REMEDIAL INVESTIGATION WORK PLAN

GSA has collected a large amount of exterior soil and groundwater data at the Goodfellow Federal Center in St. Louis from 2003 to recent. This remedial investigation work plan is the output of compiling the data, comparing it to the U.S. Environmental Protection Agency generic cleanup levels, and identifying where there are gaps in the data for a human health risk assessment. The work plan also determines how to fill in those gaps.

The plan has several purposes including:

- What GSA will do to fill data gaps.
- How specifically to carry out that work, such as methods, quality control measures, and reporting.
- Assurances that the data collection, risk assessment, and reporting are done to the highest quality under the CERCLA process.

The existing data GSA reviewed showed that while there are some chemical exceedances in the soil, they are not as widespread as expected. GSA assumes that further data collection will affirm the data trends.

The risk of encountering contaminants in the soil and groundwater is low and the magnitude of exposure varies, according to GSA environmental protection specialists. GSA assesses risks involved in many scenarios such as those for current and future commercial or industrial workers, construction workers, trench workers, and future hypothetical residents.

The document provides the introduction, site settings, evaluation of past data, and work plan rationale.

- Appendix A-1 through A-4 shows a summary of the historical soil sampling and analysis.
- Appendix C - Sampling and Analysis Plan (SAP) consisting of:
    - A Field Sampling Plan (FSP)
    - A Quality Assurance Project Plan (QAPP), which provides a detailed description of the planned field sampling and testing procedures for the Remedial Investigation (RI).
- Appendix D - Risk Assessment Work Plan (RAWP) provides a detailed description of how the baseline human health risk assessment (HHRA) will be completed to support the Remedial Investigation (RI).

This work plan is one step in the CERCLA process, which GSA is following in preparation for transferring ownership of the property sometime around 2024.

The Missouri Department of Natural Resources approved this RIWP in March 2021.

If you have any questions concerning these data, please email r6environmental@gsa.gov and GSA will provide responses from the appropriate experts.

Please note: The tables and figures in this 968-page plan are not accessible for people using screen reader technology. The information can be furnished upon request by contacting 816-223-6198 or r6environmental@gsa.gov.

FINAL
REMEDIAL INVESTIGATION WORK PLAN
GOODFELLOW FEDERAL COMPLEX
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MISSOURI (MO0602AF)
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APPENDICES

1.0 INTRODUCTION

This Remedial Investigation Work Plan (RIWP) provides a detailed description of the sampling and testing to be conducted for the Remedial Investigation for the Goodfellow Federal Complex (GFC) in St. Louis, Missouri (Site – Figures 1 and 2). This RIWP was prepared in accordance with the United States Environmental Protection Agency's (USEPA's) Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final, OSWER Directive 9355.3-01. This RIWP will be submitted to the Missouri Department of Natural Resources (MDNR) Federal Facilities Section for approval.

A Sampling and Analysis Plan (SAP) consisting of a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP) is attached as Appendix C. Additionally, a Risk Assessment Work Plan (RAWP) is attached as Appendix D.

1.1 Project Objectives

The objectives of the activities described in this RIWP include the following:

- Define the horizontal and vertical extent of affected groundwater, soil, that are above risk-based concentrations.
- Determine the current and future risks from affected media to current and future receptors at the GFC.

2.0 SITE BACKGROUND AND SETTING

2.1 Facility Description

The GFC is at 4300 Goodfellow Boulevard in St. Louis, Missouri and occupies a portion of the former St. Louis Ordnance Plant (SLOP) near the western boundary of the City of St. Louis, Missouri (Figure 1). The GFC encompasses approximately 64 acres, and is bordered northeast by the former SLOP, southeast by Planned Industrial Drive, southwest by Edelle Avenue and the SLOP, and northwest by Goodfellow Boulevard. The GFC is developed with buildings, utility tunnels, and a separated stormwater and sanitary sewer collection system. Maps showing these features are provided in Appendix B. (b) (7)(F)

The SLOP was constructed in the early 1940s and fabricated .30 and .50 caliber ammunition. Based on evaluation summarized in this Work Plan, the targeted contaminants for additional sampling and testing at the Site include metals, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Results of previous sampling and testing for several other contaminants including cyanide, and phosphorus indicate that additional sampling and testing for these contaminants is not required. Per agreement with MDNR, GSA will collect samples for explosives near the former bunker areas.

2.2 Site Physical Setting

The GFC is on the northern flank of the Ozark Plateau in the Dissected Till Plains Physiographic Province, which is characterized by gently rolling hills (Miller et al. 1974). From Goodfellow Boulevard, the Site generally slopes towards the east, the northern portion of the Site slopes to the northeast, and the south portion of the site slopes to the southeast.

The Mississippi River is approximately 2.5 miles east of the site. Although drainage from the site generally follows the topographic gradient toward the Mississippi River, surface water that leaves the site is directed through the storm/sanitary sewers and a wastewater treatment facility before discharging into the Mississippi River (SCS Engineers [SCS] 2008). Based on the general topographic gradient, groundwater flows towards the east and the Mississippi River (Figure 1).

The ground surface at the Site is covered by landscaped areas, streets, parking lots, buildings, and other structures. Site surface soils are identified as Urban Land-Upland with 0- to 5-percent slopes (U.S. Department of Agriculture [USDA] 1979). The Urban Land designation applies to areas where structures, asphalt, concrete, and other impervious materials cover more than 85 percent of the surface area. Subsurface investigations at the Site have identified soils below fill as predominantly silty clay or silty clay loam (Geotechnology, Inc. 2006; SCS 2008). Detailed cross sections showing the general Site geology and anticipated depth of groundwater occurrence are provided on Figures 3 and 4. In general, the Site geology consists of a surficial layer of variable granular fill that is underlain by low permeability cohesive soils (CL/CH). (b) (7)(F) [redacted] Previous drilling data indicates that the cohesive soils are variably saturated with some perched groundwater present. Several previous direct push groundwater sampling locations at the Site did not yield sufficient groundwater for sampling and testing. The low permeability soil and bedrock will reduce potential contaminant migration. Preferential flow paths may exist along utility trench granular backfill and other increased permeability zones.

2.3 Operational History

Construction of the SLOP began in January 1941 and was completed in May 1942. The St. Louis Ordnance Plant was the largest small-arms ammunition installation in the world and embodied three operating divisions. The GFC was known as Plant No. 1 and located on the east side of Goodfellow Boulevard. A map showing the layout of Plant No. 1 is provided in Appendix B. During World War II, Buildings 102 and 103 housed the production of .30 caliber ammunition, while Buildings 104 and 105 housed the production of .50 caliber ammunition.

The small arms ammunition production within Buildings 102, 103, 104, and 105 consisted of brass cartridge annealing and shaping, powder and primer packing, lead core insertion, and sorting, packaging, and shipping. Powder canning and storage buildings included blast proof concrete bunkers (Former Buildings 102 G/H, 103 F/H, 104 G/J, 105 G/J) located south of the main production buildings. Powder was moved from the bunkers and brought into Buildings 102 D, 103 D, 104 E, and 105 E for packing. Primer was brought into Buildings 102 E, 103 E, 140 F, and 105

F for packing. Cartridge annealing and shaping took place in the production buildings, as did sorting, packaging, and shipping of the completed cartridges.

Smaller buildings (102 J, 102 K, 103 J, 103 K, 104 M, 104 N, 105 M, and 105 N) adjacent to production buildings were used for storage of oils and lacquer. Oils and lacquer were transferred from storage areas through a series of mechanical piping into the main production buildings. Oils were used during shaping and trimming operations and lacquer was used as a waterproofing agent applied to completed cartridges.

Building 103 F (previously designated as Building 112) was originally constructed to shape and form lead cores for munitions. Numerous slug forming machines, lead presses, and a remelt room operated on the first floor of Building 112. The building was used for storage following decommissioning and most recently contained a kitchen and cafeteria.

Steam was generated for heating purposes in the Boiler House (Building 111) and was delivered to buildings across the Site through a series of underground utility tunnels. Natural gas was used to fire the boiler system. The boiler house was decommissioned and removed in approximately 1970. Currently, the GFC is heated with smaller roof-mounted boiler units operated with natural gas. Former Building 211 was a Boiler Plant, like Building 111. The EPA aerial report shows coal storage next Building 211 and across the street to the east. No documentation on the fuel source outside the EPA aerial report was discovered. No evidence of tanks or fuel storage have been identified.

Electrical power enters the Site (b) (7)(F) where it is distributed to various transformer vaults in the main buildings. SCS (2008) reported that the primary transformers have been replaced and the fluids in the secondary electrical transformers have been replaced with non-PCB containing oil. Building 208B was originally a substation constructed in 1941/42, then converted to a motor pool facility building in 1987, and now used for storage by a removal contactor.

As of 2019, transformer vaults in (b) (7)(F) still have transformers (not the original) and power to the original/old transformer vault locations where sampling was completed. These locations also have several safety hazards restricting entry per 2013 safety audit.

The original/old transformer vaults in (b) (7)(F) have been abandoned during a recent vault project and no longer have transformers or power to them. However, there may still be cable trays running through the vaults. The transformers/equipment were relocated outside. You can enter the (b) (7)(F) original/old vaults with a site-specific safety plan (SSSP) for additional sampling.

Total of 11 vaults replaced to date, as follows:

(b) (7)(F)

[redacted]

Most original vaults are accessed from the exterior of the buildings.

Cartridge manufacturing ended at Plant No. 1 at the close of World War II. Reportedly, lead core melting and processing continued in Building 103F through February 1957 (SCS 2008). The U.S. Department of Defense (DOD) converted the Site in the 1960's and 1970's to a Federal Office Complex under the management of the U.S. General Services Administration (GSA). The DOD reportedly spent in excess of $50 million dollars for redevelopment. The four primary munitions manufacturing buildings (102, 103, 104, and 105) were decommissioned and converted into office and warehouse space. The grounds surrounding the buildings were graded and converted into parking and greenspace. The powder bunkers were removed during a redevelopment project in 1980. The Site is currently a federal office complex whose primary tenants include GSA, [redacted]

A facility map with historical information for the Site prepared by Tetra Tech (2016) is included in Appendix B.

2.4 Current and Historical Site Use

Known historical uses of the GFC property include a residence and farmstead (dairy farm) between 1912 and 1925, a community garden between 1936 and 1940, Hickey Park from 1940 to 1941, and Plant No. 1 of the SLOP from 1941 through the close of World War II. Table 1 of the RAWP (Appendix D) lists the individual buildings at the GFC, their historical use and current use.

The Site area is currently zoned Industrial District. The current potential exposure scenarios include commercial/industrial workers, trench workers and construction workers The Site is fenced with 24-hour controlled site access. Approximately 80% of the Site is covered by pavement or buildings.

Contractors working in designated areas are required to develop Health and Safety Plans. As a conservative measure, GSA requires HASP for all projects where contractors are working in the following areas:

- Penthouses
- Mechanical spaces
- Telephone and electrical closets
- Above ceilings and below raised floors
- Basements/Basement tunnels/crawl spaces
- Exterior Grounds
- Substations and electrical vaults
- Building HVAC air handlers, VAV's, and ductwork

Historic testing data indicates that asbestos and chemical constituents are present in some of the noted work areas. Building interior areas are not part of the RIWP.

GSA has developed a Safety and Health Specification that is included in most construction and/or professional service contracts for work being completed in these spaces defining the contaminants and risks.

Many of the interior facilities and grounds on GFC have been reported to be environmentally contaminated with varying concentrations of hazardous chemicals/materials. The interior spaces are primarily impacted by metal exceedances in dust, with the main concerns in the mechanical type rooms or non-tenant spaces as listed above. Asbestos-containing materials are also present in some of these spaces and are currently being managed in place. Building electrical spaces, including electrical vaults, and interior/exterior ground soil and groundwater) are reported to contain a variety of polychlorinated biphenyl (PCB) contamination.

The tenant occupied areas are on an enhanced cleaning schedule and are sampled via wipe samples and indoor air sampled regularly. Results of sampling activities are posted on the Goodfellow Reading Room -- https://www.gsa.gov/about-us/regions/welcome-to-the-heartland-region-6/buildings-and-facilities/missouri/goodfellow-federal-center/goodfellow-federal-center-reading-room. Health and safety plans are not required for tenant occupied areas.

The interior contaminants along with asbestos and lead-paint are being managed in place under TSCA and occupational health and safety procedures.

A current tenant, (b) (7)(F) with Building 105D, performs analyses of human pathogens (CDC Biosafety Level 2: Salmonella, E. coli, Listeria, Campylobacter which cause illness when ingested) and veterinary drug residues such as antibiotics or hormones used in food producing animals. The laboratory has been at this location since about 1980. Operations and analyses have changed over that time period. In addition to a microbiology laboratory and veterinary residue chemistry laboratory, the laboratory used to be a food laboratory testing moisture, protein, and fat, as well as residues for some pesticides. At one time, there also had been a pathology laboratory. The laboratory (b) (7)(F) has a Chemical Hygiene and Biosafety Plan, tracks hazardous waste generated, (b) (7)(F) The possibility of a release is low due to the quantities used/stored and disposal of waste in a drum under manifest.

The City of St. Louis Ordinance 66777 (https://www.stlouis-mo.gov/internal-apps/legislative/upload/Ordinances/BOAPdf/66777x00.pdf) prohibits the use of groundwater as drinking water and also prohibits the drilling or installation of wells for potable water supply within the City of St. Louis. Although site cleanup will allow, at a minimum, for activities allowed under zoning, unless unrestricted use/unlimited exposure (UU/UE) is achieved during remediation land-use controls will be implemented in the deed rather than relying on zoning which can change.

GSA acknowledges that certain contaminant risks at the site may require land use controls regardless of zoning. The use of such land use controls, and deed notifications are allowed under both a timely and early transfer authority.

3.0 EXISTING DATA EVALUATION

3.1 Goodfellow Federal Complex Database

Past investigation data for the GFC is stored in a Microsoft Access® database (Database). The GFC Database contains analytical testing data from historical reports. Database information includes testing results of soil, groundwater, crawlspace soil, concrete, dust, drinking water, sump water, and other media. Historic data for some reports does not include each data category (e.g., data from some reports lack sample depth information). Numerous phases of environmental sampling and testing have been performed at the Site as documented in the GFC database. For purposes of the RIWP, we have used the historical data to assist in guiding the proposed sampling and testing. Overall, we believe that the historical data is useful for the noted purpose. The proposed sampling approach is based on Database queries, historic sampling results and comparison to applicable regulatory and background screening levels that have been added to the Database.

Although not all QA/QC data from previous investigations was directly compared to the work plan QAPP, there is a good level of confidence in the data. Example, the OEE report included trip blanks, duplicate samples, equipment blanks, and MS/MSD samples with a full data validation in Section of the that report. PA/SI completed a laboratory data quality review discussed in Section 1.3.1 of that report.

As part of pulling in past data into the database, some historic data did not include each data category (e.g., data from some reports lack sample depth information). If items like this were noted, the data was not included in the past data analysis. Therefore, the data within the database has been screened to applicable screening values discussed already, included in this RIWP, and will be used during the RI process of assessing extent and human health risk.

Import of historic data to the database involved compiling sample data beyond that provided in electronic laboratory reports, such as sample location, depth, media, and associated report. Quality checks were focused on data verification, including verifying locations using CADD, verifying key data points and units using the lab reports, and verifying media designations and depths using report text descriptions. Additional verification was performed after data was imported by generating exceedance reports in the database for comparison to historic report findings.

3.2 Previous Investigations

Historic site investigation reports that were reviewed as part of this RIWP are included in Appendix E (on CD). Other Site information was also reviewed including PCB removal activities and historic operations. A summary of three major sampling and testing efforts completed at the Site between 2008 and 2016 is provided below.

3.2.1 Site/Remedial Investigation Reports

Remedial Investigation Report (Tetra Tech, September 2016)
The focus of this report was investigation of on-site legacy contamination associated with the former ordnance plant operations. Targeted exterior sampling locations included Buildings 107, 136F (fire equipment storage), 102E, 102J, 102K, 102 A/B/C, 104 A/B/C/D, 108A and 111. COPCs were VOCs, SVOCs, and PCBs. Approximately 74 soil samples and one groundwater sample were collected and tested.

Occupational Exposure Evaluation Report. Rev 00. (Tetra Tech, June 2013).
To evaluate occupational exposures, sampling and testing of interior concrete, interior surface dust, crawlspace soil, exterior soil and groundwater was performed. Testing parameters included PCBs, metals, asbestos, SVOCs, VOCs, total petroleum hydrocarbons (TPH), pesticides, and herbicides. The following number of samples exhibited detections of one or more constituent of potential concern (COPC):

- Interior concrete – 54
- Interior surface dust – 60
- Crawlspace soil – 35
- Exterior soil – 41
- Exterior groundwater – 7

Combined Preliminary Assessment/Site Inspection Report - (SCS Engineers, August 2008)
The purpose of this report was to characterize and evaluate sources and pathways for COPCs. Various media were sampled including surface wipe, paint chip, soil, groundwater, sump water, tunnel water, and air. Testing parameters included PCBs, metals, SVOCs, VOCs, TPH and explosives. This report includes a summary of previous investigations (Appendix E). Some of the testing data for this effort lack sufficient information (e.g., soil sample depth) for effective use in the Database. The following number of samples were collected and tested for one or more COPC:

- Surface soil – 163
- Subsurface soil – 90
- Sediment – 49
- Groundwater – 15
- Sump and tunnel water – 6
- Air – 22
- Paint – 13
- Surface wipe - 123

Aerial Photographic Analysis Report (USEPA, May 2000)

A USEPA report titled Aerial Photographic Analysis, St. Louis (EX) Ordinance and Army Ammunition Plants, St. Louis, Missouri, dated May 2000 was reviewed to help identify potential areas of environmental concern. The ten aerial photographs reviewed by USEPA were between 1937 and 1998 (62 years). The summary below includes relevant items identified by USEPA that are located at or adjacent to the Site. A key finding by USEPA is that waste disposal facilities such as landfills, disposal trenches, or liquid waste holding ponds or treatment lagoons were not discerned throughout the observation time period.

1937 Site is agricultural land and surface water flow is generally towards the east.

1941 The St. Louis Ordnance Plant (SLOP) is under construction including railroad spurs.

1953 Coal stockpiles are identified to the northeast of the Site and possible fuel tanks are suspected to the south/southeast of the Site. Both features are located outside the Site footprint. A storage yard is located south of Building 105 A/B/C (off-site). Explosive storage buildings are identified on and off site. USEPA states “The plant has no discernible waste handling and disposal area nor are there discernible solid or liquid waste disposal structures such as landfills, pits, burn pits, holding ponds, or treatment lagoon.”

1958 Coal storage and fuel tank area do not appear to be changed since 1953. The storage yard area located south of Building 105 A/B/C in 1953 is now a parking area. Explosive storage buildings have not changed since 1953. USEPA states “There are no discernible solid or liquid water disposal structures such as landfills, pits, burn pits, holding ponds, or treatment lagoons within Plant #1 and #2 areas.”

1965 The coal stockpiles to the northeast of the Site have been removed. The fuel storage area to the south and on-site explosive storage are unchanged since 1958. USEPA reports “The storage yards in the southern portion of the Site continue to contain supplies and accumulations of debris. There are no discernible solid or liquid waste disposal structures such as landfills, pits, burn pits, holding ponds or treatment lagoons.” The noted storage yard area is north of Building 122.

1971 Ten fuel storage tanks reported south of the Site have been removed. The explosive storage area has changed with automobiles now present next to these areas. The storage area in the south portion of the Site no longer contains supplies. USEPA states “The accumulations of debris are scattered and appear to reflect dismantling activity. There are no discernible solid or liquid waste disposal structures such as landfills, pits, burn pits, holding ponds, or treatment lagoons.

1980 The reported fuel storage area located south of the Site is now a parking lot. Railroad tracks at the Site have been removed and these areas have been converted to parking lots. It should be noted that GSA does not know the extent of railroad track removal. According to one of the Field Office project managers, Railroad tracks have been unearthed a few times over the years during construction projects. The explosive storage buildings have been dismantled and replaced with parking areas. The storage yard areas are now parking areas.

1985 Much of the noted observations for 1985 are for dismantling of building located east and southeast of the Site.

1994 Substantial changes not noted since 1980.

1998 Substantial changes not noted since 1980.

3.2.2 Demolition and Remediation Reports

Small Arms Firing Range, Remediation Report, Building 105 (SCS Engineers 2003)
Reported on the demolition, remediation and confirmation wipe sampling of the small arms firing range located in the basement of Building 105. SCS Engineers (SCS) prepared a report documenting the demolition and remediation of the small arms firing range (SAFR). SCS supervised remediation of the abandoned SAFR in the basement of Building 105. The activities performed consisted of demolition and removal of material associated with the firing range, cleaning the designated firing range area, and containerization of generated waste streams. The procedures generally followed the GSA Environmental Management Technical Guide for maintaining Indoor Firing Ranges. Remediation activities included HEPA vacuuming wood, plastic debris, and metal prior to size reduction and load-out for disposal as non-hazardous waste. Demolition activities included removal, size reduction (using cutting torches and wood saws, as appropriate), and containerization of firing range debris (various wood and plastic) and removal of bullet pit sand. Bullet pit sand was removed from the range using a truck mounted vacuum with hopper. Two (2) twenty - cubic yard roll-off boxes were used for containerizing hazardous wastes (including bullet pit sand and wood framing that was deemed hazardous due to its exposure either to lead bullets or bullet pit sand) generated from the remediation activities.

After HEPA vacuuming, the metal backstop of the bullet pit was reduced in size using a cutting torch and recycled off-site. The remaining wood structure was HEPA vacuumed prior to being reduced in size using a wood saw. The vacuumed pieces of the wood structure were disposed as non-hazardous waste. Upon removal of firing range materials, the concrete ceilings, walls, and floors within the containment area were washed with one pass of a 3000-psi pressure washer. All rinsate from pressure washing was captured, prefiltered through a 50-micron filter, and containerized for waste stream profiling. It is not known if the State of Missouri was involved with range cleanup. State correspondence about the range cleanup or concurrence is not in the file.

3.2.3 PCB Reports

Numerous memoranda, notes, manifests, and removal documentation date from 1985 to 1997 regarding PCBs at GFC. Substantial documentation of the assessment, removal and disposal of PCBs and related items from GFC was reviewed. Records of the assessment, removal and disposal activities for PCB related equipment and fluids are on file with GSA. Previous PCB sampling and testing was performed at the Site and will be supplemented by the sampling and testing proposed herein.

Previous concrete sampling at the Site identified targeted locations with PCB concentrations greater than 1 mg/kg. Most of the identified locations are associated with the locations of former PCB containing electric transformers or similar PCB containing equipment.
According to the GSA Region 6 vertical transportation specialist, only eight of the twenty-four elevators at the Site are hydraulic elevators. There is no documentation of significant past releases. As agreed during the December 2020 teleconference between GSA and MDNR, PCB releases in the concrete and elevators will be handled with TSCA versus MDNR Federal Facilities/CERCLA. However, the groundwater pathway will be evaluated, and samples will be collected for PCBs.

3.2.4 Background Inorganic Concentration Studies

Background studies for metals have been prepared for the area of GFC and are included in the RAWP. A Site-Specific Environmental Baseline Survey for St. Louis Army Ammunition Plant in St. Louis, Missouri (URS, 2004) was prepared for a nearby site and the resulting background levels are considered representative for the GFC. Additional inorganic constituent background data is available from the Combined Preliminary Assessment/Site Inspection Report (SCS Engineers, 2008). The Upper Tolerance Level (UTL) described in the URS 2004 survey was added to the Database and was used for screening and evaluation of sampling data, as applicable.

4.0 WORK PLAN RATIONALE

4.1 Data Quality Objectives

Data quality objectives (DQOs) are described in the QAPP (Appendix C).

4.2 Contaminants of Potential Concern

COPCs were selected based on detailed evaluation of previous sampling data collected at the GFC. Summary information including maps showing the proposed sampling for the media of concern and Database summary tables are provided in Appendix A-1 through A-4. The primary COPC include:

- Targeted Munitions[1] Related Metals: antimony, arsenic, copper, lead, and zinc: EPA Method 6010
- PAHs EPA Method 8270
- VOCs: EPA Method 8260 (mainly groundwater)
- Total Petroleum Hydrocarbon (TPH) – testing near oil storage areas (lube oil) maintenance areas and Building 115
- Nitroaromatics, nitramines, and nitrate esters near the former bunkers (Buildings 102 G, 103 F, 104 J, and 105 J)
- PCBs:
  - Aroclor analysis list per EPA Method 8082 and
  - Twelve dioxin-like congeners per EPA Method 1668 (10% of surface soil samples):
    - Non-ortho substituted PCBs: 77, 81, 126, and 169, and
    - Mono-ortho substituted PCBs: 105, 114, 118, 123, 156, 157, 167, and 189.

4.3 Work Plan Approach

The previous Site data was reviewed to assess proposed, initial sampling locations for the media of interest. Adjustments to the proposed sampling locations based on site observations will be conducted, as needed, in coordination with MDNR representatives. For efficiency and when applicable, additional sampling beyond that provided herein will be performed in coordination with the MDNR based on the initial testing results. This approach will allow the required data to be collected during one mobilization to the Site, to the extent possible. A description of the proposed sampling locations and frequency is below. Additional sampling information is provided in the FSP and QAPP (Appendix C).

4.3.1 Groundwater

Groundwater will be assessed using 19 permanent monitoring wells installed at the proposed locations shown in Appendix A-1. The perimeter spacing of the initial monitoring wells is approximately 500 feet (i.e., one well / 3.5 acres). The proposed monitoring well network will

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[1] Technical Guidance for Military Munitions Response Actions, Manual No. 200-1-15, U.S. Army Corps of Engineers, October 30, 2018.

provide adequate spatial coverage for initial characterization. All monitoring wells will be completed to competent bedrock. Frequently shallow groundwater at these types of sites is primarily located in the weathered zone just above bedrock.

Proposed laboratory testing of groundwater samples includes VOCs, PAHs, five targeted metals, and PCBs (both Aroclor and Congeners). Additionally, targeted sampling for petroleum contaminants (TPH) and explosives (nitroaromatics, nitramines, and nitrate esters) analyzes will be run on at least one downgradient well near historical operations (former bunkers and oil storage areas (lube oil) maintenance areas and Building 115 and VOCs for locations near Building 122B and Building 110). Dissolved metals testing will be included at a frequency of 20% of the groundwater samples collected for testing.

4.3.2 Surface Soil

Surface and subsurface soil will be assessed using soil borings installed at the proposed locations shown in Appendix A-2. Surface soil samples will be comprised of material from 0 to 2 feet below the base of surface pavement or vegetative layer. 49 previous surface soil sampling locations were completed, and results are summarized in Appendix A-2.

- Various constituents were analyzed including metals, PCBs, PAHs, VOCs, and asbestos. Each constituent was not analyzed at each location.
- Metals were detected at various locations above screening levels.
- PCBs were detected at one surface soil sampling location above industrial RSLs.

- PAHs were detected at seven surface soil sampling locations above residential RSLs and at one surface sampling location above industrial RSLs.
- Other detected constituents were below residential RSLs and/or background.

Based on historical site uses and existing data, the COPCs for surface soil samples are PCBs, PAHs, and five metals. The five metals were selected based on the commonly occurring metals for munitions sites (arsenic, antimony, copper, lead, and zinc) and previous testing results. Soil testing of PCB congeners, as summarized in the RAWP and QAPP, will be performed on 10% of the exterior surface soil samples with sampling preference near areas exhibiting previous PCB detections. Additionally, targeted sampling for petroleum contaminants (TPH) and explosives (nitroaromatics, nitramines, and nitrate esters) analyzes will be run on select soil samples collected near historical operations (former bunkers and oil storage areas (lube oil) maintenance areas and Building 115; and solvents (VOCs) for Building 122B and Building 110.

Surface soil sampling frequency will be a minimum of one sample per acre (approximately 200-foot spacing) across outdoor portions of the Site. Judgmental sampling will be implemented to optimize sampling locations at former building operations, areas where petroleum hydrocarbons were used/stored, underground storage tank, former powder bunkers, and previous exceedance locations. Depths may also be adjusted deeper than 10 feet near transformers vault locations to target the likely zone of a potential release. During the December 11, 2020 teleconference discussion, it was determined by MDNR that they do not view the rail beds and spurs as a CERCLA issue, but they should be noted that they existed in the transfer documents.

4.3.3 Subsurface Soil

A summary of subsurface soil sampling and testing and proposed subsurface soil sampling locations are provided in Appendix A -3. 59 previous subsurface soil sampling locations were completed.

- Various constituents were tested including metals, PCBs, PAHs, VOCs, pesticides, herbicides and asbestos.
- PAHs were detected in 3 of the subsurface soil sampling locations at concentrations above residential RSLs.
- Other tested constituents were below residential RSLs.
- Construction worker and trench worker are the primary exposure pathways for subsurface soil.

Although there have been 59 previous subsurface soil samples collected across the site, review of the subsurface maps shows a lack of sampling locations across the site for the site COPCs (PCBs, PAHs, and the five metals). This presents a subsurface soil data gap regarding potential extent and sufficient data for risk assessment. It is proposed that a subsurface sample be collected at each of the proposed surface soil boring locations and analyzed for PCBs, PAHs, and five metals, similar to the surface soil locations. Additionally, targeted sampling for petroleum contaminants (TPH) and explosives (nitroaromatics, nitramines, and nitrate esters) analyzes will be run on select samples near historical operations (former bunkers and oil storage areas (lube oil) maintenance areas and Building 115 and solvents (VOCs) for locations at Building 122B and Building 110).

A total of two (2) soil samples per boring (surface and subsurface) are planned for collection. The subsurface soil sample will be collected within the 2 to 4-foot interval unless disturbed soils or other field observations dictate sample collection at a deeper depth. An example is collection of a deeper interval near a former transformer vault location. Subsurface soil samples will be monitored with a photoionization detector (PID). Soil samples exhibiting elevated PID readings will be considered for VOC testing.

As described in the RAWP (Appendix D), the trench worker will be assessed if volatile organic compounds are detected in groundwater. Soil gas samples will be collected if VOCs are found in the groundwater at concentrations that indicate the potential for vapor migration. The construction worker will be evaluated for inhalation of particulates using all sample data collected from 0-10 ft bgs.

4.3.4 Crawlspace Surface Soil

As agreed with MDNR, the crawl spaces/tunnels will not be sampled during the RIWP investigation, as only releases under CERCLA will be addressed, and there are no mechanisms for releases, other than at Building 102B with previous DoD photo lab. It was determined that the asbestos in the crawlspace/basements is a NESHAP issue, and not viewed as a CERCLA issue. Therefore, it was determined that GSA will work with the MDNR Air Pollution Control Program to address the asbestos issues as needed.

Although chemical sampling will not be completed in the crawlspaces as part of this RIWP, a summary of soil sampling and testing performed in the crawlspaces is in Appendix A-4.

- Various constituents were tested including explosives, metals, PCBs, PAHs, VOCs, and asbestos.
- Several metals were detected above screening levels.
- A few crawlspace soil samples exhibited exceedances of industrials RSLs for benzo(a)pyrene and PCBs.
- Asbestos was detected in crawlspace soil samples from each building that was tested for asbestos.

GSA is currently sampling for asbestos in the tunnels, basements, and suspect drop zones within the crawlspaces as part of our NESHAP program.

4.3.5 Data Handling and Analysis

Data generated for the RI will include laboratory data and sample location data. Laboratory data will be in an Excel electronic data deliverable (EDD) format that is compatible for direct import to the Database. The required data formatting for importing to the Database will be provided to the laboratory. Sample location data (such as latitude, longitude, and depth) will also be obtained. These data will be compiled and formatted in Excel for import into Database. Organized field data and related project documentation will be provided electronically to GSA weekly.

4.3.6 Remedial Investigation Report

Prior to starting the Remedial Investigation Report (RIR), project data will be reviewed to assess if the required RI data collection has been completed. Within 120 days of the completion of field work, as defined by receipt of last analytical results, an RIR will be prepared and submitted to the GSA and the MDNR. The RIR will include a summary of the field activities conducted, data generated, figures with sampling locations, a discussion of the data, and a human health risk assessment.

5.0 REMEDIAL INVESTIGATION TASKS

The tasks that are proposed in the RIWP for the GFC are briefly outlined below:

Scoping: An on-site meeting was held on August 14, 2019 with Mr. Eric Gorman of the GSA and Mr. Jim Harris of the MDNR. Several teleconference meetings were also conducted. Conceptual approaches and general methods for conducting the RI were discussed.

Work Plan Development: This RIWP was developed to achieve the objectives given in the scope of work. A review of existing data and scoping discussions with the GSA and the MDNR was conducted to assist in the work plan development.

Field Investigation: The scope of the proposed field investigation is presented in the SAP, which consists of the FSP and the QAPP.

Sample Analysis/Validation: Procedures for this task are described in the QAPP.

Data Evaluation: The RIR will include a comprehensive evaluation and summary of the data collected. The format of the RIR will be consistent with USEPA Guidance[2]. The RIR will include details and results of the sampling and testing, contamination assessment, data evaluation including fate and transport, and risk assessment.

Risk Assessment: Potential human health and environmental risks associated with the Site will be evaluated.

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[2] Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, October 1988.

6.0 SCHEDULE

Schedule Item	Anticipated Timeframe / Deadline
Submit GFC RIWP (Draft) to GSA	May 2020
Submit GFC RIWP (Draft Final) to the MDNR	February 2021
Obtain final approval of the RIWP from the MDNR	February 2021 (depends on MDNR review schedule)
Complete RI field activities	Within 120 days of RIWP approval and/or contract award
Conduct meeting with MDNR on baseline human health and environmental risk assessments.	Prior to completion of the RIR
Submit the RIR to the MDNR	Within 120 days of the completion of field work, as defined by receipt of last analytical results.

7.0 PROJECT MANAGEMENT

A project team will be retained to conduct the activities described in this RIWP. The project team will be led by the Consultant, which will be responsible for project management, field oversight, and report preparation. Additional activities such as drilling and sampling, laboratory analytical testing, and risk assessment will be fulfilled by the project team.

The positions, functions, and responsibilities shown below represent the structure of the project team.

Consultant Project Manager:

- Responsible for managing project activities.
- Responsible for obtaining the necessary agreements for the project and is in contact with the owner's representatives and regulatory agencies providing information regarding the status of the project.
- Responsible for organizing field oversight, sampling and testing, record keeping, and maintaining communication with the Field Team Manager.

Field Team Manager:

- Coordinates activities conducted at the site through consultation with the Consultant Project Manager.
- Provides advice and consultation to the Consultant Project Manager regarding the health and safety of those involved in assessment activities.
- Prepares and oversees the implementation of the Site Safety Plan and the Field Sampling Plan.
- Responsible for coordination, sample collection, field monitoring, analysis of samples, and interpretation of data under the direction of the Consultant Project Manager.
- Responsible for leading and coordinating the day-to-day activities of the various resource specialists under their supervision.
- Development and implementation of field-related work plans, assurance of schedule compliance, and adherence to management-developed study requirements.
- Coordination and management of field staff including sampling and drilling staff.
- Implementation of QC for technical data provided by the field staff including field measurement data.
- Authorship, review, and approval of text and graphics required for field team efforts.
- Participation in the preparation of the final report.

Technical Staff:

- Collect and analyze data.
- Prepare various task reports and support materials.
- Experienced professionals with the degree of specialization and technical competence required to effectively and efficiently perform the required work.
- Report directly to the Field Team Managers.

Laboratory Project Manager:

- Ensure that all resources of the laboratory are available on an as-required basis.
- Coordinates laboratory analysis, supervises in-house chain-of-custody, schedules sample analysis, oversees data review, oversees preparation of analytical reports, and approves final analytical reports prior to submission to the Consultant.

Laboratory Quality Assurance Officer:

- Reviews laboratory quality assurance and quality control documentation.
- Determines laboratory corrective action, if required.
- Provides technical representation of laboratory quality assurance procedures.
- Prepares laboratory Standard Operating Procedures.

Laboratory Sample Custodian:

- Receives, inspects, and records the condition of incoming sample containers.
- Verifies chain-of-custody and signs appropriate documents.
- Notifies laboratory manager and laboratory supervisor of sample receipt and inspection.
- Assigns a unique identification number and customer number and enters each into the sample receiving log.
- Initiates transfer of the samples to the appropriate laboratory sections.
- Monitors access/storage of samples or extracts.

8.0 REFERENCES

Remedial Investigation Report Final, General Services Administration, GoodFellow Federal Complex, St. Louis, Missouri, Contract Number GS10F0076K, Order Number GS-06P-10-GX-A-0030/GS-P06-11GX5201; prepared for General Services Administration; prepared by Tetra Tech, Inc.; Report dated September 2016.

Occupational Exposure Evaluation Report, Rev. 00, General Services Administration, Goodfellow Federal Complex, St. Louis, Missouri, Contract Number GS10F0076K, Order Number GS-06P-10-GX-A-0030/GS-P-06-11-GX-5201; prepared for General Services Administration; prepared by Tetra Tech, Inc.; report dated June 2013.

Work Plan and Quality Assurance Project Plan, For Occupational Exposure Evaluation, Final; *General Services Administration, Goodfellow Federal Complex, St. Louis, Missouri, Contract Number GS10F0076K, Order Number GS-06P-10-GX-A-0030/GS-P-06-11-GX-5201*; prepared for General Services Administration; prepared by Tetra Tech EM Inc.; report dated April 2012.

File Review and Summary of Site Conditions, Former St. Louis Ordnance Plant, St. Louis, Missouri; prepared for General Services Administration; prepared by Terracon Consultants, Inc.; Terracon Project No. 15107048, report dated December 20, 2010.

Limited Site Investigation, Federal Complex, 4300 Goodfellow Boulevard, St. Louis, Missouri; prepared for General Services Administration; prepared by Terracon Consultants, Inc.; Terracon Project No. 15107073, report dated November 5, 2010.

Combined Preliminary Assessment/Site Inspection Report; prepared for Saint Louis Federal Center; prepared by SCS Engineers; report dated August 2008, File No. 02200070.56.

Interim Site Inspection Report, Buildings 101 & 110, Saint Louis Federal Center, 4300 Goodfellow Boulevard, Saint Louis, Missouri; prepared for General Services Administration; prepared by SCS Engineers; report dated November 2006, File No. 02200070.56.

Final Report, Phase I Environmental Site Assessment, Federal Records Center, 4300 Goodfellow Boulevard, St. Louis, Missouri; prepared for Weston E.I.D.; prepared by Geotechnology, Inc.; Report No. 0847601.51DA, dated November 21, 2006.

Environmental Site Investigation, Building Series 104 Interim Report, Saint Louis Federal Center, 4300 Goodfellow Boulevard, Saint Louis, Missouri; prepared for General Services Administration; prepared by SCS Engineers; report dated March 2006, File No. 02200070.27.

Environmental Site Investigation, Building Series 105 Interim Report, Saint Louis Federal Center, 4300 Goodfellow Boulevard, Saint Louis, Missouri; prepared for General Services Administration; prepared by SCS Engineers; report dated March 2006, File No. 02200070.27.

Environmental Site Investigation, Buildings 108A and 108B, Preliminary Report, Saint Louis Federal Center, 4300 Goodfellow Boulevard, Saint Louis, Missouri; prepared for General Services Administration; prepared by SCS Engineers; report dated December 2004, File No. 02200070.27.

Environmental Site Investigation, Former Buildings 104K and 104L, Saint Louis Federal Center, 4300 Goodfellow Boulevard, Saint Louis, Missouri; prepared for General Services Administration; prepared by SCS engineers; report Dated December 2004, File No. 02200070.27.

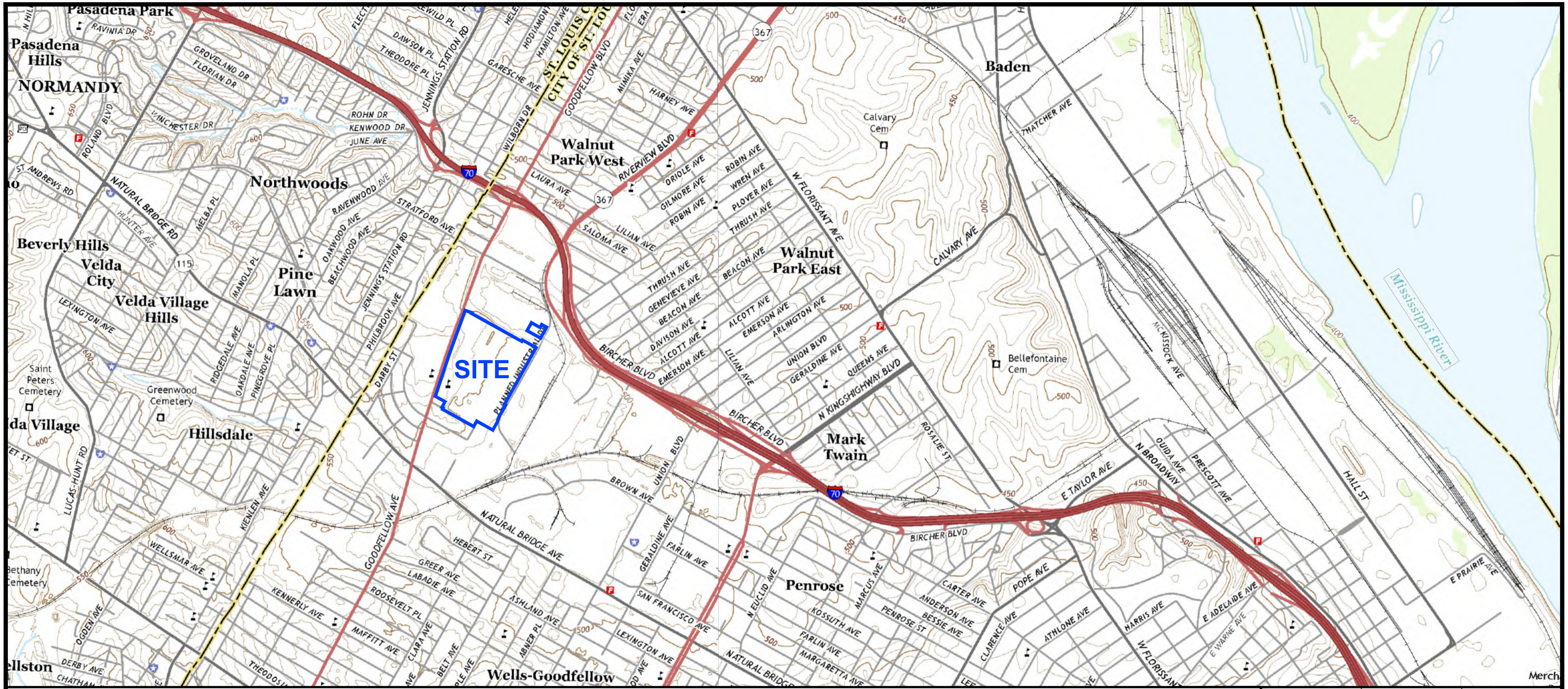
Site Investigation Report, Buildings 103, 103D, 103E, St. Louis Federal Center, 4300 Goodfellow, St. Louis, Missouri; prepared for U.S. General Services Administration; prepared by SCS Engineers; report dated June 4, 2004, 02200070.27.

