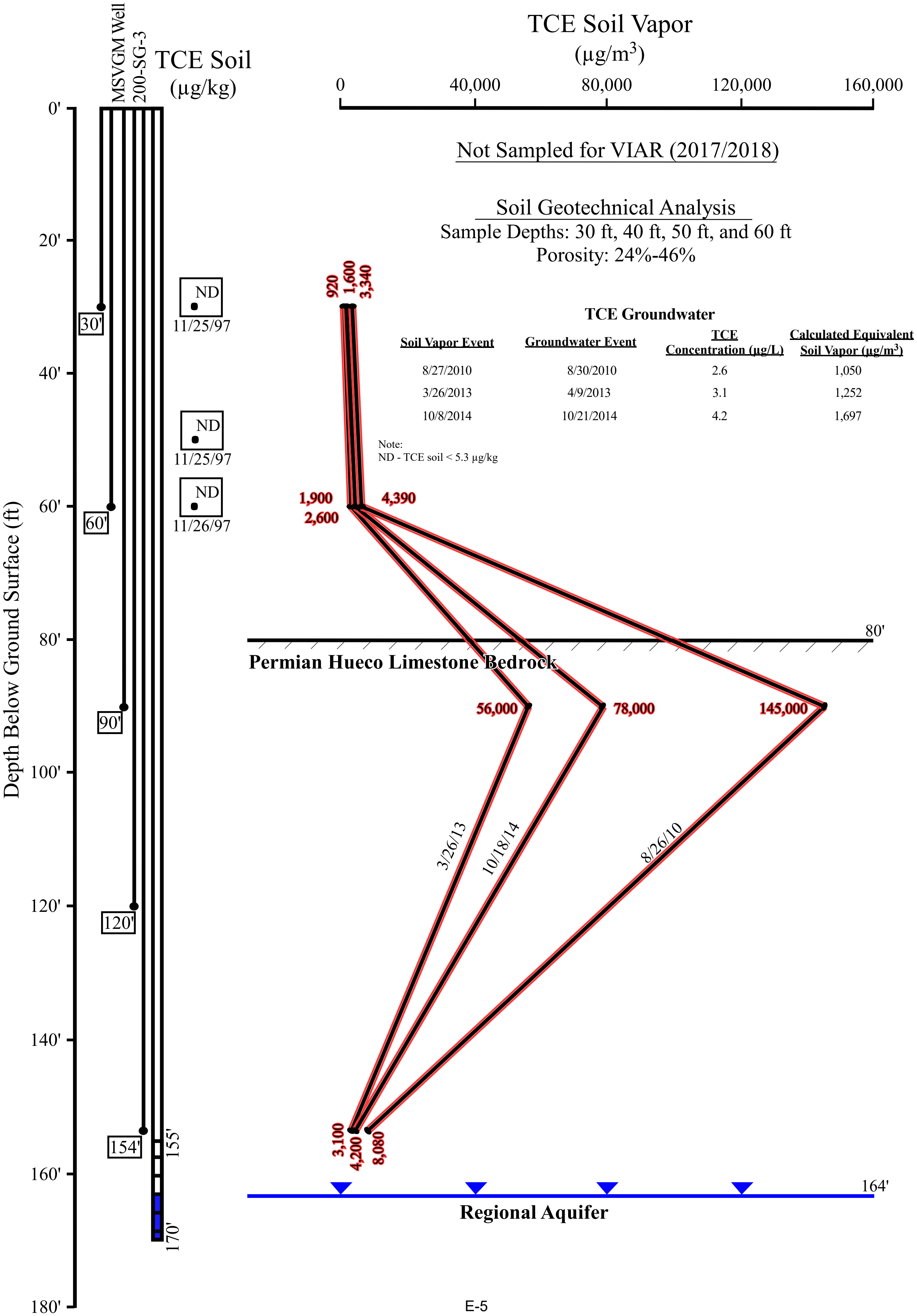
Porosity: 24%-46%

Freon 113 Groundwater

Soil Vapor Event	Groundwater Event	Freon 113 Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m³)
8/27/2010	8/30/2010	180	3,888,000
3/26/2013	4/9/2013	150	3,240,000
10/8/2014	10/21/2014	89	1,922,000

Note:
ND - Freon 113 soil < 11.0 µg/kg

MSVGM Well 200-SG-3 Vertical Concentration Profile For TCE



Not Sampled for VIAR (2017/2018)