Environmental Site Investigation Report, Buildings 102, 103, 104, and 112, St. Louis Federal Center, 4300 Goodfellow Boulevard, St. Louis, Missouri; prepared for General Services Administration, U.S. General Services Administration; prepared by SCS Engineers; report dated November 2003, File No. 02200070.19.

Small Arms Firing Range Remediation Report, Building 105, Federal Center, 4300 Goodfellow, St. Louis, Missouri; prepared for U.S. General Services Administration; prepared by SCS Engineers; report dated March 18, 2003.

Phase I Environmental Site Assessment, Federal Center, 4300 Goodfellow Boulevard, St. *Louis, MO 63120, Building No.: Various*; prepared for General Services Administration; prepared by Marc Enviro Services LLC; MES Project No. MES-01-2001-0042, report dated January 24, 2002.

EPA/540/G-89/004, OSWER Directive 9355.3-01, October 1988; *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final*; Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.



NOTES

1. Plan adapted from 7.5 minute U.S.G.S. maps for Clayton, Missouri and Granite City, Illinois-Missouri quadrangles, last revised in 2015.

2. Site is approximately 66 acres.

N

0 2,000 4,000
SCALE IN FEET

Drawn By: WAH	Ck'd By: JYG	App'vd By: KJH
Date: 2-12-20	Date: 2-14-20	Date: 2-15-20

etegra

juniper environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

SITE LOCATION AND TOPOGRAPHY

Project Number
J034500.01

FIGURE 1

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.

2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

┼┼┼┼┼┼ Former Railroad Track Location (From 7.5 Minute U.S.G.S. Quadrangle Map for Clayton, Missouri Dated 1954)

N

0 250 500

SCALE IN FEET

Drawn By: WAH	Ck'd By: JYG	App'vd By: KJH
Date: 2-12-20	Date: 2-14-20	Date: 2-15-20

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St. Louis, Missouri

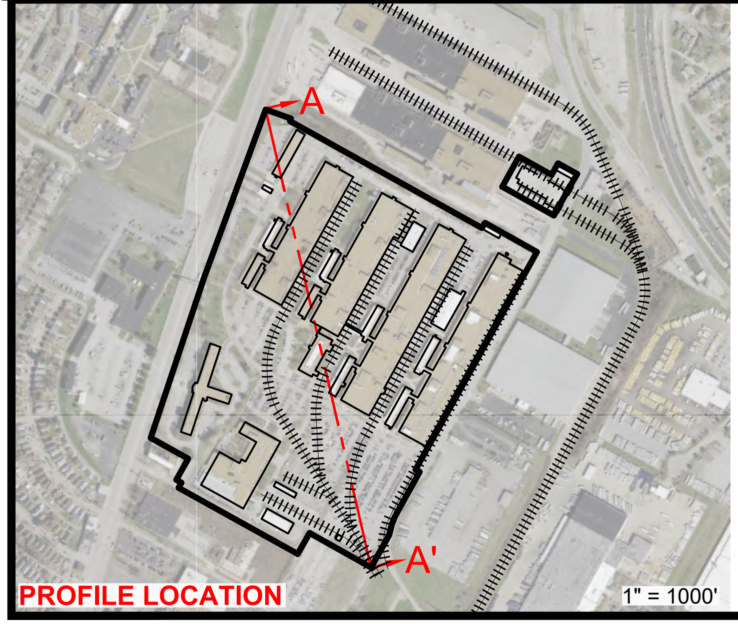
AERIAL SITE MAP

Project Number
J034500.01

FIGURE 2

(b) (7)(F)

[redacted]



PROFILE LOCATION

NOTES

1. Subsurface information based mainly on borings completed by Tetra-Tech in 2016 and Geotechnology in 2009.
2. All features are approximate.
3. This plan contains Controlled Unclassified Information (CUI).

STRATIGRAPHY LEGEND

▩	Fill Material
▨	Cohesive Soils - CL through CH
☰	Shale Bedrock
▽	Estimated Groundwater Elevation

SCALE IN FEET
HORIZONTAL 1" = 200'
VERTICAL 1" = 10'

Drawn By: WAH	Ck'd By: JYG	App'vd By: KJH
Date: 2-12-20	Date: 2-14-20	Date: 2-15-20

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St. Louis, Missouri

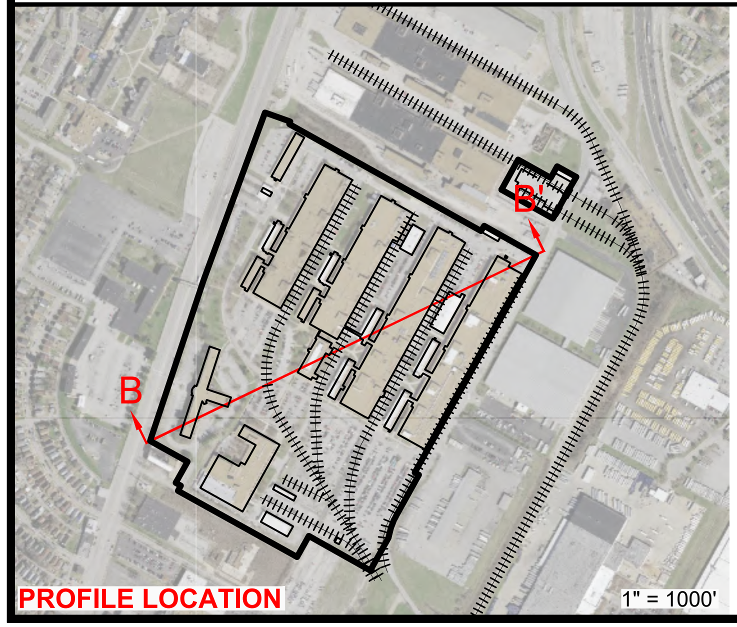
GENERALIZED
CROSS-SECTION A-A'

Project Number
J034500.01

FIGURE 3

(b) (7)(F)

[redacted]



PROFILE LOCATION

NOTES

1. Subsurface information based mainly on borings completed by Tetra-Tech in 2016 and Geotechnology in 2009.
2. All features are approximate.
3. This plan contains Controlled Unclassified Information (CUI).

STRATIGRAPHY LEGEND

▩	Fill Material
▨	Cohesive Soils - CL through CH
▤	Shale Bedrock
▽	Estimated Groundwater Elevation

SCALE IN FEET
HORIZONTAL 1" = 200'
VERTICAL 1" = 10'

Drawn By: WAH	Ck'd By: JYG	App'vd By: KJH
Date: 2-12-20	Date: 2-14-20	Date: 2-15-20

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St. Louis, Missouri

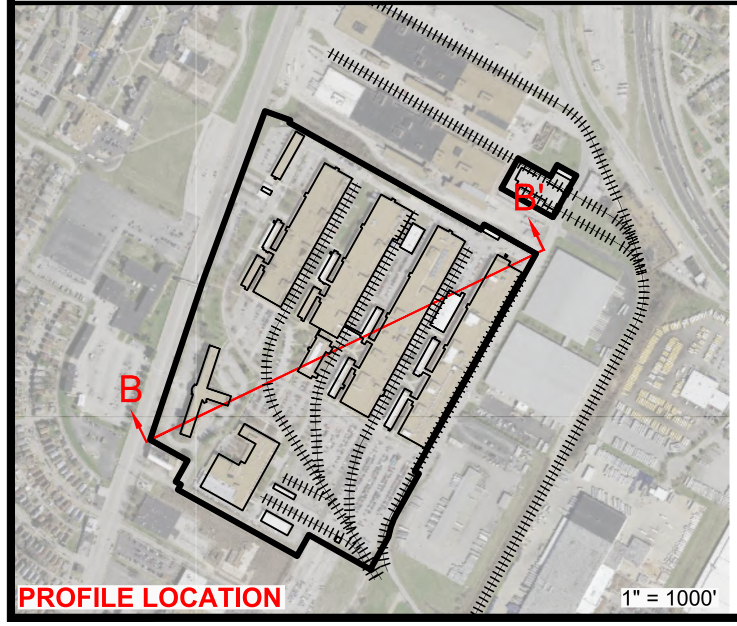
GENERALIZED CROSS-SECTION B-B'

Project Number J034500.01

FIGURE 4

(b) (7)(F)

[redacted]



NOTES

1. Subsurface information based mainly on borings completed by Tetra-Tech in 2016 and Geotechnology in 2009.
2. All features are approximate.
3. Potential exposure pathways are typical throughout the site.
4. This plan contains Controlled Unclassified Information (CUI).

STRATIGRAPHY LEGEND

▩	Fill Material
▧	Cohesive Soils - CL through CH
☰	Shale Bedrock
▼	Estimated Groundwater Elevation

SCALE IN FEET
HORIZONTAL 1" = 200'
VERTICAL 1" = 10'

Drawn By: WAH	Ck'd By: JYG	App'vd By: KJH
Date: 2-12-20	Date: 2-14-20	Date: 2-15-20

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

POTENTIAL EXPOSURE PATHWAYS

Project Number
J034500.01

FIGURE 5

APPENDIX A

APPENDIX A-1
GROUNDWATER

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. All features are approximate.
3. This plan contains Controlled Unclassified Information (CUI).

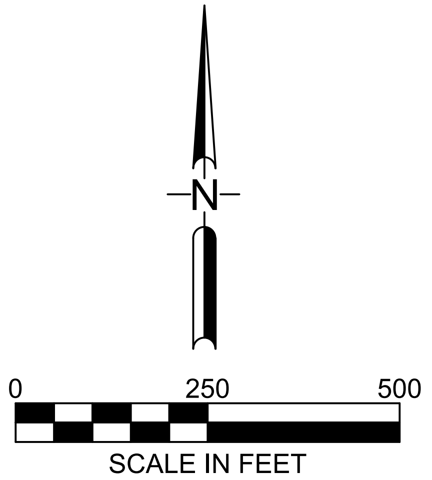
LEGEND

⊙ Groundwater Sample Location (2016 Tetra Tech)

◆ Groundwater Sample Location (2013 by Tetra Tech)

⊕ Groundwater Sample Location (2008 SCS Engineers)

▲ Proposed Permanent Groundwater Monitoring Well Location



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Date: 4-8-20	Date: 4-8-20	Date: 4-8-20

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St. Louis, Missouri

GROUNDWATER SAMPLE LOCATIONS

Project Number
J034500.01

APPENDIX A-1

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. All features are approximate.
3. This plan contains Controlled Unclassified Information (CUI).

LEGEND

▲ Proposed Permanent Groundwater Monitoring Well Location

N

0 250 500

SCALE IN FEET

Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

etegra

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GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PROPOSED GROUNDWATER SAMPLE LOCATIONS

Project Number J034500.01	FIGURE 3

GROUNDWATER

Summary: 10 Total Groundwater Samples

Analyte Group	Samples	Detections	Residential VISL Exceedances	Industrial VISL Exceedances
PCBs (Aroclor)	1	0	0	0
PCBs (1668A) (Total)	2	2	2	1
PAHs	7	3	0	0
VOCs	7	2	1	1
Herbicides	1	0	0	0
Pesticides	1	0	0	0

Industrial VISL Exceedances

Analyte	Result	Industrial VISL	Units	Sample
Trichloroethene	0.0042 J 0.0049 J	0.00342	mg/L	DPTGW-1 & DUP
PCBs, Total	2.63 J	0.00126	mg/L	DPTGW-9

Residential VISL Exceedances

Analyte	Result	Residential VISL	Units	Sample
Trichloroethene	0.0042 J 0.0049 J	0.00082	mg/L	DPTGW-1 & DUP
PCBs, Total	0.000663 J	0.00029	mg/L	DPTGW-27
PCBs, Total	2.63 J	0.00029	mg/L	DPTGW-9

Specific PCB compounds in the 1668A analysis are shown on the groundwater detection table.

Note that analyte groups include various numbers of constituent, for example:
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Herbicides - 10 constituents
Pesticides - 22 constituents

APPENDIX A-1
HISTORICAL DETECTIONS IN GROUNDWATER
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Tapwater RSL	MCL	Residential GW VISL	Industrial GW VISL
1668A	DPTGW-27	Heptachlorobiphenyl, 2,2',3,3',4,5,6'-	0.0000983	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Heptachlorobiphenyl, 2,2',3,3',4,5',6'-	0.0000609	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Heptachlorobiphenyl, 2,2',3,4',5,5',6-	0.0000656	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Heptachlorobiphenyls, Total	0.0002248	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Hexachlorobiphenyls, Total	0.0000522	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Octachlorobiphenyl, 2,2',3,3',4,4',5,6'-	0.0000312	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Octachlorobiphenyl, 2,2',3,3',4,4',5,6-	0.0000308	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Octachlorobiphenyls, Total	0.000062	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	PCBs 110 + 115	0.0000356	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	PCBs 156 + 157	0.0000522	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	PCBs 44 + 47 + 65	0.000166	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Pentachlorobiphenyl, 2,3,3',4,4'-	0.0000759	mg/L	J	0.000004		0.00061	0.00267
1668A	DPTGW-27	Pentachlorobiphenyls, Total	0.0001115	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Polychlorinated biphenyls (PCBs), Total	0.0006632	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Tetrachlorobiphenyl, 2,3',4,5'-	0.0000467	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-27	Tetrachlorobiphenyls, Total	0.0002127	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Decachlorobiphenyl	0.000524	mg/L	J		0.0005		
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,3',4,4',5-	0.127	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,3',4,5,5'-	0.0231	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,3',4,5,6'-	0.139	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,3',4,5',6'-	0.0734	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,3',4,5',6-	0.00481	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,3',4,6,6'-	0.0162	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,3',5,5',6-	0.0203	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,3',5,6,6'-	0.0464	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,4,4',5',6-	0.075	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,2',3,4',5,5',6-	0.131	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,3,3',4,4',5,5'-	0.00545	mg/L		0.000004		0.00119	0.00519
1668A	DPTGW-9	Heptachlorobiphenyl, 2,3,3',4,4',5,6-	0.0276	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyl, 2,3,3',4,4',5',6-	0.00549	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Heptachlorobiphenyls, Total	1.01495	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,2',3,3',4,5'-	0.00723	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,2',3,3',4,6'-	0.0806	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,2',3,3',4,6-	0.00158	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,2',3,3',5,5'-	0.00323	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,2',3,3',5,6-	0.00789	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,2',3,3',6,6'-	0.0349	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,2',3,4,5,5'-	0.0667	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,2',3,4',5,5'-	0.0308	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,2',3,4,5',6-	0.0162	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,3,3',4,4',6-	0.023	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,3,3',4',5,5'-	0.00339	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,3,3',4',5',6-	0.0198	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Hexachlorobiphenyl, 2,3',4,4',5,5'-	0.00806	mg/L		0.000004		0.00088	0.00384
1668A	DPTGW-9	Hexachlorobiphenyls, Total	1.179508	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Nonachlorobiphenyl, 2,2',3,3',4,4',5,5',6-	0.00985	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Nonachlorobiphenyl, 2,2',3,3',4,4',5,6,6'-	0.00119	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Nonachlorobiphenyl, 2,2',3,3',4,5,5',6,6'-	0.00144	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Nonachlorobiphenyls, Total	0.01248	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Octachlorobiphenyl, 2,2',3,3',4,4',5,5'-	0.053	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Octachlorobiphenyl, 2,2',3,3',4,4',5,6'-	0.0307	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Octachlorobiphenyl, 2,2',3,3',4,4',5,6-	0.0246	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Octachlorobiphenyl, 2,2',3,3',4,5,6,6'-	0.00837	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Octachlorobiphenyl, 2,2',3,3',4,5',6,6'-	0.0059	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Octachlorobiphenyl, 2,2',3,3',5,5',6,6'-	0.00784	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Octachlorobiphenyl, 2,2',3,4,4',5,5',6-	0.0325	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Octachlorobiphenyl, 2,3,3',4,4',5,5',6-	0.00392	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Octachlorobiphenyls, Total	0.21533	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 108 + 124	0.000183	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 110 + 115	0.0381	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 128 + 166	0.0146	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 129 + 138 + 163	0.251	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 135 + 151	0.106	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 139 + 140	0.000228	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 147 + 149	0.231	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 153 + 168	0.254	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 156 + 157	0.0193	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 171 + 173	0.0422	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 180 + 193	0.278	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 198 + 199	0.0485	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 20 + 28	0.0000402	mg/L	J		0.0005	0.00029	0.00126

APPENDIX A-1
HISTORICAL DETECTIONS IN GROUNDWATER
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Tapwater RSL	MCL	Residential GW VISL	Industrial GW VISL
1668A	DPTGW-9	PCBs 41 + 71 + 40	0.000069	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 44 + 47 + 65	0.000308	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 45 + 51	0.0000838	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 49 + 69	0.0000873	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 83 + 99	0.00221	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 85 + 116	0.000106	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 86 + 87 + 97 + 109 + 119 + 125	0.069	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 93 + 100	0.00984	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	PCBs 98 + 102	0.00031	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Pentachlorobiphenyl, 2,2',3,3',4-	0.000332	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Pentachlorobiphenyl, 2,2',3,3',6-	0.00283	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Pentachlorobiphenyl, 2,2',3,5,5'-	0.00766	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Pentachlorobiphenyl, 2,2',3,5',6-	0.0529	mg/L			0.0005	0.00029	0.00126
1668A	DPTGW-9	Pentachlorobiphenyl, 2,3,3',4,4'-	0.00191	mg/L		0.000004		0.00061	0.00267
1668A	DPTGW-9	Pentachlorobiphenyl, 2,3,3',4',5-	0.000351	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Pentachlorobiphenyl, 2,3',4,4',5-	0.0179	mg/L		0.000004		0.0006	0.00262
1668A	DPTGW-9	Pentachlorobiphenyls, Total	0.203632	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Polychlorinated biphenyls (PCBs), Total	2.6310986	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Tetrachlorobiphenyl, 2,2',5,5'-	0.00193	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Tetrachlorobiphenyl, 2,3,3',4'-	0.0000366	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Tetrachlorobiphenyl, 2,3,3',5-	0.00172	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Tetrachlorobiphenyl, 2,3,4',6-	0.0000614	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Tetrachlorobiphenyl, 3,3',4,5'-	0.000294	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Tetrachlorobiphenyls, Total	0.0045901	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Trichlorobiphenyl, 2,4',5-	0.0000299	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Trichlorobiphenyl, 2,4',6-	0.0000144	mg/L	J		0.0005	0.00029	0.00126
1668A	DPTGW-9	Trichlorobiphenyls, Total	0.0000845	mg/L	J		0.0005	0.00029	0.00126
SVOCs	DPTGW-1	Bis(2-ethylhexyl)phthalate	0.00012	mg/L	J	0.0056	0.006		
SVOCs	DPTGW-1	Dinitrophenol, 2,4-	0.001	mg/L	R	0.036			
SVOCs	DPTGW-1	Fluoranthene	0.000064	mg/L	J	0.08			
SVOCs	DPTGW-1-DUP	Bis(2-ethylhexyl)phthalate	0.00015	mg/L	J	0.0056	0.006		
SVOCs	DPTGW-1-DUP	Di-n-octylphthalate	0.000093	mg/L	J	0.02			
SVOCs	DPTGW-24	Bis(2-ethylhexyl)phthalate	0.00019	mg/L	J	0.0056	0.006		
SVOCs	DPTGW-25	Bis(2-ethylhexyl)phthalate	0.00012	mg/L	J	0.0056	0.006		
SVOCs	DPTGW-37	Bis(2-ethylhexyl)phthalate	0.0059	mg/L		0.0056	0.006		
SVOCs	DPTGW-37	Butyl benzyl phthalate	0.000093	mg/L	J	0.016			
SVOCs	DPTGW-37	Diethyl phthalate	0.00007	mg/L	J	1.5			
SVOCs	DPTGW-37	Fluoranthene	0.000055	mg/L	J	0.08			
SVOCs	DPTGW-37	Phenanthrene	0.000054	mg/L	J				
SVOCs	DPTGW-37	Phenyl Methyl Ketone (Acetophenone)	0.0001	mg/L	J	0.19			
SVOCs	DPTGW-6	Bis(2-ethylhexyl)phthalate	0.00023	mg/L	J	0.0056	0.006		
SVOCs	DPTGW-6	Di-n-octylphthalate	0.00012	mg/L	J	0.02			
VOCs	DPTGW-1	Dichloroethylene, 1,2-cis-	0.0033	mg/L	J	0.0036	0.07		
VOCs	DPTGW-1	Trichloroethene	0.0042	mg/L	J	0.00028	0.005	0.00082	0.00342
VOCs	DPTGW-1-DUP	Dichloroethylene, 1,2-cis-	0.0044	mg/L	J	0.0036	0.07		
VOCs	DPTGW-1-DUP	Trichloroethene	0.0049	mg/L	J	0.00028	0.005	0.00082	0.00342

APPENDIX A-2
SURFACE SOIL

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

● Surface Soil Sample Location

DRAFT

0 250 500

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: KJH	App'vd By: KJH
Date: 3-2-20	Date: 3-2-20	Date: 3-3-20

etegra

juniper environmental

GEOTECHNOLOGY INC

FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PREVIOUS EXTERIOR SURFACE SOIL SAMPLING LOCATIONS

Project Number
J034500.01

APPENDIX A-2

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.

2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

☆ Proposed Surface Soil Sample Location (53)

● ● ● Surface Soil Sample Analyzed for PAH
- ● Below Residential RSLs
- ● Above Residential RSLs
- ● Above Industrial RSLs

DRAFT

0 250 500

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: KJH	App'vd By: KJH
Date: 3-2-20	Date: 3-2-20	Date: 3-3-20

etegra

juniper
environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PREVIOUS EXTERIOR SURFACE SOIL SAMPLING LOCATIONS ANALYZED FOR PAH

Project Number
J034500.01

APPENDIX A-2

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

☆ Proposed Surface Soil Sample Location (65)

● ● Surface Soil Sample Analyzed for PCB
- ● Below Residential RSLs
- ● Above Industrial RSLs

DRAFT

0 250 500

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: KJH	App'vd By: KJH
Date: 3-2-20	Date: 3-2-20	Date: 3-3-20

etegra

juniper environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PREVIOUS EXTERIOR SURFACE SOIL SAMPLING LOCATIONS ANALYZED FOR PCB

Project Number
J034500.01

APPENDIX A-2

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

☆ Proposed Surface Soil Sample Location (65)

● ● Surface Soil Sample Analyzed for PCB
- ● Below Residential RSLs
- ● Above Industrial RSLs

DRAFT

0 250 500

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: KJH	App'vd By: KJH
Date: 3-2-20	Date: 3-2-20	Date: 3-3-20

etegra

juniper environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PREVIOUS EXTERIOR SURFACE SOIL SAMPLING LOCATIONS ANALYZED FOR PCB

Project Number
J034500.01

APPENDIX A-2

SURFACE SOIL

Summary: 49 Total Surface Soil Samples

Analyte Group	Samples	Detections	Industrial RSL Exceedances	Residential RSL Exceedances	Background Exceedances
Mercury	32	32	0	0	0
Other RCRA 8 Metals	32	145	25	30	8
Other Metals	1	13	0	3	0
PCBs	7	3	1	1	N/A
PAHs	33	243	1	14	N/A
VOCs	8	8	0	0	N/A
Herbicides	0	0	0	0	N/A
Pesticides	0	0	0	0	N/A
Asbestos	6	1	N/A	N/A	N/A

Asbestos (Amosite) trace detection 0.5% at DPT-21 in footprint of former Building 104 G/H/I (Powder Storage).

Background Exceedances

Analyte	Result	Background	Units	Sample	Comment
Chromium	28.9	25.5	mg/kg	B-10A 0-2	Below Residential RSL
Chromium	26.4	25.5	mg/kg	B-16A 0-2	Below Residential RSL
Chromium	34.9	25.5	mg/kg	B-17A 0-2	Below Residential RSL
Chromium	27.0	25.5	mg/kg	B-18A 0-2	Below Residential RSL
Chromium	37.0	25.5	mg/kg	B-22A 0-2	Below Residential RSL
Arsenic	16.9	12.3	mg/kg	B-24A 0-2	
Chromium	32.9	25.5	mg/kg	B-25A 0-2	Below Residential RSL
Chromium	31.1	25.5	mg/kg	B-4A 0-2	Below Residential RSL

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comment
PCBs					
Aroclor 1260	1.2	0.99	mg/kg	DPTS-150 (Composite)	
PAHs					
Benzo(a)pyrene	11.6	2.1	mg/kg	B-11A 0-2	
Metals					
Arsenic	3.76	3.0	mg/kg	B-10A 0-2	Below background value
Arsenic	10.2	3.0	mg/kg	B-11A 0-2	Below background value
Arsenic	5.03	3.0	mg/kg	B-12A 0-2	Below background value
Arsenic	4.83	3.0	mg/kg	B-13A 0-2	Below background value
Arsenic	6.91	3.0	mg/kg	B-14A 0-2	Below background value
Arsenic	9.71	3.0	mg/kg	B-15A 0-2	Below background value
Arsenic	9.2	3.0	mg/kg	B-16A 0-2	Below background value
Arsenic	4.59	3.0	mg/kg	B-17A 0-2	Below background value
Arsenic	11.5	3.0	mg/kg	B-18A 0-2	Below background value
Arsenic	4.93	3.0	mg/kg	B-19A 0-2	Below background value
Arsenic	4.84	3.0	mg/kg	B-1A 0-2	Below background value
Arsenic	3.49	3.0	mg/kg	B-20A 0-2	Below background value
Arsenic	4.59	3.0	mg/kg	B-21A 0-2	Below background value
Arsenic	4.27	3.0	mg/kg	B-22A 0-2	Below background value
Arsenic	4.65	3.0	mg/kg	B-23A 0-2	Below background value
Arsenic	16.9	3.0	mg/kg	B-24A 0-2	
Arsenic	8.75	3.0	mg/kg	B-25A 0-2	Below background value
Arsenic	5.57	3.0	mg/kg	B-26A 0-2	Below background value
Arsenic	4.52	3.0	mg/kg	B-27A 0-2	Below background value
Arsenic	7.48	3.0	mg/kg	B-28A 0-2	Below background value
Arsenic	3.99	3.0	mg/kg	B-4A 0-2	Below background value
Arsenic	3.39	3.0	mg/kg	B-7A 0-2	Below background value
Arsenic	5.41	3.0	mg/kg	B-8A 0-2	Below background value
Arsenic	5.04	3.0	mg/kg	B-9A 0-2	Below background value
Arsenic	8.4	3.0	mg/kg	SB41	Below background value

SURFACE SOIL

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comment
PCBs					
Aroclor 1260	1.2	0.24	mg/kg	DPTS-150 (Composite)	
PAHs					
Benzo(a)anthracene	1.2	1.1	mg/kg	B-11A 0-2	
Benzo(a)pyrene	11.6	0.11	mg/kg	B-11A 0-2	
Benzo(b)fluoranthene	15.3	1.1	mg/kg	B-11A 0-2	
Dibenzo(a,h)anthracene	1.45	0.11	mg/kg	B-11A 0-2	
Benzo(a)pyrene	0.47	0.11	mg/kg	B-13A 0-2	
Benzo(a)pyrene	0.505	0.11	mg/kg	B-16A 0-2	
Benzo(a)pyrene	0.971	0.11	mg/kg	B-19A 0-2	
Benzo(b)fluoranthene	1.31	1.1	mg/kg	B-19A 0-2	
Dibenzo(a,h)anthracene	0.166	0.11	mg/kg	B-19A 0-2	
Benzo(a)pyrene	0.889	0.11	mg/kg	B-7A 0-2	
Benzo(b)fluoranthene	1.32	1.1	mg/kg	B-7A 0-2	
Dibenzo(a,h)anthracene	0.182	0.11	mg/kg	B-7A 0-2	
Benzo(a)pyrene	0.22	0.11	mg/kg	DPTS-128 (Composite)	
Benzo(a)pyrene	0.31	0.11	mg/kg	DPTS-9	
Metals					
Cobalt	11	2.3	mg/kg	SB41	Below background value
Iron	20,000	5,500	mg/kg	SB41	Below background value
Manganese	610	180	mg/kg	SB41	Below background value
Arsenic	3.76	0.68	mg/kg	B-10A 0-2	Below background value
Arsenic	10.2	0.68	mg/kg	B-11A 0-2	Below background value
Arsenic	5.03	0.68	mg/kg	B-12A 0-2	Below background value
Arsenic	4.83	0.68	mg/kg	B-13A 0-2	Below background value
Arsenic	6.91	0.68	mg/kg	B-14A 0-2	Below background value
Arsenic	9.71	0.68	mg/kg	B-15A 0-2	Below background value
Arsenic	9.2	0.68	mg/kg	B-16A 0-2	Below background value
Arsenic	4.59	0.68	mg/kg	B-17A 0-2	Below background value
Arsenic	11.5	0.68	mg/kg	B-18A 0-2	Below background value
Arsenic	4.93	0.68	mg/kg	B-19A 0-2	Below background value
Arsenic	4.84	0.68	mg/kg	B-1A 0-2	Below background value
Arsenic	3.49	0.68	mg/kg	B-20A 0-2	Below background value
Arsenic	4.59	0.68	mg/kg	B-21A 0-2	Below background value
Arsenic	4.27	0.68	mg/kg	B-22A 0-2	Below background value
Arsenic	4.65	0.68	mg/kg	B-23A 0-2	Below background value
Arsenic	16.9	0.68	mg/kg	B-24A 0-2	
Arsenic	8.75	0.68	mg/kg	B-25A 0-2	Below background value
Arsenic	5.57	0.68	mg/kg	B-26A 0-2	Below background value
Arsenic	4.52	0.68	mg/kg	B-27A 0-2	Below background value
Arsenic	7.48	0.68	mg/kg	B-28A 0-2	Below background value
Arsenic	2.88	0.68	mg/kg	B-3A 0-2	Below background value
Arsenic	3.99	0.68	mg/kg	B-4A 0-2	Below background value
Arsenic	2.74	0.68	mg/kg	B-5A 0-2	Below background value
Arsenic	3.39	0.68	mg/kg	B-7A 0-2	Below background value
Arsenic	5.41	0.68	mg/kg	B-8A 0-2	Below background value
Arsenic	5.04	0.68	mg/kg	B-9A 0-2	Below background value
Arsenic	2.49	0.68	mg/kg	DPTS-21	Below background value
Arsenic	1.46	0.68	mg/kg	DPTS-33	Below background value
Arsenic	2.2	0.68	mg/kg	DPTS-34	Below background value
Arsenic	8.4	0.68	mg/kg	SB41	Below background value

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Other RCRA 8 Metals - 7 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Mercury	B-10A 0-2	Mercury	0.022	mg/Kg		1.1	4.6	0.154
Mercury	B-11A 0-2	Mercury	0.084	mg/Kg		1.1	4.6	0.154
Mercury	B-12A 0-2	Mercury	0.054	mg/Kg		1.1	4.6	0.154
Mercury	B-13A 0-2	Mercury	0.12	mg/Kg		1.1	4.6	0.154
Mercury	B-14A 0-2	Mercury	0.039	mg/Kg		1.1	4.6	0.154
Mercury	B-15A 0-2	Mercury	0.03	mg/Kg		1.1	4.6	0.154
Mercury	B-16A 0-2	Mercury	0.09	mg/Kg		1.1	4.6	0.154
Mercury	B-17A 0-2	Mercury	0.033	mg/Kg		1.1	4.6	0.154
Mercury	B-18A 0-2	Mercury	0.035	mg/Kg		1.1	4.6	0.154
Mercury	B-19A 0-2	Mercury	0.121	mg/Kg		1.1	4.6	0.154
Mercury	B-1A 0-2	Mercury	0.032	mg/Kg		1.1	4.6	0.154
Mercury	B-20A 0-2	Mercury	0.026	mg/Kg		1.1	4.6	0.154
Mercury	B-21A 0-2	Mercury	0.023	mg/Kg		1.1	4.6	0.154
Mercury	B-22A 0-2	Mercury	0.008	mg/Kg	J	1.1	4.6	0.154
Mercury	B-23A 0-2	Mercury	0.031	mg/Kg		1.1	4.6	0.154
Mercury	B-24A 0-2	Mercury	0.06	mg/Kg		1.1	4.6	0.154
Mercury	B-25A 0-2	Mercury	0.074	mg/Kg		1.1	4.6	0.154
Mercury	B-26A 0-2	Mercury	0.021	mg/Kg		1.1	4.6	0.154
Mercury	B-27A 0-2	Mercury	0.005	mg/Kg	J	1.1	4.6	0.154
Mercury	B-28A 0-2	Mercury	0.022	mg/Kg		1.1	4.6	0.154
Mercury	B-2A 0-2	Mercury	0.028	mg/Kg		1.1	4.6	0.154
Mercury	B-3A 0-2	Mercury	0.034	mg/Kg		1.1	4.6	0.154
Mercury	B-4A 0-2	Mercury	0.045	mg/Kg		1.1	4.6	0.154
Mercury	B-5A 0-2	Mercury	0.047	mg/Kg		1.1	4.6	0.154
Mercury	B-6A 0-2	Mercury	0.029	mg/Kg		1.1	4.6	0.154
Mercury	B-7A 0-2	Mercury	0.076	mg/Kg		1.1	4.6	0.154
Mercury	B-8A 0-2	Mercury	0.035	mg/Kg		1.1	4.6	0.154
Mercury	B-9A 0-2	Mercury	0.029	mg/Kg		1.1	4.6	0.154
Mercury	DPTS-21	Mercury	0.0106	mg/Kg		1.1	4.6	0.154
Mercury	DPTS-33	Mercury	0.00164	mg/Kg	J	1.1	4.6	0.154
Mercury	DPTS-34	Mercury	0.0193	mg/Kg		1.1	4.6	0.154
Mercury	SB41	Mercury	0.025	mg/Kg		1.1	4.6	0.154
Metals	B-10A 0-2	Arsenic	3.76	mg/Kg		0.68	3	12.3
Metals	B-10A 0-2	Barium	102	mg/Kg		1500	22000	
Metals	B-10A 0-2	Chromium	28.9	mg/Kg		12000	180000	25.5
Metals	B-10A 0-2	Lead	21.2	mg/Kg		400	800	363
Metals	B-11A 0-2	Arsenic	10.2	mg/Kg		0.68	3	12.3
Metals	B-11A 0-2	Barium	93.6	mg/Kg		1500	22000	
Metals	B-11A 0-2	Cadmium	0.16	mg/Kg	J	70	800	3.84
Metals	B-11A 0-2	Chromium	15.1	mg/Kg		12000	180000	25.5
Metals	B-11A 0-2	Lead	16.2	mg/Kg		400	800	363
Metals	B-12A 0-2	Arsenic	5.03	mg/Kg		0.68	3	12.3
Metals	B-12A 0-2	Barium	124	mg/Kg		1500	22000	
Metals	B-12A 0-2	Chromium	16.5	mg/Kg		12000	180000	25.5
Metals	B-12A 0-2	Lead	23.3	mg/Kg		400	800	363
Metals	B-13A 0-2	Arsenic	4.83	mg/Kg		0.68	3	12.3
Metals	B-13A 0-2	Barium	149	mg/Kg		1500	22000	
Metals	B-13A 0-2	Cadmium	0.24	mg/Kg		70	800	3.84
Metals	B-13A 0-2	Chromium	23.3	mg/Kg		12000	180000	25.5
Metals	B-13A 0-2	Lead	77.7	mg/Kg		400	800	363
Metals	B-14A 0-2	Arsenic	6.91	mg/Kg		0.68	3	12.3
Metals	B-14A 0-2	Barium	201	mg/Kg		1500	22000	
Metals	B-14A 0-2	Chromium	18.6	mg/Kg		12000	180000	25.5
Metals	B-14A 0-2	Lead	18.3	mg/Kg		400	800	363
Metals	B-15A 0-2	Arsenic	9.71	mg/Kg		0.68	3	12.3
Metals	B-15A 0-2	Barium	139	mg/Kg		1500	22000	

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Metals	B-15A 0-2	Chromium	18.9	mg/Kg		12000	180000	25.5
Metals	B-15A 0-2	Lead	21.1	mg/Kg		400	800	363
Metals	B-16A 0-2	Arsenic	9.2	mg/Kg		0.68	3	12.3
Metals	B-16A 0-2	Barium	181	mg/Kg		1500	22000	
Metals	B-16A 0-2	Cadmium	0.39	mg/Kg		70	800	3.84
Metals	B-16A 0-2	Chromium	26.4	mg/Kg		12000	180000	25.5
Metals	B-16A 0-2	Lead	163	mg/Kg		400	800	363
Metals	B-17A 0-2	Arsenic	4.59	mg/Kg		0.68	3	12.3
Metals	B-17A 0-2	Barium	201	mg/Kg		1500	22000	
Metals	B-17A 0-2	Chromium	34.9	mg/Kg		12000	180000	25.5
Metals	B-18A 0-2	Arsenic	11.5	mg/Kg		0.68	3	12.3
Metals	B-18A 0-2	Barium	186	mg/Kg		1500	22000	
Metals	B-18A 0-2	Chromium	27	mg/Kg		12000	180000	25.5
Metals	B-18A 0-2	Lead	16.5	mg/Kg		400	800	363
Metals	B-19A 0-2	Arsenic	4.93	mg/Kg		0.68	3	12.3
Metals	B-19A 0-2	Barium	426	mg/Kg		1500	22000	
Metals	B-19A 0-2	Chromium	22.8	mg/Kg		12000	180000	25.5
Metals	B-19A 0-2	Lead	120	mg/Kg		400	800	363
Metals	B-1A 0-2	Arsenic	4.84	mg/Kg		0.68	3	12.3
Metals	B-1A 0-2	Barium	161	mg/Kg		1500	22000	
Metals	B-1A 0-2	Cadmium	0.38	mg/Kg		70	800	3.84
Metals	B-1A 0-2	Chromium	19.8	mg/Kg		12000	180000	25.5
Metals	B-1A 0-2	Lead	18.9	mg/Kg		400	800	363
Metals	B-20A 0-2	Arsenic	3.49	mg/Kg		0.68	3	12.3
Metals	B-20A 0-2	Barium	182	mg/Kg		1500	22000	
Metals	B-20A 0-2	Cadmium	0.17	mg/Kg	J	70	800	3.84
Metals	B-20A 0-2	Chromium	22.3	mg/Kg		12000	180000	25.5
Metals	B-20A 0-2	Lead	11.5	mg/Kg		400	800	363
Metals	B-21A 0-2	Arsenic	4.59	mg/Kg		0.68	3	12.3
Metals	B-21A 0-2	Barium	105	mg/Kg		1500	22000	
Metals	B-21A 0-2	Chromium	19	mg/Kg		12000	180000	25.5
Metals	B-21A 0-2	Lead	10.4	mg/Kg		400	800	363
Metals	B-22A 0-2	Arsenic	4.27	mg/Kg		0.68	3	12.3
Metals	B-22A 0-2	Barium	83.5	mg/Kg		1500	22000	
Metals	B-22A 0-2	Chromium	37	mg/Kg		12000	180000	25.5
Metals	B-22A 0-2	Lead	16	mg/Kg		400	800	363
Metals	B-23A 0-2	Arsenic	4.65	mg/Kg		0.68	3	12.3
Metals	B-23A 0-2	Barium	128	mg/Kg		1500	22000	
Metals	B-23A 0-2	Chromium	23.8	mg/Kg		12000	180000	25.5
Metals	B-23A 0-2	Lead	10.9	mg/Kg		400	800	363
Metals	B-24A 0-2	Arsenic	16.9	mg/Kg		0.68	3	12.3
Metals	B-24A 0-2	Barium	140	mg/Kg		1500	22000	
Metals	B-24A 0-2	Cadmium	0.18	mg/Kg	J	70	800	3.84
Metals	B-24A 0-2	Chromium	21.7	mg/Kg		12000	180000	25.5
Metals	B-24A 0-2	Lead	49	mg/Kg		400	800	363
Metals	B-25A 0-2	Arsenic	8.75	mg/Kg		0.68	3	12.3
Metals	B-25A 0-2	Barium	234	mg/Kg		1500	22000	
Metals	B-25A 0-2	Cadmium	0.51	mg/Kg		70	800	3.84
Metals	B-25A 0-2	Chromium	32.9	mg/Kg		12000	180000	25.5
Metals	B-25A 0-2	Lead	77.9	mg/Kg		400	800	363
Metals	B-26A 0-2	Arsenic	5.57	mg/Kg		0.68	3	12.3
Metals	B-26A 0-2	Barium	166	mg/Kg		1500	22000	
Metals	B-26A 0-2	Chromium	19.9	mg/Kg		12000	180000	25.5
Metals	B-26A 0-2	Lead	19.4	mg/Kg		400	800	363
Metals	B-27A 0-2	Arsenic	4.52	mg/Kg		0.68	3	12.3
Metals	B-27A 0-2	Barium	6.55	mg/Kg		1500	22000	