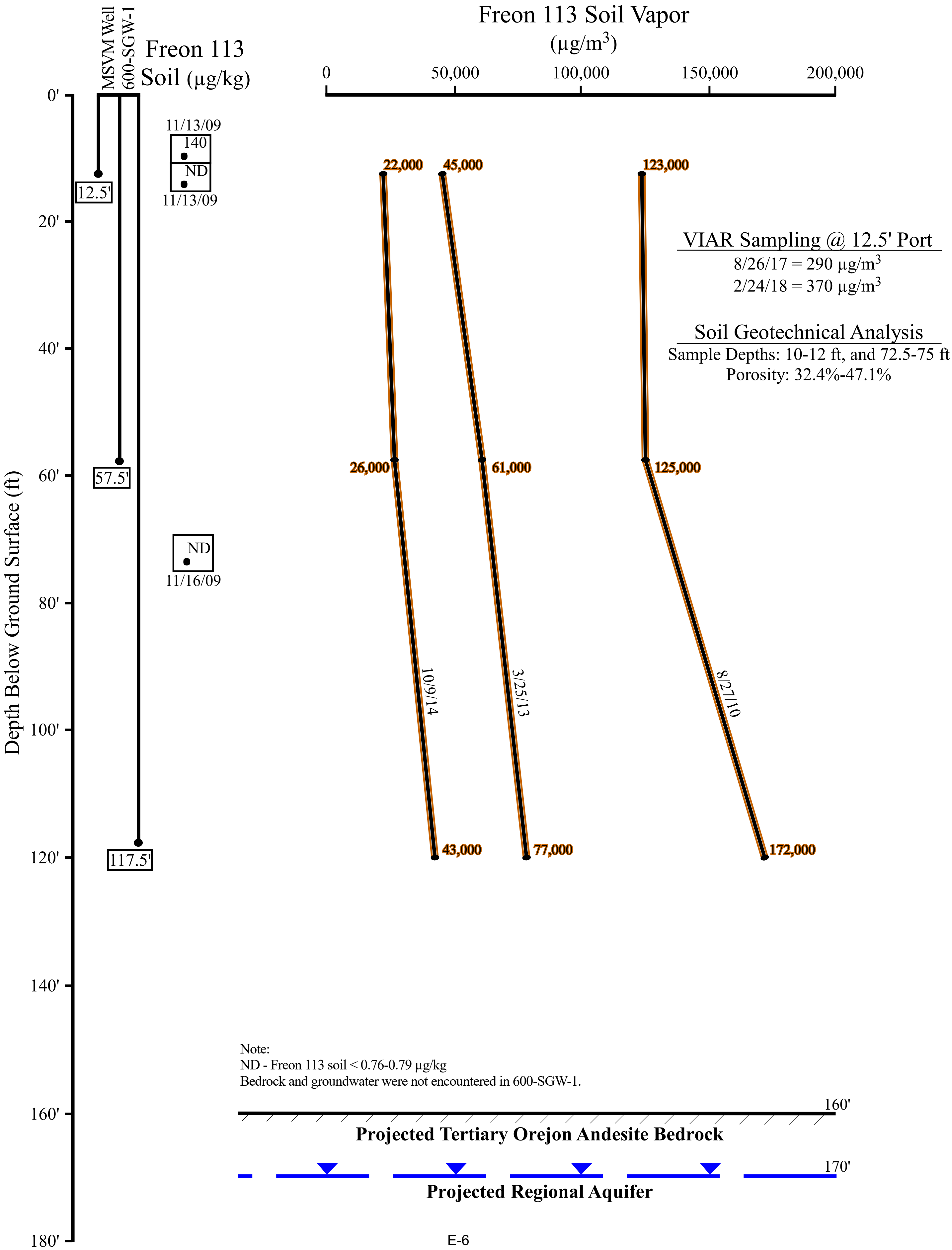
Soil Geotechnical Analysis
Sample Depths: 30 ft, 40 ft, 50 ft, and 60 ft
Porosity: 24%-46%

TCE Groundwater

Soil Vapor Event	Groundwater Event	TCE Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m³)
8/27/2010	8/30/2010	2.6	1,050
3/26/2013	4/9/2013	3.1	1,252
10/8/2014	10/21/2014	4.2	1,697