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Metals	B-27A 0-2	Cadmium	0.16	mg/Kg	J	70	800	3.84
Metals	B-27A 0-2	Chromium	4.48	mg/Kg		12000	180000	25.5
Metals	B-27A 0-2	Selenium	2.3	mg/Kg	J	39	580	
Metals	B-28A 0-2	Arsenic	7.48	mg/Kg		0.68	3	12.3
Metals	B-28A 0-2	Barium	141	mg/Kg		1500	22000	
Metals	B-28A 0-2	Chromium	18.2	mg/Kg		12000	180000	25.5
Metals	B-28A 0-2	Lead	29.8	mg/Kg		400	800	363
Metals	B-2A 0-2	Cadmium	0.12	mg/Kg	J	70	800	3.84
Metals	B-2A 0-2	Chromium	18.1	mg/Kg		12000	180000	25.5
Metals	B-2A 0-2	Lead	10.7	mg/Kg		400	800	363
Metals	B-3A 0-2	Arsenic	2.88	mg/Kg		0.68	3	12.3
Metals	B-3A 0-2	Barium	167	mg/Kg		1500	22000	
Metals	B-3A 0-2	Cadmium	0.1	mg/Kg	J	70	800	3.84
Metals	B-3A 0-2	Chromium	16.2	mg/Kg		12000	180000	25.5
Metals	B-3A 0-2	Lead	9.61	mg/Kg		400	800	363
Metals	B-4A 0-2	Arsenic	3.99	mg/Kg		0.68	3	12.3
Metals	B-4A 0-2	Barium	94.6	mg/Kg		1500	22000	
Metals	B-4A 0-2	Chromium	31.1	mg/Kg		12000	180000	25.5
Metals	B-4A 0-2	Lead	11.9	mg/Kg		400	800	363
Metals	B-5A 0-2	Arsenic	2.74	mg/Kg		0.68	3	12.3
Metals	B-5A 0-2	Barium	115	mg/Kg		1500	22000	
Metals	B-5A 0-2	Cadmium	0.1	mg/Kg	J	70	800	3.84
Metals	B-5A 0-2	Chromium	19.7	mg/Kg		12000	180000	25.5
Metals	B-5A 0-2	Lead	13.7	mg/Kg		400	800	363
Metals	B-6A 0-2	Barium	87.5	mg/Kg		1500	22000	
Metals	B-6A 0-2	Chromium	20.6	mg/Kg		12000	180000	25.5
Metals	B-6A 0-2	Lead	9.98	mg/Kg		400	800	363
Metals	B-7A 0-2	Arsenic	3.39	mg/Kg		0.68	3	12.3
Metals	B-7A 0-2	Barium	114	mg/Kg		1500	22000	
Metals	B-7A 0-2	Cadmium	0.12	mg/Kg	J	70	800	3.84
Metals	B-7A 0-2	Chromium	21.6	mg/Kg		12000	180000	25.5
Metals	B-7A 0-2	Lead	33.3	mg/Kg		400	800	363
Metals	B-8A 0-2	Arsenic	5.41	mg/Kg		0.68	3	12.3
Metals	B-8A 0-2	Barium	155	mg/Kg		1500	22000	
Metals	B-8A 0-2	Chromium	18.5	mg/Kg		12000	180000	25.5
Metals	B-8A 0-2	Lead	15.3	mg/Kg		400	800	363
Metals	B-9A 0-2	Arsenic	5.04	mg/Kg		0.68	3	12.3
Metals	B-9A 0-2	Barium	100	mg/Kg		1500	22000	
Metals	B-9A 0-2	Chromium	18.1	mg/Kg		12000	180000	25.5
Metals	B-9A 0-2	Lead	16.6	mg/Kg		400	800	363
Metals	DPTS-21	Arsenic	2.49	mg/Kg	J	0.68	3	12.3
Metals	DPTS-21	Barium	50.7	mg/Kg	J	1500	22000	
Metals	DPTS-21	Chromium	14.9	mg/Kg	J	12000	180000	25.5
Metals	DPTS-21	Lead	7.52	mg/Kg	J	400	800	363
Metals	DPTS-21	Selenium	0.793	mg/Kg		39	580	
Metals	DPTS-33	Arsenic	1.46	mg/Kg		0.68	3	12.3
Metals	DPTS-33	Barium	27.6	mg/Kg	J	1500	22000	
Metals	DPTS-33	Cadmium	0.457	mg/Kg		70	800	3.84
Metals	DPTS-33	Chromium	2.45	mg/Kg	J	12000	180000	25.5
Metals	DPTS-33	Lead	188	mg/Kg	J	400	800	363
Metals	DPTS-33	Silver	0.0867	mg/Kg	J	39	580	
Metals	DPTS-34	Arsenic	2.2	mg/Kg		0.68	3	12.3
Metals	DPTS-34	Barium	80.7	mg/Kg	J	1500	22000	
Metals	DPTS-34	Chromium	9.24	mg/Kg	J	12000	180000	25.5
Metals	DPTS-34	Lead	7.34	mg/Kg	J	400	800	363
Metals	DPTS-34	Selenium	0.161	mg/Kg	J	39	580	

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Metals	SB41	Aluminum	11000	mg/Kg		7700	110000	54,730
Metals	SB41	Arsenic	8.4	mg/Kg		0.68	3	12.3
Metals	SB41	Barium	150	mg/Kg		1500	22000	
Metals	SB41	Beryllium	0.93	mg/Kg		16	230	1.01
Metals	SB41	Calcium	8000	mg/Kg				
Metals	SB41	Chromium	21	mg/Kg		12000	180000	25.5
Metals	SB41	Cobalt	11	mg/Kg		2.3	35	13
Metals	SB41	Copper	14	mg/Kg		310	4700	59.1
Metals	SB41	Iron	20000	mg/Kg		5500	82000	35460
Metals	SB41	Lead	18	mg/Kg		400	800	363
Metals	SB41	Magnesium	2200	mg/Kg				
Metals	SB41	Manganese	610	mg/Kg		180	2600	1904
Metals	SB41	Nickel	17	mg/Kg		84	1200	27.9
Metals	SB41	Potassium	590	mg/Kg				
Metals	SB41	Sodium	120	mg/Kg	B			
Metals	SB41	Vanadium	39	mg/Kg		39	580	72
Metals	SB41	Zinc	36	mg/Kg		2300	35000	414
PCBs	DPTS-138_ Comp_ DPT-18-20	Aroclor 1260	0.02	mg/Kg	J	0.24	0.99	
PCBs	DPTS-150_ Comp_ DPT-21-23	Aroclor 1260	1.2	mg/Kg		0.24	0.99	
PCBs	DPTS-158_ Comp_ DPT-24-27	Aroclor 1260	0.11	mg/Kg		0.24	0.99	
SVOCs	B-10A 0-2	Benz(a)anthracene	0.008	mg/Kg		1.1	21	
SVOCs	B-10A 0-2	Benzo(a)pyrene	0.006	mg/Kg		0.11	2.1	
SVOCs	B-10A 0-2	Benzo(b)Fluoranthene	0.01	mg/Kg		1.1	21	
SVOCs	B-10A 0-2	Chrysene	0.007	mg/Kg		110	2100	
SVOCs	B-10A 0-2	Fluoranthene	0.015	mg/Kg		240	3000	
SVOCs	B-10A 0-2	Phenanthrene	0.004	mg/Kg				
SVOCs	B-10A 0-2	Pyrene	0.012	mg/Kg		180	2300	
SVOCs	B-11A 0-2	Acenaphthene	4.51	mg/Kg		360	4500	
SVOCs	B-11A 0-2	Acenaphthylene	0.363	mg/Kg				
SVOCs	B-11A 0-2	Anthracene	8.91	mg/Kg		1800	23000	
SVOCs	B-11A 0-2	Benz(a)anthracene	12	mg/Kg		1.1	21	
SVOCs	B-11A 0-2	Benzo(a)pyrene	11.6	mg/Kg		0.11	2.1	
SVOCs	B-11A 0-2	Benzo(b)Fluoranthene	15.3	mg/Kg		1.1	21	
SVOCs	B-11A 0-2	Benzo(ghi)perylene	4.92	mg/Kg				
SVOCs	B-11A 0-2	Benzo(k)Fluoranthene	5.23	mg/Kg		11	210	
SVOCs	B-11A 0-2	Chrysene	12.6	mg/Kg		110	2100	
SVOCs	B-11A 0-2	Dibenzo(a,h)anthracene	1.45	mg/Kg		0.11	2.1	
SVOCs	B-11A 0-2	Fluoranthene	34.3	mg/Kg		240	3000	
SVOCs	B-11A 0-2	Fluorene	4.47	mg/Kg		240	3000	
SVOCs	B-11A 0-2	Indeno(1,2,3-cd)pyrene	4.62	mg/Kg		1.1	21	
SVOCs	B-11A 0-2	Naphthalene	0.855	mg/Kg		3.8	17	
SVOCs	B-11A 0-2	Phenanthrene	29.9	mg/Kg				
SVOCs	B-11A 0-2	Pyrene	27.3	mg/Kg		180	2300	
SVOCs	B-12A 0-2	Acenaphthene	0.008	mg/Kg		360	4500	
SVOCs	B-12A 0-2	Anthracene	0.018	mg/Kg		1800	23000	
SVOCs	B-12A 0-2	Benz(a)anthracene	0.068	mg/Kg		1.1	21	
SVOCs	B-12A 0-2	Benzo(a)pyrene	0.073	mg/Kg		0.11	2.1	
SVOCs	B-12A 0-2	Benzo(b)Fluoranthene	0.103	mg/Kg		1.1	21	

APPENDIX A-2
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ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	B-12A 0-2	Benzo(ghi)perylene	0.037	mg/Kg				
SVOCs	B-12A 0-2	Benzo(k)Fluoranthene	0.035	mg/Kg		11	210	
SVOCs	B-12A 0-2	Chrysene	0.084	mg/Kg		110	2100	
SVOCs	B-12A 0-2	Dibenzo(a,h)anthracene	0.009	mg/Kg		0.11	2.1	
SVOCs	B-12A 0-2	Fluoranthene	0.193	mg/Kg		240	3000	
SVOCs	B-12A 0-2	Fluorene	0.007	mg/Kg		240	3000	
SVOCs	B-12A 0-2	Indeno(1,2,3-cd)pyrene	0.034	mg/Kg		1.1	21	
SVOCs	B-12A 0-2	Phenanthrene	0.107	mg/Kg				
SVOCs	B-12A 0-2	Pyrene	0.16	mg/Kg		180	2300	
SVOCs	B-13A 0-2	Acenaphthene	0.041	mg/Kg		360	4500	
SVOCs	B-13A 0-2	Acenaphthylene	0.004	mg/Kg	J			
SVOCs	B-13A 0-2	Anthracene	0.074	mg/Kg		1800	23000	
SVOCs	B-13A 0-2	Benz(a)anthracene	0.42	mg/Kg		1.1	21	
SVOCs	B-13A 0-2	Benzo(a)pyrene	0.47	mg/Kg		0.11	2.1	
SVOCs	B-13A 0-2	Benzo(b)Fluoranthene	0.753	mg/Kg		1.1	21	
SVOCs	B-13A 0-2	Benzo(ghi)perylene	0.213	mg/Kg				
SVOCs	B-13A 0-2	Benzo(k)Fluoranthene	0.263	mg/Kg		11	210	
SVOCs	B-13A 0-2	Chrysene	0.568	mg/Kg		110	2100	
SVOCs	B-13A 0-2	Dibenzo(a,h)anthracene	0.064	mg/Kg		0.11	2.1	
SVOCs	B-13A 0-2	Fluoranthene	1.19	mg/Kg		240	3000	
SVOCs	B-13A 0-2	Fluorene	0.02	mg/Kg		240	3000	
SVOCs	B-13A 0-2	Indeno(1,2,3-cd)pyrene	0.203	mg/Kg		1.1	21	
SVOCs	B-13A 0-2	Phenanthrene	0.573	mg/Kg				
SVOCs	B-13A 0-2	Pyrene	1.01	mg/Kg		180	2300	
SVOCs	B-14A 0-2	Benz(a)anthracene	0.009	mg/Kg		1.1	21	
SVOCs	B-14A 0-2	Benzo(a)pyrene	0.011	mg/Kg		0.11	2.1	
SVOCs	B-14A 0-2	Benzo(b)Fluoranthene	0.016	mg/Kg		1.1	21	
SVOCs	B-14A 0-2	Benzo(ghi)perylene	0.016	mg/Kg				
SVOCs	B-14A 0-2	Benzo(k)Fluoranthene	0.005	mg/Kg		11	210	
SVOCs	B-14A 0-2	Chrysene	0.008	mg/Kg		110	2100	
SVOCs	B-14A 0-2	Fluoranthene	0.015	mg/Kg		240	3000	
SVOCs	B-14A 0-2	Indeno(1,2,3-cd)pyrene	0.006	mg/Kg		1.1	21	
SVOCs	B-14A 0-2	Phenanthrene	0.008	mg/Kg				
SVOCs	B-14A 0-2	Pyrene	0.013	mg/Kg		180	2300	
SVOCs	B-15A 0-2	Acenaphthene	0.005	mg/Kg		360	4500	
SVOCs	B-15A 0-2	Anthracene	0.014	mg/Kg		1800	23000	
SVOCs	B-15A 0-2	Benz(a)anthracene	0.047	mg/Kg		1.1	21	
SVOCs	B-15A 0-2	Benzo(a)pyrene	0.053	mg/Kg		0.11	2.1	
SVOCs	B-15A 0-2	Benzo(b)Fluoranthene	0.073	mg/Kg		1.1	21	
SVOCs	B-15A 0-2	Benzo(ghi)perylene	0.028	mg/Kg				
SVOCs	B-15A 0-2	Benzo(k)Fluoranthene	0.023	mg/Kg		11	210	
SVOCs	B-15A 0-2	Chrysene	0.061	mg/Kg		110	2100	
SVOCs	B-15A 0-2	Dibenzo(a,h)anthracene	0.007	mg/Kg		0.11	2.1	
SVOCs	B-15A 0-2	Fluoranthene	0.113	mg/Kg		240	3000	
SVOCs	B-15A 0-2	Fluorene	0.008	mg/Kg		240	3000	
SVOCs	B-15A 0-2	Indeno(1,2,3-cd)pyrene	0.024	mg/Kg		1.1	21	
SVOCs	B-15A 0-2	Phenanthrene	0.049	mg/Kg				
SVOCs	B-15A 0-2	Pyrene	0.104	mg/Kg		180	2300	
SVOCs	B-16A 0-2	Acenaphthene	0.038	mg/Kg		360	4500	
SVOCs	B-16A 0-2	Acenaphthylene	0.018	mg/Kg				
SVOCs	B-16A 0-2	Anthracene	0.082	mg/Kg		1800	23000	
SVOCs	B-16A 0-2	Benz(a)anthracene	0.468	mg/Kg		1.1	21	
SVOCs	B-16A 0-2	Benzo(a)pyrene	0.505	mg/Kg		0.11	2.1	
SVOCs	B-16A 0-2	Benzo(b)Fluoranthene	0.84	mg/Kg		1.1	21	
SVOCs	B-16A 0-2	Benzo(ghi)perylene	0.187	mg/Kg				
SVOCs	B-16A 0-2	Benzo(k)Fluoranthene	0.281	mg/Kg		11	210	

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	B-16A 0-2	Chrysene	0.62	mg/Kg		110	2100	
SVOCs	B-16A 0-2	Dibenzo(a,h)anthracene	0.061	mg/Kg		0.11	2.1	
SVOCs	B-16A 0-2	Fluoranthene	1.21	mg/Kg		240	3000	
SVOCs	B-16A 0-2	Fluorene	0.032	mg/Kg		240	3000	
SVOCs	B-16A 0-2	Indeno(1,2,3-cd)pyrene	0.192	mg/Kg		1.1	21	
SVOCs	B-16A 0-2	Naphthalene	0.003	mg/Kg	J	3.8	17	
SVOCs	B-16A 0-2	Phenanthrene	0.539	mg/Kg				
SVOCs	B-16A 0-2	Pyrene	0.951	mg/Kg		180	2300	
SVOCs	B-19A 0-2	Acenaphthene	0.113	mg/Kg		360	4500	
SVOCs	B-19A 0-2	Acenaphthylene	0.045	mg/Kg				
SVOCs	B-19A 0-2	Anthracene	0.294	mg/Kg		1800	23000	
SVOCs	B-19A 0-2	Benz(a)anthracene	0.916	mg/Kg		1.1	21	
SVOCs	B-19A 0-2	Benzo(a)pyrene	0.971	mg/Kg		0.11	2.1	
SVOCs	B-19A 0-2	Benzo(b)Fluoranthene	1.31	mg/Kg		1.1	21	
SVOCs	B-19A 0-2	Benzo(ghi)perylene	0.686	mg/Kg				
SVOCs	B-19A 0-2	Benzo(k)Fluoranthene	0.433	mg/Kg		11	210	
SVOCs	B-19A 0-2	Chrysene	1.16	mg/Kg		110	2100	
SVOCs	B-19A 0-2	Dibenzo(a,h)anthracene	0.166	mg/Kg		0.11	2.1	
SVOCs	B-19A 0-2	Fluoranthene	2.63	mg/Kg		240	3000	
SVOCs	B-19A 0-2	Fluorene	0.096	mg/Kg		240	3000	
SVOCs	B-19A 0-2	Indeno(1,2,3-cd)pyrene	0.547	mg/Kg		1.1	21	
SVOCs	B-19A 0-2	Naphthalene	0.04	mg/Kg		3.8	17	
SVOCs	B-19A 0-2	Phenanthrene	1.81	mg/Kg				
SVOCs	B-19A 0-2	Pyrene	1.94	mg/Kg		180	2300	
SVOCs	B-22A 0-2	Chrysene	0.003	mg/Kg	J	110	2100	
SVOCs	B-24A 0-2	Benz(a)anthracene	0.099	mg/Kg		1.1	21	
SVOCs	B-24A 0-2	Benzo(a)pyrene	0.064	mg/Kg		0.11	2.1	
SVOCs	B-24A 0-2	Benzo(b)Fluoranthene	0.09	mg/Kg		1.1	21	
SVOCs	B-24A 0-2	Benzo(ghi)perylene	0.066	mg/Kg				
SVOCs	B-24A 0-2	Benzo(k)Fluoranthene	0.031	mg/Kg	J	11	210	
SVOCs	B-24A 0-2	Chrysene	0.079	mg/Kg		110	2100	
SVOCs	B-24A 0-2	Fluoranthene	0.142	mg/Kg		240	3000	
SVOCs	B-24A 0-2	Indeno(1,2,3-cd)pyrene	0.053	mg/Kg		1.1	21	
SVOCs	B-24A 0-2	Phenanthrene	0.061	mg/Kg				
SVOCs	B-24A 0-2	Pyrene	0.134	mg/Kg		180	2300	
SVOCs	B-25A 0-2	Anthracene	0.007	mg/Kg		1800	23000	
SVOCs	B-25A 0-2	Benz(a)anthracene	0.035	mg/Kg		1.1	21	
SVOCs	B-25A 0-2	Benzo(a)pyrene	0.03	mg/Kg		0.11	2.1	
SVOCs	B-25A 0-2	Benzo(b)Fluoranthene	0.057	mg/Kg		1.1	21	
SVOCs	B-25A 0-2	Benzo(ghi)perylene	0.023	mg/Kg				
SVOCs	B-25A 0-2	Benzo(k)Fluoranthene	0.016	mg/Kg		11	210	
SVOCs	B-25A 0-2	Chrysene	0.038	mg/Kg		110	2100	
SVOCs	B-25A 0-2	Dibenzo(a,h)anthracene	0.005	mg/Kg		0.11	2.1	
SVOCs	B-25A 0-2	Fluoranthene	0.078	mg/Kg		240	3000	
SVOCs	B-25A 0-2	Indeno(1,2,3-cd)pyrene	0.02	mg/Kg		1.1	21	
SVOCs	B-25A 0-2	Phenanthrene	0.04	mg/Kg				
SVOCs	B-25A 0-2	Pyrene	0.072	mg/Kg		180	2300	
SVOCs	B-26A 0-2	Benz(a)anthracene	0.123	mg/Kg		1.1	21	
SVOCs	B-26A 0-2	Benzo(a)pyrene	0.1	mg/Kg		0.11	2.1	
SVOCs	B-26A 0-2	Benzo(b)Fluoranthene	0.142	mg/Kg		1.1	21	
SVOCs	B-26A 0-2	Benzo(ghi)perylene	0.066	mg/Kg				
SVOCs	B-26A 0-2	Benzo(k)Fluoranthene	0.04	mg/Kg	J	11	210	
SVOCs	B-26A 0-2	Chrysene	0.1	mg/Kg		110	2100	
SVOCs	B-26A 0-2	Fluoranthene	0.303	mg/Kg		240	3000	
SVOCs	B-26A 0-2	Indeno(1,2,3-cd)pyrene	0.057	mg/Kg		1.1	21	
SVOCs	B-26A 0-2	Phenanthrene	0.074	mg/Kg				

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	B-26A 0-2	Pyrene	0.264	mg/Kg		180	2300	
SVOCs	B-28A 0-2	Fluoranthene	0.555	mg/Kg		240	3000	
SVOCs	B-28A 0-2	Pyrene	0.44	mg/Kg	J	180	2300	
SVOCs	B-2A 0-2	Benz(a)anthracene	0.009	mg/Kg		1.1	21	
SVOCs	B-2A 0-2	Benzo(a)pyrene	0.006	mg/Kg		0.11	2.1	
SVOCs	B-2A 0-2	Benzo(b)Fluoranthene	0.011	mg/Kg		1.1	21	
SVOCs	B-2A 0-2	Benzo(ghi)perylene	0.005	mg/Kg				
SVOCs	B-2A 0-2	Benzo(k)Fluoranthene	0.004	mg/Kg	J	11	210	
SVOCs	B-2A 0-2	Chrysene	0.006	mg/Kg		110	2100	
SVOCs	B-2A 0-2	Fluoranthene	0.014	mg/Kg		240	3000	
SVOCs	B-2A 0-2	Indeno(1,2,3-cd)pyrene	0.004	mg/Kg		1.1	21	
SVOCs	B-2A 0-2	Phenanthrene	0.004	mg/Kg				
SVOCs	B-2A 0-2	Pyrene	0.01	mg/Kg		180	2300	
SVOCs	B-3A 0-2	Benz(a)anthracene	0.006	mg/Kg		1.1	21	
SVOCs	B-3A 0-2	Benzo(b)Fluoranthene	0.005	mg/Kg		1.1	21	
SVOCs	B-3A 0-2	Fluoranthene	0.009	mg/Kg		240	3000	
SVOCs	B-3A 0-2	Pyrene	0.009	mg/Kg		180	2300	
SVOCs	B-4A 0-2	Benz(a)anthracene	0.003	mg/Kg	J	1.1	21	
SVOCs	B-4A 0-2	Fluoranthene	0.005	mg/Kg		240	3000	
SVOCs	B-4A 0-2	Pyrene	0.004	mg/Kg		180	2300	
SVOCs	B-5A 0-2	Benz(a)anthracene	0.012	mg/Kg		1.1	21	
SVOCs	B-5A 0-2	Benzo(a)pyrene	0.007	mg/Kg		0.11	2.1	
SVOCs	B-5A 0-2	Benzo(b)Fluoranthene	0.013	mg/Kg		1.1	21	
SVOCs	B-5A 0-2	Benzo(ghi)perylene	0.009	mg/Kg				
SVOCs	B-5A 0-2	Benzo(k)Fluoranthene	0.005	mg/Kg		11	210	
SVOCs	B-5A 0-2	Chrysene	0.007	mg/Kg		110	2100	
SVOCs	B-5A 0-2	Fluoranthene	0.022	mg/Kg		240	3000	
SVOCs	B-5A 0-2	Indeno(1,2,3-cd)pyrene	0.006	mg/Kg		1.1	21	
SVOCs	B-5A 0-2	Phenanthrene	0.006	mg/Kg				
SVOCs	B-5A 0-2	Pyrene	0.018	mg/Kg		180	2300	
SVOCs	B-7A 0-2	Acenaphthene	0.168	mg/Kg		360	4500	
SVOCs	B-7A 0-2	Acenaphthylene	0.028	mg/Kg				
SVOCs	B-7A 0-2	Anthracene	0.529	mg/Kg		1800	23000	
SVOCs	B-7A 0-2	Benz(a)anthracene	1.04	mg/Kg		1.1	21	
SVOCs	B-7A 0-2	Benzo(a)pyrene	0.889	mg/Kg		0.11	2.1	
SVOCs	B-7A 0-2	Benzo(b)Fluoranthene	1.32	mg/Kg		1.1	21	
SVOCs	B-7A 0-2	Benzo(ghi)perylene	0.622	mg/Kg				
SVOCs	B-7A 0-2	Benzo(k)Fluoranthene	0.449	mg/Kg		11	210	
SVOCs	B-7A 0-2	Chrysene	1.11	mg/Kg		110	2100	
SVOCs	B-7A 0-2	Dibenzo(a,h)anthracene	0.182	mg/Kg		0.11	2.1	
SVOCs	B-7A 0-2	Fluoranthene	4.17	mg/Kg		240	3000	
SVOCs	B-7A 0-2	Fluorene	0.144	mg/Kg		240	3000	
SVOCs	B-7A 0-2	Indeno(1,2,3-cd)pyrene	0.631	mg/Kg		1.1	21	
SVOCs	B-7A 0-2	Naphthalene	0.02	mg/Kg	J	3.8	17	
SVOCs	B-7A 0-2	Phenanthrene	2.48	mg/Kg				
SVOCs	B-7A 0-2	Pyrene	3.23	mg/Kg		180	2300	
SVOCs	B-8A 0-2	Benz(a)anthracene	0.013	mg/Kg		1.1	21	
SVOCs	B-8A 0-2	Benzo(a)pyrene	0.009	mg/Kg		0.11	2.1	
SVOCs	B-8A 0-2	Benzo(b)Fluoranthene	0.014	mg/Kg		1.1	21	
SVOCs	B-8A 0-2	Benzo(ghi)perylene	0.009	mg/Kg				
SVOCs	B-8A 0-2	Benzo(k)Fluoranthene	0.005	mg/Kg		11	210	
SVOCs	B-8A 0-2	Chrysene	0.01	mg/Kg		110	2100	
SVOCs	B-8A 0-2	Fluoranthene	0.032	mg/Kg		240	3000	
SVOCs	B-8A 0-2	Indeno(1,2,3-cd)pyrene	0.005	mg/Kg		1.1	21	
SVOCs	B-8A 0-2	Phenanthrene	0.016	mg/Kg				
SVOCs	B-8A 0-2	Pyrene	0.029	mg/Kg		180	2300	

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	B-9A 0-2	Acenaphthene	0.01	mg/Kg		360	4500	
SVOCs	B-9A 0-2	Acenaphthylene	0.008	mg/Kg				
SVOCs	B-9A 0-2	Anthracene	0.027	mg/Kg		1800	23000	
SVOCs	B-9A 0-2	Benz(a)anthracene	0.087	mg/Kg		1.1	21	
SVOCs	B-9A 0-2	Benzo(a)pyrene	0.091	mg/Kg		0.11	2.1	
SVOCs	B-9A 0-2	Benzo(b)Fluoranthene	0.137	mg/Kg		1.1	21	
SVOCs	B-9A 0-2	Benzo(ghi)perylene	0.063	mg/Kg				
SVOCs	B-9A 0-2	Benzo(k)Fluoranthene	0.043	mg/Kg		11	210	
SVOCs	B-9A 0-2	Chrysene	0.115	mg/Kg		110	2100	
SVOCs	B-9A 0-2	Dibenzo(a,h)anthracene	0.015	mg/Kg		0.11	2.1	
SVOCs	B-9A 0-2	Fluoranthene	0.229	mg/Kg		240	3000	
SVOCs	B-9A 0-2	Fluorene	0.008	mg/Kg		240	3000	
SVOCs	B-9A 0-2	Indeno(1,2,3-cd)pyrene	0.05	mg/Kg		1.1	21	
SVOCs	B-9A 0-2	Phenanthrene	0.138	mg/Kg				
SVOCs	B-9A 0-2	Pyrene	0.191	mg/Kg		180	2300	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Anthracene	0.0017	mg/Kg	J	1800	23000	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Benz(a)anthracene	0.017	mg/Kg		1.1	21	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Benzo(a)pyrene	0.018	mg/Kg		0.11	2.1	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Benzo(b)Fluoranthene	0.023	mg/Kg		1.1	21	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Benzo(ghi)perylene	0.014	mg/Kg				
SVOCs	DPTS-119_ Comp_ DPT-10-12	Benzo(k)Fluoranthene	0.014	mg/Kg		11	210	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Bis(2-ethylhexyl)phthalate	0.15	mg/Kg		39	160	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Caprolactam	0.0029	mg/Kg	J	3100	40000	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Carbazole	0.0021	mg/Kg	J			
SVOCs	DPTS-119_ Comp_ DPT-10-12	Chrysene	0.024	mg/Kg		110	2100	

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	DPTS-119_ Comp_ DPT-10-12	Dibenzo(a,h)anthracene	0.003	mg/Kg	J	0.11	2.1	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Fluoranthene	0.036	mg/Kg		240	3000	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Indeno(1,2,3-cd)pyrene	0.016	mg/Kg		1.1	21	
SVOCs	DPTS-119_ Comp_ DPT-10-12	Phenanthrene	0.013	mg/Kg				
SVOCs	DPTS-119_ Comp_ DPT-10-12	Pyrene	0.033	mg/Kg		180	2300	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Acenaphthene	0.013	mg/Kg		360	4500	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Acenaphthylene	0.003	mg/Kg	J			
SVOCs	DPTS-128_ Comp_ DPT-13-17	Anthracene	0.048	mg/Kg		1800	23000	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Benz(a)anthracene	0.21	mg/Kg		1.1	21	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Benzaldehyde	0.013	mg/Kg		170	820	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Benzo(a)pyrene	0.22	mg/Kg		0.11	2.1	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Benzo(b)Fluoranthene	0.34	mg/Kg		1.1	21	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Benzo(ghi)perylene	0.16	mg/Kg				
SVOCs	DPTS-128_ Comp_ DPT-13-17	Benzo(k)Fluoranthene	0.12	mg/Kg		11	210	

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	DPTS-128_ Comp_ DPT-13-17	Bis(2-ethylhexyl)phthalate	0.02	mg/Kg		39	160	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Butyl Benzyl Phthalate	0.0063	mg/Kg	J	290	1200	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Caprolactam	0.021	mg/Kg		3100	40000	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Carbazole	0.038	mg/Kg				
SVOCs	DPTS-128_ Comp_ DPT-13-17	Chrysene	0.26	mg/Kg		110	2100	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Dibenzo(a,h)anthracene	0.036	mg/Kg		0.11	2.1	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Dibenzofuran	0.0054	mg/Kg		7.3	100	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Diethyl Phthalate	0.0022	mg/Kg	J	5100	66000	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Di-n-butyl phthalate	0.013	mg/Kg		630	8200	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Fluoranthene	0.53	mg/Kg		240	3000	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Fluorene	0.013	mg/Kg		240	3000	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Indeno(1,2,3-cd)pyrene	0.21	mg/Kg		1.1	21	
SVOCs	DPTS-128_ Comp_ DPT-13-17	Phenanthrene	0.24	mg/Kg				
SVOCs	DPTS-128_ Comp_ DPT-13-17	Phenol	0.0022	mg/Kg	J	1900	25000	

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	DPTS-128_ Comp_ DPT-13-17	Pyrene	0.42	mg/Kg		180	2300	
SVOCs	DPTS-3	Acenaphthene	0.0071	mg/Kg		360	4500	
SVOCs	DPTS-3	Acenaphthylene	0.0071	mg/Kg				
SVOCs	DPTS-3	Anthracene	0.029	mg/Kg		1800	23000	
SVOCs	DPTS-3	Benz(a)anthracene	0.12	mg/Kg		1.1	21	
SVOCs	DPTS-3	Benzo(a)pyrene	0.11	mg/Kg		0.11	2.1	
SVOCs	DPTS-3	Benzo(b)fluoranthene	0.16	mg/Kg		1.1	21	
SVOCs	DPTS-3	Benzo(ghi)perylene	0.082	mg/Kg				
SVOCs	DPTS-3	Benzo(k)fluoranthene	0.061	mg/Kg		11	210	
SVOCs	DPTS-3	Bis(2-ethylhexyl)phthalate	4.4	mg/Kg		39	160	
SVOCs	DPTS-3	Carbazole	0.015	mg/Kg				
SVOCs	DPTS-3	Chlorophenyl phenyl ether, 4-	0.0021	mg/Kg	J			
SVOCs	DPTS-3	Chrysene	0.14	mg/Kg		110	2100	
SVOCs	DPTS-3	Dibenzo(a,h)anthracene	0.024	mg/Kg		0.11	2.1	
SVOCs	DPTS-3	Dibenzofuran	0.0049	mg/Kg	J	7.3	100	
SVOCs	DPTS-3	Diethyl phthalate	0.0017	mg/Kg	J	5100	66000	
SVOCs	DPTS-3	Di-n-butyl phthalate	0.0029	mg/Kg	J	630	8200	
SVOCs	DPTS-3	Di-n-octylphthalate	0.023	mg/Kg		63	820	
SVOCs	DPTS-3	Fluoranthene	0.23	mg/Kg		240	3000	
SVOCs	DPTS-3	Fluorene	0.0066	mg/Kg		240	3000	
SVOCs	DPTS-3	Indeno(1,2,3-cd)pyrene	0.089	mg/Kg		1.1	21	
SVOCs	DPTS-3	Methylnaphthalene, 2-	0.0025	mg/Kg	J	24	300	
SVOCs	DPTS-3	Naphthalene	0.0038	mg/Kg	J	3.8	17	
SVOCs	DPTS-3	Nitroaniline, 3-	0.002	mg/Kg	J			
SVOCs	DPTS-3	Phenanthrene	0.12	mg/Kg				
SVOCs	DPTS-3	Pyrene	0.21	mg/Kg		180	2300	
SVOCs	DPTS-41	Acenaphthene	0.0055	mg/Kg	J	360	4500	
SVOCs	DPTS-41	Anthracene	0.016	mg/Kg		1800	23000	
SVOCs	DPTS-41	Benz(a)anthracene	0.041	mg/Kg		1.1	21	
SVOCs	DPTS-41	Benzo(a)pyrene	0.051	mg/Kg		0.11	2.1	
SVOCs	DPTS-41	Benzo(b)fluoranthene	0.07	mg/Kg		1.1	21	
SVOCs	DPTS-41	Benzo(ghi)perylene	0.046	mg/Kg				
SVOCs	DPTS-41	Benzo(k)fluoranthene	0.038	mg/Kg		11	210	
SVOCs	DPTS-41	Biphenyl, 1,1´-	0.004	mg/Kg	J	4.7	20	
SVOCs	DPTS-41	Bis(2-ethylhexyl)phthalate	0.014	mg/Kg		39	160	
SVOCs	DPTS-41	Carbazole	0.011	mg/Kg				
SVOCs	DPTS-41	Chrysene	0.06	mg/Kg		110	2100	
SVOCs	DPTS-41	Dibenzo(a,h)anthracene	0.012	mg/Kg		0.11	2.1	
SVOCs	DPTS-41	Dibenzofuran	0.005	mg/Kg	J	7.3	100	
SVOCs	DPTS-41	Di-n-butyl phthalate	0.0046	mg/Kg	J	630	8200	
SVOCs	DPTS-41	Fluoranthene	0.11	mg/Kg		240	3000	
SVOCs	DPTS-41	Fluorene	0.0099	mg/Kg		240	3000	
SVOCs	DPTS-41	Indeno(1,2,3-cd)pyrene	0.04	mg/Kg		1.1	21	
SVOCs	DPTS-41	Methylnaphthalene, 2-	0.017	mg/Kg		24	300	
SVOCs	DPTS-41	Naphthalene	0.0033	mg/Kg	J	3.8	17	
SVOCs	DPTS-41	Phenanthrene	0.076	mg/Kg				
SVOCs	DPTS-41	Pyrene	0.088	mg/Kg		180	2300	
SVOCs	DPTS-9	Acenaphthene	0.029	mg/Kg		360	4500	
SVOCs	DPTS-9	Acenaphthylene	0.014	mg/Kg				
SVOCs	DPTS-9	Anthracene	0.1	mg/Kg		1800	23000	
SVOCs	DPTS-9	Benz(a)anthracene	0.31	mg/Kg		1.1	21	
SVOCs	DPTS-9	Benzo(a)pyrene	0.31	mg/Kg		0.11	2.1	
SVOCs	DPTS-9	Benzo(b)fluoranthene	0.49	mg/Kg		1.1	21	

APPENDIX A-2
HISTORICAL DETECTIONS IN SURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	DPTS-9	Benzo(ghi)perylene	0.21	mg/Kg				
SVOCs	DPTS-9	Benzo(k)fluoranthene	0.19	mg/Kg		11	210	
SVOCs	DPTS-9	Biphenyl, 1,1´-	0.0044	mg/Kg	J	4.7	20	
SVOCs	DPTS-9	Bis(2-ethylhexyl)phthalate	0.0071	mg/Kg		39	160	
SVOCs	DPTS-9	Carbazole	0.053	mg/Kg				
SVOCs	DPTS-9	Chrysene	0.44	mg/Kg		110	2100	
SVOCs	DPTS-9	Dibenzo(a,h)anthracene	0.054	mg/Kg		0.11	2.1	
SVOCs	DPTS-9	Dibenzofuran	0.032	mg/Kg		7.3	100	
SVOCs	DPTS-9	Di-n-butyl phthalate	0.0028	mg/Kg	J	630	8200	
SVOCs	DPTS-9	Fluoranthene	0.82	mg/Kg		240	3000	
SVOCs	DPTS-9	Fluorene	0.025	mg/Kg		240	3000	
SVOCs	DPTS-9	Indeno(1,2,3-cd)pyrene	0.23	mg/Kg		1.1	21	
SVOCs	DPTS-9	Methylnaphthalene, 2-	0.031	mg/Kg		24	300	
SVOCs	DPTS-9	Methylphenol, 3&4-	0.0035	mg/Kg	J	6.3	82	
SVOCs	DPTS-9	Naphthalene	0.021	mg/Kg		3.8	17	
SVOCs	DPTS-9	Phenanthrene	0.53	mg/Kg				
SVOCs	DPTS-9	Phenol	0.0025	mg/Kg	J	1900	25000	
SVOCs	DPTS-9	Phenyl Methyl Ketone (Acetophenone)	0.0055	mg/Kg	J	780	12000	
SVOCs	DPTS-9	Pyrene	0.7	mg/Kg		180	2300	
VOCs	DPTS-110_ DPT-7	Acetone	0.065	mg/Kg		6100	67000	
VOCs	DPTS-116_ DPT-9	Acetone	0.044	mg/Kg		6100	67000	
VOCs	DPTS-127_ DPT-13	Acetone	0.081	mg/Kg		6100	67000	
VOCs	DPTS-133_ DPT-15	Acetone	0.065	mg/Kg		6100	67000	
VOCs	DPTS-3	Acetone	0.021	mg/Kg		6100	67000	
VOCs	DPTS-41	Acetone	0.32	mg/Kg		6100	67000	
VOCs	DPTS-41	Methyl Ethyl Ketone	0.035	mg/Kg		2700	19000	
VOCs	DPTS-9	Acetone	0.037	mg/Kg		6100	67000	

APPENDIX A-3
SUBSURFACE SOIL

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

★ Proposed Subsurface Soil Sample Location (74)

N

0 250 500

SCALE IN FEET

Drawn By: WAH	Ck'd By: KJH	App'vd By: KJH
Date: 3-2-20	Date: 3-2-20	Date: 3-3-20

etegra

juniper environmental

GEOTECHNOLOGY INC FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PROPOSED EXTERIOR SUBSURFACE SOIL SAMPLING LOCATIONS

Project Number J034500.01

APPENDIX A-3

(b) (7)(F)

[redacted]

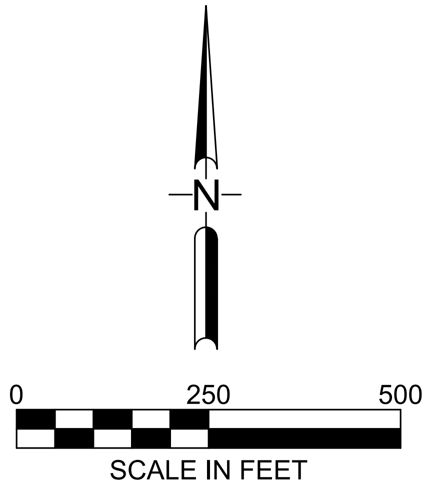
NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.

2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

● ● ● Subsurface Soil Sample Analyzed for PAH
  - ● Below Residential RSLs
  - ● Above Residential RSLs
  - ● Above Industrial RSLs



Drawn By: WAH	Ck'd By: KJH	App'vd By: KJH
Date: 3-2-20	Date: 3-2-20	Date: 3-3-20

etegra

juniper environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PREVIOUS EXTERIOR SUBSURFACE SOIL SAMPLING LOCATIONS ANALYZED FOR PAH

Project Number
J034500.01

APPENDIX A-3

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

● Subsurface Soil Sample Analyzed for PCB (Below Residential RSLs)

N

0 250 500

SCALE IN FEET

Drawn By: WAH	Ck'd By: KJH	App'vd By: KJH
Date: 3-2-20	Date: 3-2-20	Date: 3-3-20

etegra

juniper
environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PREVIOUS EXTERIOR SUBSURFACE SOIL SAMPLING LOCATIONS ANALYZED FOR PCB

Project Number
J034500.01

APPENDIX A-3

(b) (7)(F)

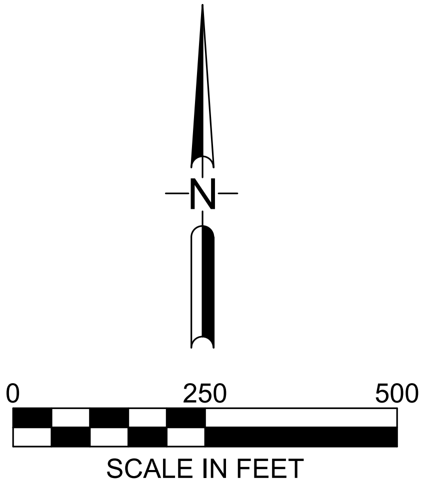
[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

● Subsurface Soil Sample Analyzed for Metals
  - ● Below Residential RSLs (or Background for Arsenic)



Drawn By: WAH	Ck'd By: KJH	App'vd By: KJH
Date: 3-2-20	Date: 3-2-20	Date: 3-3-20

etegra

juniper
environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PREVIOUS EXTERIOR SUBSURFACE SOIL SAMPLING LOCATIONS ANALYZED FOR METALS

Project Number
J034500.01

APPENDIX A-3

SUBSURFACE SOIL

Summary: 59 Total Subsurface Soil Samples

Analyte Group	Samples	Detections	Industrial RSL Exceedances	Residential RSL Exceedances	Background Exceedances
Mercury	1	1	0	0	0
Other RCRA 8 Metals	1	5	0	0	0
Other Metals	0	0	0	0	0
PCBs	20	3	0	0	N/A
PAHs	30	193	1	7	N/A
VOCs	29	26	0	0	N/A
Herbicides	3	0	0	0	N/A
Pesticides	3	0	0	0	N/A
Asbestos	14	0	N/A	N/A	N/A

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample
PAHs				
Benzo(a)pyrene	0.57	0.11	mg/kg	DPTS-131 (DPT-14)
Benzo(a)anthracene	4	1.1	mg/kg	DPTS-2
Benzo(a)pyrene	2.9	0.11	mg/kg	DPTS-2
Ideno(1,2,3-cd)pyrene	3	1.1	mg/kg	DPTS-2
Benzo(b)fluoranthene	5.5	1.1	mg/kg	DPTS-2
Dibenzo(a,h)anthracene	0.82	0.11	mg/kg	DPTS-2
Benzo(a)pyrene	0.24	0.11	mg/kg	DPTS-32

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample
PAHs				
Benzo(a)pyrene	2.9	2.1	mg/kg	DPTS-2

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Other RCRA 8 Metals - 7 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents

APPENDIX A-3
HISTORICAL DETECTIONS IN SUBSURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Mercury	DPTS-20	Mercury	0.00138	mg/Kg	J	1.1	4.6	0.154
Mercury	DPTS-20-DUP	Mercury	0.00494	mg/Kg		1.1	4.6	0.154
Metals	DPTS-20	Arsenic	2.66	mg/Kg	J	0.68	3	12.3
Metals	DPTS-20	Barium	73	mg/Kg	J	1500	22000	
Metals	DPTS-20	Chromium	14.4	mg/Kg	J			25.5
Metals	DPTS-20	Lead	7.83	mg/Kg	J	400	800	363
Metals	DPTS-20	Selenium	0.865	mg/Kg		39	580	
Metals	DPTS-20-DUP	Arsenic	2.67	mg/Kg	J	0.68	3	12.3
Metals	DPTS-20-DUP	Barium	51.2	mg/Kg	J	1500	22000	
Metals	DPTS-20-DUP	Chromium	10.6	mg/Kg	J			25.5
Metals	DPTS-20-DUP	Lead	7.8	mg/Kg	J	400	800	363
Metals	DPTS-20-DUP	Selenium	0.933	mg/Kg		39	580	
PCBs	DPTS-139_DPT-18	Aroclor 1260	0.021	mg/Kg		0.24	0.99	
PCBs	DPTS-144_DPT-20	Aroclor 1260	0.024	mg/Kg	P	0.24	0.99	
PCBs	DPTS-151_DPT-21	Aroclor 1260	0.045	mg/Kg		0.24	0.99	
SVOCs	DPTS-1	Bis(2-ethylhexyl)phthalate	0.0051	mg/Kg	J	39	160	
SVOCs	DPTS-120_DPT-10	Benz(a)anthracene	0.0045	mg/Kg	J	1.1	21	
SVOCs	DPTS-120_DPT-10	Chrysene	0.0045	mg/Kg	J	110	2100	
SVOCs	DPTS-120_DPT-10	Fluoranthene	0.0082	mg/Kg		240	3000	
SVOCs	DPTS-120_DPT-10	Phenanthrene	0.0045	mg/Kg	J			
SVOCs	DPTS-120_DPT-10	Pyrene	0.0069	mg/Kg	J	180	2300	
SVOCs	DPTS-122_DPT-11	Bis(2-ethylhexyl)phthalate	0.0085	mg/Kg		39	160	
SVOCs	DPTS-122_DPT-11	Caprolactam	0.01	mg/Kg		3100	40000	
SVOCs	DPTS-122_DPT-11	Di-n-butyl phthalate	0.011	mg/Kg		630	8200	
SVOCs	DPTS-124_DPT-12	Benz(a)anthracene	0.004	mg/Kg	J	1.1	21	
SVOCs	DPTS-124_DPT-12	Benzo(a)pyrene	0.0085	mg/Kg		0.11	2.1	
SVOCs	DPTS-124_DPT-12	Benzo(b)Fluoranthene	0.013	mg/Kg		1.1	21	
SVOCs	DPTS-124_DPT-12	Benzo(ghi)perylene	0.037	mg/Kg				
SVOCs	DPTS-124_DPT-12	Benzo(k)Fluoranthene	0.007	mg/Kg		11	210	
SVOCs	DPTS-124_DPT-12	Bis(2-ethylhexyl)phthalate	0.0057	mg/Kg	J	39	160	
SVOCs	DPTS-124_DPT-12	Butyl Benzyl Phthalate	0.003	mg/Kg	J	290	1200	
SVOCs	DPTS-124_DPT-12	Chrysene	0.011	mg/Kg		110	2100	
SVOCs	DPTS-124_DPT-12	Dibenzo(a,h)anthracene	0.0038	mg/Kg	J	0.11	2.1	
SVOCs	DPTS-124_DPT-12	Di-n-butyl phthalate	0.0068	mg/Kg	J	630	8200	
SVOCs	DPTS-124_DPT-12	Fluoranthene	0.0052	mg/Kg		240	3000	
SVOCs	DPTS-124_DPT-12	Indeno(1,2,3-cd)pyrene	0.011	mg/Kg		1.1	21	
SVOCs	DPTS-124_DPT-12	Pyrene	0.005	mg/Kg		180	2300	
SVOCs	DPTS-125_DPT-12	Anthracene	0.0021	mg/Kg	J	1800	23000	
SVOCs	DPTS-125_DPT-12	Benz(a)anthracene	0.0067	mg/Kg		1.1	21	
SVOCs	DPTS-125_DPT-12	Benzo(a)pyrene	0.0069	mg/Kg		0.11	2.1	
SVOCs	DPTS-125_DPT-12	Benzo(b)Fluoranthene	0.0085	mg/Kg		1.1	21	
SVOCs	DPTS-125_DPT-12	Benzo(ghi)perylene	0.0086	mg/Kg				
SVOCs	DPTS-125_DPT-12	Benzo(k)Fluoranthene	0.0038	mg/Kg	J	11	210	
SVOCs	DPTS-125_DPT-12	Bis(2-ethylhexyl)phthalate	0.01	mg/Kg		39	160	
SVOCs	DPTS-125_DPT-12	Caprolactam	0.012	mg/Kg		3100	40000	
SVOCs	DPTS-125_DPT-12	Chrysene	0.0082	mg/Kg		110	2100	
SVOCs	DPTS-125_DPT-12	Diethyl Phthalate	0.0021	mg/Kg	J	5100	66000	
SVOCs	DPTS-125_DPT-12	Di-n-butyl phthalate	0.012	mg/Kg		630	8200	
SVOCs	DPTS-125_DPT-12	Fluoranthene	0.014	mg/Kg		240	3000	
SVOCs	DPTS-125_DPT-12	Indeno(1,2,3-cd)pyrene	0.007	mg/Kg		1.1	21	
SVOCs	DPTS-125_DPT-12	Phenanthrene	0.0084	mg/Kg				
SVOCs	DPTS-125_DPT-12	Pyrene	0.014	mg/Kg		180	2300	
SVOCs	DPTS-129_DPT-13	Benz(a)anthracene	0.0033	mg/Kg	J	1.1	21	
SVOCs	DPTS-129_DPT-13	Benzo(a)pyrene	0.0036	mg/Kg	J	0.11	2.1	
SVOCs	DPTS-129_DPT-13	Benzo(b)Fluoranthene	0.0063	mg/Kg		1.1	21	

APPENDIX A-3
HISTORICAL DETECTIONS IN SUBSURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	DPTS-129_DPT-13	Benzo(ghi)perylene	0.0047	mg/Kg				
SVOCs	DPTS-129_DPT-13	Benzo(k)Fluoranthene	0.0024	mg/Kg	J	11	210	
SVOCs	DPTS-129_DPT-13	Bis(2-ethylhexyl)phthalate	0.011	mg/Kg		39	160	
SVOCs	DPTS-129_DPT-13	Caprolactam	0.014	mg/Kg		3100	40000	
SVOCs	DPTS-129_DPT-13	Chrysene	0.0035	mg/Kg	J	110	2100	
SVOCs	DPTS-129_DPT-13	Diethyl Phthalate	0.0026	mg/Kg	J	5100	66000	
SVOCs	DPTS-129_DPT-13	Di-n-butyl phthalate	0.014	mg/Kg		630	8200	
SVOCs	DPTS-129_DPT-13	Fluoranthene	0.0055	mg/Kg		240	3000	
SVOCs	DPTS-129_DPT-13	Indeno(1,2,3-cd)pyrene	0.0043	mg/Kg		1.1	21	
SVOCs	DPTS-129_DPT-13	Phenanthrene	0.0025	mg/Kg	J			
SVOCs	DPTS-129_DPT-13	Pyrene	0.0049	mg/Kg		180	2300	
SVOCs	DPTS-131_DPT-14	Acenaphthene	0.2	mg/Kg		360	4500	
SVOCs	DPTS-131_DPT-14	Acenaphthylene	0.0047	mg/Kg				
SVOCs	DPTS-131_DPT-14	Anthracene	0.46	mg/Kg		1800	23000	
SVOCs	DPTS-131_DPT-14	Benz(a)anthracene	0.66	mg/Kg		1.1	21	
SVOCs	DPTS-131_DPT-14	Benzaldehyde	0.0042	mg/Kg	J	170	820	
SVOCs	DPTS-131_DPT-14	Benzo(a)pyrene	0.57	mg/Kg		0.11	2.1	
SVOCs	DPTS-131_DPT-14	Benzo(b)Fluoranthene	0.66	mg/Kg		1.1	21	
SVOCs	DPTS-131_DPT-14	Benzo(ghi)perylene	0.38	mg/Kg				
SVOCs	DPTS-131_DPT-14	Benzo(k)Fluoranthene	0.27	mg/Kg		11	210	
SVOCs	DPTS-131_DPT-14	Biphenyl, 1,1´-	0.015	mg/Kg		4.7	20	
SVOCs	DPTS-131_DPT-14	Bis(2-ethylhexyl)phthalate	0.016	mg/Kg		39	160	
SVOCs	DPTS-131_DPT-14	Butyl Benzyl Phthalate	0.0027	mg/Kg	J	290	1200	
SVOCs	DPTS-131_DPT-14	Caprolactam	0.022	mg/Kg		3100	40000	
SVOCs	DPTS-131_DPT-14	Carbazole	0.22	mg/Kg				
SVOCs	DPTS-131_DPT-14	Chrysene	0.64	mg/Kg		110	2100	
SVOCs	DPTS-131_DPT-14	Dibenzo(a,h)anthracene	0.085	mg/Kg		0.11	2.1	
SVOCs	DPTS-131_DPT-14	Dibenzofuran	0.13	mg/Kg		7.3	100	
SVOCs	DPTS-131_DPT-14	Diethyl Phthalate	0.0033	mg/Kg	J	5100	66000	
SVOCs	DPTS-131_DPT-14	Di-n-butyl phthalate	0.014	mg/Kg		630	8200	
SVOCs	DPTS-131_DPT-14	Fluoranthene	2	mg/Kg		240	3000	
SVOCs	DPTS-131_DPT-14	Fluorene	0.16	mg/Kg		240	3000	
SVOCs	DPTS-131_DPT-14	Indeno(1,2,3-cd)pyrene	0.4	mg/Kg		1.1	21	
SVOCs	DPTS-131_DPT-14	Methylnaphthalene, 2-	0.048	mg/Kg		24	300	
SVOCs	DPTS-131_DPT-14	Methylphenol, 3&4-	0.0035	mg/Kg	J	6.3	82	
SVOCs	DPTS-131_DPT-14	Naphthalene	0.082	mg/Kg		3.8	17	
SVOCs	DPTS-131_DPT-14	Phenanthrene	1.8	mg/Kg				
SVOCs	DPTS-131_DPT-14	Phenol	0.0024	mg/Kg	J	1900	25000	
SVOCs	DPTS-131_DPT-14	Pyrene	1.7	mg/Kg		180	2300	
SVOCs	DPTS-134_DPT-15	Bis(2-ethylhexyl)phthalate	0.01	mg/Kg		39	160	
SVOCs	DPTS-134_DPT-15	Butyl Benzyl Phthalate	0.0031	mg/Kg	J	290	1200	
SVOCs	DPTS-134_DPT-15	Caprolactam	0.015	mg/Kg		3100	40000	
SVOCs	DPTS-134_DPT-15	Diethyl Phthalate	0.0031	mg/Kg	J	5100	66000	
SVOCs	DPTS-134_DPT-15	Di-n-butyl phthalate	0.013	mg/Kg		630	8200	
SVOCs	DPTS-136_DPT-16	Anthracene	0.0052	mg/Kg		1800	23000	
SVOCs	DPTS-136_DPT-16	Benz(a)anthracene	0.037	mg/Kg		1.1	21	
SVOCs	DPTS-136_DPT-16	Benzo(a)pyrene	0.042	mg/Kg		0.11	2.1	
SVOCs	DPTS-136_DPT-16	Benzo(b)Fluoranthene	0.065	mg/Kg		1.1	21	
SVOCs	DPTS-136_DPT-16	Benzo(ghi)perylene	0.035	mg/Kg				
SVOCs	DPTS-136_DPT-16	Benzo(k)Fluoranthene	0.069	mg/Kg		11	210	
SVOCs	DPTS-136_DPT-16	Bis(2-ethylhexyl)phthalate	0.039	mg/Kg		39	160	
SVOCs	DPTS-136_DPT-16	Butyl Benzyl Phthalate	0.0048	mg/Kg	J	290	1200	
SVOCs	DPTS-136_DPT-16	Caprolactam	0.011	mg/Kg		3100	40000	
SVOCs	DPTS-136_DPT-16	Carbazole	0.0039	mg/Kg	J			
SVOCs	DPTS-136_DPT-16	Chrysene	0.045	mg/Kg		110	2100	

APPENDIX A-3
HISTORICAL DETECTIONS IN SUBSURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	DPTS-136_DPT-16	Dibenzo(a,h)anthracene	0.0077	mg/Kg		0.11	2.1	
SVOCs	DPTS-136_DPT-16	Diethyl Phthalate	0.0024	mg/Kg	J	5100	66000	
SVOCs	DPTS-136_DPT-16	Di-n-butyl phthalate	0.014	mg/Kg		630	8200	
SVOCs	DPTS-136_DPT-16	Fluoranthene	0.079	mg/Kg		240	3000	
SVOCs	DPTS-136_DPT-16	Indeno(1,2,3-cd)pyrene	0.039	mg/Kg		1.1	21	
SVOCs	DPTS-136_DPT-16	Phenanthrene	0.027	mg/Kg				
SVOCs	DPTS-136_DPT-16	Pyrene	0.067	mg/Kg		180	2300	
SVOCs	DPTS-147_DPT-17	Bis(2-ethylhexyl)phthalate	0.0094	mg/Kg		39	160	
SVOCs	DPTS-147_DPT-17	Butyl Benzyl Phthalate	0.0026	mg/Kg	J	290	1200	
SVOCs	DPTS-147_DPT-17	Caprolactam	0.011	mg/Kg		3100	40000	
SVOCs	DPTS-147_DPT-17	Diethyl Phthalate	0.0023	mg/Kg	J	5100	66000	
SVOCs	DPTS-147_DPT-17	Di-n-butyl phthalate	0.012	mg/Kg		630	8200	
SVOCs	DPTS-15	Benzaldehyde	0.0053	mg/Kg	J	170	820	
SVOCs	DPTS-15	Benzo(b)fluoranthene	0.0018	mg/Kg	J	1.1	21	
SVOCs	DPTS-15	Bis(2-ethylhexyl)phthalate	0.0098	mg/Kg		39	160	
SVOCs	DPTS-15	Carbazole	0.0028	mg/Kg	J			
SVOCs	DPTS-15	Di-n-butyl phthalate	0.0036	mg/Kg	J	630	8200	
SVOCs	DPTS-17	Anthracene	0.0023	mg/Kg	J	1800	23000	
SVOCs	DPTS-17	Benz(a)anthracene	0.012	mg/Kg		1.1	21	
SVOCs	DPTS-17	Benzo(a)pyrene	0.0085	mg/Kg		0.11	2.1	
SVOCs	DPTS-17	Benzo(b)fluoranthene	0.0093	mg/Kg		1.1	21	
SVOCs	DPTS-17	Benzo(ghi)perylene	0.0076	mg/Kg				
SVOCs	DPTS-17	Benzo(k)fluoranthene	0.0059	mg/Kg	J	11	210	
SVOCs	DPTS-17	Chrysene	0.013	mg/Kg		110	2100	
SVOCs	DPTS-17	Fluoranthene	0.017	mg/Kg		240	3000	
SVOCs	DPTS-17	Indeno(1,2,3-cd)pyrene	0.0057	mg/Kg	J	1.1	21	
SVOCs	DPTS-17	Phenanthrene	0.013	mg/Kg				
SVOCs	DPTS-17	Pyrene	0.026	mg/Kg		180	2300	
SVOCs	DPTS-2	Acenaphthene	0.32	mg/Kg		360	4500	
SVOCs	DPTS-2	Acenaphthylene	0.021	mg/Kg				
SVOCs	DPTS-2	Anthracene	0.91	mg/Kg		1800	23000	
SVOCs	DPTS-2	Benz(a)anthracene	4	mg/Kg		1.1	21	
SVOCs	DPTS-2	Benzo(a)pyrene	2.9	mg/Kg		0.11	2.1	
SVOCs	DPTS-2	Benzo(b)fluoranthene	5.5	mg/Kg		1.1	21	
SVOCs	DPTS-2	Benzo(ghi)perylene	2.8	mg/Kg				
SVOCs	DPTS-2	Benzo(k)fluoranthene	1.6	mg/Kg		11	210	
SVOCs	DPTS-2	Biphenyl, 1,1´-	0.0045	mg/Kg	J	4.7	20	
SVOCs	DPTS-2	Carbazole	0.61	mg/Kg				
SVOCs	DPTS-2	Chrysene	4.3	mg/Kg		110	2100	
SVOCs	DPTS-2	Dibenzo(a,h)anthracene	0.82	mg/Kg		0.11	2.1	
SVOCs	DPTS-2	Dibenzofuran	0.097	mg/Kg		7.3	100	
SVOCs	DPTS-2	Di-n-butyl phthalate	0.011	mg/Kg		630	8200	
SVOCs	DPTS-2	Fluoranthene	7.8	mg/Kg		240	3000	
SVOCs	DPTS-2	Fluorene	0.35	mg/Kg		240	3000	
SVOCs	DPTS-2	Indeno(1,2,3-cd)pyrene	3	mg/Kg		1.1	21	
SVOCs	DPTS-2	Methylnaphthalene, 2-	0.0098	mg/Kg		24	300	
SVOCs	DPTS-2	Naphthalene	0.019	mg/Kg		3.8	17	
SVOCs	DPTS-2	Phenanthrene	5.2	mg/Kg				
SVOCs	DPTS-2	Pyrene	6.6	mg/Kg		180	2300	
SVOCs	DPTS-22	Acenaphthene	0.015	mg/Kg		360	4500	
SVOCs	DPTS-22	Acenaphthylene	0.0021	mg/Kg	J			
SVOCs	DPTS-22	Anthracene	0.037	mg/Kg		1800	23000	
SVOCs	DPTS-22	Benz(a)anthracene	0.067	mg/Kg		1.1	21	
SVOCs	DPTS-22	Benzo(a)pyrene	0.06	mg/Kg		0.11	2.1	
SVOCs	DPTS-22	Benzo(b)fluoranthene	0.07	mg/Kg		1.1	21	

APPENDIX A-3
HISTORICAL DETECTIONS IN SUBSURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	DPTS-22	Benzo(ghi)perylene	0.038	mg/Kg				
SVOCs	DPTS-22	Benzo(k)fluoranthene	0.031	mg/Kg		11	210	
SVOCs	DPTS-22	Biphenyl, 1,1´-	0.0018	mg/Kg	J	4.7	20	
SVOCs	DPTS-22	Bis(2-ethylhexyl)phthalate	0.0092	mg/Kg		39	160	
SVOCs	DPTS-22	Carbazole	0.013	mg/Kg				
SVOCs	DPTS-22	Chrysene	0.069	mg/Kg		110	2100	
SVOCs	DPTS-22	Dibenzo(a,h)anthracene	0.0096	mg/Kg		0.11	2.1	
SVOCs	DPTS-22	Dibenzofuran	0.011	mg/Kg		7.3	100	
SVOCs	DPTS-22	Fluoranthene	0.16	mg/Kg		240	3000	
SVOCs	DPTS-22	Fluorene	0.018	mg/Kg		240	3000	
SVOCs	DPTS-22	Indeno(1,2,3-cd)pyrene	0.043	mg/Kg		1.1	21	
SVOCs	DPTS-22	Methylnaphthalene, 2-	0.004	mg/Kg	J	24	300	
SVOCs	DPTS-22	Naphthalene	0.0041	mg/Kg	J	3.8	17	
SVOCs	DPTS-22	Phenanthrene	0.16	mg/Kg				
SVOCs	DPTS-22	Pyrene	0.15	mg/Kg		180	2300	
SVOCs	DPTS-23	Benzo(b)fluoranthene	0.0022	mg/Kg	J	1.1	21	
SVOCs	DPTS-23	Bis(2-ethylhexyl)phthalate	0.0099	mg/Kg		39	160	
SVOCs	DPTS-23	Chrysene	0.0019	mg/Kg	J	110	2100	
SVOCs	DPTS-23	Di-n-butyl phthalate	0.0045	mg/Kg	J	630	8200	
SVOCs	DPTS-23	Fluoranthene	0.0029	mg/Kg	J	240	3000	
SVOCs	DPTS-23	Phenanthrene	0.003	mg/Kg	J			
SVOCs	DPTS-23	Pyrene	0.0029	mg/Kg	J	180	2300	
SVOCs	DPTS-27	Bis(2-ethylhexyl)phthalate	0.027	mg/Kg		39	160	
SVOCs	DPTS-27	Caprolactam	0.0053	mg/Kg	J	3100	40000	
SVOCs	DPTS-27	Diethyl phthalate	0.0017	mg/Kg	J	5100	66000	
SVOCs	DPTS-27	Dimethylphenol, 2,4-	0.0042	mg/Kg	J	130	1600	
SVOCs	DPTS-27	Di-n-butyl phthalate	0.0037	mg/Kg	J	630	8200	
SVOCs	DPTS-27	Nitrophenol, 4-	0.0018	mg/Kg	J			
SVOCs	DPTS-28	Acenaphthene	0.0022	mg/Kg	J	360	4500	
SVOCs	DPTS-28	Anthracene	0.0055	mg/Kg	J	1800	23000	
SVOCs	DPTS-28	Benz(a)anthracene	0.014	mg/Kg		1.1	21	
SVOCs	DPTS-28	Benzo(a)pyrene	0.013	mg/Kg		0.11	2.1	
SVOCs	DPTS-28	Benzo(b)fluoranthene	0.016	mg/Kg		1.1	21	
SVOCs	DPTS-28	Benzo(ghi)perylene	0.011	mg/Kg				
SVOCs	DPTS-28	Benzo(k)fluoranthene	0.0069	mg/Kg		11	210	
SVOCs	DPTS-28	Bis(2-ethylhexyl)phthalate	0.12	mg/Kg		39	160	
SVOCs	DPTS-28	Carbazole	0.0033	mg/Kg	J			
SVOCs	DPTS-28	Chrysene	0.017	mg/Kg		110	2100	
SVOCs	DPTS-28	Dibenzo(a,h)anthracene	0.0029	mg/Kg	J	0.11	2.1	
SVOCs	DPTS-28	Dibenzofuran	0.002	mg/Kg	J	7.3	100	
SVOCs	DPTS-28	Diethyl phthalate	0.0038	mg/Kg	J	5100	66000	
SVOCs	DPTS-28	Di-n-butyl phthalate	0.0094	mg/Kg		630	8200	
SVOCs	DPTS-28	Fluoranthene	0.035	mg/Kg		240	3000	
SVOCs	DPTS-28	Fluorene	0.0029	mg/Kg	J	240	3000	
SVOCs	DPTS-28	Indeno(1,2,3-cd)pyrene	0.011	mg/Kg		1.1	21	
SVOCs	DPTS-28	Methylnaphthalene, 2-	0.0023	mg/Kg	J	24	300	
SVOCs	DPTS-28	Naphthalene	0.0031	mg/Kg	J	3.8	17	
SVOCs	DPTS-28	Phenanthrene	0.029	mg/Kg				
SVOCs	DPTS-28	Pyrene	0.031	mg/Kg		180	2300	
SVOCs	DPTS-29	Benzo(a)pyrene	0.0017	mg/Kg	J	0.11	2.1	
SVOCs	DPTS-29	Benzo(b)fluoranthene	0.0018	mg/Kg	J	1.1	21	
SVOCs	DPTS-29	Benzo(ghi)perylene	0.0018	mg/Kg	J			
SVOCs	DPTS-29	Benzo(k)fluoranthene	0.0021	mg/Kg	J	11	210	
SVOCs	DPTS-29	Bis(2-ethylhexyl)phthalate	0.05	mg/Kg		39	160	
SVOCs	DPTS-29	Diethyl phthalate	0.0037	mg/Kg	J	5100	66000	

APPENDIX A-3
HISTORICAL DETECTIONS IN SUBSURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	DPTS-29	Di-n-butyl phthalate	0.0079	mg/Kg		630	8200	
SVOCs	DPTS-29	Indeno(1,2,3-cd)pyrene	0.0018	mg/Kg	J	1.1	21	
SVOCs	DPTS-29	Phenanthrene	0.0025	mg/Kg	J			
SVOCs	DPTS-31	Acenaphthene	0.0086	mg/Kg		360	4500	
SVOCs	DPTS-31	Acenaphthylene	0.013	mg/Kg				
SVOCs	DPTS-31	Anthracene	0.03	mg/Kg		1800	23000	
SVOCs	DPTS-31	Benz(a)anthracene	0.092	mg/Kg		1.1	21	
SVOCs	DPTS-31	Benzaldehyde	0.0054	mg/Kg	J	170	820	
SVOCs	DPTS-31	Benzo(a)pyrene	0.088	mg/Kg		0.11	2.1	
SVOCs	DPTS-31	Benzo(b)fluoranthene	0.098	mg/Kg		1.1	21	
SVOCs	DPTS-31	Benzo(ghi)perylene	0.0019	mg/Kg	J			
SVOCs	DPTS-31	Benzo(k)fluoranthene	0.047	mg/Kg		11	210	
SVOCs	DPTS-31	Bis(2-ethylhexyl)phthalate	0.014	mg/Kg		39	160	
SVOCs	DPTS-31	Carbazole	0.014	mg/Kg				
SVOCs	DPTS-31	Chrysene	0.097	mg/Kg		110	2100	
SVOCs	DPTS-31	Dibenzo(a,h)anthracene	0.015	mg/Kg		0.11	2.1	
SVOCs	DPTS-31	Dibenzofuran	0.0085	mg/Kg		7.3	100	
SVOCs	DPTS-31	Di-n-butyl phthalate	0.0035	mg/Kg	J	630	8200	
SVOCs	DPTS-31	Fluoranthene	0.2	mg/Kg		240	3000	
SVOCs	DPTS-31	Fluorene	0.012	mg/Kg		240	3000	
SVOCs	DPTS-31	Indeno(1,2,3-cd)pyrene	0.063	mg/Kg		1.1	21	
SVOCs	DPTS-31	Methylnaphthalene, 2-	0.0055	mg/Kg	J	24	300	
SVOCs	DPTS-31	Naphthalene	0.0068	mg/Kg		3.8	17	
SVOCs	DPTS-31	Phenanthrene	0.13	mg/Kg				
SVOCs	DPTS-31	Pyrene	0.17	mg/Kg		180	2300	
SVOCs	DPTS-32	Acenaphthene	0.025	mg/Kg		360	4500	
SVOCs	DPTS-32	Acenaphthylene	0.025	mg/Kg				
SVOCs	DPTS-32	Anthracene	0.13	mg/Kg		1800	23000	
SVOCs	DPTS-32	Benz(a)anthracene	0.28	mg/Kg		1.1	21	
SVOCs	DPTS-32	Benzo(a)pyrene	0.24	mg/Kg		0.11	2.1	
SVOCs	DPTS-32	Benzo(b)fluoranthene	0.3	mg/Kg		1.1	21	
SVOCs	DPTS-32	Benzo(ghi)perylene	0.15	mg/Kg				
SVOCs	DPTS-32	Benzo(k)fluoranthene	0.14	mg/Kg		11	210	
SVOCs	DPTS-32	Bis(2-ethylhexyl)phthalate	0.015	mg/Kg		39	160	
SVOCs	DPTS-32	Butyl benzyl phthalate	0.0099	mg/Kg		290	1200	
SVOCs	DPTS-32	Carbazole	0.046	mg/Kg				
SVOCs	DPTS-32	Chrysene	0.29	mg/Kg		110	2100	
SVOCs	DPTS-32	Dibenzo(a,h)anthracene	0.048	mg/Kg		0.11	2.1	
SVOCs	DPTS-32	Dibenzofuran	0.021	mg/Kg		7.3	100	
SVOCs	DPTS-32	Di-n-butyl phthalate	0.0038	mg/Kg	J	630	8200	
SVOCs	DPTS-32	Fluoranthene	0.55	mg/Kg		240	3000	
SVOCs	DPTS-32	Fluorene	0.04	mg/Kg		240	3000	
SVOCs	DPTS-32	Indeno(1,2,3-cd)pyrene	0.14	mg/Kg		1.1	21	
SVOCs	DPTS-32	Methylnaphthalene, 2-	0.0033	mg/Kg	J	24	300	
SVOCs	DPTS-32	Naphthalene	0.0062	mg/Kg	J	3.8	17	
SVOCs	DPTS-32	Phenanthrene	0.47	mg/Kg				
SVOCs	DPTS-32	Pyrene	0.43	mg/Kg		180	2300	
SVOCs	DPTS-37	Diethyl phthalate	0.0026	mg/Kg	J	5100	66000	
SVOCs	DPTS-38	Bis(2-ethylhexyl)phthalate	0.0037	mg/Kg	J	39	160	
SVOCs	DPTS-42	Bis(2-ethylhexyl)phthalate	0.0089	mg/Kg		39	160	
SVOCs	DPTS-42	Di-n-butyl phthalate	0.0024	mg/Kg	J	630	8200	
SVOCs	DPTS-42-DUP	Bis(2-ethylhexyl)phthalate	0.0048	mg/Kg	J	39	160	
SVOCs	DPTS-43	Benzaldehyde	0.0041	mg/Kg	J	170	820	
SVOCs	DPTS-43	Bis(2-ethylhexyl)phthalate	0.0042	mg/Kg	J	39	160	
SVOCs	DPTS-5	Anthracene	0.0028	mg/Kg	J	1800	23000	

APPENDIX A-3
HISTORICAL DETECTIONS IN SUBSURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
SVOCs	DPTS-5	Benz(a)anthracene	0.007	mg/Kg		1.1	21	
SVOCs	DPTS-5	Benzo(a)pyrene	0.0075	mg/Kg		0.11	2.1	
SVOCs	DPTS-5	Benzo(b)fluoranthene	0.0092	mg/Kg		1.1	21	
SVOCs	DPTS-5	Benzo(ghi)perylene	0.0081	mg/Kg				
SVOCs	DPTS-5	Benzo(k)fluoranthene	0.0036	mg/Kg	J	11	210	
SVOCs	DPTS-5	Bis(2-ethylhexyl)phthalate	0.0022	mg/Kg	J	39	160	
SVOCs	DPTS-5	Chrysene	0.0088	mg/Kg		110	2100	
SVOCs	DPTS-5	Fluoranthene	0.019	mg/Kg		240	3000	
SVOCs	DPTS-5	Indeno(1,2,3-cd)pyrene	0.0064	mg/Kg	J	1.1	21	
SVOCs	DPTS-5	Phenanthrene	0.015	mg/Kg				
SVOCs	DPTS-5	Pyrene	0.02	mg/Kg		180	2300	
SVOCs	DPTS-6	Bis(2-ethylhexyl)phthalate	0.0066	mg/Kg		39	160	
SVOCs	DPTS-6	Caprolactam	0.0059	mg/Kg	J	3100	40000	
SVOCs	DPTS-6	Di-n-butyl phthalate	0.0026	mg/Kg	J	630	8200	
SVOCs	DPTS-7	Benzo(a)pyrene	0.0017	mg/Kg	J	0.11	2.1	
SVOCs	DPTS-7	Benzo(b)fluoranthene	0.0026	mg/Kg	J	1.1	21	
SVOCs	DPTS-7	Benzo(k)fluoranthene	0.002	mg/Kg	J	11	210	
SVOCs	DPTS-7	Bis(2-ethylhexyl)phthalate	0.014	mg/Kg		39	160	
SVOCs	DPTS-7	Diethyl phthalate	0.0021	mg/Kg	J	5100	66000	
SVOCs	DPTS-7	Di-n-butyl phthalate	0.0057	mg/Kg	J	630	8200	
SVOCs	DPTS-7	Fluoranthene	0.002	mg/Kg	J	240	3000	
SVOCs	DPTS-7	Nitroaniline, 3-	0.0027	mg/Kg	J			
SVOCs	DPTS-7	Phenanthrene	0.0026	mg/Kg	J			
SVOCs	DPTS-7	Pyrene	0.0023	mg/Kg	J	180	2300	
SVOCs	DPTS-8	Benz(a)anthracene	0.0062	mg/Kg	J	1.1	21	
SVOCs	DPTS-8	Benzo(a)pyrene	0.004	mg/Kg	J	0.11	2.1	
SVOCs	DPTS-8	Benzo(b)fluoranthene	0.0074	mg/Kg		1.1	21	
SVOCs	DPTS-8	Benzo(ghi)perylene	0.0043	mg/Kg	J			
SVOCs	DPTS-8	Benzo(k)fluoranthene	0.0042	mg/Kg	J	11	210	
SVOCs	DPTS-8	Bis(2-ethylhexyl)phthalate	0.0037	mg/Kg	J	39	160	
SVOCs	DPTS-8	Chrysene	0.0066	mg/Kg		110	2100	
SVOCs	DPTS-8	Fluoranthene	0.0072	mg/Kg		240	3000	
SVOCs	DPTS-8	Indeno(1,2,3-cd)pyrene	0.0053	mg/Kg	J	1.1	21	
SVOCs	DPTS-8	Nitrobenzene	0.0033	mg/Kg	J	5.1	22	
SVOCs	DPTS-8	Phenanthrene	0.0031	mg/Kg	J			
SVOCs	DPTS-8	Pyrene	0.0055	mg/Kg	J	180	2300	
SVOCs	DPTS-8-FD	Benz(a)anthracene	0.0068	mg/Kg		1.1	21	
SVOCs	DPTS-8-FD	Benzo(b)fluoranthene	0.016	mg/Kg		1.1	21	
SVOCs	DPTS-8-FD	Benzo(ghi)perylene	0.0088	mg/Kg				
SVOCs	DPTS-8-FD	Benzo(k)fluoranthene	0.015	mg/Kg		11	210	
SVOCs	DPTS-8-FD	Bis(2-ethylhexyl)phthalate	0.0073	mg/Kg		39	160	
SVOCs	DPTS-8-FD	Chrysene	0.0099	mg/Kg		110	2100	
SVOCs	DPTS-8-FD	Di-n-butyl phthalate	0.0039	mg/Kg	J	630	8200	
SVOCs	DPTS-8-FD	Fluoranthene	0.016	mg/Kg		240	3000	
SVOCs	DPTS-8-FD	Indeno(1,2,3-cd)pyrene	0.0077	mg/Kg		1.1	21	
SVOCs	DPTS-8-FD	Phenanthrene	0.0071	mg/Kg				
SVOCs	DPTS-8-FD	Pyrene	0.018	mg/Kg		180	2300	
VOCs	DPTS-1	Acetone	0.0039	mg/Kg	J	6100	67000	
VOCs	DPTS-1	Dichloroethylene, 1,2-cis-	0.0036	mg/Kg		16	230	
VOCs	DPTS-1	Trichloroethene	0.021	mg/Kg		0.41	1.9	
VOCs	DPTS-131_DPT-14	Acetone	0.027	mg/Kg		6100	67000	
VOCs	DPTS-134_DPT-15	Acetone	0.025	mg/Kg		6100	67000	
VOCs	DPTS-15	Acetone	0.018	mg/Kg		6100	67000	
VOCs	DPTS-17	Acetone	0.11	mg/Kg		6100	67000	
VOCs	DPTS-17	Methyl Ethyl Ketone	0.019	mg/Kg		2700	19000	

APPENDIX A-3
HISTORICAL DETECTIONS IN SUBSURFACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
VOCs	DPTS-2	Acetone	0.014	mg/Kg		6100	67000	
VOCs	DPTS-27	Acetone	0.021	mg/Kg		6100	67000	
VOCs	DPTS-28	Acetone	0.025	mg/Kg		6100	67000	
VOCs	DPTS-28	Carbon disulfide	0.011	mg/Kg		77	350	
VOCs	DPTS-29	Acetone	0.013	mg/Kg	J	6100	67000	
VOCs	DPTS-31	Acetone	0.07	mg/Kg		6100	67000	
VOCs	DPTS-31	Methyl Ethyl Ketone	0.0054	mg/Kg	J	2700	19000	
VOCs	DPTS-32	Acetone	0.086	mg/Kg		6100	67000	
VOCs	DPTS-32	Methyl Ethyl Ketone	0.011	mg/Kg		2700	19000	
VOCs	DPTS-37	Acetone	0.0079	mg/Kg	J	6100	67000	
VOCs	DPTS-42	Acetone	0.018	mg/Kg		6100	67000	
VOCs	DPTS-42	Methyl Ethyl Ketone	0.0021	mg/Kg	J	2700	19000	
VOCs	DPTS-42	Trichloroethene	0.0055	mg/Kg		0.41	1.9	
VOCs	DPTS-42-DUP	Acetone	0.025	mg/Kg		6100	67000	
VOCs	DPTS-42-DUP	Trichloroethene	0.0068	mg/Kg		0.41	1.9	
VOCs	DPTS-5	Acetone	0.072	mg/Kg		6100	67000	
VOCs	DPTS-5	Carbon disulfide	0.017	mg/Kg		77	350	
VOCs	DPTS-5	Methyl Ethyl Ketone	0.016	mg/Kg		2700	19000	
VOCs	DPTS-6	Acetone	0.012	mg/Kg	J	6100	67000	
VOCs	DPTS-8	Acetone	0.023	mg/Kg		6100	67000	
VOCs	DPTS-8-FD	Acetone	0.032	mg/Kg		6100	67000	

APPENDIX A-4
CRAWLSPACE SOIL

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).
3. Building 102 is inaccessible due to safety concerns.