Note:
ND - TCE soil < 5.3 µg/kg

MSVM Well 600-SGW-1 Vertical Concentration Profile For Freon 113



VIAR Sampling @ 12.5' Port

8/26/17 = 290 µg/m³

2/24/18 = 370 µg/m³

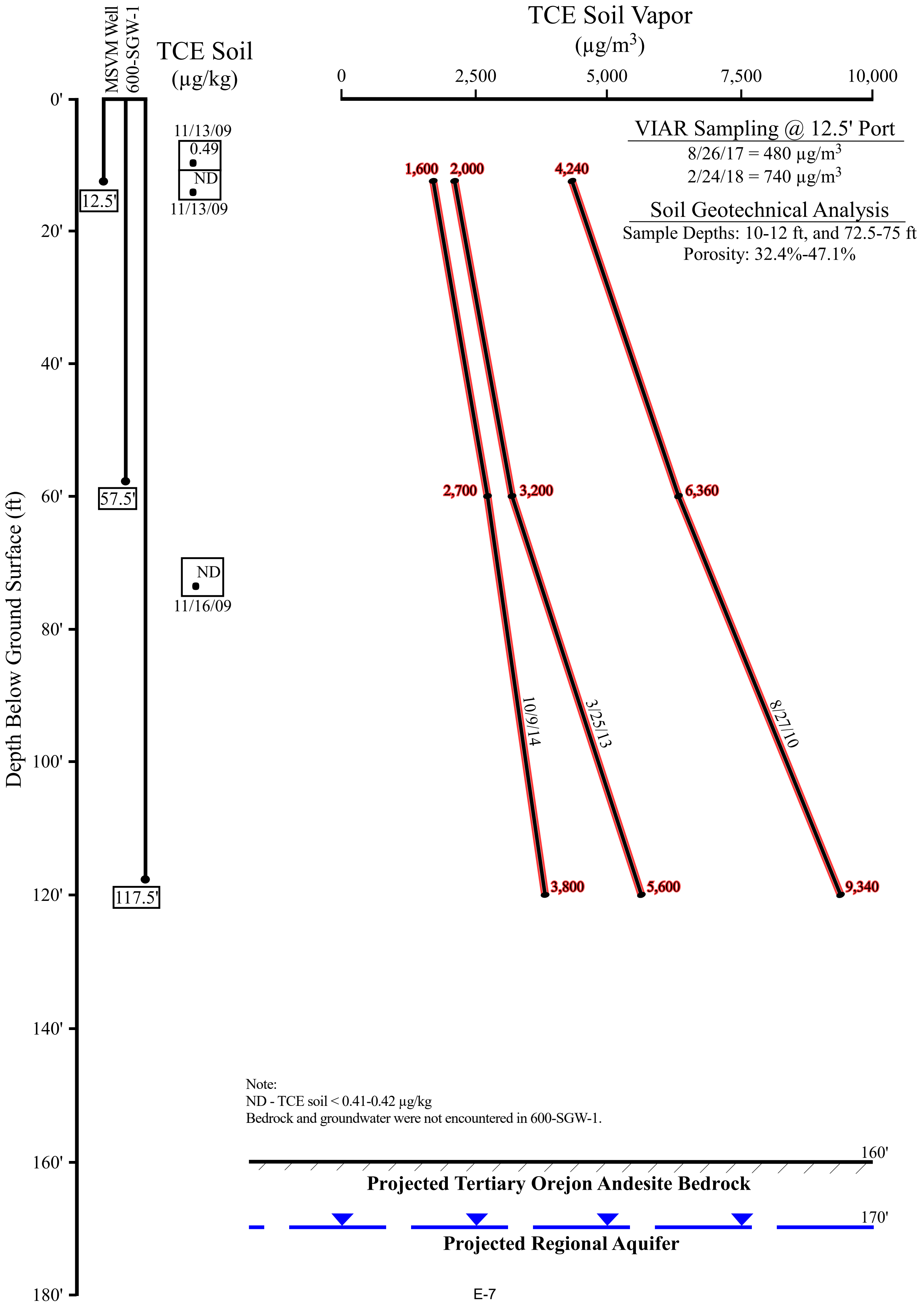
Soil Geotechnical Analysis

Sample Depths: 10-12 ft, and 72.5-75 ft

Porosity: 32.4%-47.1%