LEGEND

▨ Approximate Limits of Crawl Space Area

▲ Crawl Space Soil Sample Location (Tetra Tech 2016)

■ Craw Space Soil Sample Location (SCS Engineers 2008)

N

0 250 500

SCALE IN FEET

Drawn By: WAH	Ck'd By: KJH	App'vd By: KJH
Date: 3-2-20	Date: 3-2-20	Date: 3-3-20

etegra

juniper environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PREVIOUS CRAWL SPACE SOIL SAMPLING LOCATIONS

Project Number
J034500.01

APPENDIX A-4

CRAWLSPACE SOIL
BUILDING 102 A/B/C

Summary: 17 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	6	1	0	0	N/A
Mercury	14	12	1	0	8
Lead	13	13	8	7	9
Other Metals	10	151	49	18	38
PCBs	5	1	1	0	N/A
PAHs	12	170	58	22	N/A
VOCs	2	3	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Mercury	0.87	0.154	mg/kg	102CSSS106	Below Residential RSL
Mercury	0.7	0.154	mg/kg	102D SS-10	Below Residential RSL
Mercury	0.26	0.154	mg/kg	102D SS-11	Below Residential RSL
Mercury	0.89	0.154	mg/kg	102D SS-13	Below Residential RSL
Mercury	0.25	0.154	mg/kg	102D SS-14	Below Residential RSL
Mercury	1.5	0.154	mg/kg	102D SS-8	Below Industrial RSL
Mercury	0.18	0.154	mg/kg	102D SS-9	Below Residential RSL
Mercury	1	0.154	mg/kg	102 SED-1	Below Residential RSL
Arsenic	200	12.3	mg/kg	102D SS-11	
Arsenic	30	12.3	mg/kg	102D SS-13	
Arsenic	18	12.3	mg/kg	102D SS-14	
Arsenic	17	12.3	mg/kg	102D SS-8	
Arsenic	570	12.3	mg/kg	102D SS-9	
Cadmium	5.1	3.84	mg/kg	102 SED-1	Below Residential RSL
Cadmium	4.6	3.84	mg/kg	102D SS-10	Below Residential RSL
Cadmium	4.8	3.84	mg/kg	102D SS-11	Below Residential RSL
Cadmium	3.9	3.84	mg/kg	102D SS-8	Below Residential RSL
Cadmium	5.4	3.84	mg/kg	102D SS-9	Below Residential RSL
Chromium	110	25.5	mg/kg	102D SS-10	Below Residential RSL
Chromium	80	25.5	mg/kg	102D SS-11	Below Residential RSL
Chromium	110	25.5	mg/kg	102D SS-13	Below Residential RSL
Chromium	35	25.5	mg/kg	102D SS-14	Below Residential RSL
Chromium	89	25.5	mg/kg	102D SS-8	Below Residential RSL
Chromium	130	25.5	mg/kg	102D SS-9	Below Residential RSL
Cobalt	37	13.0	mg/kg	102D SS-9	
Copper	170000	59.1	mg/kg	102 SED-1	
Copper	4700	59.1	mg/kg	102CSSS101	Below Industrial RSL
Copper	6500	59.1	mg/kg	102D SS-10	
Copper	3600	59.1	mg/kg	102D SS-11	Below Industrial RSL
Copper	230000	59.1	mg/kg	102D SS-13	
Copper	280	59.1	mg/kg	102D SS-14	Below Residential RSL
Copper	740	59.1	mg/kg	102D SS-8	Below Industrial RSL
Copper	3700	59.1	mg/kg	102D SS-9	Below Industrial RSL
Lead	2300	363	mg/kg	102CSSS104	
Lead	640	363	mg/kg	102 SED-1	Below Industrial RSL
Lead	2900	363	mg/kg	102CSSS103	
Lead	1300	363	mg/kg	102CSSS106	
Lead	1100	363	mg/kg	102D SS-10	
Lead	880	363	mg/kg	102D SS-11	
Lead	2500	363	mg/kg	102D SS-13	
Lead	390	363	mg/kg	102D SS-14	Below Residential RSL
Lead	2100	363	mg/kg	102D SS-8	
Nickel	28	27.9	mg/kg	102D SS-10	Below Residential RSL
Nickel	46	27.9	mg/kg	102D SS-11	Below Residential RSL
Nickel	99	27.9	mg/kg	102D SS-13	Below Industrial RSL
Nickel	52	27.9	mg/kg	102D SS-8	Below Residential RSL
Nickel	93	27.9	mg/kg	102D SS-9	Below Industrial RSL
Zinc	75000	414	mg/kg	102 SED-1	
Zinc	1800	414	mg/kg	102CSSS101	Below Residential RSL
Zinc	2900	414	mg/kg	102D SS-10	Below Industrial RSL
Zinc	1600	414	mg/kg	102D SS-11	Below Residential RSL
Zinc	12000	414	mg/kg	102D SS-13	Below Industrial RSL
Zinc	1900	414	mg/kg	102D SS-14	Below Residential RSL
Zinc	1200	414	mg/kg	102D SS-8	Below Residential RSL
Zinc	530	414	mg/kg	102D SS-9	Below Residential RSL

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
Metals					
Arsenic	3.7	3.0	mg/kg	102 SED-1	Below Background
Arsenic	5.5	3.0	mg/kg	102CSSS108	Below Background
Arsenic	7.3	3.0	mg/kg	102D SS-10	Below Background
Arsenic	200	3.0	mg/kg	102D SS-11	
Arsenic	30	3.0	mg/kg	102D SS-13	

Industrial RSL Exceedances, continued

Analyte	Result	Industrial RSL	Units	Sample	Comments
Arsenic	18	3.0	mg/kg	102D SS-14	
Arsenic	17	3.0	mg/kg	102D SS-8	
Arsenic	570	3.0	mg/kg	102D SS-9	
Cobalt	37	35.0	mg/kg	102D SS-9	
Copper	170000	4700	mg/kg	102 SED-1	
Copper	6500	4700	mg/kg	102D SS-10	
Copper	230000	4700	mg/kg	102D SS-13	
Iron	360000	82000	mg/kg	102D SS-11	
Iron	240000	82000	mg/kg	102D SS-13	
Iron	100000	82000	mg/kg	102D SS-14	
Iron	150000	82000	mg/kg	102D SS-8	
Iron	450000	82000	mg/kg	102D SS-9	
Lead	2300	800	mg/kg	102CSSS104	
Lead	2900	800	mg/kg	102CSSS103	
Lead	1300	800	mg/kg	102CSSS106	
Lead	1100	800	mg/kg	102D SS-10	
Lead	880	800	mg/kg	102D SS-11	
Lead	2500	800	mg/kg	102D SS-13	
Lead	2100	800	mg/kg	102D SS-8	
Zinc	75000	35000	mg/kg	102 SED-1	
PAHs					
Benz(a)anthracene	48	21.0	mg/kg	102CSSS104	
Benz(a)anthracene	180	21.0	mg/kg	102D SS-9	
Benzo(a)pyrene	42	2.1	mg/kg	102CSSS104	
Benzo(a)pyrene	6.2	2.1	mg/kg	102CSSS106	
Benzo(a)pyrene	2.2	2.1	mg/kg	102CSSS108	
Benzo(a)pyrene	2.6	2.1	mg/kg	102D SS-10	
Benzo(a)pyrene	26	2.1	mg/kg	102D SS-11	
Benzo(a)pyrene	4.8	2.1	mg/kg	102D SS-13	
Benzo(a)pyrene	8.9	2.1	mg/kg	102D SS-14	
Benzo(a)pyrene	7.8	2.1	mg/kg	102D SS-8	
Benzo(a)pyrene	150	2.1	mg/kg	102D SS-9	
Benzo(b)fluoranthene	50	21.0	mg/kg	102CSSS104	
Benzo(b)Fluoranthene	33	21.0	mg/kg	102D SS-11	
Benzo(b)Fluoranthene	190	21.0	mg/kg	102D SS-9	
Dibenzo(a,h)anthracene	4	2.1	mg/kg	102CSSS104	
Dibenzo(a,h)anthracene	5.1	2.1	mg/kg	102D SS-11	
Dibenzo(a,h)anthracene	2.2	2.1	mg/kg	102D SS-14	
Dibenzo(a,h)anthracene	3.5	2.1	mg/kg	102D SS-8	
Dibenzo(a,h)anthracene	24	2.1	mg/kg	102D SS-9	
Dinitrotoluene, 2,4-	39	7.4	mg/kg	102D SS-13	
Dinitrotoluene, 2,6-	2	1.5	mg/kg	102D SS-13	
Indeno(1,2,3-cd)pyrene	76	21.0	mg/kg	102D SS-9	

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
Metals					
Mercury	1.5	1.1	mg/kg	102D SS-8	
Antimony	5.1	3.1	mg/kg	102 SED-1	
Antimony	4.4	3.1	mg/kg	102D SS-11	
Antimony	15	3.1	mg/kg	102D SS-13	
Antimony	5.6	3.1	mg/kg	102D SS-8	
Antimony	3.2	3.1	mg/kg	102D SS-9	
Arsenic	3.7	0.68	mg/kg	102 SED-1	Below Background
Arsenic	2.7	0.68	mg/kg	102CSSS105	Below Background
Arsenic	5.5	0.68	mg/kg	102CSSS108	Below Background
Arsenic	7.3	0.68	mg/kg	102D SS-10	Below Background
Arsenic	200	0.68	mg/kg	102D SS-11	
Arsenic	30	0.68	mg/kg	102D SS-13	
Arsenic	18	0.68	mg/kg	102D SS-14	
Arsenic	17	0.68	mg/kg	102D SS-8	
Arsenic	570	0.68	mg/kg	102D SS-9	
Cobalt	3.4	2.3	mg/kg	102D SS-10	Below Background
Cobalt	25	2.3	mg/kg	102D SS-11	
Cobalt	10	2.3	mg/kg	102D SS-13	Below Background
Cobalt	5.5	2.3	mg/kg	102D SS-14	Below Background
Cobalt	15	2.3	mg/kg	102D SS-8	
Cobalt	37	2.3	mg/kg	102D SS-9	
Copper	170000	310	mg/kg	102 SED-1	
Copper	4700	310	mg/kg	102CSSS101	
Copper	6500	310	mg/kg	102D SS-10	
Copper	3600	310	mg/kg	102D SS-11	
Copper	230000	310	mg/kg	102D SS-13	
Copper	740	310	mg/kg	102D SS-8	
Copper	3700	310	mg/kg	102D SS-9	
Iron	6800	5500	mg/kg	102 SED-1	Below Background
Iron	34000	5500	mg/kg	102D SS-10	Below Background

Residential RSL Exceedances, continued

Analyte	Result	Residential RSL	Units	Sample	Comments
Iron	360000	5500	mg/kg	102D SS-11	
Iron	240000	5500	mg/kg	102D SS-13	
Iron	100000	5500	mg/kg	102D SS-14	
Iron	150000	5500	mg/kg	102D SS-8	
Iron	450000	5500	mg/kg	102D SS-9	
Lead	2300	400	mg/kg	102CSSS104	
Lead	640	400	mg/kg	102 SED-1	
Lead	2900	400	mg/kg	102CSSS103	
Lead	1300	400	mg/kg	102CSSS106	
Lead	1100	400	mg/kg	102D SS-10	
Lead	880	400	mg/kg	102D SS-11	
Lead	2500	400	mg/kg	102D SS-13	
Lead	2100	400	mg/kg	102D SS-8	
Manganese	1300	180	mg/kg	102D SS-11	Below Background
Manganese	620	180	mg/kg	102D SS-13	Below Background
Manganese	520	180	mg/kg	102D SS-14	Below Background
Manganese	970	180	mg/kg	102D SS-8	Below Background
Manganese	1900	180	mg/kg	102D SS-9	Below Background
Nickel	99	84	mg/kg	102D SS-13	
Nickel	93	84	mg/kg	102D SS-9	
Silver	530	39	mg/kg	102D SS-11	
Silver	50	39	mg/kg	102D SS-8	
Silver	410	39	mg/kg	102D SS-9	
Vanadium	120	39	mg/kg	102D SS-11	Below Background
Vanadium	140	39	mg/kg	102D SS-9	Below Background
Zinc	75000	2300	mg/kg	102 SED-1	
Zinc	2900	2300	mg/kg	102D SS-10	
Zinc	12000	2300	mg/kg	102D SS-13	
PCBs					
Aroclor 1260	0.4	0.24	mg/kg	102D SS-11	
PAHs					
Benz(a)anthracene	1.8	1.1	mg/kg	102D SS-10	
Benz(a)anthracene	14	1.1	mg/kg	102D SS-11	
Benz(a)anthracene	2.7	1.1	mg/kg	102CSSS108	
Benz(a)anthracene	7.3	1.1	mg/kg	102CSSS106	
Benz(a)anthracene	5.2	1.1	mg/kg	102D SS-8	
Benz(a)anthracene	48	1.1	mg/kg	102CSSS104	
Benz(a)anthracene	180	1.1	mg/kg	102D SS-9	
Benz(a)anthracene	8.7	1.1	mg/kg	102D SS-13	
Benz(a)anthracene	8.2	1.1	mg/kg	102D SS-14	
Benz(a)anthracene	1.9	1.1	mg/kg	102CSSS103	
Benzo(a)pyrene	6.2	0.11	mg/kg	102CSSS106	
Benzo(a)pyrene	150	0.11	mg/kg	102D SS-9	
Benzo(a)pyrene	2.2	0.11	mg/kg	102CSSS108	
Benzo(a)pyrene	7.8	0.11	mg/kg	102D SS-8	
Benzo(a)pyrene	4.8	0.11	mg/kg	102D SS-13	
Benzo(a)pyrene	8.9	0.11	mg/kg	102D SS-14	
Benzo(a)pyrene	26	0.11	mg/kg	102D SS-11	
Benzo(a)pyrene	42	0.11	mg/kg	102CSSS104	
Benzo(a)pyrene	1.7	0.11	mg/kg	102CSSS103	
Benzo(a)pyrene	0.51	0.11	mg/kg	102CSSS105	
Benzo(a)pyrene	2.6	0.11	mg/kg	102D SS-10	
Benzo(b)fluoranthene	2.6	1.1	mg/kg	102CSSS108	
Benzo(b)Fluoranthene	33	1.1	mg/kg	102D SS-11	
Benzo(b)fluoranthene	7.3	1.1	mg/kg	102CSSS106	
Benzo(b)Fluoranthene	190	1.1	mg/kg	102D SS-9	
Benzo(b)Fluoranthene	10	1.1	mg/kg	102D SS-14	
Benzo(b)Fluoranthene	13	1.1	mg/kg	102D SS-13	
Benzo(b)fluoranthene	50	1.1	mg/kg	102CSSS104	
Benzo(b)Fluoranthene	5.6	1.1	mg/kg	102D SS-8	
Benzo(b)fluoranthene	1.6	1.1	mg/kg	102CSSS103	
Benzo(b)Fluoranthene	5.8	1.1	mg/kg	102D SS-10	
Benzo(k)Fluoranthene	21	11	mg/kg	102D SS-13	
Benzo(k)Fluoranthene	30	11	mg/kg	102D SS-11	
Benzo(k)Fluoranthene	16	11	mg/kg	102D SS-9	
Benzo(k)Fluoranthene	17	11	mg/kg	102CSSS104	
Chrysene	290	110	mg/kg	102D SS-9	
Dibenzo(a,h)anthracene	4	0.11	mg/kg	102CSSS104	
Dibenzo(a,h)anthracene	0.46	0.11	mg/kg	102CSSS103	
Dibenzo(a,h)anthracene	24	0.11	mg/kg	102D SS-9	
Dibenzo(a,h)anthracene	3.5	0.11	mg/kg	102D SS-8	
Dibenzo(a,h)anthracene	0.62	0.11	mg/kg	102CSSS108	
Dibenzo(a,h)anthracene	2.2	0.11	mg/kg	102D SS-14	
Dibenzo(a,h)anthracene	5.1	0.11	mg/kg	102D SS-11	
Dibenzo(a,h)anthracene	0.92	0.11	mg/kg	102CSSS106	
Dibenzo(a,h)anthracene	1.2	0.11	mg/kg	102D SS-13	
Dinitrotoluene, 2,4-	39	1.7	mg/kg	102D SS-13	

Residential RSL Exceedances, continued

Analyte	Result	Residential RSL	Units	Sample	Comments
Dinitrotoluene, 2,6-	2	0.36	mg/kg	102D SS-13	
Fluoranthene	350	240	mg/kg	102D SS-9	
Indeno(1,2,3-cd)pyrene	2.9	1.1	mg/kg	102D SS-10	
Indeno(1,2,3-cd)pyrene	12	1.1	mg/kg	102D SS-11	
Indeno(1,2,3-cd)pyrene	1.4	1.1	mg/kg	102CSSS108	
Indeno(1,2,3-cd)pyrene	4	1.1	mg/kg	102D SS-14	
Indeno(1,2,3-cd)pyrene	3.8	1.1	mg/kg	102CSSS106	
Indeno(1,2,3-cd)pyrene	5.8	1.1	mg/kg	102D SS-8	
Indeno(1,2,3-cd)pyrene	20	1.1	mg/kg	102CSSS104	
Indeno(1,2,3-cd)pyrene	76	1.1	mg/kg	102D SS-9	
Indeno(1,2,3-cd)pyrene	2.3	1.1	mg/kg	102D SS-13	
Pyrene	310	180	mg/kg	102D SS-9	

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 102 D

Summary: 21 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	16	0	0	0	N/A
Mercury	21	21	0	0	3
Lead	21	21	1	0	2
Other Metals	21	352	114	24	19
PCBs	16	0	0	0	N/A
PAHs	6	6	1	0	N/A
VOCs	0	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Mercury	0.85	0.154	mg/kg	102D CORNER SPILL	Below Residential RSL
Mercury	0.37	0.154	mg/kg	102D SS-1 SHALLOW	Below Residential RSL
Mercury	0.7	0.154	mg/kg	102D SS-2 DEEP	Below Residential RSL
Arsenic	54	12.3	mg/kg	102D SS-7 SHALLOW	
Beryllium	1.1	1.01	mg/kg	102D SS-3 DEEP	Below Residential RSL
Beryllium	2.2	1.01	mg/kg	102D- SS-2 (DEEP)	Below Residential RSL
Beryllium	1.1	1.01	mg/kg	102D SS-3 (DEEP)	Below Residential RSL
Beryllium	1.7	1.01	mg/kg	102D- SS-5 (DEEP)	Below Residential RSL
Chromium	60	25.5	mg/kg	102D SS-7 SHALLOW	Below Residential RSL
Chromium	28	25.5	mg/kg	102D SS-3 DEEP	Below Residential RSL
Chromium	26	25.5	mg/kg	102D SS-6 DEEP	Below Residential RSL
Chromium	87	25.5	mg/kg	102D CORNER SPILL	Below Residential RSL
Chromium	78	25.5	mg/kg	102D SS-6 SHALLOW	Below Residential RSL
Chromium	29	25.5	mg/kg	102D- SS-5 (DEEP)	Below Residential RSL
Copper	390	59.1	mg/kg	102D CORNER SPILL	Below Industrial RSL
Lead	380	363	mg/kg	102D SS-7 SHALLOW	Below Residential RSL
Lead	410	363	mg/kg	102D SS-2 SHALLOW	Below Industrial RSL
Nickel	75	27.9	mg/kg	102D CORNER SPILL	Below Residential RSL
Nickel	42	27.9	mg/kg	102D- SS-2 (DEEP)	Below Residential RSL
Nickel	32	27.9	mg/kg	102D SS-3 DEEP	Below Residential RSL
Thallium	2.6	0.53	mg/kg	102D CORNER SPILL	
Thallium	1.5	0.53	mg/kg	102DCS SED	
Zinc	440	414	mg/kg	102D CORNER SPILL	Below Residential RSL
Zinc	420	414	mg/kg	102D SS-6 SHALLOW	Below Residential RSL

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
Metals					
Arsenic	11	3.0	mg/kg	102D CORNER SPILL	Below Background
Arsenic	4.9	3.0	mg/kg	102D- SS-1 (DEEP)	Below Background
Arsenic	6.5	3.0	mg/kg	102D SS-1 DEEP	Below Background
Arsenic	6.8	3.0	mg/kg	102D SS-1 SHALLOW	Below Background
Arsenic	5.3	3.0	mg/kg	102D- SS-2 (DEEP)	Below Background
Arsenic	5.5	3.0	mg/kg	102D SS-2 DEEP	Below Background
Arsenic	9.1	3.0	mg/kg	102D SS-2 SHALLOW	Below Background
Arsenic	4.4	3.0	mg/kg	102D SS-3 (DEEP)	Below Background
Arsenic	7	3.0	mg/kg	102D SS-3 DEEP	Below Background
Arsenic	8	3.0	mg/kg	102D SS-3 SHALLOW	Below Background
Arsenic	4.8	3.0	mg/kg	102D SS-4 (DEEP)	Below Background
Arsenic	8.5	3.0	mg/kg	102D SS-4 DEEP	Below Background
Arsenic	9.2	3.0	mg/kg	102D SS-4 SHALLOW	Below Background
Arsenic	6.2	3.0	mg/kg	102D- SS-5 (DEEP)	Below Background
Arsenic	9.8	3.0	mg/kg	102D SS-5 DEEP	Below Background
Arsenic	9.4	3.0	mg/kg	102D SS-5 SHALLOW	Below Background
Arsenic	4.4	3.0	mg/kg	102D SS-6 DEEP	Below Background
Arsenic	7.5	3.0	mg/kg	102D SS-6 SHALLOW	Below Background
Arsenic	4.9	3.0	mg/kg	102D SS-7 DEEP	Below Background
Arsenic	54	3.0	mg/kg	102D SS-7 SHALLOW	
Arsenic	8.1	3.0	mg/kg	102DCS SED	Below Background
Cobalt	21	13	mg/kg	102D- SS-2 (DEEP)	
Cobalt	15	13	mg/kg	102D SS-3 (DEEP)	
Cobalt	14	13	mg/kg	102D SS-3 DEEP	
Iron	110000	82000	mg/kg	102D CORNER SPILL	
Thallium	2.6	1.2	mg/kg	102D CORNER SPILL	
Thallium	1.5	1.2	mg/kg	102DCS SED	

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
Metals					
Aluminum	18000	7700	mg/kg	102D SS-7 DEEP	Below Background
Aluminum	18000	7700	mg/kg	102D SS-5 DEEP	Below Background
Aluminum	16000	7700	mg/kg	102D SS-5 SHALLOW	Below Background
Aluminum	16000	7700	mg/kg	102D- SS-5 (DEEP)	Below Background
Aluminum	17000	7700	mg/kg	102D SS-4 SHALLOW	Below Background
Aluminum	24000	7700	mg/kg	102D SS-6 DEEP	Below Background
Aluminum	14000	7700	mg/kg	102D SS-4 (DEEP)	Below Background

Residential RSL Exceedances, continued

Analyte	Result	Residential RSL	Units	Sample	Comments
Aluminum	25000	7700	mg/kg	102D SS-6 SHALLOW	Below Background
Aluminum	16000	7700	mg/kg	102D SS-3 SHALLOW	Below Background
Aluminum	16000	7700	mg/kg	102D- SS-1 (DEEP)	Below Background
Aluminum	21000	7700	mg/kg	102D SS-3 DEEP	Below Background
Aluminum	17000	7700	mg/kg	102D SS-4 DEEP	Below Background
Aluminum	10000	7700	mg/kg	102D SS-3 (DEEP)	Below Background
Aluminum	17000	7700	mg/kg	102D SS-2 SHALLOW	Below Background
Aluminum	9900	7700	mg/kg	102D CORNER SPILL	Below Background
Aluminum	18000	7700	mg/kg	102D SS-7 SHALLOW	Below Background
Aluminum	14000	7700	mg/kg	102D SS-1 DEEP	Below Background
Aluminum	14000	7700	mg/kg	102D SS-2 DEEP	Below Background
Aluminum	16000	7700	mg/kg	102D- SS-2 (DEEP)	Below Background
Aluminum	13000	7700	mg/kg	102D SS-1 SHALLOW	Below Background
Aluminum	16000	7700	mg/kg	102DCS SED	Below Background
Arsenic	8	0.68	mg/kg	102D SS-3 SHALLOW	Below Background
Arsenic	6.2	0.68	mg/kg	102D- SS-5 (DEEP)	Below Background
Arsenic	6.5	0.68	mg/kg	102D SS-1 DEEP	Below Background
Arsenic	9.2	0.68	mg/kg	102D SS-4 SHALLOW	Below Background
Arsenic	8.5	0.68	mg/kg	102D SS-4 DEEP	Below Background
Arsenic	7	0.68	mg/kg	102D SS-3 DEEP	Below Background
Arsenic	6.8	0.68	mg/kg	102D SS-1 SHALLOW	Below Background
Arsenic	9.1	0.68	mg/kg	102D SS-2 SHALLOW	Below Background
Arsenic	5.3	0.68	mg/kg	102D- SS-2 (DEEP)	Below Background
Arsenic	4.9	0.68	mg/kg	102D- SS-1 (DEEP)	Below Background
Arsenic	9.8	0.68	mg/kg	102D SS-5 DEEP	Below Background
Arsenic	5.5	0.68	mg/kg	102D SS-2 DEEP	Below Background
Arsenic	4.4	0.68	mg/kg	102D SS-3 (DEEP)	Below Background
Arsenic	4.8	0.68	mg/kg	102D SS-4 (DEEP)	Below Background
Arsenic	9.4	0.68	mg/kg	102D SS-5 SHALLOW	Below Background
Arsenic	4.4	0.68	mg/kg	102D SS-6 DEEP	Below Background
Arsenic	11	0.68	mg/kg	102D CORNER SPILL	Below Background
Arsenic	54	0.68	mg/kg	102D SS-7 SHALLOW	
Arsenic	8.1	0.68	mg/kg	102DCS SED	Below Background
Arsenic	4.9	0.68	mg/kg	102D SS-7 DEEP	Below Background
Arsenic	7.5	0.68	mg/kg	102D SS-6 SHALLOW	Below Background
Cobalt	11	2.3	mg/kg	102D SS-6 SHALLOW	Below Background
Cobalt	7.9	2.3	mg/kg	102D SS-3 SHALLOW	Below Background
Cobalt	9.9	2.3	mg/kg	102D SS-1 SHALLOW	Below Background
Cobalt	10	2.3	mg/kg	102D- SS-1 (DEEP)	Below Background
Cobalt	5.5	2.3	mg/kg	102D SS-7 DEEP	Below Background
Cobalt	8.8	2.3	mg/kg	102D CORNER SPILL	Below Background
Cobalt	21	2.3	mg/kg	102D- SS-2 (DEEP)	
Cobalt	9.4	2.3	mg/kg	102D SS-2 SHALLOW	Below Background
Cobalt	9	2.3	mg/kg	102D SS-2 DEEP	Below Background
Cobalt	6.3	2.3	mg/kg	102D SS-7 SHALLOW	Below Background
Cobalt	15	2.3	mg/kg	102D SS-3 (DEEP)	
Cobalt	8.7	2.3	mg/kg	102D SS-1 DEEP	Below Background
Cobalt	9.4	2.3	mg/kg	102D SS-5 SHALLOW	Below Background
Cobalt	8.9	2.3	mg/kg	102D- SS-5 (DEEP)	Below Background
Cobalt	8.9	2.3	mg/kg	102DCS SED	Below Background
Cobalt	8.8	2.3	mg/kg	102D SS-4 DEEP	Below Background
Cobalt	8.2	2.3	mg/kg	102D SS-4 SHALLOW	Below Background
Cobalt	8.8	2.3	mg/kg	102D SS-5 DEEP	Below Background
Cobalt	3.7	2.3	mg/kg	102D SS-4 (DEEP)	Below Background
Cobalt	14	2.3	mg/kg	102D SS-3 DEEP	
Cobalt	2.4	2.3	mg/kg	102D SS-6 DEEP	Below Background
Copper	390	310	mg/kg	102D CORNER SPILL	
Iron	20000	5500	mg/kg	102D SS-7 SHALLOW	Below Background
Iron	19000	5500	mg/kg	102D- SS-2 (DEEP)	Below Background
Iron	19000	5500	mg/kg	102D SS-1 SHALLOW	Below Background
Iron	19000	5500	mg/kg	102D SS-1 DEEP	Below Background
Iron	21000	5500	mg/kg	102DCS SED	Below Background
Iron	27000	5500	mg/kg	102D SS-6 SHALLOW	Below Background
Iron	22000	5500	mg/kg	102D- SS-5 (DEEP)	Below Background
Iron	22000	5500	mg/kg	102D SS-4 SHALLOW	Below Background
Iron	22000	5500	mg/kg	102D SS-5 SHALLOW	Below Background
Iron	22000	5500	mg/kg	102D SS-4 DEEP	Below Background
Iron	23000	5500	mg/kg	102D SS-3 DEEP	Below Background
Iron	17000	5500	mg/kg	102D SS-4 (DEEP)	Below Background
Iron	21000	5500	mg/kg	102D SS-3 SHALLOW	Below Background
Iron	23000	5500	mg/kg	102D SS-5 DEEP	Below Background
Iron	17000	5500	mg/kg	102D SS-2 DEEP	Below Background
Iron	110000	5500	mg/kg	102D CORNER SPILL	
Iron	16000	5500	mg/kg	102D SS-3 (DEEP)	Below Background
Iron	22000	5500	mg/kg	102D- SS-1 (DEEP)	Below Background
Iron	22000	5500	mg/kg	102D SS-2 SHALLOW	Below Background
Iron	17000	5500	mg/kg	102D SS-7 DEEP	Below Background

Residential RSL Exceedances, continued

Analyte	Result	Residential RSL	Units	Sample	Comments
Iron	21000	5500	mg/kg	102D SS-6 DEEP	Below Background
Lead	410	400	mg/kg	102D SS-2 SHALLOW	
Manganese	400	180	mg/kg	102D CORNER SPILL	Below Background
Manganese	290	180	mg/kg	102D- SS-1 (DEEP)	Below Background
Manganese	590	180	mg/kg	102D SS-3 SHALLOW	Below Background
Manganese	280	180	mg/kg	102D SS-6 SHALLOW	Below Background
Manganese	930	180	mg/kg	102D SS-5 SHALLOW	Below Background
Manganese	500	180	mg/kg	102D SS-5 DEEP	Below Background
Manganese	370	180	mg/kg	102D SS-7 DEEP	Below Background
Manganese	410	180	mg/kg	102D SS-7 SHALLOW	Below Background
Manganese	680	180	mg/kg	102D SS-1 DEEP	Below Background
Manganese	780	180	mg/kg	102D SS-4 SHALLOW	Below Background
Manganese	630	180	mg/kg	102D SS-4 DEEP	Below Background
Manganese	400	180	mg/kg	102D- SS-5 (DEEP)	Below Background
Manganese	840	180	mg/kg	102D SS-3 DEEP	Below Background
Manganese	270	180	mg/kg	102D SS-3 (DEEP)	Below Background
Manganese	860	180	mg/kg	102D SS-2 SHALLOW	Below Background
Manganese	620	180	mg/kg	102DCS SED	Below Background
Manganese	1000	180	mg/kg	102D- SS-2 (DEEP)	Below Background
Manganese	930	180	mg/kg	102D SS-1 SHALLOW	Below Background
Silver	450	39	mg/kg	102D CORNER SPILL	
Thallium	1.5	0.078	mg/kg	102DCS SED	
Thallium	2.6	0.078	mg/kg	102D CORNER SPILL	
Vanadium	44	39	mg/kg	102D SS-6 SHALLOW	Below Background
Vanadium	40	39	mg/kg	102D SS-5 SHALLOW	Below Background
Vanadium	41	39	mg/kg	102D SS-5 DEEP	Below Background
Vanadium	42	39	mg/kg	102D SS-3 DEEP	Below Background
Vanadium	41	39	mg/kg	102D SS-4 SHALLOW	Below Background
Vanadium	41	39	mg/kg	102D SS-2 SHALLOW	Below Background
Vanadium	40	39	mg/kg	102D- SS-1 (DEEP)	Below Background
Vanadium	45	39	mg/kg	102D- SS-5 (DEEP)	Below Background
PAHs					
Dibenzo(a,h)anthracene	0.26	0.11	mg/kg	102D CORNER SPILL	

Additionally, two crawlspace soil samples exhibited asbestos detections (102D-IS1 and 102D-IS2).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 102 E

Summary: 2 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	1	0	0	0	N/A
Mercury	1	1	0	0	0
Lead	3	2	0	0	0
Other Metals	19	19	6	2	2
PCBs	1	0	0	0	N/A
PAHs	0	0	0	0	N/A
VOCs	0	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Arsenic	6.8	12.3	mg/kg	102ECSSOIL	
Thallium	1.3	0.53	mg/kg	102ECSSOIL	

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
Metals					
Arsenic	6.8	3.0	mg/kg	102ECSSOIL	
Thallium	1.3	1.2	mg/kg	102ECSSOIL	

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
Metals					
Aluminum	17000	7700	mg/kg	102ECSSOIL	Below Background
Arsenic	6.8	0.68	mg/kg	102ECSSOIL	
Cobalt	12	2.3	mg/kg	102ECSSOIL	Below Background
Iron	20000	5500	mg/kg	102ECSSOIL	Below Background
Manganese	740	180	mg/kg	102ECSSOIL	Below Background
Thallium	1.3	0.078	mg/kg	102ECSSOIL	

Additionally, two crawlspace soil samples exhibited asbestos detections (102E-IS1 and 102E-IS2).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 103 A/B/C

Summary: 7 Crawlspace Soil Samples Total
A membrane is present covering crawlspace soils in this building.

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	2	0	0	0	N/A
Mercury	7	7	0	0	3
Lead	7	7	2	1	2
Other Metals	2	37	12	3	11
PCBs	2	0	0	0	N/A
PAHs	7	108	14	1	N/A
VOCs	2	2	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Mercury	0.37	0.154	mg/kg	103CSSOIL2	Below Residential RSL
Mercury	0.373	0.154	mg/kg	103-IS1	Below Residential RSL
Mercury	0.335	0.154	mg/kg	103-IS3	Below Residential RSL
Lead	738	363	mg/kg	103-IS3	
Lead	1010	363	mg/kg	103-IS5	
Beryllium	1.2	1.01	mg/kg	103CSSOIL1	Below Residential RSL
Beryllium	1.1	1.01	mg/kg	103CSSOIL4	Below Residential RSL
Chromium	27	25.5	mg/kg	103CSSOIL1	Below Residential RSL
Chromium	29	25.5	mg/kg	103CSSOIL4	Below Residential RSL
Cobalt	18	13	mg/kg	103CSSOIL4	Below Industrial RSL
Copper	87	59.1	mg/kg	103CSSOIL1	Below Residential RSL
Iron	37000	35460	mg/kg	103CSSOIL4	Below Industrial RSL
Nickel	34	27.9	mg/kg	103CSSOIL1	Below Residential RSL
Nickel	39	27.9	mg/kg	103CSSOIL4	Below Residential RSL
Thallium	1.2	0.53	mg/kg	103CSSOIL1	Below Industrial RSL
Thallium	1.3	0.53	mg/kg	103CSSOIL4	

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
PAHs					
Benzo(a)pyrene	3.2	2.1	mg/kg	103-IS3	
Metals					
Arsenic	5.8	3	mg/kg	103CSSOIL1	Below Background
Arsenic	4.6	3	mg/kg	103CSSOIL4	Below Background
Thallium	1.3	1.2	mg/kg	103CSSOIL4	
Lead	1010	800	mg/kg	103-IS4	

Residential RSL Excceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
PAHs					
Benzo(a)pyrene	0.38	0.11	mg/kg	103CSSOIL1	
Benzo(a)pyrene	0.12	0.11	mg/kg	103-IS1	
Benzo(a)anthracene	3.1	1.1	mg/kg	103-IS3	
Benzo(a)pyrene	3.2	0.11	mg/kg	103-IS3	
Benzo(b)fluoranthene	4.7	1.1	mg/kg	103-IS3	
Dibenzo(a,h)anthracene	0.83	0.11	mg/kg	103-IS3	
Indeno(1,2,3-cd)pyrene	3.3	1.1	mg/kg	103-IS3	
Benzo(a)anthracene	1.8	1.1	mg/kg	103-IS4	
Benzo(a)pyrene	1.6	0.11	mg/kg	103-IS4	
Benzo(b)fluoranthene	2.2	1.1	mg/kg	103-IS4	
Dibenzo(a,h)anthracene	0.25	0.11	mg/kg	103-IS4	
Indeno(1,2,3-cd)pyrene	1.3	1.1	mg/kg	103-IS4	
Benzo(a)pyrene	0.58	0.11	mg/kg	103-IS5	
Dibenzo(a,h)anthracene	0.12	0.11	mg/kg	103-IS5	
Metals					
Aluminum	17000	7700	mg/kg	103CSSOIL1	Below Background
Aluminum	15000	7700	mg/kg	103CSSOIL4	Below Background
Arsenic	5.8	0.68	mg/kg	103CSSOIL1	Below Background
Arsenic	4.6	0.68	mg/kg	103CSSOIL4	Below Background
Cobalt	10	2.3	mg/kg	103CSSOIL1	Below Background
Cobalt	18	2.3	mg/kg	103CSSOIL4	
Iron	21000	5500	mg/kg	103CSSOIL1	Below Background
Iron	37000	5500	mg/kg	103CSSOIL4	
Lead	738	400	mg/kg	103-IS3	
Lead	1010	400	mg/kg	103-IS4	
Manganese	630	180	mg/kg	103CSSOIL1	Below Background
Manganese	660	180	mg/kg	103CSSOIL4	Below Background
Thallium	1.2	0.078	mg/kg	103CSSOIL1	
Thallium	1.3	0.078	mg/kg	103CSSOIL4	

Additionally, four crawlspace soil samples exhibited asbestos detections (103-IS2, 103-IS3, 103-IS4, and 103-IS5).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents

PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 103 D

Summary: 5 Crawlspace Soil Samples Total (one field duplicate)

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	2	0	0	0	N/A
Mercury	2	2	0	0	1
Lead	5	5	0	0	0
Other Metals	2	33	10	2	0
PCBs	2	0	0	0	N/A
PAHs	2	20	0	0	N/A
VOCs	2	2	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Mercury	0.84	0.154	mg/kg	103DCSSS2	Below Residential RSL

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
Metals					
Arsenic	5.9	3	mg/kg	103DCSSS1	Below Background
Arsenic	4.6	3	mg/kg	103DCSSS2	Below Background

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
Metals					
Aluminum	9600	7700	mg/kg	103DCSSS1	Below Background
Aluminum	9900	7700	mg/kg	103DCSSS2	Below Background
Arsenic	5.9	0.69	mg/kg	103DCSSS1	Below Background
Arsenic	4.6	0.68	mg/kg	103DCSSS2	Below Background
Cobalt	7.7	2.3	mg/kg	103DCSSS1	Below Background
Cobalt	4.7	2.3	mg/kg	103DCSSS2	Below Background
Iron	16000	5500	mg/kg	103DCSSS1	Below Background
Iron	14000	5500	mg/kg	103DCSSS2	Below Background
Manganese	620	180	mg/kg	103DCSSS1	Below Background
Manganese	270	180	mg/kg	103DCSSS2	Below Background

Additionally, three crawlspace soil samples exhibited asbestos detections (103D-IS1, 103D-IS1-FD, and 103D-IS2).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 103 E

Summary: 4 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	2	0	0	0	N/A
Mercury	2	2	0	0	0
Lead	4	4	2	0	2
Other Metals	1	34	5	1	1
PCBs	2	0	0	0	N/A
PAHs	1	2	0	0	N/A
VOCs	2	1	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Cobalt	22	13	mg/kg	102ECSSS2	
Lead	482	363	mg/kg	103E-IS1	Below Industrial RSL
Lead	681	363	mg/kg	103E-IS2	Below Industrial RSL

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
Metals					
Arsenic	3.3	3	mg/kg	102ECSSS2	Below Background

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
Metals					
Aluminum	10000	7700	mg/kg	102ECSSS2	Below Background
Arsenic	3.3	0.68	mg/kg	102ECSSS2	Below Background
Cobalt	22	2.3	mg/kg	102ECSSS2	
Iron	25000	5500	mg/kg	102ECSSS2	Below Background
Manganese	190	180	mg/kg	102ECSSS2	Below Background
Lead	482	400	mg/kg	103E-IS1	
Lead	681	400	mg/kg	103E-IS2	

Additionally, two crawlspace soil samples exhibited asbestos detections (103E-IS1 and 103E-IS2).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 103 F

Summary: 2 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	0	0	0	0	N/A
Mercury	2	2	0	0	1
Lead	2	2	0	0	0
Other Metals	0	0	0	0	0
PCBs	0	0	0	0	N/A
PAHs	0	0	0	0	N/A
VOCs	0	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Mercury	0.51	0.154	mg/kg	103F-IS2	Below Residential RSL

Additionally, two crawlspace soil samples exhibited asbestos detections (103F-IS1 and 103F-IS2).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 104 A/B/C/D

Summary: 6 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	0	0	0	0	N/A
Mercury	0	0	0	0	0
Lead	6	6	1	0	1
Other Metals	0	0	0	0	0
PCBs	0	0	0	0	N/A
PAHs	0	0	0	0	N/A
VOCs	0	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Lead	429	363	mg/kg	104-IS4	Below Industrial RSL

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
Metals					
Lead	429	400	mg/kg	104-IS4	

Additionally, four crawlspace soil samples exhibited asbestos detections (104-IS1, 104-IS2, 104-IS3, and 104-IS4).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 104 E

Summary: 4 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	1	0	0	0	N/A
Mercury	2	2	0	0	0
Lead	4	4	1	1	1
Other Metals	2	32	10	2	1
PCBs	2	1	0	0	N/A
PAHs	2	28	5	1	N/A
VOCs	0	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Beryllium	1.5	1.01	mg/kg	104ECSSS1	Below Residential RSL
Lead	1930	363	mg/kg	104E-IS1	

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
PAHs					
Benzo(a)pyrene	5.2	2.1	mg/kg	104E-IS1	
Metals					
Arsenic	7.3	3	mg/kg	104ECSSS1	Below Background
Arsenic	3.7	3	mg/kg	104ECSSS2	Below Background
Lead	1930	800	mg/kg	104E-IS1	

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
PAHs					
Benzo(a)anthracene	4.5	1.1	mg/kg	104E-IS1	
Benzo(a)pyrene	5.2	0.11	mg/kg	104E-IS1	
Benzo(b)fluoranthene	8	1.1	mg/kg	104E-IS1	
Dibenzo(a,h)anthracene	1.2	0.11	mg/kg	104E-IS1	
Ideno(1,2,3-cd)pyrene	5.1	1.1	mg/kg	104E-IS1	
Metals					
Aluminum	9400	7700	mg/kg	104ECSSS1	Below Background
Aluminum	8800	7700	mg/kg	104ECSSS2	Below Background
Arsenic	7.3	0.68	mg/kg	104ECSSS1	Below Background
Arsenic	3.7	0.68	mg/kg	104ECSSS2	Below Background
Cobalt	11	2.3	mg/kg	104ECSSS1	Below Background
Cobalt	6.9	2.3	mg/kg	104ECSSS2	Below Background
Iron	18000	5500	mg/kg	104ECSSS1	Below Background
Iron	13000	5500	mg/kg	104ECSSS2	Below Background
Lead	1930	400	mg/kg	104E-IS1	
Manganese	230	180	mg/kg	104ECSSS1	Below Background
Manganese	380	180	mg/kg	104ECSSS2	Below Background

Additionally, one crawlspace soil sample exhibited asbestos detections (104E-IS1).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 104 F

Summary: 3 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	1	0	0	0	N/A
Mercury	1	1	0	0	0
Lead	3	3	1	1	1
Other Metals	1	17	5	1	0
PCBs	1	0	0	0	N/A
PAHs	0	0	0	0	N/A
VOCs	0	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Lead	1080	363	mg/kg	104F-IS1	

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
Metals					
Arsenic	5	3	mg/kg	104FCSSS1	Below Background
Lead	1080	800	mg/kg	104F-IS1	

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
Metals					
Aluminum	11000	7700	mg/kg	104FCSSS1	Below Background
Arsenic	5	0.68	mg/kg	104FCSSS1	Below Background
Cobalt	8.5	2.3	mg/kg	104FCSSS1	Below Background
Iron	15000	5500	mg/kg	104FCSSS1	Below Background
Manganese	270	180	mg/kg	104FCSSS1	Below Background
Lead	1080	400	mg/kg	104F-IS1	

Additionally, one crawlspace soil sample exhibited asbestos detections (104F-IS1).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 105 A/B/C/D

Summary: 13 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	7	0	0	0	N/A
Mercury	7	7	0	0	1
Lead	13	13	0	0	0
Other Metals	7	115	33	7	3
PCBs	7	3	1	0	N/A
PAHs	7	13	0	0	N/A
VOCs	5	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Chromium	28	25.5	mg/kg	105BSS1	Below Residential RSL
Copper	92	59.1	mg/kg	105BSS1	Below Residential RSL
Copper	82	59.1	mg/kg	105CSS1	Below Residential RSL
Mercury	0.19	0.154	mg/kg	105CSS1	Below Residential RSL

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
Metals					
Arsenic	4.9	3	mg/kg	105ASS1	Below Background
Arsenic	7	3	mg/kg	105ASS2	Below Background
Arsenic	6.3	3	mg/kg	105BSS1	Below Background
Arsenic	4.7	3	mg/kg	105BSS2	Below Background
Arsenic	6.4	3	mg/kg	105CSS1	Below Background
Arsenic	5.3	3	mg/kg	105CSS2	Below Background
Arsenic	3.6	3	mg/kg	105DCSSS1	Below Background

Residential RSL Excceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
PAHs					
Benzo(a)pyrene	0.13	0.11	mg/kg	105BSS1	
Metals					
Aluminum	11000	7700	mg/kg	105ASS1	Below Background
Aluminum	11000	7700	mg/kg	105ASS2	Below Background
Aluminum	18000	7700	mg/kg	105BSS1	Below Background
Aluminum	11000	7700	mg/kg	105BSS2	Below Background
Aluminum	10000	7700	mg/kg	105CSS1	Below Background
Aluminum	9900	7700	mg/kg	105CSS2	Below Background
Arsenic	4.9	0.68	mg/kg	105ASS1	Below Background
Arsenic	7	0.68	mg/kg	105ASS2	Below Background
Arsenic	6.3	0.68	mg/kg	105BSS1	Below Background
Arsenic	4.7	0.68	mg/kg	105BSS2	Below Background
Arsenic	6.4	0.68	mg/kg	105CSS1	Below Background
Arsenic	5.3	0.68	mg/kg	105CSS2	Below Background
Arsenic	3.6	0.68	mg/kg	105DCSSS1	Below Background
Cobalt	6	2.3	mg/kg	105ASS1	Below Background
Cobalt	7.1	2.3	mg/kg	105ASS2	Below Background
Cobalt	11	2.3	mg/kg	105BSS1	Below Background
Cobalt	5.5	2.3	mg/kg	105BSS2	Below Background
Cobalt	8.7	2.3	mg/kg	105CSS1	Below Background
Cobalt	5.4	2.3	mg/kg	105CSS2	Below Background
Iron	16000	5500	mg/kg	105ASS1	Below Background
Iron	17000	5500	mg/kg	105ASS2	Below Background
Iron	21000	5500	mg/kg	105BSS1	Below Background
Iron	15000	5500	mg/kg	105BSS2	Below Background
Iron	15000	5500	mg/kg	105CSS1	Below Background
Iron	15000	5500	mg/kg	105CSS2	Below Background
Iron	5800	5500	mg/kg	105DCSSS1	Below Background
Manganese	450	180	mg/kg	105ASS1	Below Background
Manganese	560	180	mg/kg	105ASS2	Below Background
Manganese	580	180	mg/kg	105BSS1	Below Background
Manganese	400	180	mg/kg	105BSS2	Below Background
Manganese	620	180	mg/kg	105CSS1	Below Background
Manganese	340	180	mg/kg	105CSS2	Below Background
Manganese	420	180	mg/kg	105DCSSS1	Below Background

Additionally, two crawlspace soil samples exhibited asbestos detections (105-IS4 and 105-IS5).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 105 E

Summary: 4 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	2	0	0	0	N/A
Mercury	2	2	0	0	0
Lead	4	4	0	0	0
Other Metals	2	35	9	2	1
PCBs	2	0	0	0	N/A
PAHs	2	9	1	0	N/A
VOCs	2	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Cobalt	28	13	mg/kg	105ESS2	Below Industrial RSL

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
Metals					
Arsenic	3.4	3	mg/kg	105ESS1	Below Background
Arsenic	5.3	3	mg/kg	105ESS2	Below Background

Residential RSL Excceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
PAHs					
Benzo(a)pyrene	0.18	0.11	mg/kg	105ESS2	
Metals					
Aluminum	12000	7700	mg/kg	105ESS1	Below Background
Aluminum	9800	7700	mg/kg	105ESS2	Below Background
Arsenic	3.4	0.68	mg/kg	105ESS1	Below Background
Arsenic	5.3	0.68	mg/kg	105ESS2	Below Background
Cobalt	6	2.3	mg/kg	105ESS1	Below Background
Cobalt	28	2.3	mg/kg	105ESS2	
Iron	13000	5500	mg/kg	105ESS1	Below Background
Iron	14000	5500	mg/kg	105ESS2	Below Background
Manganese	940	180	mg/kg	105ESS2	Below Background

Additionally, two crawlspace soil samples exhibited asbestos detections (105E-IS1 and 105E-IS2).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 105 F

Summary: 4 Crawlspace Soil Samples Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	2	0	0	0	N/A
Mercury	2	2	0	0	0
Lead	4	4	0	0	0
Other Metals	2	34	10	2	2
PCBs	2	0	0	0	N/A
PAHs	2	10	1	0	N/A
VOCs	2	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Cobalt	14	13	mg/kg	105FSS2	Below Industrial RSL
Manganese	2000	1904	mg/kg	105FSS1	Below Industrial RSL

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
Metals					
Arsenic	4.7	3	mg/kg	105FSS1	Below Background
Arsenic	5.2	3	mg/kg	105FSS2	Below Background

Residential RSL Excceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
PAHs					
Benzo(a)pyrene	0.47	0.11	mg/kg	105FSS2	
Metals					
Aluminum	15000	7700	mg/kg	105FSS1	Below Background
Aluminum	12000	7700	mg/kg	105FSS2	Below Background
Arsenic	4.7	0.68	mg/kg	105FSS1	Below Background
Arsenic	5.2	0.68	mg/kg	105FSS2	Below Background
Cobalt	4.9	2.3	mg/kg	105FSS1	Below Background
Cobalt	14	2.3	mg/kg	105FSS2	
Iron	15000	5500	mg/kg	105FSS1	Below Background
Iron	21000	5500	mg/kg	105FSS2	Below Background
Manganese	2000	180	mg/kg	105FSS1	
Manganese	420	180	mg/kg	105FSS2	Below Background

Additionally, two crawlspace soil samples exhibited asbestos detections (105F-IS1 and 105F-IS2).

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 107

Summary: 1 Crawlspace Soil Sample Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	0	0	0	0	N/A
Mercury	0	0	0	0	0
Lead	1	1	1	0	1
Other Metals	0	0	0	0	0
PCBs	0	0	0	0	N/A
PAHs	0	0	0	0	N/A
VOCs	0	0	0	0	N/A

Background Exceedances

Analyte	Result	Background	Units	Sample	Comments
Lead	554	363	mg/kg	107-IS1	Below Industrial RSL

Residential RSL Excceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
Metals					
Lead	554	400	mg/kg	107-IS1	

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

CRAWLSPACE SOIL
BUILDING 108

Summary: 1 Crawlspace Soil Sample Total

Analyte Group	Samples	Detections	Residential RSL Exceedances	Industrial RSL Exceedances	Background Exceedances
Explosives	0	0	0	0	N/A
Mercury	0	0	0	0	0
Lead	0	0	0	0	0
Other Metals	0	0	0	0	0
PCBs	1	1	1	1	N/A
PAHs	0	0	0	0	N/A
VOCs	0	0	0	0	N/A

Industrial RSL Exceedances

Analyte	Result	Industrial RSL	Units	Sample	Comments
PCBs					
Aroclor 1260	1.5	0.99	mg/kg	108BLSSS1	

Residential RSL Exceedances

Analyte	Result	Residential RSL	Units	Sample	Comments
PCBs					
Aroclor 1260	1.5	0.99	mg/kg	108BLSSS1	

Note that analyte groups include various numbers of constituent, for example:
Mercury - 1 constituent
Lead - 1 constituent
Other Metals - 21 constituents
PCBs - 7 constituents
PAHs - 16 constituents
VOCs - 50 constituents
Explosives - 14 constituents

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	Explosives	102D SS-8	Dinitrotoluene, 2-Amino-4,6-	0.26	mg/kg	J	15	230	
Building 102 A/B/C	Mercury	102CSSS101	Mercury	0.017	mg/kg	B	1.1	4.6	0.154
Building 102 A/B/C	Mercury	102CSSS102	Mercury	0.1	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102CSSS103	Mercury	0.15	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102CSSS104	Mercury	0.12	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102CSSS106	Mercury	0.87	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102CSSS107	Mercury	0.086	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102D SS-10	Mercury	0.7	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102D SS-11	Mercury	0.26	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102D SS-13	Mercury	0.89	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102D SS-14	Mercury	0.25	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102D SS-8	Mercury	1.5	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Mercury	102D SS-9	Mercury	0.18	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Metals	102 SED-1	Aluminum	780	mg/kg		7700	110000	54730
Building 102 A/B/C	Metals	102 SED-1	Antimony	5.1	mg/kg		3.1	47	
Building 102 A/B/C	Metals	102 SED-1	Arsenic	3.7	mg/kg		0.68	3	12.3
Building 102 A/B/C	Metals	102 SED-1	Barium	67	mg/kg		1500	22000	
Building 102 A/B/C	Metals	102 SED-1	Beryllium	0.096	mg/kg	B	16	230	1.01
Building 102 A/B/C	Metals	102 SED-1	Cadmium	5.1	mg/kg		70	800	3.84
Building 102 A/B/C	Metals	102 SED-1	Calcium	85000	mg/kg				
Building 102 A/B/C	Metals	102 SED-1	Chromium	16	mg/kg		12000	180000	25.5
Building 102 A/B/C	Metals	102 SED-1	Cobalt	1.3	mg/kg		2.3	35	13
Building 102 A/B/C	Metals	102 SED-1	Copper	170000	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102 SED-1	Iron	6800	mg/kg		5500	82000	35460
Building 102 A/B/C	Metals	102 SED-1	Lead	640	mg/kg		400	800	363
Building 102 A/B/C	Metals	102 SED-1	Magnesium	1400	mg/kg				
Building 102 A/B/C	Metals	102 SED-1	Manganese	65	mg/kg		180	2600	1904
Building 102 A/B/C	Metals	102 SED-1	Mercury	1	mg/kg		1.1	4.6	0.154
Building 102 A/B/C	Metals	102 SED-1	Nickel	26	mg/kg		84	1200	27.9
Building 102 A/B/C	Metals	102 SED-1	Potassium	4200	mg/kg				
Building 102 A/B/C	Metals	102 SED-1	Selenium	5.3	mg/kg		39	580	0.777
Building 102 A/B/C	Metals	102 SED-1	Silver	6.3	mg/kg		39	580	
Building 102 A/B/C	Metals	102 SED-1	Sodium	31000	mg/kg				
Building 102 A/B/C	Metals	102 SED-1	Vanadium	3.4	mg/kg		39	580	72
Building 102 A/B/C	Metals	102 SED-1	Zinc	75000	mg/kg		2300	35000	414
Building 102 A/B/C	Metals	102CSSS101	Copper	4700	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102CSSS101	Lead	250	mg/kg		400	800	363
Building 102 A/B/C	Metals	102CSSS101	Zinc	1800	mg/kg		2300	35000	414
Building 102 A/B/C	Metals	102CSSS103	Lead	2900	mg/kg		400	800	363
Building 102 A/B/C	Metals	102CSSS104	Lead	2300	mg/kg		400	800	363

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	Metals	102CSSS105	Arsenic	2.7	mg/kg		0.68	3	12.3
Building 102 A/B/C	Metals	102CSSS105	Copper	27	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102CSSS105	Silver	0.97	mg/kg		39	580	
Building 102 A/B/C	Metals	102CSSS106	Lead	1300	mg/kg		400	800	363
Building 102 A/B/C	Metals	102CSSS108	Arsenic	5.5	mg/kg		0.68	3	12.3
Building 102 A/B/C	Metals	102CSSS108	Lead	220	mg/kg		400	800	363
Building 102 A/B/C	Metals	102D SS-10	Aluminum	810	mg/kg		7700	110000	54730
Building 102 A/B/C	Metals	102D SS-10	Arsenic	7.3	mg/kg		0.68	3	12.3
Building 102 A/B/C	Metals	102D SS-10	Barium	290	mg/kg		1500	22000	
Building 102 A/B/C	Metals	102D SS-10	Cadmium	4.6	mg/kg		70	800	3.84
Building 102 A/B/C	Metals	102D SS-10	Calcium	250000	mg/kg				
Building 102 A/B/C	Metals	102D SS-10	Chromium	110	mg/kg		12000	180000	25.5
Building 102 A/B/C	Metals	102D SS-10	Cobalt	3.4	mg/kg		2.3	35	13
Building 102 A/B/C	Metals	102D SS-10	Copper	6500	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102D SS-10	Iron	34000	mg/kg		5500	82000	35460
Building 102 A/B/C	Metals	102D SS-10	Lead	1100	mg/kg		400	800	363
Building 102 A/B/C	Metals	102D SS-10	Magnesium	9900	mg/kg				
Building 102 A/B/C	Metals	102D SS-10	Manganese	180	mg/kg		180	2600	1904
Building 102 A/B/C	Metals	102D SS-10	Nickel	28	mg/kg		84	1200	27.9
Building 102 A/B/C	Metals	102D SS-10	Potassium	110	mg/kg				
Building 102 A/B/C	Metals	102D SS-10	Selenium	1.2	mg/kg		39	580	0.777
Building 102 A/B/C	Metals	102D SS-10	Silver	9.9	mg/kg		39	580	
Building 102 A/B/C	Metals	102D SS-10	Sodium	1200	mg/kg				
Building 102 A/B/C	Metals	102D SS-10	Vanadium	6	mg/kg		39	580	72
Building 102 A/B/C	Metals	102D SS-10	Zinc	2900	mg/kg		2300	35000	414
Building 102 A/B/C	Metals	102D SS-11	Aluminum	1700	mg/kg		7700	110000	54730
Building 102 A/B/C	Metals	102D SS-11	Antimony	4.4	mg/kg		3.1	47	
Building 102 A/B/C	Metals	102D SS-11	Arsenic	200	mg/kg		0.68	3	12.3
Building 102 A/B/C	Metals	102D SS-11	Barium	120	mg/kg		1500	22000	
Building 102 A/B/C	Metals	102D SS-11	Cadmium	4.8	mg/kg		70	800	3.84
Building 102 A/B/C	Metals	102D SS-11	Calcium	10000	mg/kg				
Building 102 A/B/C	Metals	102D SS-11	Chromium	80	mg/kg		12000	180000	25.5
Building 102 A/B/C	Metals	102D SS-11	Cobalt	25	mg/kg		2.3	35	13
Building 102 A/B/C	Metals	102D SS-11	Copper	3600	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102D SS-11	Iron	360000	mg/kg		5500	82000	35460
Building 102 A/B/C	Metals	102D SS-11	Lead	880	mg/kg		400	800	363
Building 102 A/B/C	Metals	102D SS-11	Magnesium	5000	mg/kg				
Building 102 A/B/C	Metals	102D SS-11	Manganese	1300	mg/kg		180	2600	1904
Building 102 A/B/C	Metals	102D SS-11	Nickel	46	mg/kg		84	1200	27.9
Building 102 A/B/C	Metals	102D SS-11	Potassium	440	mg/kg				

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	Metals	102D SS-11	Silver	530	mg/kg		39	580	
Building 102 A/B/C	Metals	102D SS-11	Sodium	760	mg/kg				
Building 102 A/B/C	Metals	102D SS-11	Vanadium	120	mg/kg		39	580	72
Building 102 A/B/C	Metals	102D SS-11	Zinc	1600	mg/kg		2300	35000	414
Building 102 A/B/C	Metals	102D SS-12	Aluminum	2.2	mg/kg	B	7700	110000	54730
Building 102 A/B/C	Metals	102D SS-12	Antimony	1	mg/kg	B	3.1	47	
Building 102 A/B/C	Metals	102D SS-12	Barium	4.2	mg/kg		1500	22000	
Building 102 A/B/C	Metals	102D SS-12	Cadmium	0.11	mg/kg	B	70	800	3.84
Building 102 A/B/C	Metals	102D SS-12	Calcium	1000	mg/kg				
Building 102 A/B/C	Metals	102D SS-12	Chromium	0.17	mg/kg	B	12000	180000	25.5
Building 102 A/B/C	Metals	102D SS-12	Cobalt	0.27	mg/kg	B	2.3	35	13
Building 102 A/B/C	Metals	102D SS-12	Copper	8.4	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102D SS-12	Iron	1500	mg/kg		5500	82000	35460
Building 102 A/B/C	Metals	102D SS-12	Lead	18	mg/kg		400	800	363
Building 102 A/B/C	Metals	102D SS-12	Magnesium	73	mg/kg				
Building 102 A/B/C	Metals	102D SS-12	Manganese	22	mg/kg		180	2600	1904
Building 102 A/B/C	Metals	102D SS-12	Nickel	0.47	mg/kg	B	84	1200	27.9
Building 102 A/B/C	Metals	102D SS-12	Potassium	53	mg/kg				
Building 102 A/B/C	Metals	102D SS-12	Selenium	0.27	mg/kg	B	39	580	0.777
Building 102 A/B/C	Metals	102D SS-12	Sodium	310	mg/kg				
Building 102 A/B/C	Metals	102D SS-12	Zinc	230	mg/kg		2300	35000	414
Building 102 A/B/C	Metals	102D SS-13	Aluminum	610	mg/kg		7700	110000	54730
Building 102 A/B/C	Metals	102D SS-13	Antimony	15	mg/kg		3.1	47	
Building 102 A/B/C	Metals	102D SS-13	Arsenic	30	mg/kg		0.68	3	12.3
Building 102 A/B/C	Metals	102D SS-13	Barium	63	mg/kg		1500	22000	
Building 102 A/B/C	Metals	102D SS-13	Beryllium	0.18	mg/kg	B	16	230	1.01
Building 102 A/B/C	Metals	102D SS-13	Calcium	5000	mg/kg				
Building 102 A/B/C	Metals	102D SS-13	Chromium	110	mg/kg		12000	180000	25.5
Building 102 A/B/C	Metals	102D SS-13	Cobalt	10	mg/kg		2.3	35	13
Building 102 A/B/C	Metals	102D SS-13	Copper	230000	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102D SS-13	Iron	240000	mg/kg		5500	82000	35460
Building 102 A/B/C	Metals	102D SS-13	Lead	2500	mg/kg		400	800	363
Building 102 A/B/C	Metals	102D SS-13	Magnesium	630	mg/kg				
Building 102 A/B/C	Metals	102D SS-13	Manganese	620	mg/kg		180	2600	1904
Building 102 A/B/C	Metals	102D SS-13	Nickel	99	mg/kg		84	1200	27.9
Building 102 A/B/C	Metals	102D SS-13	Potassium	180	mg/kg				
Building 102 A/B/C	Metals	102D SS-13	Selenium	1.8	mg/kg		39	580	0.777
Building 102 A/B/C	Metals	102D SS-13	Silver	4.1	mg/kg		39	580	
Building 102 A/B/C	Metals	102D SS-13	Sodium	6200	mg/kg				
Building 102 A/B/C	Metals	102D SS-13	Vanadium	7.9	mg/kg		39	580	72

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	Metals	102D SS-13	Zinc	12000	mg/kg		2300	35000	414
Building 102 A/B/C	Metals	102D SS-14	Aluminum	200	mg/kg		7700	110000	54730
Building 102 A/B/C	Metals	102D SS-14	Arsenic	18	mg/kg		0.68	3	12.3
Building 102 A/B/C	Metals	102D SS-14	Barium	93	mg/kg		1500	22000	
Building 102 A/B/C	Metals	102D SS-14	Beryllium	0.42	mg/kg	B	16	230	1.01
Building 102 A/B/C	Metals	102D SS-14	Cadmium	1.5	mg/kg		70	800	3.84
Building 102 A/B/C	Metals	102D SS-14	Calcium	80000	mg/kg				
Building 102 A/B/C	Metals	102D SS-14	Chromium	35	mg/kg		12000	180000	25.5
Building 102 A/B/C	Metals	102D SS-14	Cobalt	5.5	mg/kg		2.3	35	13
Building 102 A/B/C	Metals	102D SS-14	Copper	280	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102D SS-14	Iron	100000	mg/kg		5500	82000	35460
Building 102 A/B/C	Metals	102D SS-14	Lead	390	mg/kg		400	800	363
Building 102 A/B/C	Metals	102D SS-14	Magnesium	10000	mg/kg				
Building 102 A/B/C	Metals	102D SS-14	Manganese	520	mg/kg		180	2600	1904
Building 102 A/B/C	Metals	102D SS-14	Nickel	19	mg/kg		84	1200	27.9
Building 102 A/B/C	Metals	102D SS-14	Potassium	2000	mg/kg				
Building 102 A/B/C	Metals	102D SS-14	Sodium	1100	mg/kg				
Building 102 A/B/C	Metals	102D SS-14	Vanadium	6.9	mg/kg		39	580	72
Building 102 A/B/C	Metals	102D SS-14	Zinc	1900	mg/kg		2300	35000	414
Building 102 A/B/C	Metals	102D SS-8	Aluminum	2300	mg/kg		7700	110000	54730
Building 102 A/B/C	Metals	102D SS-8	Antimony	5.6	mg/kg		3.1	47	
Building 102 A/B/C	Metals	102D SS-8	Arsenic	17	mg/kg		0.68	3	12.3
Building 102 A/B/C	Metals	102D SS-8	Barium	290	mg/kg		1500	22000	
Building 102 A/B/C	Metals	102D SS-8	Cadmium	3.9	mg/kg		70	800	3.84
Building 102 A/B/C	Metals	102D SS-8	Calcium	25000	mg/kg				
Building 102 A/B/C	Metals	102D SS-8	Chromium	89	mg/kg		12000	180000	25.5
Building 102 A/B/C	Metals	102D SS-8	Cobalt	15	mg/kg		2.3	35	13
Building 102 A/B/C	Metals	102D SS-8	Copper	740	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102D SS-8	Iron	150000	mg/kg		5500	82000	35460
Building 102 A/B/C	Metals	102D SS-8	Lead	2100	mg/kg		400	800	363
Building 102 A/B/C	Metals	102D SS-8	Magnesium	2100	mg/kg				
Building 102 A/B/C	Metals	102D SS-8	Manganese	970	mg/kg		180	2600	1904
Building 102 A/B/C	Metals	102D SS-8	Nickel	52	mg/kg		84	1200	27.9
Building 102 A/B/C	Metals	102D SS-8	Potassium	880	mg/kg				
Building 102 A/B/C	Metals	102D SS-8	Silver	50	mg/kg		39	580	
Building 102 A/B/C	Metals	102D SS-8	Sodium	880	mg/kg				
Building 102 A/B/C	Metals	102D SS-8	Vanadium	35	mg/kg		39	580	72
Building 102 A/B/C	Metals	102D SS-8	Zinc	1200	mg/kg		2300	35000	414
Building 102 A/B/C	Metals	102D SS-9	Aluminum	510	mg/kg		7700	110000	54730
Building 102 A/B/C	Metals	102D SS-9	Antimony	3.2	mg/kg		3.1	47	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	Metals	102D SS-9	Arsenic	570	mg/kg		0.68	3	12.3
Building 102 A/B/C	Metals	102D SS-9	Barium	29	mg/kg		1500	22000	
Building 102 A/B/C	Metals	102D SS-9	Cadmium	5.4	mg/kg		70	800	3.84
Building 102 A/B/C	Metals	102D SS-9	Calcium	500	mg/kg				
Building 102 A/B/C	Metals	102D SS-9	Chromium	130	mg/kg		12000	180000	25.5
Building 102 A/B/C	Metals	102D SS-9	Cobalt	37	mg/kg		2.3	35	13
Building 102 A/B/C	Metals	102D SS-9	Copper	3700	mg/kg		310	4700	59.1
Building 102 A/B/C	Metals	102D SS-9	Iron	450000	mg/kg		5500	82000	35460
Building 102 A/B/C	Metals	102D SS-9	Lead	28	mg/kg		400	800	363
Building 102 A/B/C	Metals	102D SS-9	Magnesium	190	mg/kg				
Building 102 A/B/C	Metals	102D SS-9	Manganese	1900	mg/kg		180	2600	1904
Building 102 A/B/C	Metals	102D SS-9	Nickel	93	mg/kg		84	1200	27.9
Building 102 A/B/C	Metals	102D SS-9	Potassium	400	mg/kg				
Building 102 A/B/C	Metals	102D SS-9	Silver	410	mg/kg		39	580	
Building 102 A/B/C	Metals	102D SS-9	Sodium	830	mg/kg				
Building 102 A/B/C	Metals	102D SS-9	Vanadium	140	mg/kg		39	580	72
Building 102 A/B/C	Metals	102D SS-9	Zinc	530	mg/kg		2300	35000	414
Building 102 A/B/C	PCBs	102D SS-11	Aroclor 1260	0.4	mg/kg		0.24	0.99	
Building 102 A/B/C	SVOCs	102CSSS103	Acenaphthene	0.075	mg/kg	J	360	4500	
Building 102 A/B/C	SVOCs	102CSSS103	Anthracene	0.31	mg/kg		1800	23000	
Building 102 A/B/C	SVOCs	102CSSS103	Benz(a)anthracene	1.9	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS103	Benzo(a)pyrene	1.7	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS103	Benzo(b)fluoranthene	1.6	mg/kg	N	1.1	21	
Building 102 A/B/C	SVOCs	102CSSS103	Benzo(ghi)perylene	1.3	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS103	Benzo(k)Fluoranthene	2	mg/kg	N	11	210	
Building 102 A/B/C	SVOCs	102CSSS103	Chrysene	1.7	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102CSSS103	Dibenzo(a,h)anthracene	0.46	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS103	Fluoranthene	3.8	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102CSSS103	Fluorene	0.062	mg/kg	J	240	3000	
Building 102 A/B/C	SVOCs	102CSSS103	Indeno(1,2,3-cd)pyrene	1.1	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS103	Phenanthrene	1.5	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS103	Pyrene	2.7	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102CSSS104	Acenaphthene	8.2	mg/kg		360	4500	
Building 102 A/B/C	SVOCs	102CSSS104	Acenaphthylene	0.96	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS104	Anthracene	16	mg/kg		1800	23000	
Building 102 A/B/C	SVOCs	102CSSS104	Benz(a)anthracene	48	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS104	Benzo(a)pyrene	42	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS104	Benzo(b)fluoranthene	50	mg/kg	M	1.1	21	
Building 102 A/B/C	SVOCs	102CSSS104	Benzo(ghi)perylene	23	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS104	Benzo(k)Fluoranthene	17	mg/kg	M	11	210	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	SVOCs	102CSSS104	Chrysene	60	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102CSSS104	Dibenzo(a,h)anthracene	4	mg/kg	H	0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS104	Fluoranthene	120	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102CSSS104	Fluorene	6.3	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102CSSS104	Indeno(1,2,3-cd)pyrene	20	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS104	Naphthalene	3	mg/kg		3.8	17	
Building 102 A/B/C	SVOCs	102CSSS104	Phenanthrene	110	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS104	Pyrene	110	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102CSSS105	Acenaphthene	0.024	mg/kg	J	360	4500	
Building 102 A/B/C	SVOCs	102CSSS105	Acenaphthylene	0.031	mg/kg	J			
Building 102 A/B/C	SVOCs	102CSSS105	Anthracene	0.1	mg/kg		1800	23000	
Building 102 A/B/C	SVOCs	102CSSS105	Benz(a)anthracene	0.52	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS105	Benzo(a)pyrene	0.51	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS105	Benzo(b)fluoranthene	0.51	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS105	Benzo(ghi)perylene	0.42	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS105	Benzo(k)Fluoranthene	0.46	mg/kg		11	210	
Building 102 A/B/C	SVOCs	102CSSS105	Chrysene	0.51	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102CSSS105	Dibenzo(a,h)anthracene	0.081	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS105	Fluoranthene	0.95	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102CSSS105	Fluorene	0.025	mg/kg	J	240	3000	
Building 102 A/B/C	SVOCs	102CSSS105	Indeno(1,2,3-cd)pyrene	0.33	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS105	Phenanthrene	0.48	mg/kg	J			
Building 102 A/B/C	SVOCs	102CSSS105	Pyrene	0.79	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102CSSS106	Acenaphthene	0.87	mg/kg		360	4500	
Building 102 A/B/C	SVOCs	102CSSS106	Acenaphthylene	0.061	mg/kg	J			
Building 102 A/B/C	SVOCs	102CSSS106	Anthracene	2.1	mg/kg		1800	23000	
Building 102 A/B/C	SVOCs	102CSSS106	Benz(a)anthracene	7.3	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS106	Benzo(a)pyrene	6.2	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS106	Benzo(b)fluoranthene	7.3	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS106	Benzo(ghi)perylene	4.8	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS106	Benzo(k)Fluoranthene	4.1	mg/kg		11	210	
Building 102 A/B/C	SVOCs	102CSSS106	Chrysene	6.7	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102CSSS106	Dibenzo(a,h)anthracene	0.92	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS106	Fluoranthene	17	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102CSSS106	Fluorene	0.66	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102CSSS106	Indeno(1,2,3-cd)pyrene	3.8	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS106	Naphthalene	0.042	mg/kg	J	3.8	17	
Building 102 A/B/C	SVOCs	102CSSS106	Phenanthrene	11	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS106	Pyrene	13	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102CSSS108	Acenaphthene	0.21	mg/kg		360	4500	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	SVOCs	102CSSS108	Acenaphthylene	0.059	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS108	Anthracene	0.59	mg/kg		1800	23000	
Building 102 A/B/C	SVOCs	102CSSS108	Benz(a)anthracene	2.7	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS108	Benzo(a)pyrene	2.2	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS108	Benzo(b)fluoranthene	2.6	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS108	Benzo(ghi)perylene	1.9	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS108	Benzo(k)Fluoranthene	1.5	mg/kg		11	210	
Building 102 A/B/C	SVOCs	102CSSS108	Chrysene	2.3	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102CSSS108	Dibenzo(a,h)anthracene	0.62	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102CSSS108	Fluoranthene	6.5	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102CSSS108	Fluorene	0.14	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102CSSS108	Indeno(1,2,3-cd)pyrene	1.4	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102CSSS108	Naphthalene	0.024	mg/kg	J	3.8	17	
Building 102 A/B/C	SVOCs	102CSSS108	Phenanthrene	2.8	mg/kg				
Building 102 A/B/C	SVOCs	102CSSS108	Pyrene	5.6	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102D SS-10	Acenaphthylene	0.35	mg/kg	J			
Building 102 A/B/C	SVOCs	102D SS-10	Benz(a)anthracene	1.8	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-10	Benzo(a)pyrene	2.6	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-10	Benzo(b)Fluoranthene	5.8	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-10	Benzo(ghi)perylene	4.3	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-10	Benzo(k)Fluoranthene	4.1	mg/kg		11	210	
Building 102 A/B/C	SVOCs	102D SS-10	Bis(2-ethylhexyl)phthalate	2.6	mg/kg	J	39	160	
Building 102 A/B/C	SVOCs	102D SS-10	Chrysene	6.2	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102D SS-10	Fluoranthene	4.8	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-10	Indeno(1,2,3-cd)pyrene	2.9	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-10	Phenanthrene	0.78	mg/kg	J			
Building 102 A/B/C	SVOCs	102D SS-10	Pyrene	4.9	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102D SS-11	Acenaphthene	0.19	mg/kg	J	360	4500	
Building 102 A/B/C	SVOCs	102D SS-11	Acenaphthylene	2.6	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-11	Anthracene	1.8	mg/kg		1800	23000	
Building 102 A/B/C	SVOCs	102D SS-11	Benz(a)anthracene	14	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-11	Benzo(a)pyrene	26	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-11	Benzo(b)Fluoranthene	33	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-11	Benzo(ghi)perylene	12	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-11	Benzo(k)Fluoranthene	30	mg/kg		11	210	
Building 102 A/B/C	SVOCs	102D SS-11	Carbazole	1.1	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-11	Chrysene	24	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102D SS-11	Dibenzo(a,h)anthracene	5.1	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-11	Dibenzofuran	0.11	mg/kg	J	7.3	100	
Building 102 A/B/C	SVOCs	102D SS-11	Di-n-butyl phthalate	0.16	mg/kg	J	630	8200	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	SVOCs	102D SS-11	Fluoranthene	19	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-11	Fluorene	0.17	mg/kg	J	240	3000	
Building 102 A/B/C	SVOCs	102D SS-11	Indeno(1,2,3-cd)pyrene	12	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-11	Methylnaphthalene, 2-	0.1	mg/kg	J	24	300	
Building 102 A/B/C	SVOCs	102D SS-11	Naphthalene	0.13	mg/kg	J	3.8	17	
Building 102 A/B/C	SVOCs	102D SS-11	Phenanthrene	3.3	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-11	Pyrene	9.2	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102D SS-12	Bis(2-ethylhexyl)phthalate	0.99	mg/kg		39	160	
Building 102 A/B/C	SVOCs	102D SS-12	Carbazole	0.11	mg/kg	J			
Building 102 A/B/C	SVOCs	102D SS-12	Chrysene	0.15	mg/kg	J	110	2100	
Building 102 A/B/C	SVOCs	102D SS-12	Dibenzofuran	0.099	mg/kg	J	7.3	100	
Building 102 A/B/C	SVOCs	102D SS-12	Diethyl Phthalate	0.11	mg/kg	J	5100	66000	
Building 102 A/B/C	SVOCs	102D SS-12	Fluoranthene	0.48	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-12	Phenanthrene	1.3	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-13	Acenaphthene	0.38	mg/kg		360	4500	
Building 102 A/B/C	SVOCs	102D SS-13	Acenaphthylene	0.066	mg/kg	J			
Building 102 A/B/C	SVOCs	102D SS-13	Anthracene	3.5	mg/kg		1800	23000	
Building 102 A/B/C	SVOCs	102D SS-13	Benz(a)anthracene	8.7	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-13	Benzo(a)pyrene	4.8	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-13	Benzo(b)Fluoranthene	13	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-13	Benzo(ghi)perylene	2.3	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-13	Benzo(k)Fluoranthene	21	mg/kg		11	210	
Building 102 A/B/C	SVOCs	102D SS-13	Carbazole	0.98	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-13	Chrysene	16	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102D SS-13	Dibenzo(a,h)anthracene	1.2	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-13	Dibenzofuran	0.48	mg/kg		7.3	100	
Building 102 A/B/C	SVOCs	102D SS-13	Di-n-butyl phthalate	0.33	mg/kg	J	630	8200	
Building 102 A/B/C	SVOCs	102D SS-13	Dinitrotoluene, 2,4-	39	mg/kg		1.7	7.4	
Building 102 A/B/C	SVOCs	102D SS-13	Dinitrotoluene, 2,6-	2	mg/kg		0.36	1.5	
Building 102 A/B/C	SVOCs	102D SS-13	Fluoranthene	41	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-13	Fluorene	0.3	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-13	Indeno(1,2,3-cd)pyrene	2.3	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-13	Methylnaphthalene, 2-	0.33	mg/kg		24	300	
Building 102 A/B/C	SVOCs	102D SS-13	Naphthalene	0.21	mg/kg		3.8	17	
Building 102 A/B/C	SVOCs	102D SS-13	Nitrosodiphenylamine, n-	1.7	mg/kg		110	470	
Building 102 A/B/C	SVOCs	102D SS-13	Phenanthrene	23	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-13	Pyrene	21	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102D SS-14	Acenaphthene	1.2	mg/kg		360	4500	
Building 102 A/B/C	SVOCs	102D SS-14	Acenaphthylene	0.12	mg/kg	J			
Building 102 A/B/C	SVOCs	102D SS-14	Anthracene	4.5	mg/kg		1800	23000	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	SVOCs	102D SS-14	Benz(a)anthracene	8.2	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-14	Benzo(a)pyrene	8.9	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-14	Benzo(b)Fluoranthene	10	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-14	Benzo(ghi)perylene	4.4	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-14	Benzo(k)Fluoranthene	8.1	mg/kg		11	210	
Building 102 A/B/C	SVOCs	102D SS-14	Bis(2-ethylhexyl)phthalate	2.5	mg/kg		39	160	
Building 102 A/B/C	SVOCs	102D SS-14	Carbazole	3.1	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-14	Chrysene	10	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102D SS-14	Dibenzo(a,h)anthracene	2.2	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-14	Dibenzofuran	0.52	mg/kg		7.3	100	
Building 102 A/B/C	SVOCs	102D SS-14	Fluoranthene	47	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-14	Fluorene	0.82	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-14	Indeno(1,2,3-cd)pyrene	4	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-14	Methylnaphthalene, 2-	0.099	mg/kg	J	24	300	
Building 102 A/B/C	SVOCs	102D SS-14	Naphthalene	0.16	mg/kg	J	3.8	17	
Building 102 A/B/C	SVOCs	102D SS-14	Phenanthrene	17	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-14	Pyrene	20	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102D SS-8	Acenaphthene	0.37	mg/kg		360	4500	
Building 102 A/B/C	SVOCs	102D SS-8	Acenaphthylene	0.46	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-8	Anthracene	2.3	mg/kg		1800	23000	
Building 102 A/B/C	SVOCs	102D SS-8	Benz(a)anthracene	5.2	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-8	Benzo(a)pyrene	7.8	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-8	Benzo(b)Fluoranthene	5.6	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-8	Benzo(ghi)perylene	18	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-8	Benzo(k)Fluoranthene	5	mg/kg		11	210	
Building 102 A/B/C	SVOCs	102D SS-8	Bis(2-ethylhexyl)phthalate	0.48	mg/kg		39	160	
Building 102 A/B/C	SVOCs	102D SS-8	Carbazole	2.2	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-8	Chrysene	8	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102D SS-8	Dibenzo(a,h)anthracene	3.5	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-8	Dibenzofuran	0.17	mg/kg		7.3	100	
Building 102 A/B/C	SVOCs	102D SS-8	Di-n-butyl phthalate	0.12	mg/kg	J	630	8200	
Building 102 A/B/C	SVOCs	102D SS-8	Fluoranthene	12	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-8	Fluorene	0.34	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-8	Indeno(1,2,3-cd)pyrene	5.8	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-8	Methylnaphthalene, 2-	0.044	mg/kg	J	24	300	
Building 102 A/B/C	SVOCs	102D SS-8	Phenanthrene	6.5	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-8	Pyrene	11	mg/kg		180	2300	
Building 102 A/B/C	SVOCs	102D SS-9	Acenaphthene	0.9	mg/kg		360	4500	
Building 102 A/B/C	SVOCs	102D SS-9	Acenaphthylene	0.72	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-9	Anthracene	16	mg/kg		1800	23000	