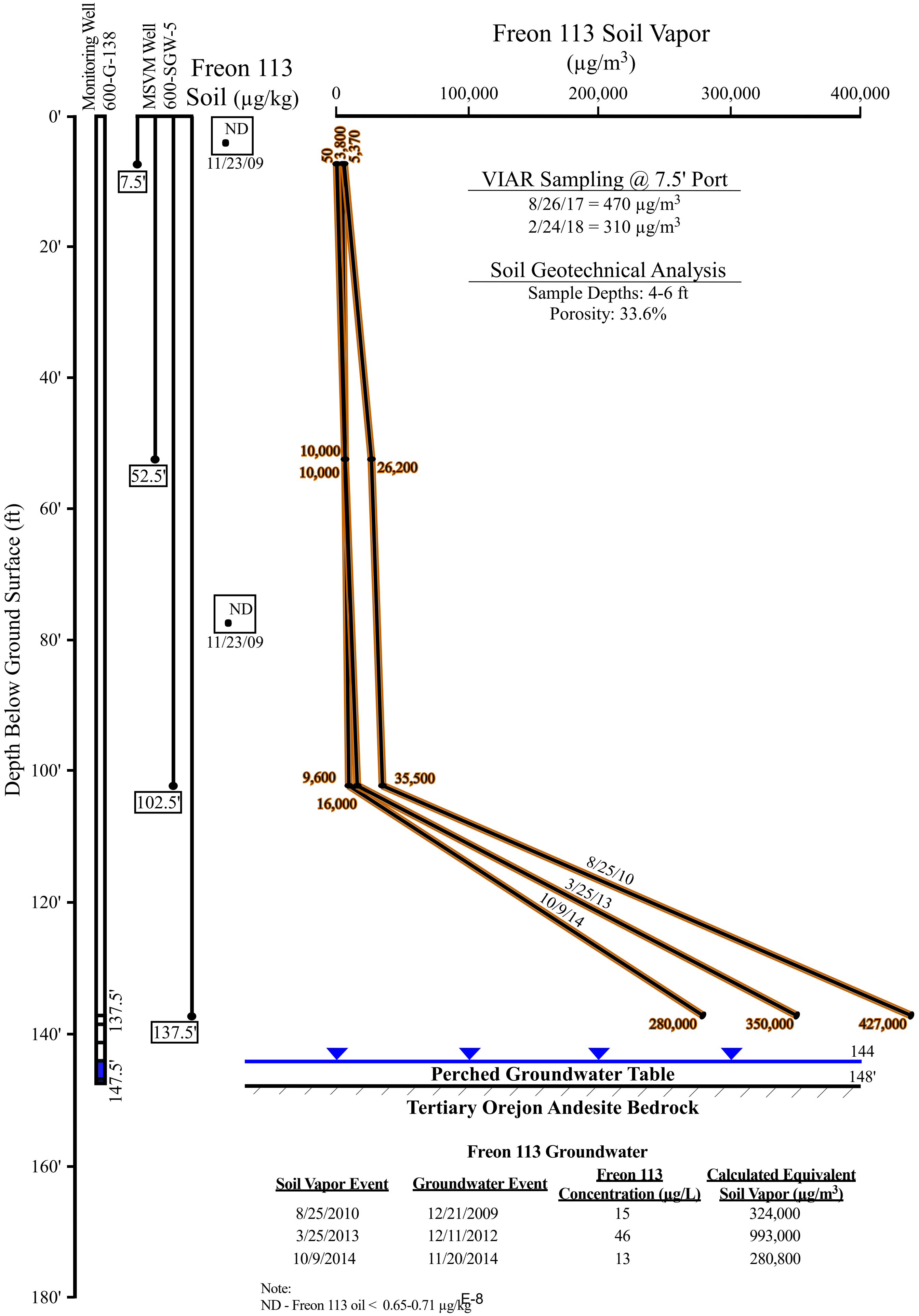
Note:
ND - Freon 113 soil < 0.76-0.79 µg/kg
Bedrock and groundwater were not encountered in 600-SGW-1.

MSVM Well 600-SGW-1 Vertical Concentration Profile For TCE



Note:
ND - TCE soil < 0.41-0.42 µg/kg
Bedrock and groundwater were not encountered in 600-SGW-1.