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GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 A/B/C	SVOCs	102D SS-9	Benz(a)anthracene	180	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-9	Benzo(a)pyrene	150	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-9	Benzo(b)Fluoranthene	190	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-9	Benzo(ghi)perylene	78	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-9	Benzo(k)Fluoranthene	16	mg/kg		11	210	
Building 102 A/B/C	SVOCs	102D SS-9	Carbazole	9.3	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-9	Chrysene	290	mg/kg		110	2100	
Building 102 A/B/C	SVOCs	102D SS-9	Dibenzo(a,h)anthracene	24	mg/kg		0.11	2.1	
Building 102 A/B/C	SVOCs	102D SS-9	Dibenzofuran	0.4	mg/kg	J	7.3	100	
Building 102 A/B/C	SVOCs	102D SS-9	Fluoranthene	350	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-9	Fluorene	1.4	mg/kg		240	3000	
Building 102 A/B/C	SVOCs	102D SS-9	Indeno(1,2,3-cd)pyrene	76	mg/kg		1.1	21	
Building 102 A/B/C	SVOCs	102D SS-9	Methylnaphthalene, 2-	0.092	mg/kg	J	24	300	
Building 102 A/B/C	SVOCs	102D SS-9	Naphthalene	0.18	mg/kg	J	3.8	17	
Building 102 A/B/C	SVOCs	102D SS-9	Phenanthrene	61	mg/kg				
Building 102 A/B/C	SVOCs	102D SS-9	Pyrene	310	mg/kg		180	2300	
Building 102 A/B/C	VOCs	102D SS-12	Acetone	4.6	mg/kg		6100	67000	
Building 102 A/B/C	VOCs	102D SS-12	Hexanone, 2-	0.44	mg/kg		20	130	
Building 102 A/B/C	VOCs	102D SS-12	Methyl Ethyl Ketone	1.4	mg/kg		2700	19000	
Building 102 D	Cyanide	102D CORNER SPILL	Cyanide, Total	10	mg/kg		2.3	15	
Building 102 D	Cyanide	102DCS SED	Cyanide, Total	0.19	mg/kg		2.3	15	
Building 102 D	Mercury	102D CORNER SPILL	Mercury	0.85	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D- SS-1 (DEEP)	Mercury	0.033	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-1 DEEP	Mercury	0.028	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-1 SHALLOW	Mercury	0.37	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D- SS-2 (DEEP)	Mercury	0.014	mg/kg	B	1.1	4.6	0.154
Building 102 D	Mercury	102D SS-2 DEEP	Mercury	0.7	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-2 SHALLOW	Mercury	0.055	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-3 (DEEP)	Mercury	0.019	mg/kg	B	1.1	4.6	0.154
Building 102 D	Mercury	102D SS-3 DEEP	Mercury	0.028	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-3 SHALLOW	Mercury	0.034	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-4 (DEEP)	Mercury	0.036	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-4 DEEP	Mercury	0.044	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-4 SHALLOW	Mercury	0.054	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D- SS-5 (DEEP)	Mercury	0.024	mg/kg	B	1.1	4.6	0.154
Building 102 D	Mercury	102D SS-5 DEEP	Mercury	0.047	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-5 SHALLOW	Mercury	0.053	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-6 DEEP	Mercury	0.023	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-6 SHALLOW	Mercury	0.093	mg/kg		1.1	4.6	0.154
Building 102 D	Mercury	102D SS-7 DEEP	Mercury	0.019	mg/kg	B	1.1	4.6	0.154

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Mercury	102D SS-7 SHALLOW	Mercury	0.0086	mg/kg	B	1.1	4.6	0.154
Building 102 D	Mercury	102DCS SED	Mercury	0.089	mg/kg		1.1	4.6	0.154
Building 102 D	Metals	102D CORNER SPILL	Aluminum	9900	mg/kg		7700	110000	54730
Building 102 D	Metals	102D CORNER SPILL	Arsenic	11	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D CORNER SPILL	Barium	10	mg/kg		1500	22000	
Building 102 D	Metals	102D CORNER SPILL	Cadmium	2	mg/kg		70	800	3.84
Building 102 D	Metals	102D CORNER SPILL	Calcium	5100	mg/kg				
Building 102 D	Metals	102D CORNER SPILL	Chromium	87	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D CORNER SPILL	Cobalt	8.8	mg/kg		2.3	35	13
Building 102 D	Metals	102D CORNER SPILL	Copper	390	mg/kg		310	4700	59.1
Building 102 D	Metals	102D CORNER SPILL	Iron	110000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D CORNER SPILL	Lead	54	mg/kg		400	800	363
Building 102 D	Metals	102D CORNER SPILL	Magnesium	36000	mg/kg				
Building 102 D	Metals	102D CORNER SPILL	Manganese	400	mg/kg		180	2600	1904
Building 102 D	Metals	102D CORNER SPILL	Nickel	75	mg/kg		84	1200	27.9
Building 102 D	Metals	102D CORNER SPILL	Potassium	12000	mg/kg				
Building 102 D	Metals	102D CORNER SPILL	Selenium	0.75	mg/kg		39	580	0.777
Building 102 D	Metals	102D CORNER SPILL	Silver	450	mg/kg		39	580	
Building 102 D	Metals	102D CORNER SPILL	Sodium	11000	mg/kg				
Building 102 D	Metals	102D CORNER SPILL	Thallium	2.6	mg/kg		0.078	1.2	0.53
Building 102 D	Metals	102D CORNER SPILL	Vanadium	2	mg/kg		39	580	72
Building 102 D	Metals	102D CORNER SPILL	Zinc	440	mg/kg		2300	35000	414
Building 102 D	Metals	102D- SS-1 (DEEP)	Aluminum	16000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D- SS-1 (DEEP)	Antimony	1.7	mg/kg	B	3.1	47	
Building 102 D	Metals	102D- SS-1 (DEEP)	Arsenic	4.9	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D- SS-1 (DEEP)	Barium	100	mg/kg		1500	22000	
Building 102 D	Metals	102D- SS-1 (DEEP)	Beryllium	0.56	mg/kg		16	230	1.01
Building 102 D	Metals	102D- SS-1 (DEEP)	Calcium	2800	mg/kg				
Building 102 D	Metals	102D- SS-1 (DEEP)	Chromium	20	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D- SS-1 (DEEP)	Cobalt	10	mg/kg		2.3	35	13
Building 102 D	Metals	102D- SS-1 (DEEP)	Copper	14	mg/kg		310	4700	59.1
Building 102 D	Metals	102D- SS-1 (DEEP)	Iron	22000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D- SS-1 (DEEP)	Lead	18	mg/kg		400	800	363
Building 102 D	Metals	102D- SS-1 (DEEP)	Magnesium	1800	mg/kg				
Building 102 D	Metals	102D- SS-1 (DEEP)	Manganese	290	mg/kg		180	2600	1904
Building 102 D	Metals	102D- SS-1 (DEEP)	Nickel	12	mg/kg		84	1200	27.9
Building 102 D	Metals	102D- SS-1 (DEEP)	Potassium	790	mg/kg				
Building 102 D	Metals	102D- SS-1 (DEEP)	Sodium	180	mg/kg				
Building 102 D	Metals	102D- SS-1 (DEEP)	Vanadium	40	mg/kg		39	580	72
Building 102 D	Metals	102D- SS-1 (DEEP)	Zinc	41	mg/kg		2300	35000	414

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GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Metals	102D SS-1 DEEP	Aluminum	14000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-1 DEEP	Arsenic	6.5	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-1 DEEP	Barium	190	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-1 DEEP	Cadmium	0.21	mg/kg		70	800	3.84
Building 102 D	Metals	102D SS-1 DEEP	Calcium	3900	mg/kg				
Building 102 D	Metals	102D SS-1 DEEP	Chromium	21	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-1 DEEP	Cobalt	8.7	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-1 DEEP	Copper	14	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-1 DEEP	Iron	19000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-1 DEEP	Lead	15	mg/kg		400	800	363
Building 102 D	Metals	102D SS-1 DEEP	Magnesium	3400	mg/kg				
Building 102 D	Metals	102D SS-1 DEEP	Manganese	680	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-1 DEEP	Nickel	20	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-1 DEEP	Potassium	1300	mg/kg				
Building 102 D	Metals	102D SS-1 DEEP	Sodium	110	mg/kg				
Building 102 D	Metals	102D SS-1 DEEP	Vanadium	39	mg/kg		39	580	72
Building 102 D	Metals	102D SS-1 DEEP	Zinc	46	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-1 SHALLOW	Aluminum	13000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-1 SHALLOW	Arsenic	6.8	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-1 SHALLOW	Barium	130	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-1 SHALLOW	Cadmium	0.48	mg/kg		70	800	3.84
Building 102 D	Metals	102D SS-1 SHALLOW	Calcium	8000	mg/kg				
Building 102 D	Metals	102D SS-1 SHALLOW	Chromium	20	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-1 SHALLOW	Cobalt	9.9	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-1 SHALLOW	Copper	17	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-1 SHALLOW	Iron	19000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-1 SHALLOW	Lead	18	mg/kg		400	800	363
Building 102 D	Metals	102D SS-1 SHALLOW	Magnesium	4500	mg/kg				
Building 102 D	Metals	102D SS-1 SHALLOW	Manganese	930	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-1 SHALLOW	Nickel	23	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-1 SHALLOW	Potassium	1300	mg/kg				
Building 102 D	Metals	102D SS-1 SHALLOW	Sodium	270	mg/kg				
Building 102 D	Metals	102D SS-1 SHALLOW	Vanadium	37	mg/kg		39	580	72
Building 102 D	Metals	102D SS-1 SHALLOW	Zinc	52	mg/kg		2300	35000	414
Building 102 D	Metals	102D- SS-2 (DEEP)	Aluminum	16000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D- SS-2 (DEEP)	Antimony	1.6	mg/kg	B	3.1	47	
Building 102 D	Metals	102D- SS-2 (DEEP)	Arsenic	5.3	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D- SS-2 (DEEP)	Barium	230	mg/kg		1500	22000	
Building 102 D	Metals	102D- SS-2 (DEEP)	Beryllium	2.2	mg/kg		16	230	1.01
Building 102 D	Metals	102D- SS-2 (DEEP)	Calcium	4100	mg/kg				

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Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Metals	102D- SS-2 (DEEP)	Chromium	21	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D- SS-2 (DEEP)	Cobalt	21	mg/kg		2.3	35	13
Building 102 D	Metals	102D- SS-2 (DEEP)	Copper	14	mg/kg		310	4700	59.1
Building 102 D	Metals	102D- SS-2 (DEEP)	Iron	19000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D- SS-2 (DEEP)	Lead	25	mg/kg		400	800	363
Building 102 D	Metals	102D- SS-2 (DEEP)	Magnesium	2300	mg/kg				
Building 102 D	Metals	102D- SS-2 (DEEP)	Manganese	1000	mg/kg		180	2600	1904
Building 102 D	Metals	102D- SS-2 (DEEP)	Nickel	42	mg/kg		84	1200	27.9
Building 102 D	Metals	102D- SS-2 (DEEP)	Potassium	780	mg/kg				
Building 102 D	Metals	102D- SS-2 (DEEP)	Sodium	250	mg/kg				
Building 102 D	Metals	102D- SS-2 (DEEP)	Vanadium	36	mg/kg		39	580	72
Building 102 D	Metals	102D- SS-2 (DEEP)	Zinc	27	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-2 DEEP	Aluminum	14000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-2 DEEP	Arsenic	5.5	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-2 DEEP	Barium	200	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-2 DEEP	Beryllium	0.058	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-2 DEEP	Cadmium	0.22	mg/kg	B	70	800	3.84
Building 102 D	Metals	102D SS-2 DEEP	Calcium	2300	mg/kg				
Building 102 D	Metals	102D SS-2 DEEP	Chromium	19	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-2 DEEP	Cobalt	9	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-2 DEEP	Copper	18	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-2 DEEP	Iron	17000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-2 DEEP	Lead	50	mg/kg		400	800	363
Building 102 D	Metals	102D SS-2 DEEP	Magnesium	2900	mg/kg				
Building 102 D	Metals	102D SS-2 DEEP	Manganese	150	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-2 DEEP	Nickel	21	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-2 DEEP	Potassium	1500	mg/kg				
Building 102 D	Metals	102D SS-2 DEEP	Sodium	150	mg/kg				
Building 102 D	Metals	102D SS-2 DEEP	Vanadium	38	mg/kg		39	580	72
Building 102 D	Metals	102D SS-2 DEEP	Zinc	67	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-2 SHALLOW	Aluminum	17000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-2 SHALLOW	Arsenic	9.1	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-2 SHALLOW	Barium	200	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-2 SHALLOW	Beryllium	0.14	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-2 SHALLOW	Cadmium	0.25	mg/kg		70	800	3.84
Building 102 D	Metals	102D SS-2 SHALLOW	Calcium	4000	mg/kg				
Building 102 D	Metals	102D SS-2 SHALLOW	Chromium	20	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-2 SHALLOW	Cobalt	9.4	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-2 SHALLOW	Copper	19	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-2 SHALLOW	Iron	22000	mg/kg		5500	82000	35460

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Metals	102D SS-2 SHALLOW	Lead	410	mg/kg		400	800	363
Building 102 D	Metals	102D SS-2 SHALLOW	Magnesium	3800	mg/kg				
Building 102 D	Metals	102D SS-2 SHALLOW	Manganese	860	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-2 SHALLOW	Nickel	23	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-2 SHALLOW	Potassium	1700	mg/kg				
Building 102 D	Metals	102D SS-2 SHALLOW	Sodium	340	mg/kg				
Building 102 D	Metals	102D SS-2 SHALLOW	Vanadium	41	mg/kg		39	580	72
Building 102 D	Metals	102D SS-2 SHALLOW	Zinc	59	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-3 (DEEP)	Aluminum	10000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-3 (DEEP)	Arsenic	4.4	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-3 (DEEP)	Barium	89	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-3 (DEEP)	Beryllium	1.1	mg/kg		16	230	1.01
Building 102 D	Metals	102D SS-3 (DEEP)	Calcium	2700	mg/kg				
Building 102 D	Metals	102D SS-3 (DEEP)	Chromium	20	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-3 (DEEP)	Cobalt	15	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-3 (DEEP)	Copper	9.2	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-3 (DEEP)	Iron	16000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-3 (DEEP)	Lead	8.8	mg/kg		400	800	363
Building 102 D	Metals	102D SS-3 (DEEP)	Magnesium	1600	mg/kg				
Building 102 D	Metals	102D SS-3 (DEEP)	Manganese	270	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-3 (DEEP)	Nickel	14	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-3 (DEEP)	Potassium	450	mg/kg				
Building 102 D	Metals	102D SS-3 (DEEP)	Vanadium	26	mg/kg		39	580	72
Building 102 D	Metals	102D SS-3 (DEEP)	Zinc	20	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-3 DEEP	Aluminum	21000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-3 DEEP	Arsenic	7	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-3 DEEP	Barium	230	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-3 DEEP	Beryllium	1.1	mg/kg		16	230	1.01
Building 102 D	Metals	102D SS-3 DEEP	Calcium	3400	mg/kg				
Building 102 D	Metals	102D SS-3 DEEP	Chromium	28	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-3 DEEP	Cobalt	14	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-3 DEEP	Copper	16	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-3 DEEP	Iron	23000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-3 DEEP	Lead	15	mg/kg		400	800	363
Building 102 D	Metals	102D SS-3 DEEP	Magnesium	3200	mg/kg				
Building 102 D	Metals	102D SS-3 DEEP	Manganese	840	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-3 DEEP	Nickel	32	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-3 DEEP	Potassium	1300	mg/kg				
Building 102 D	Metals	102D SS-3 DEEP	Sodium	240	mg/kg				
Building 102 D	Metals	102D SS-3 DEEP	Vanadium	42	mg/kg		39	580	72

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Metals	102D SS-3 DEEP	Zinc	44	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-3 SHALLOW	Aluminum	16000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-3 SHALLOW	Arsenic	8	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-3 SHALLOW	Barium	170	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-3 SHALLOW	Beryllium	0.37	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-3 SHALLOW	Cadmium	0.11	mg/kg	B	70	800	3.84
Building 102 D	Metals	102D SS-3 SHALLOW	Calcium	3000	mg/kg				
Building 102 D	Metals	102D SS-3 SHALLOW	Chromium	21	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-3 SHALLOW	Cobalt	7.9	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-3 SHALLOW	Copper	17	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-3 SHALLOW	Iron	21000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-3 SHALLOW	Lead	46	mg/kg		400	800	363
Building 102 D	Metals	102D SS-3 SHALLOW	Magnesium	3400	mg/kg				
Building 102 D	Metals	102D SS-3 SHALLOW	Manganese	590	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-3 SHALLOW	Nickel	22	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-3 SHALLOW	Potassium	1300	mg/kg				
Building 102 D	Metals	102D SS-3 SHALLOW	Sodium	260	mg/kg				
Building 102 D	Metals	102D SS-3 SHALLOW	Vanadium	37	mg/kg		39	580	72
Building 102 D	Metals	102D SS-3 SHALLOW	Zinc	52	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-4 (DEEP)	Aluminum	14000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-4 (DEEP)	Arsenic	4.8	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-4 (DEEP)	Barium	76	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-4 (DEEP)	Beryllium	0.49	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-4 (DEEP)	Calcium	3800	mg/kg				
Building 102 D	Metals	102D SS-4 (DEEP)	Chromium	18	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-4 (DEEP)	Cobalt	3.7	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-4 (DEEP)	Copper	11	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-4 (DEEP)	Iron	17000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-4 (DEEP)	Lead	12	mg/kg		400	800	363
Building 102 D	Metals	102D SS-4 (DEEP)	Magnesium	1500	mg/kg				
Building 102 D	Metals	102D SS-4 (DEEP)	Manganese	160	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-4 (DEEP)	Nickel	10	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-4 (DEEP)	Potassium	660	mg/kg				
Building 102 D	Metals	102D SS-4 (DEEP)	Vanadium	29	mg/kg		39	580	72
Building 102 D	Metals	102D SS-4 (DEEP)	Zinc	37	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-4 DEEP	Aluminum	17000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-4 DEEP	Arsenic	8.5	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-4 DEEP	Barium	230	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-4 DEEP	Beryllium	0.24	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-4 DEEP	Cadmium	0.2	mg/kg	B	70	800	3.84

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Metals	102D SS-4 DEEP	Calcium	5100	mg/kg				
Building 102 D	Metals	102D SS-4 DEEP	Chromium	22	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-4 DEEP	Cobalt	8.8	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-4 DEEP	Copper	19	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-4 DEEP	Iron	22000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-4 DEEP	Lead	23	mg/kg		400	800	363
Building 102 D	Metals	102D SS-4 DEEP	Magnesium	3500	mg/kg				
Building 102 D	Metals	102D SS-4 DEEP	Manganese	630	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-4 DEEP	Nickel	22	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-4 DEEP	Potassium	1600	mg/kg				
Building 102 D	Metals	102D SS-4 DEEP	Sodium	240	mg/kg				
Building 102 D	Metals	102D SS-4 DEEP	Vanadium	39	mg/kg		39	580	72
Building 102 D	Metals	102D SS-4 DEEP	Zinc	63	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-4 SHALLOW	Aluminum	17000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-4 SHALLOW	Arsenic	9.2	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-4 SHALLOW	Barium	150	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-4 SHALLOW	Beryllium	0.57	mg/kg		16	230	1.01
Building 102 D	Metals	102D SS-4 SHALLOW	Cadmium	0.17	mg/kg	B	70	800	3.84
Building 102 D	Metals	102D SS-4 SHALLOW	Calcium	2700	mg/kg				
Building 102 D	Metals	102D SS-4 SHALLOW	Chromium	23	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-4 SHALLOW	Cobalt	8.2	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-4 SHALLOW	Copper	16	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-4 SHALLOW	Iron	22000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-4 SHALLOW	Lead	20	mg/kg		400	800	363
Building 102 D	Metals	102D SS-4 SHALLOW	Magnesium	2900	mg/kg				
Building 102 D	Metals	102D SS-4 SHALLOW	Manganese	780	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-4 SHALLOW	Nickel	22	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-4 SHALLOW	Potassium	1500	mg/kg				
Building 102 D	Metals	102D SS-4 SHALLOW	Sodium	130	mg/kg	B			
Building 102 D	Metals	102D SS-4 SHALLOW	Vanadium	41	mg/kg		39	580	72
Building 102 D	Metals	102D SS-4 SHALLOW	Zinc	57	mg/kg		2300	35000	414
Building 102 D	Metals	102D- SS-5 (DEEP)	Aluminum	16000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D- SS-5 (DEEP)	Antimony	1.5	mg/kg	B	3.1	47	
Building 102 D	Metals	102D- SS-5 (DEEP)	Arsenic	6.2	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D- SS-5 (DEEP)	Barium	96	mg/kg		1500	22000	
Building 102 D	Metals	102D- SS-5 (DEEP)	Beryllium	1.7	mg/kg		16	230	1.01
Building 102 D	Metals	102D- SS-5 (DEEP)	Calcium	3000	mg/kg				
Building 102 D	Metals	102D- SS-5 (DEEP)	Chromium	29	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D- SS-5 (DEEP)	Cobalt	8.9	mg/kg		2.3	35	13
Building 102 D	Metals	102D- SS-5 (DEEP)	Copper	12	mg/kg		310	4700	59.1

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Metals	102D- SS-5 (DEEP)	Iron	22000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D- SS-5 (DEEP)	Lead	10	mg/kg		400	800	363
Building 102 D	Metals	102D- SS-5 (DEEP)	Magnesium	1900	mg/kg				
Building 102 D	Metals	102D- SS-5 (DEEP)	Manganese	400	mg/kg		180	2600	1904
Building 102 D	Metals	102D- SS-5 (DEEP)	Nickel	19	mg/kg		84	1200	27.9
Building 102 D	Metals	102D- SS-5 (DEEP)	Potassium	660	mg/kg				
Building 102 D	Metals	102D- SS-5 (DEEP)	Sodium	120	mg/kg				
Building 102 D	Metals	102D- SS-5 (DEEP)	Vanadium	45	mg/kg		39	580	72
Building 102 D	Metals	102D- SS-5 (DEEP)	Zinc	23	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-5 DEEP	Aluminum	18000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-5 DEEP	Arsenic	9.8	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-5 DEEP	Barium	180	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-5 DEEP	Beryllium	0.14	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-5 DEEP	Cadmium	0.1	mg/kg	B	70	800	3.84
Building 102 D	Metals	102D SS-5 DEEP	Calcium	2500	mg/kg				
Building 102 D	Metals	102D SS-5 DEEP	Chromium	21	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-5 DEEP	Cobalt	8.8	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-5 DEEP	Copper	19	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-5 DEEP	Iron	23000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-5 DEEP	Lead	22	mg/kg		400	800	363
Building 102 D	Metals	102D SS-5 DEEP	Magnesium	3300	mg/kg				
Building 102 D	Metals	102D SS-5 DEEP	Manganese	500	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-5 DEEP	Nickel	22	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-5 DEEP	Potassium	1900	mg/kg				
Building 102 D	Metals	102D SS-5 DEEP	Sodium	150	mg/kg				
Building 102 D	Metals	102D SS-5 DEEP	Vanadium	41	mg/kg		39	580	72
Building 102 D	Metals	102D SS-5 DEEP	Zinc	61	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-5 SHALLOW	Aluminum	16000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-5 SHALLOW	Arsenic	9.4	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-5 SHALLOW	Barium	260	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-5 SHALLOW	Beryllium	0.16	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-5 SHALLOW	Cadmium	0.22	mg/kg	B	70	800	3.84
Building 102 D	Metals	102D SS-5 SHALLOW	Calcium	4200	mg/kg				
Building 102 D	Metals	102D SS-5 SHALLOW	Chromium	21	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-5 SHALLOW	Cobalt	9.4	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-5 SHALLOW	Copper	19	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-5 SHALLOW	Iron	22000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-5 SHALLOW	Lead	63	mg/kg		400	800	363
Building 102 D	Metals	102D SS-5 SHALLOW	Magnesium	3900	mg/kg				
Building 102 D	Metals	102D SS-5 SHALLOW	Manganese	930	mg/kg		180	2600	1904

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Metals	102D SS-5 SHALLOW	Nickel	22	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-5 SHALLOW	Potassium	1900	mg/kg				
Building 102 D	Metals	102D SS-5 SHALLOW	Sodium	420	mg/kg				
Building 102 D	Metals	102D SS-5 SHALLOW	Vanadium	40	mg/kg		39	580	72
Building 102 D	Metals	102D SS-5 SHALLOW	Zinc	63	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-6 DEEP	Aluminum	24000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-6 DEEP	Arsenic	4.4	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-6 DEEP	Barium	81	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-6 DEEP	Beryllium	0.42	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-6 DEEP	Calcium	3700	mg/kg				
Building 102 D	Metals	102D SS-6 DEEP	Chromium	26	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-6 DEEP	Cobalt	2.4	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-6 DEEP	Copper	15	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-6 DEEP	Iron	21000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-6 DEEP	Lead	13	mg/kg		400	800	363
Building 102 D	Metals	102D SS-6 DEEP	Magnesium	2400	mg/kg				
Building 102 D	Metals	102D SS-6 DEEP	Manganese	59	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-6 DEEP	Nickel	12	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-6 DEEP	Potassium	1000	mg/kg				
Building 102 D	Metals	102D SS-6 DEEP	Sodium	160	mg/kg				
Building 102 D	Metals	102D SS-6 DEEP	Vanadium	37	mg/kg		39	580	72
Building 102 D	Metals	102D SS-6 DEEP	Zinc	35	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-6 SHALLOW	Aluminum	25000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-6 SHALLOW	Arsenic	7.5	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-6 SHALLOW	Barium	130	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-6 SHALLOW	Beryllium	0.96	mg/kg		16	230	1.01
Building 102 D	Metals	102D SS-6 SHALLOW	Cadmium	0.16	mg/kg	B	70	800	3.84
Building 102 D	Metals	102D SS-6 SHALLOW	Calcium	5000	mg/kg				
Building 102 D	Metals	102D SS-6 SHALLOW	Chromium	78	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-6 SHALLOW	Cobalt	11	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-6 SHALLOW	Copper	22	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-6 SHALLOW	Iron	27000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-6 SHALLOW	Lead	22	mg/kg		400	800	363
Building 102 D	Metals	102D SS-6 SHALLOW	Magnesium	3100	mg/kg				
Building 102 D	Metals	102D SS-6 SHALLOW	Manganese	280	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-6 SHALLOW	Nickel	26	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-6 SHALLOW	Potassium	1200	mg/kg				
Building 102 D	Metals	102D SS-6 SHALLOW	Sodium	270	mg/kg				
Building 102 D	Metals	102D SS-6 SHALLOW	Vanadium	44	mg/kg		39	580	72
Building 102 D	Metals	102D SS-6 SHALLOW	Zinc	420	mg/kg		2300	35000	414

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Metals	102D SS-7 DEEP	Aluminum	18000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-7 DEEP	Arsenic	4.9	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-7 DEEP	Barium	130	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-7 DEEP	Beryllium	0.18	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-7 DEEP	Calcium	3700	mg/kg				
Building 102 D	Metals	102D SS-7 DEEP	Chromium	21	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-7 DEEP	Cobalt	5.5	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-7 DEEP	Copper	12	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-7 DEEP	Iron	17000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-7 DEEP	Lead	23	mg/kg		400	800	363
Building 102 D	Metals	102D SS-7 DEEP	Magnesium	2700	mg/kg				
Building 102 D	Metals	102D SS-7 DEEP	Manganese	370	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-7 DEEP	Nickel	12	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-7 DEEP	Potassium	1200	mg/kg				
Building 102 D	Metals	102D SS-7 DEEP	Sodium	220	mg/kg				
Building 102 D	Metals	102D SS-7 DEEP	Vanadium	34	mg/kg		39	580	72
Building 102 D	Metals	102D SS-7 DEEP	Zinc	38	mg/kg		2300	35000	414
Building 102 D	Metals	102D SS-7 SHALLOW	Aluminum	18000	mg/kg		7700	110000	54730
Building 102 D	Metals	102D SS-7 SHALLOW	Arsenic	54	mg/kg		0.68	3	12.3
Building 102 D	Metals	102D SS-7 SHALLOW	Barium	150	mg/kg		1500	22000	
Building 102 D	Metals	102D SS-7 SHALLOW	Beryllium	0.14	mg/kg	B	16	230	1.01
Building 102 D	Metals	102D SS-7 SHALLOW	Cadmium	0.2	mg/kg	B	70	800	3.84
Building 102 D	Metals	102D SS-7 SHALLOW	Calcium	12000	mg/kg				
Building 102 D	Metals	102D SS-7 SHALLOW	Chromium	60	mg/kg		12000	180000	25.5
Building 102 D	Metals	102D SS-7 SHALLOW	Cobalt	6.3	mg/kg		2.3	35	13
Building 102 D	Metals	102D SS-7 SHALLOW	Copper	23	mg/kg		310	4700	59.1
Building 102 D	Metals	102D SS-7 SHALLOW	Iron	20000	mg/kg		5500	82000	35460
Building 102 D	Metals	102D SS-7 SHALLOW	Lead	380	mg/kg		400	800	363
Building 102 D	Metals	102D SS-7 SHALLOW	Magnesium	4100	mg/kg				
Building 102 D	Metals	102D SS-7 SHALLOW	Manganese	410	mg/kg		180	2600	1904
Building 102 D	Metals	102D SS-7 SHALLOW	Nickel	14	mg/kg		84	1200	27.9
Building 102 D	Metals	102D SS-7 SHALLOW	Potassium	1400	mg/kg				
Building 102 D	Metals	102D SS-7 SHALLOW	Sodium	140	mg/kg				
Building 102 D	Metals	102D SS-7 SHALLOW	Vanadium	35	mg/kg		39	580	72
Building 102 D	Metals	102D SS-7 SHALLOW	Zinc	150	mg/kg		2300	35000	414
Building 102 D	Metals	102DCS SED	Aluminum	16000	mg/kg		7700	110000	54730
Building 102 D	Metals	102DCS SED	Arsenic	8.1	mg/kg		0.68	3	12.3
Building 102 D	Metals	102DCS SED	Barium	190	mg/kg		1500	22000	
Building 102 D	Metals	102DCS SED	Beryllium	0.51	mg/kg		16	230	1.01
Building 102 D	Metals	102DCS SED	Cadmium	0.82	mg/kg		70	800	3.84

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	Metals	102DCS SED	Calcium	6800	mg/kg				
Building 102 D	Metals	102DCS SED	Chromium	22	mg/kg		12000	180000	25.5
Building 102 D	Metals	102DCS SED	Cobalt	8.9	mg/kg		2.3	35	13
Building 102 D	Metals	102DCS SED	Copper	27	mg/kg		310	4700	59.1
Building 102 D	Metals	102DCS SED	Iron	21000	mg/kg		5500	82000	35460
Building 102 D	Metals	102DCS SED	Lead	120	mg/kg		400	800	363
Building 102 D	Metals	102DCS SED	Magnesium	4000	mg/kg				
Building 102 D	Metals	102DCS SED	Manganese	620	mg/kg		180	2600	1904
Building 102 D	Metals	102DCS SED	Nickel	19	mg/kg		84	1200	27.9
Building 102 D	Metals	102DCS SED	Potassium	1600	mg/kg				
Building 102 D	Metals	102DCS SED	Silver	10	mg/kg		39	580	
Building 102 D	Metals	102DCS SED	Sodium	210	mg/kg				
Building 102 D	Metals	102DCS SED	Thallium	1.5	mg/kg		0.078	1.2	0.53
Building 102 D	Metals	102DCS SED	Vanadium	36	mg/kg		39	580	72
Building 102 D	Metals	102DCS SED	Zinc	84	mg/kg		2300	35000	414
Building 102 D	Phosphorous	102D CORNER SPILL	Phosphorous	140	mg/kg		0.16	2.3	
Building 102 D	Phosphorous	102DCS SED	Phosphorous	520	mg/kg		0.16	2.3	
Building 102 D	SVOCs	102D CORNER SPILL	anthracene	0.0052	mg/kg	J	1800	23000	
Building 102 D	SVOCs	102D CORNER SPILL	Benz(a)anthracene	0.075	mg/kg		1.1	21	
Building 102 D	SVOCs	102D CORNER SPILL	Benzo(a)pyrene	0.09	mg/kg		0.11	2.1	
Building 102 D	SVOCs	102D CORNER SPILL	Benzo(b)fluoranthene	0.14	mg/kg		1.1	21	
Building 102 D	SVOCs	102D CORNER SPILL	Benzo(ghi)perylene	0.19	mg/kg				
Building 102 D	SVOCs	102D CORNER SPILL	Benzo(k)fluoranthene	0.072	mg/kg		11	210	
Building 102 D	SVOCs	102D CORNER SPILL	Benzoic Acid	3.5	mg/kg		25000	330000	
Building 102 D	SVOCs	102D CORNER SPILL	Bis(2-ethylhexyl)phthalate	2.2	mg/kg		39	160	
Building 102 D	SVOCs	102D CORNER SPILL	Butyl Benzyl Phthalate	49	mg/kg		290	1200	
Building 102 D	SVOCs	102D CORNER SPILL	Chrysene	0.17	mg/kg		110	2100	
Building 102 D	SVOCs	102D CORNER SPILL	Dibenzo(a,h)anthracene	0.26	mg/kg		0.11	2.1	
Building 102 D	SVOCs	102D CORNER SPILL	Diethyl Phthalate	0.014	mg/kg		5100	66000	
Building 102 D	SVOCs	102D CORNER SPILL	Di-n-butyl phthalate	0.58	mg/kg		630	8200	
Building 102 D	SVOCs	102D CORNER SPILL	Di-n-octylphthalate	0.19	mg/kg	J	63	820	
Building 102 D	SVOCs	102D CORNER SPILL	Fluoranthene	0.13	mg/kg		240	3000	
Building 102 D	SVOCs	102D CORNER SPILL	Indeno(1,2,3-cd)pyrene	0.24	mg/kg		1.1	21	
Building 102 D	SVOCs	102D CORNER SPILL	Naphthalene	0.062	mg/kg		3.8	17	
Building 102 D	SVOCs	102D CORNER SPILL	Phenanthrene	0.14	mg/kg				
Building 102 D	SVOCs	102D CORNER SPILL	Pyrene	0.15	mg/kg		180	2300	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Acenaphthene	0.0059	mg/kg	J	360	4500	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	anthracene	0.0065	mg/kg	J	1800	23000	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Benz(a)anthracene	0.016	mg/kg	J	1.1	21	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Benzo(a)pyrene	0.018	mg/kg	J	0.11	2.1	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Benzo(b)fluoranthene	0.016	mg/kg	J	1.1	21	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Benzo(ghi)perylene	0.027	mg/kg	J			
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Bis(2-ethylhexyl)phthalate	0.04	mg/kg	J	39	160	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Chrysene	0.017	mg/kg	J	110	2100	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Dibenzo(a,h)anthracene	0.021	mg/kg	J	0.11	2.1	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Fluoranthene	0.028	mg/kg	J	240	3000	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Fluorene	0.0083	mg/kg	J	240	3000	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Indeno(1,2,3-cd)pyrene	0.024	mg/kg	J	1.1	21	
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Phenanthrene	0.045	mg/kg				
Building 102 D	SVOCs	102D- SS-1 (DEEP)	Pyrene	0.031	mg/kg	J	180	2300	
Building 102 D	SVOCs	102D- SS-2 (DEEP)	Benzo(ghi)perylene	0.0096	mg/kg	J			
Building 102 D	SVOCs	102D- SS-2 (DEEP)	Dibenzo(a,h)anthracene	0.01	mg/kg	J	0.11	2.1	
Building 102 D	SVOCs	102D- SS-2 (DEEP)	Indeno(1,2,3-cd)pyrene	0.0089	mg/kg	J	1.1	21	
Building 102 D	SVOCs	102D SS-3 (DEEP)	Benzo(ghi)perylene	0.013	mg/kg	J			
Building 102 D	SVOCs	102D SS-3 (DEEP)	Indeno(1,2,3-cd)pyrene	0.0072	mg/kg	J	1.1	21	
Building 102 D	SVOCs	102D SS-4 (DEEP)	Benz(a)anthracene	0.0095	mg/kg	J	1.1	21	
Building 102 D	SVOCs	102D SS-4 (DEEP)	Benzo(b)Fluoranthene	0.01	mg/kg	J	1.1	21	
Building 102 D	SVOCs	102D SS-4 (DEEP)	Benzo(ghi)perylene	0.018	mg/kg	J			
Building 102 D	SVOCs	102D SS-4 (DEEP)	Chrysene	0.012	mg/kg	J	110	2100	
Building 102 D	SVOCs	102D SS-4 (DEEP)	Dibenzo(a,h)anthracene	0.011	mg/kg	J	0.11	2.1	
Building 102 D	SVOCs	102D SS-4 (DEEP)	Fluoranthene	0.018	mg/kg	J	240	3000	
Building 102 D	SVOCs	102D SS-4 (DEEP)	Indeno(1,2,3-cd)pyrene	0.015	mg/kg	J	1.1	21	
Building 102 D	SVOCs	102D SS-4 (DEEP)	Phenanthrene	0.015	mg/kg	J			
Building 102 D	SVOCs	102D SS-4 (DEEP)	Pyrene	0.02	mg/kg	J	180	2300	
Building 102 D	SVOCs	102D- SS-5 (DEEP)	Benzo(ghi)perylene	0.013	mg/kg	J			
Building 102 D	SVOCs	102D- SS-5 (DEEP)	Dibenzo(a,h)anthracene	0.014	mg/kg	J	0.11	2.1	
Building 102 D	SVOCs	102D- SS-5 (DEEP)	Indeno(1,2,3-cd)pyrene	0.011	mg/kg	J	1.1	21	
Building 102 E	Cyanide	102ECSSOIL	Cyanide, Total	0.22	mg/kg	B	2.3	15	
Building 102 E	Mercury	102ECSSOIL	Mercury	0.028	mg/kg		1.1	4.6	0.154
Building 102 E	Metals	102ECSSOIL	Aluminum	17000	mg/kg		7700	110000	54730
Building 102 E	Metals	102ECSSOIL	Arsenic	6.8	mg/kg		0.68	3	12.3
Building 102 E	Metals	102ECSSOIL	Barium	240	mg/kg		1500	22000	
Building 102 E	Metals	102ECSSOIL	Beryllium	0.87	mg/kg		16	230	1.01
Building 102 E	Metals	102ECSSOIL	Cadmium	0.15	mg/kg	B	70	800	3.84
Building 102 E	Metals	102ECSSOIL	Calcium	8500	mg/kg				
Building 102 E	Metals	102ECSSOIL	Chromium	23	mg/kg		12000	180000	25.5
Building 102 E	Metals	102ECSSOIL	Cobalt	12	mg/kg		2.3	35	13
Building 102 E	Metals	102ECSSOIL	Copper	13	mg/kg		310	4700	59.1
Building 102 E	Metals	102ECSSOIL	Iron	20000	mg/kg		5500	82000	35460
Building 102 E	Metals	102ECSSOIL	Lead	47	mg/kg		400	800	363