MSVM Well 600-SGW-5 Vertical Concentration Profile For Freon 113



VIAR Sampling @ 7.5' Port

8/26/17 = 470 µg/m³
2/24/18 = 310 µg/m³

Soil Geotechnical Analysis

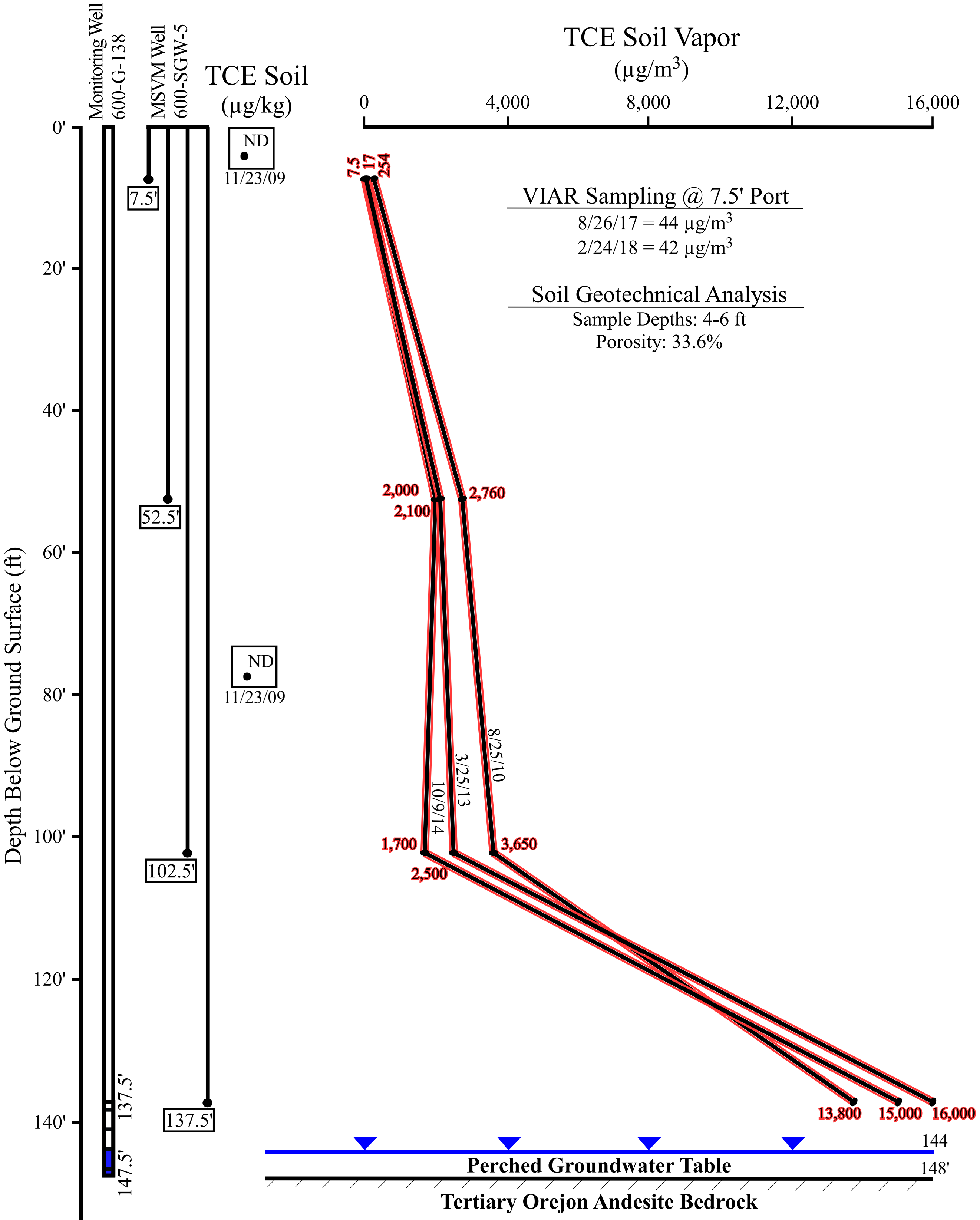
Sample Depths: 4-6 ft
Porosity: 33.6%

Freon 113 Groundwater

Soil Vapor Event	Groundwater Event	Freon 113 Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m³)
8/25/2010	12/21/2009	15	324,000
3/25/2013	12/11/2012	46	993,000
10/9/2014	11/20/2014	13	280,800

Note:
ND - Freon 113 oil < 0.65-0.71 µg/kg

MSVGM Well 600-SGW-5 Vertical Concentration Profile For TCE



TCE Groundwater

Soil Vapor Event	Groundwater Event	TCE Concentration (µg/L)	Calculated Equivalent Soil Vapor (µg/m³)
8/25/2010	12/21/2009	86	34,000
3/25/2013	12/11/2012	110	44,440
10/9/2014	11/20/2014	65	26,260

Note:
ND - TCE soil < 0.35-0.35 µg/kg