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 102 E	Metals	102ECSSOIL	Magnesium	2800	mg/kg				
Building 102 E	Metals	102ECSSOIL	Manganese	740	mg/kg		180	2600	1904
Building 102 E	Metals	102ECSSOIL	Nickel	21	mg/kg		84	1200	27.9
Building 102 E	Metals	102ECSSOIL	Potassium	940	mg/kg				
Building 102 E	Metals	102ECSSOIL	Sodium	360	mg/kg				
Building 102 E	Metals	102ECSSOIL	Thallium	1.3	mg/kg		0.078	1.2	0.53
Building 102 E	Metals	102ECSSOIL	Vanadium	38	mg/kg		39	580	72
Building 102 E	Metals	102ECSSOIL	Zinc	41	mg/kg		2300	35000	414
Building 102 E	Metals	102E-IS1	Lead	242	mg/kg	J	400	800	363
Building 102 E	Metals	102E-IS2	Lead	33.2	mg/kg	J	400	800	363
Building 102 E	Phosphorous	102ECSSOIL	Phosphorous	160	mg/kg		0.16	2.3	
Building 103 A/B/C	Cyanide	103CSSOIL1	Cyanide, Total	0.28	mg/kg	B	2.3	15	
Building 103 A/B/C	Mercury	103CSSOIL1	Mercury	0.12	mg/kg		1.1	4.6	0.154
Building 103 A/B/C	Mercury	103CSSOIL4	Mercury	0.071	mg/kg		1.1	4.6	0.154
Building 103 A/B/C	Mercury	103-IS1	Mercury	0.373	mg/kg		1.1	4.6	0.154
Building 103 A/B/C	Mercury	103-IS2	Mercury	0.0621	mg/kg		1.1	4.6	0.154
Building 103 A/B/C	Mercury	103-IS3	Mercury	0.335	mg/kg		1.1	4.6	0.154
Building 103 A/B/C	Mercury	103-IS4	Mercury	0.145	mg/kg		1.1	4.6	0.154
Building 103 A/B/C	Mercury	103-IS5	Mercury	0.0884	mg/kg		1.1	4.6	0.154
Building 103 A/B/C	Metals	103CSSOIL1	Aluminum	17000	mg/kg		7700	110000	54730
Building 103 A/B/C	Metals	103CSSOIL1	Arsenic	5.8	mg/kg		0.68	3	12.3
Building 103 A/B/C	Metals	103CSSOIL1	Barium	160	mg/kg		1500	22000	
Building 103 A/B/C	Metals	103CSSOIL1	Beryllium	1.2	mg/kg		16	230	1.01
Building 103 A/B/C	Metals	103CSSOIL1	Cadmium	0.43	mg/kg		70	800	3.84
Building 103 A/B/C	Metals	103CSSOIL1	Calcium	5200	mg/kg				
Building 103 A/B/C	Metals	103CSSOIL1	Chromium	27	mg/kg		12000	180000	25.5
Building 103 A/B/C	Metals	103CSSOIL1	Cobalt	10	mg/kg		2.3	35	13
Building 103 A/B/C	Metals	103CSSOIL1	Copper	87	mg/kg		310	4700	59.1
Building 103 A/B/C	Metals	103CSSOIL1	Iron	21000	mg/kg		5500	82000	35460
Building 103 A/B/C	Metals	103CSSOIL1	Lead	21	mg/kg		400	800	363
Building 103 A/B/C	Metals	103CSSOIL1	Magnesium	3100	mg/kg				
Building 103 A/B/C	Metals	103CSSOIL1	Manganese	630	mg/kg		180	2600	1904
Building 103 A/B/C	Metals	103CSSOIL1	Nickel	34	mg/kg		84	1200	27.9
Building 103 A/B/C	Metals	103CSSOIL1	Potassium	200	mg/kg				
Building 103 A/B/C	Metals	103CSSOIL1	Selenium	0.48	mg/kg	B	39	580	0.777
Building 103 A/B/C	Metals	103CSSOIL1	Sodium	180	mg/kg				
Building 103 A/B/C	Metals	103CSSOIL1	Thallium	1.2	mg/kg		0.078	1.2	0.53
Building 103 A/B/C	Metals	103CSSOIL1	Vanadium	35	mg/kg		39	580	72
Building 103 A/B/C	Metals	103CSSOIL1	Zinc	120	mg/kg		2300	35000	414
Building 103 A/B/C	Metals	103CSSOIL4	Aluminum	15000	mg/kg		7700	110000	54730

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 103 A/B/C	Metals	103CSSOIL4	Arsenic	4.6	mg/kg		0.68	3	12.3
Building 103 A/B/C	Metals	103CSSOIL4	Barium	170	mg/kg		1500	22000	
Building 103 A/B/C	Metals	103CSSOIL4	Beryllium	1.1	mg/kg		16	230	1.01
Building 103 A/B/C	Metals	103CSSOIL4	Cadmium	0.47	mg/kg		70	800	3.84
Building 103 A/B/C	Metals	103CSSOIL4	Calcium	8000	mg/kg				
Building 103 A/B/C	Metals	103CSSOIL4	Chromium	29	mg/kg		12000	180000	25.5
Building 103 A/B/C	Metals	103CSSOIL4	Cobalt	18	mg/kg		2.3	35	13
Building 103 A/B/C	Metals	103CSSOIL4	Copper	14	mg/kg		310	4700	59.1
Building 103 A/B/C	Metals	103CSSOIL4	Iron	37000	mg/kg		5500	82000	35460
Building 103 A/B/C	Metals	103CSSOIL4	Lead	32	mg/kg		400	800	363
Building 103 A/B/C	Metals	103CSSOIL4	Magnesium	3700	mg/kg				
Building 103 A/B/C	Metals	103CSSOIL4	Manganese	660	mg/kg		180	2600	1904
Building 103 A/B/C	Metals	103CSSOIL4	Nickel	39	mg/kg		84	1200	27.9
Building 103 A/B/C	Metals	103CSSOIL4	Potassium	1400	mg/kg				
Building 103 A/B/C	Metals	103CSSOIL4	Sodium	690	mg/kg				
Building 103 A/B/C	Metals	103CSSOIL4	Thallium	1.3	mg/kg		0.078	1.2	0.53
Building 103 A/B/C	Metals	103CSSOIL4	Vanadium	38	mg/kg		39	580	72
Building 103 A/B/C	Metals	103CSSOIL4	Zinc	68	mg/kg		2300	35000	414
Building 103 A/B/C	Metals	103-IS1	Lead	24.3	mg/kg		400	800	363
Building 103 A/B/C	Metals	103-IS2	Lead	13.2	mg/kg		400	800	363
Building 103 A/B/C	Metals	103-IS3	Lead	738	mg/kg		400	800	363
Building 103 A/B/C	Metals	103-IS4	Lead	149	mg/kg		400	800	363
Building 103 A/B/C	Metals	103-IS5	Lead	1010	mg/kg		400	800	363
Building 103 A/B/C	Phosphorous	103CSSOIL1	Phosphorous	25	mg/kg		0.16	2.3	
Building 103 A/B/C	Phosphorous	103CSSOIL4	Phosphorous	250	mg/kg		0.16	2.3	
Building 103 A/B/C	SVOCs	103CSSOIL1	Acenaphthene	0.011	mg/kg	J	360	4500	
Building 103 A/B/C	SVOCs	103CSSOIL1	Acenaphthylene	0.0052	mg/kg	J			
Building 103 A/B/C	SVOCs	103CSSOIL1	Anthracene	0.072	mg/kg		1800	23000	
Building 103 A/B/C	SVOCs	103CSSOIL1	Benz(a)anthracene	0.46	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103CSSOIL1	Benzo(a)pyrene	0.38	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103CSSOIL1	Benzo(b)fluoranthene	0.46	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103CSSOIL1	Benzo(k)fluoranthene	0.5	mg/kg		11	210	
Building 103 A/B/C	SVOCs	103CSSOIL1	Carbazole	0.066	mg/kg	J			
Building 103 A/B/C	SVOCs	103CSSOIL1	Chrysene	0.52	mg/kg		110	2100	
Building 103 A/B/C	SVOCs	103CSSOIL1	Dibenzo(a,h)anthracene	0.068	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103CSSOIL1	Dibenzofuran	0.032	mg/kg	J	7.3	100	
Building 103 A/B/C	SVOCs	103CSSOIL1	Di-n-butyl phthalate	0.088	mg/kg	J	630	8200	
Building 103 A/B/C	SVOCs	103CSSOIL1	Fluoranthene	0.1	mg/kg		240	3000	
Building 103 A/B/C	SVOCs	103CSSOIL1	Fluorene	0.0087	mg/kg	J	240	3000	
Building 103 A/B/C	SVOCs	103CSSOIL1	Indeno(1,2,3-cd)pyrene	0.25	mg/kg		1.1	21	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 103 A/B/C	SVOCs	103CSSOIL1	Methylnaphthalene, 2-	0.016	mg/kg	J	24	300	
Building 103 A/B/C	SVOCs	103CSSOIL1	Naphthalene	0.024	mg/kg	J	3.8	17	
Building 103 A/B/C	SVOCs	103CSSOIL1	Phenanthrene	0.37	mg/kg				
Building 103 A/B/C	SVOCs	103CSSOIL1	Pyrene	0.65	mg/kg		180	2300	
Building 103 A/B/C	SVOCs	103CSSOIL4	Anthracene	0.0065	mg/kg	J	1800	23000	
Building 103 A/B/C	SVOCs	103CSSOIL4	Benz(a)anthracene	0.024	mg/kg	J	1.1	21	
Building 103 A/B/C	SVOCs	103CSSOIL4	Benzo(a)pyrene	0.032	mg/kg	J	0.11	2.1	
Building 103 A/B/C	SVOCs	103CSSOIL4	Benzo(b)fluoranthene	0.063	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103CSSOIL4	Benzo(k)fluoranthene	0.013	mg/kg	J	11	210	
Building 103 A/B/C	SVOCs	103CSSOIL4	Chrysene	0.05	mg/kg		110	2100	
Building 103 A/B/C	SVOCs	103CSSOIL4	Dibenzofuran	0.0052	mg/kg	J	7.3	100	
Building 103 A/B/C	SVOCs	103CSSOIL4	Di-n-butyl phthalate	0.095	mg/kg	J	630	8200	
Building 103 A/B/C	SVOCs	103CSSOIL4	Fluoranthene	0.09	mg/kg		240	3000	
Building 103 A/B/C	SVOCs	103CSSOIL4	Phenanthrene	0.028	mg/kg	J			
Building 103 A/B/C	SVOCs	103CSSOIL4	Pyrene	0.059	mg/kg		180	2300	
Building 103 A/B/C	SVOCs	103-IS1	Acenaphthene	0.0057	mg/kg	J	360	4500	
Building 103 A/B/C	SVOCs	103-IS1	Acenaphthylene	0.0037	mg/kg	J			
Building 103 A/B/C	SVOCs	103-IS1	Anthracene	0.024	mg/kg		1800	23000	
Building 103 A/B/C	SVOCs	103-IS1	Benz(a)anthracene	0.12	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS1	Benzo(a)pyrene	0.12	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS1	Benzo(b)Fluoranthene	0.18	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS1	Benzo(ghi)perylene	0.1	mg/kg				
Building 103 A/B/C	SVOCs	103-IS1	Benzo(k)Fluoranthene	0.078	mg/kg		11	210	
Building 103 A/B/C	SVOCs	103-IS1	Bis(2-ethylhexyl)phthalate	0.011	mg/kg		39	160	
Building 103 A/B/C	SVOCs	103-IS1	Carbazole	0.017	mg/kg				
Building 103 A/B/C	SVOCs	103-IS1	Chrysene	0.14	mg/kg		110	2100	
Building 103 A/B/C	SVOCs	103-IS1	Dibenzo(a,h)anthracene	0.026	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS1	Dibenzofuran	0.0079	mg/kg		7.3	100	
Building 103 A/B/C	SVOCs	103-IS1	Di-n-butyl phthalate	0.0038	mg/kg	J	630	8200	
Building 103 A/B/C	SVOCs	103-IS1	Fluoranthene	0.26	mg/kg		240	3000	
Building 103 A/B/C	SVOCs	103-IS1	Fluorene	0.0052	mg/kg	J	240	3000	
Building 103 A/B/C	SVOCs	103-IS1	Indeno(1,2,3-cd)pyrene	0.11	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS1	Phenanthrene	0.13	mg/kg				
Building 103 A/B/C	SVOCs	103-IS1	Pyrene	0.22	mg/kg		180	2300	
Building 103 A/B/C	SVOCs	103-IS2	Benz(a)anthracene	0.0031	mg/kg	J	1.1	21	
Building 103 A/B/C	SVOCs	103-IS2	Benzo(a)pyrene	0.0052	mg/kg	J	0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS2	Benzo(b)Fluoranthene	0.0093	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS2	Benzo(ghi)perylene	0.015	mg/kg				
Building 103 A/B/C	SVOCs	103-IS2	Benzo(k)Fluoranthene	0.0094	mg/kg		11	210	
Building 103 A/B/C	SVOCs	103-IS2	Bis(2-ethylhexyl)phthalate	0.018	mg/kg		39	160	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
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Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 103 A/B/C	SVOCs	103-IS2	Chrysene	0.0038	mg/kg	J	110	2100	
Building 103 A/B/C	SVOCs	103-IS2	Dibenzo(a,h)anthracene	0.015	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS2	Diethyl Phthalate	0.0024	mg/kg	J	5100	66000	
Building 103 A/B/C	SVOCs	103-IS2	Di-n-butyl phthalate	0.0077	mg/kg		630	8200	
Building 103 A/B/C	SVOCs	103-IS2	Di-n-octylphthalate	0.012	mg/kg		63	820	
Building 103 A/B/C	SVOCs	103-IS2	Fluoranthene	0.0038	mg/kg	J	240	3000	
Building 103 A/B/C	SVOCs	103-IS2	Indeno(1,2,3-cd)pyrene	0.016	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS2	Phenanthrene	0.0032	mg/kg	J			
Building 103 A/B/C	SVOCs	103-IS2	Pyrene	0.0031	mg/kg	J	180	2300	
Building 103 A/B/C	SVOCs	103-IS3	Acenaphthene	0.25	mg/kg		360	4500	
Building 103 A/B/C	SVOCs	103-IS3	Acenaphthylene	0.025	mg/kg				
Building 103 A/B/C	SVOCs	103-IS3	Anthracene	0.33	mg/kg		1800	23000	
Building 103 A/B/C	SVOCs	103-IS3	Benz(a)anthracene	3.1	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS3	Benzaldehyde	0.016	mg/kg		170	820	
Building 103 A/B/C	SVOCs	103-IS3	Benzo(a)pyrene	3.2	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS3	Benzo(b)Fluoranthene	4.7	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS3	Benzo(ghi)perylene	3.1	mg/kg				
Building 103 A/B/C	SVOCs	103-IS3	Benzo(k)Fluoranthene	2.1	mg/kg		11	210	
Building 103 A/B/C	SVOCs	103-IS3	Biphenyl, 1,1´-	0.019	mg/kg		4.7	20	
Building 103 A/B/C	SVOCs	103-IS3	Bis(2-ethylhexyl)phthalate	0.06	mg/kg		39	160	
Building 103 A/B/C	SVOCs	103-IS3	Carbazole	0.33	mg/kg				
Building 103 A/B/C	SVOCs	103-IS3	Chrysene	4	mg/kg		110	2100	
Building 103 A/B/C	SVOCs	103-IS3	Dibenzo(a,h)anthracene	0.83	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS3	Dibenzofuran	0.11	mg/kg		7.3	100	
Building 103 A/B/C	SVOCs	103-IS3	Diethyl Phthalate	0.0018	mg/kg	J	5100	66000	
Building 103 A/B/C	SVOCs	103-IS3	Di-n-butyl phthalate	0.023	mg/kg		630	8200	
Building 103 A/B/C	SVOCs	103-IS3	Fluoranthene	6.6	mg/kg		240	3000	
Building 103 A/B/C	SVOCs	103-IS3	Fluorene	0.19	mg/kg		240	3000	
Building 103 A/B/C	SVOCs	103-IS3	Indeno(1,2,3-cd)pyrene	3.3	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS3	Methylnaphthalene, 2-	0.031	mg/kg		24	300	
Building 103 A/B/C	SVOCs	103-IS3	Methylphenol, 3&4-	0.008	mg/kg		6.3	82	
Building 103 A/B/C	SVOCs	103-IS3	Naphthalene	0.059	mg/kg		3.8	17	
Building 103 A/B/C	SVOCs	103-IS3	Phenanthrene	3.2	mg/kg				
Building 103 A/B/C	SVOCs	103-IS3	Phenol	0.0039	mg/kg	J	1900	25000	
Building 103 A/B/C	SVOCs	103-IS3	Phenyl Methyl Ketone (Acetophenone)	0.0074	mg/kg		780	12000	
Building 103 A/B/C	SVOCs	103-IS3	Pyrene	5.2	mg/kg		180	2300	
Building 103 A/B/C	SVOCs	103-IS4	Acenaphthene	0.14	mg/kg		360	4500	
Building 103 A/B/C	SVOCs	103-IS4	Acenaphthylene	0.0076	mg/kg				
Building 103 A/B/C	SVOCs	103-IS4	Anthracene	0.59	mg/kg		1800	23000	

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HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
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Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 103 A/B/C	SVOCs	103-IS4	Benz(a)anthracene	1.8	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS4	Benzo(a)pyrene	1.6	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS4	Benzo(b)Fluoranthene	2.2	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS4	Benzo(ghi)perylene	1.2	mg/kg				
Building 103 A/B/C	SVOCs	103-IS4	Benzo(k)Fluoranthene	0.93	mg/kg		11	210	
Building 103 A/B/C	SVOCs	103-IS4	Biphenyl, 1,1´-	0.005	mg/kg	J	4.7	20	
Building 103 A/B/C	SVOCs	103-IS4	Bis(2-ethylhexyl)phthalate	0.07	mg/kg		39	160	
Building 103 A/B/C	SVOCs	103-IS4	Butyl Benzyl Phthalate	0.0052	mg/kg	J	290	1200	
Building 103 A/B/C	SVOCs	103-IS4	Carbazole	0.33	mg/kg				
Building 103 A/B/C	SVOCs	103-IS4	Chrysene	2.1	mg/kg		110	2100	
Building 103 A/B/C	SVOCs	103-IS4	Dibenzo(a,h)anthracene	0.25	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS4	Dibenzofuran	0.061	mg/kg		7.3	100	
Building 103 A/B/C	SVOCs	103-IS4	Di-n-butyl phthalate	0.0052	mg/kg	J	630	8200	
Building 103 A/B/C	SVOCs	103-IS4	Fluoranthene	2.8	mg/kg		240	3000	
Building 103 A/B/C	SVOCs	103-IS4	Fluorene	0.14	mg/kg		240	3000	
Building 103 A/B/C	SVOCs	103-IS4	Indeno(1,2,3-cd)pyrene	1.3	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS4	Methylnaphthalene, 2-	0.021	mg/kg		24	300	
Building 103 A/B/C	SVOCs	103-IS4	Naphthalene	0.043	mg/kg		3.8	17	
Building 103 A/B/C	SVOCs	103-IS4	Phenanthrene	2.5	mg/kg				
Building 103 A/B/C	SVOCs	103-IS4	Pyrene	2.5	mg/kg		180	2300	
Building 103 A/B/C	SVOCs	103-IS5	Acenaphthene	0.026	mg/kg		360	4500	
Building 103 A/B/C	SVOCs	103-IS5	Acenaphthylene	0.022	mg/kg				
Building 103 A/B/C	SVOCs	103-IS5	Anthracene	0.12	mg/kg		1800	23000	
Building 103 A/B/C	SVOCs	103-IS5	Benz(a)anthracene	0.59	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS5	Benzo(a)pyrene	0.58	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS5	Benzo(b)Fluoranthene	0.85	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS5	Benzo(ghi)perylene	0.54	mg/kg				
Building 103 A/B/C	SVOCs	103-IS5	Benzo(k)Fluoranthene	0.23	mg/kg		11	210	
Building 103 A/B/C	SVOCs	103-IS5	Biphenyl, 1,1´-	0.0043	mg/kg	J	4.7	20	
Building 103 A/B/C	SVOCs	103-IS5	Bis(2-ethylhexyl)phthalate	0.042	mg/kg		39	160	
Building 103 A/B/C	SVOCs	103-IS5	Butyl Benzyl Phthalate	0.0063	mg/kg	J	290	1200	
Building 103 A/B/C	SVOCs	103-IS5	Caprolactam	0.029	mg/kg		3100	40000	
Building 103 A/B/C	SVOCs	103-IS5	Carbazole	0.084	mg/kg				
Building 103 A/B/C	SVOCs	103-IS5	Chrysene	0.75	mg/kg		110	2100	
Building 103 A/B/C	SVOCs	103-IS5	Dibenzo(a,h)anthracene	0.12	mg/kg		0.11	2.1	
Building 103 A/B/C	SVOCs	103-IS5	Dibenzofuran	0.02	mg/kg		7.3	100	
Building 103 A/B/C	SVOCs	103-IS5	Diethyl Phthalate	0.0029	mg/kg	J	5100	66000	
Building 103 A/B/C	SVOCs	103-IS5	Di-n-butyl phthalate	0.008	mg/kg		630	8200	
Building 103 A/B/C	SVOCs	103-IS5	Fluoranthene	1	mg/kg		240	3000	
Building 103 A/B/C	SVOCs	103-IS5	Fluorene	0.024	mg/kg		240	3000	

APPENDIX A-4
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GOODFELLOW FEDERAL COMPLEX
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Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 103 A/B/C	SVOCs	103-IS5	Indeno(1,2,3-cd)pyrene	0.54	mg/kg		1.1	21	
Building 103 A/B/C	SVOCs	103-IS5	Methylnaphthalene, 2-	0.0084	mg/kg		24	300	
Building 103 A/B/C	SVOCs	103-IS5	Naphthalene	0.0065	mg/kg	J	3.8	17	
Building 103 A/B/C	SVOCs	103-IS5	Phenanthrene	0.63	mg/kg				
Building 103 A/B/C	SVOCs	103-IS5	Phenyl Methyl Ketone (Acetophenone)	0.0028	mg/kg	J	780	12000	
Building 103 A/B/C	SVOCs	103-IS5	Pyrene	0.95	mg/kg		180	2300	
Building 103 A/B/C	VOCs	103CSSOIL1	Trichlorofluoromethane	0.0045	mg/kg	J	2300	35000	
Building 103 A/B/C	VOCs	103CSSOIL4	Trichlorofluoromethane	0.0065	mg/kg	J	2300	35000	
Building 103 D	Mercury	103DCSSS1	Mercury	0.056	mg/kg		1.1	4.6	0.154
Building 103 D	Mercury	103DCSSS2	Mercury	0.84	mg/kg		1.1	4.6	0.154
Building 103 D	Metals	103DCSSS1	Aluminum	9600	mg/kg		7700	110000	54730
Building 103 D	Metals	103DCSSS1	Arsenic	5.9	mg/kg		0.68	3	12.3
Building 103 D	Metals	103DCSSS1	Barium	67	mg/kg		1500	22000	
Building 103 D	Metals	103DCSSS1	Beryllium	0.59	mg/kg		16	230	1.01
Building 103 D	Metals	103DCSSS1	Cadmium	0.26	mg/kg		70	800	3.84
Building 103 D	Metals	103DCSSS1	Calcium	3200	mg/kg				
Building 103 D	Metals	103DCSSS1	Chromium	17	mg/kg		12000	180000	25.5
Building 103 D	Metals	103DCSSS1	Cobalt	7.7	mg/kg		2.3	35	13
Building 103 D	Metals	103DCSSS1	Copper	11	mg/kg		310	4700	59.1
Building 103 D	Metals	103DCSSS1	Iron	16000	mg/kg		5500	82000	35460
Building 103 D	Metals	103DCSSS1	Lead	14	mg/kg		400	800	363
Building 103 D	Metals	103DCSSS1	Magnesium	2600	mg/kg				
Building 103 D	Metals	103DCSSS1	Manganese	620	mg/kg		180	2600	1904
Building 103 D	Metals	103DCSSS1	Nickel	19	mg/kg		84	1200	27.9
Building 103 D	Metals	103DCSSS1	Potassium	540	mg/kg				
Building 103 D	Metals	103DCSSS1	Sodium	600	mg/kg				
Building 103 D	Metals	103DCSSS1	Vanadium	33	mg/kg		39	580	72
Building 103 D	Metals	103DCSSS1	Zinc	36	mg/kg		2300	35000	414
Building 103 D	Metals	103DCSSS2	Aluminum	9900	mg/kg		7700	110000	54730
Building 103 D	Metals	103DCSSS2	Arsenic	4.6	mg/kg		0.68	3	12.3
Building 103 D	Metals	103DCSSS2	Barium	88	mg/kg		1500	22000	
Building 103 D	Metals	103DCSSS2	Beryllium	0.57	mg/kg		16	230	1.01
Building 103 D	Metals	103DCSSS2	Cadmium	0.22	mg/kg		70	800	3.84
Building 103 D	Metals	103DCSSS2	Calcium	3400	mg/kg				
Building 103 D	Metals	103DCSSS2	Chromium	16	mg/kg		12000	180000	25.5
Building 103 D	Metals	103DCSSS2	Cobalt	4.7	mg/kg		2.3	35	13
Building 103 D	Metals	103DCSSS2	Copper	13	mg/kg		310	4700	59.1
Building 103 D	Metals	103DCSSS2	Iron	14000	mg/kg		5500	82000	35460
Building 103 D	Metals	103DCSSS2	Lead	35	mg/kg		400	800	363

APPENDIX A-4
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Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 103 D	Metals	103DCSSS2	Magnesium	2400	mg/kg				
Building 103 D	Metals	103DCSSS2	Manganese	270	mg/kg		180	2600	1904
Building 103 D	Metals	103DCSSS2	Nickel	9.9	mg/kg		84	1200	27.9
Building 103 D	Metals	103DCSSS2	Potassium	570	mg/kg				
Building 103 D	Metals	103DCSSS2	Sodium	280	mg/kg				
Building 103 D	Metals	103DCSSS2	Vanadium	27	mg/kg		39	580	72
Building 103 D	Metals	103DCSSS2	Zinc	50	mg/kg		2300	35000	414
Building 103 D	Metals	103D-IS1	Lead	88.8	mg/kg	J	400	800	363
Building 103 D	Metals	103D-IS1-FD	Lead	126	mg/kg	J	400	800	363
Building 103 D	Metals	103D-IS2	Lead	211	mg/kg	J	400	800	363
Building 103 D	Phosphorous	103DCSSS1	Phosphorous	250	mg/kg		0.16	2.3	
Building 103 D	Phosphorous	103DCSSS2	Phosphorous	290	mg/kg		0.16	2.3	
Building 103 D	SVOCs	103DCSSS1	Anthracene	0.0037	mg/kg	J	1800	23000	
Building 103 D	SVOCs	103DCSSS1	Benz(a)anthracene	0.012	mg/kg	J	1.1	21	
Building 103 D	SVOCs	103DCSSS1	Benzo(a)pyrene	0.017	mg/kg	J	0.11	2.1	
Building 103 D	SVOCs	103DCSSS1	Benzo(b)fluoranthene	0.066	mg/kg		1.1	21	
Building 103 D	SVOCs	103DCSSS1	Bis(2-ethylhexyl)phthalate	0.015	mg/kg	J	39	160	
Building 103 D	SVOCs	103DCSSS1	Chrysene	0.047	mg/kg		110	2100	
Building 103 D	SVOCs	103DCSSS1	Dibenzofuran	0.0051	mg/kg		7.3	100	
Building 103 D	SVOCs	103DCSSS1	Di-n-butyl phthalate	0.1	mg/kg	J	630	8200	
Building 103 D	SVOCs	103DCSSS1	Dinitrotoluene, 2,4-	0.095	mg/kg		1.7	7.4	
Building 103 D	SVOCs	103DCSSS1	Fluoranthene	0.036	mg/kg	J	240	3000	
Building 103 D	SVOCs	103DCSSS1	Methylnaphthalene, 2-	0.0026	mg/kg	J	24	300	
Building 103 D	SVOCs	103DCSSS1	Naphthalene	0.0029	mg/kg	J	3.8	17	
Building 103 D	SVOCs	103DCSSS1	Nitrosodiphenylamine, n-	0.011	mg/kg	J	110	470	
Building 103 D	SVOCs	103DCSSS1	Phenanthrene	0.015	mg/kg	J			
Building 103 D	SVOCs	103DCSSS1	Pyrene	0.03	mg/kg	J	180	2300	
Building 103 D	SVOCs	103DCSSS2	Anthracene	0.012	mg/kg	J	1800	23000	
Building 103 D	SVOCs	103DCSSS2	Benz(a)anthracene	0.043	mg/kg		1.1	21	
Building 103 D	SVOCs	103DCSSS2	Benzo(a)pyrene	0.06	mg/kg		0.11	2.1	
Building 103 D	SVOCs	103DCSSS2	Benzo(b)fluoranthene	0.081	mg/kg		1.1	21	
Building 103 D	SVOCs	103DCSSS2	Benzo(k)fluoranthene	0.056	mg/kg		11	210	
Building 103 D	SVOCs	103DCSSS2	Bis(2-ethylhexyl)phthalate	0.027	mg/kg	J	39	160	
Building 103 D	SVOCs	103DCSSS2	Chrysene	0.077	mg/kg		110	2100	
Building 103 D	SVOCs	103DCSSS2	Di-n-butyl phthalate	1.3	mg/kg		630	8200	
Building 103 D	SVOCs	103DCSSS2	Fluoranthene	0.15	mg/kg		240	3000	
Building 103 D	SVOCs	103DCSSS2	Fluorene	0.0027	mg/kg	J	240	3000	
Building 103 D	SVOCs	103DCSSS2	Indeno(1,2,3-cd)pyrene	0.019	mg/kg	J	1.1	21	
Building 103 D	SVOCs	103DCSSS2	Nitrosodiphenylamine, n-	0.1	mg/kg		110	470	
Building 103 D	SVOCs	103DCSSS2	Phenanthrene	0.059	mg/kg				

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HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
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Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 103 D	SVOCs	103DCSSS2	Pyrene	0.1	mg/kg		180	2300	
Building 103 D	VOCs	103DCSSS1	Acetone	0.052	mg/kg		6100	67000	
Building 103 D	VOCs	103DCSSS2	Acetone	0.031	mg/kg		6100	67000	
Building 103 E	Cyanide	103ECSSS1	Cyanide, Total	0.23	mg/kg	B	2.3	15	
Building 103 E	Cyanide	103ECSSS2	Cyanide, Total	0.18	mg/kg	B	2.3	15	
Building 103 E	Mercury	103ECSSS1	Mercury	0.00007	mg/kg		1.1	4.6	0.154
Building 103 E	Mercury	103ECSSS2	Mercury	0.044	mg/kg		1.1	4.6	0.154
Building 103 E	Metals	103ECSSS1	Aluminum	7.7	mg/kg		7700	110000	54730
Building 103 E	Metals	103ECSSS1	Arsenic	0.0072	mg/kg		0.68	3	12.3
Building 103 E	Metals	103ECSSS1	Barium	0.15	mg/kg		1500	22000	
Building 103 E	Metals	103ECSSS1	Beryllium	0.001	mg/kg		16	230	1.01
Building 103 E	Metals	103ECSSS1	Cadmium	0.00043	mg/kg		70	800	3.84
Building 103 E	Metals	103ECSSS1	Calcium	5.1	mg/kg				
Building 103 E	Metals	103ECSSS1	Chromium	0.028	mg/kg		12000	180000	25.5
Building 103 E	Metals	103ECSSS1	Cobalt	0.0063	mg/kg		2.3	35	13
Building 103 E	Metals	103ECSSS1	Copper	0.02	mg/kg		310	4700	59.1
Building 103 E	Metals	103ECSSS1	Iron	27	mg/kg		5500	82000	35460
Building 103 E	Metals	103ECSSS1	Lead	0.059	mg/kg		400	800	363
Building 103 E	Metals	103ECSSS1	Magnesium	2.6	mg/kg				
Building 103 E	Metals	103ECSSS1	Manganese	0.23	mg/kg		180	2600	1904
Building 103 E	Metals	103ECSSS1	Nickel	0.029	mg/kg		84	1200	27.9
Building 103 E	Metals	103ECSSS1	Potassium	0.83	mg/kg				
Building 103 E	Metals	103ECSSS1	Thallium	0.00083	mg/kg	B	0.078	1.2	0.53
Building 103 E	Metals	103ECSSS1	Vanadium	0.036	mg/kg		39	580	72
Building 103 E	Metals	103ECSSS1	Zinc	0.055	mg/kg		2300	35000	414
Building 103 E	Metals	103ECSSS2	Aluminum	10000	mg/kg		7700	110000	54730
Building 103 E	Metals	103ECSSS2	Arsenic	3.3	mg/kg		0.68	3	12.3
Building 103 E	Metals	103ECSSS2	Barium	160	mg/kg		1500	22000	
Building 103 E	Metals	103ECSSS2	Beryllium	0.88	mg/kg		16	230	1.01
Building 103 E	Metals	103ECSSS2	Cadmium	0.12	mg/kg	B	70	800	3.84
Building 103 E	Metals	103ECSSS2	Calcium	11000	mg/kg				
Building 103 E	Metals	103ECSSS2	Chromium	21	mg/kg		12000	180000	25.5
Building 103 E	Metals	103ECSSS2	Cobalt	22	mg/kg		2.3	35	13
Building 103 E	Metals	103ECSSS2	Copper	12	mg/kg		310	4700	59.1
Building 103 E	Metals	103ECSSS2	Iron	25000	mg/kg		5500	82000	35460
Building 103 E	Metals	103ECSSS2	Lead	110	mg/kg		400	800	363
Building 103 E	Metals	103ECSSS2	Magnesium	4900	mg/kg				
Building 103 E	Metals	103ECSSS2	Manganese	190	mg/kg		180	2600	1904
Building 103 E	Metals	103ECSSS2	Nickel	25	mg/kg		84	1200	27.9
Building 103 E	Metals	103ECSSS2	Potassium	760	mg/kg				

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 103 E	Metals	103ECSSS2	Sodium	750	mg/kg				
Building 103 E	Metals	103ECSSS2	Vanadium	30	mg/kg		39	580	72
Building 103 E	Metals	103ECSSS2	Zinc	52	mg/kg		2300	35000	414
Building 103 E	Metals	103E-IS1	Lead	482	mg/kg	J	400	800	363
Building 103 E	Metals	103E-IS2	Lead	681	mg/kg	J	400	800	363
Building 103 E	Phosphorous	103ECSSS1	Phosphorous	1.5	mg/kg	B	0.16	2.3	
Building 103 E	Phosphorous	103ECSSS2	Phosphorous	1.3	mg/kg	B	0.16	2.3	
Building 103 E	SVOCs	103ECSSS2	Fluoranthene	0.036	mg/kg	J	240	3000	
Building 103 E	SVOCs	103ECSSS2	Pyrene	0.023	mg/kg	J	180	2300	
Building 103 E	VOCs	103ECSSS1	Trichlorofluoromethane	0.0076	mg/kg	J	2300	35000	
Building 103 F (prev 112)	Mercury	103F-IS1	Mercury	0.0334	mg/kg		1.1	4.6	0.154
Building 103 F (prev 112)	Mercury	103F-IS2	Mercury	0.51	mg/kg		1.1	4.6	0.154
Building 103 F (prev 112)	Metals	103F-IS1	Lead	109	mg/kg		400	800	363
Building 103 F (prev 112)	Metals	103F-IS2	Lead	189	mg/kg		400	800	363
Building 104 A/B/C/D	Metals	104-IS1	Lead	353	mg/kg		400	800	363
Building 104 A/B/C/D	Metals	104-IS2	Lead	21.4	mg/kg		400	800	363
Building 104 A/B/C/D	Metals	104-IS3	Lead	19	mg/kg		400	800	363
Building 104 A/B/C/D	Metals	104-IS4	Lead	429	mg/kg		400	800	363
Building 104 A/B/C/D	Metals	104-IS5	Lead	11.1	mg/kg		400	800	363
Building 104 A/B/C/D	Metals	104-IS6	Lead	7.88	mg/kg		400	800	363
Building 104 E	Mercury	104ECSSS1	Mercury	0.011	mg/kg	B	1.1	4.6	0.154
Building 104 E	Mercury	104ECSSS2	Mercury	0.044	mg/kg		1.1	4.6	0.154
Building 104 E	Metals	104ECSSS1	Aluminum	9400	mg/kg		7700	110000	54730
Building 104 E	Metals	104ECSSS1	Arsenic	7.3	mg/kg		0.68	3	12.3
Building 104 E	Metals	104ECSSS1	Barium	89	mg/kg		1500	22000	
Building 104 E	Metals	104ECSSS1	Beryllium	1.5	mg/kg		16	230	1.01
Building 104 E	Metals	104ECSSS1	Calcium	3800	mg/kg				
Building 104 E	Metals	104ECSSS1	Chromium	13	mg/kg		12000	180000	25.5
Building 104 E	Metals	104ECSSS1	Cobalt	11	mg/kg		2.3	35	13
Building 104 E	Metals	104ECSSS1	Copper	11	mg/kg		310	4700	59.1
Building 104 E	Metals	104ECSSS1	Iron	18000	mg/kg		5500	82000	35460
Building 104 E	Metals	104ECSSS1	Lead	13	mg/kg		400	800	363
Building 104 E	Metals	104ECSSS1	Magnesium	2200	mg/kg				
Building 104 E	Metals	104ECSSS1	Manganese	230	mg/kg		180	2600	1904
Building 104 E	Metals	104ECSSS1	Nickel	21	mg/kg		84	1200	27.9
Building 104 E	Metals	104ECSSS1	Potassium	480	mg/kg				
Building 104 E	Metals	104ECSSS1	Sodium	690	mg/kg				
Building 104 E	Metals	104ECSSS1	Vanadium	29	mg/kg		39	580	72
Building 104 E	Metals	104ECSSS1	Zinc	23	mg/kg		2300	35000	414
Building 104 E	Metals	104ECSSS2	Aluminum	8800	mg/kg		7700	110000	54730

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 104 E	Metals	104ECSSS2	Arsenic	3.7	mg/kg		0.68	3	12.3
Building 104 E	Metals	104ECSSS2	Barium	91	mg/kg		1500	22000	
Building 104 E	Metals	104ECSSS2	Beryllium	0.45	mg/kg		16	230	1.01
Building 104 E	Metals	104ECSSS2	Calcium	2500	mg/kg				
Building 104 E	Metals	104ECSSS2	Chromium	16	mg/kg		12000	180000	25.5
Building 104 E	Metals	104ECSSS2	Cobalt	6.9	mg/kg		2.3	35	13
Building 104 E	Metals	104ECSSS2	Copper	11	mg/kg		310	4700	59.1
Building 104 E	Metals	104ECSSS2	Iron	13000	mg/kg		5500	82000	35460
Building 104 E	Metals	104ECSSS2	Lead	12	mg/kg		400	800	363
Building 104 E	Metals	104ECSSS2	Magnesium	2500	mg/kg				
Building 104 E	Metals	104ECSSS2	Manganese	380	mg/kg		180	2600	1904
Building 104 E	Metals	104ECSSS2	Nickel	11	mg/kg		84	1200	27.9
Building 104 E	Metals	104ECSSS2	Potassium	520	mg/kg				
Building 104 E	Metals	104ECSSS2	Sodium	1400	mg/kg				
Building 104 E	Metals	104ECSSS2	Vanadium	26	mg/kg		39	580	72
Building 104 E	Metals	104ECSSS2	Zinc	31	mg/kg		2300	35000	414
Building 104 E	Metals	104E-IS1	Lead	1930	mg/kg		400	800	363
Building 104 E	Metals	104E-IS2	Lead	18.7	mg/kg		400	800	363
Building 104 E	PCBs	104ECSSS2	Aroclor 1260	0.022	mg/kg		0.24	0.99	
Building 104 E	Phosphorous	104ECSSS1	Phosphorous	99	mg/kg		0.16	2.3	
Building 104 E	Phosphorous	104ECSSS2	Phosphorous	330	mg/kg		0.16	2.3	
Building 104 E	SVOCs	104E-IS1	Acenaphthene	0.61	mg/kg		360	4500	
Building 104 E	SVOCs	104E-IS1	Acenaphthylene	0.3	mg/kg				
Building 104 E	SVOCs	104E-IS1	Anthracene	0.66	mg/kg		1800	23000	
Building 104 E	SVOCs	104E-IS1	Benz(a)anthracene	4.5	mg/kg		1.1	21	
Building 104 E	SVOCs	104E-IS1	Benzaldehyde	0.17	mg/kg		170	820	
Building 104 E	SVOCs	104E-IS1	Benzo(a)pyrene	5.2	mg/kg		0.11	2.1	
Building 104 E	SVOCs	104E-IS1	Benzo(b)Fluoranthene	8	mg/kg		1.1	21	
Building 104 E	SVOCs	104E-IS1	Benzo(ghi)perylene	5	mg/kg				
Building 104 E	SVOCs	104E-IS1	Benzo(k)Fluoranthene	2.9	mg/kg		11	210	
Building 104 E	SVOCs	104E-IS1	Biphenyl, 1,1´-	0.18	mg/kg		4.7	20	
Building 104 E	SVOCs	104E-IS1	Bis(2-ethylhexyl)phthalate	0.41	mg/kg		39	160	
Building 104 E	SVOCs	104E-IS1	Carbazole	0.36	mg/kg				
Building 104 E	SVOCs	104E-IS1	Chrysene	6	mg/kg		110	2100	
Building 104 E	SVOCs	104E-IS1	Dibenzo(a,h)anthracene	1.2	mg/kg		0.11	2.1	
Building 104 E	SVOCs	104E-IS1	Dibenzofuran	0.38	mg/kg		7.3	100	
Building 104 E	SVOCs	104E-IS1	Dichlorophenol, 2,4-	0.0067	mg/kg	J	19	250	
Building 104 E	SVOCs	104E-IS1	Dimethylphenol, 2,4-	0.028	mg/kg		130	1600	
Building 104 E	SVOCs	104E-IS1	Di-n-butyl phthalate	0.035	mg/kg		630	8200	
Building 104 E	SVOCs	104E-IS1	Dinitrotoluene, 2,4-	0.59	mg/kg		1.7	7.4	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 104 E	SVOCs	104E-IS1	Fluoranthene	12	mg/kg		240	3000	
Building 104 E	SVOCs	104E-IS1	Fluorene	0.27	mg/kg		240	3000	
Building 104 E	SVOCs	104E-IS1	Indeno(1,2,3-cd)pyrene	5.1	mg/kg		1.1	21	
Building 104 E	SVOCs	104E-IS1	Methylnaphthalene, 2-	0.39	mg/kg		24	300	
Building 104 E	SVOCs	104E-IS1	Methylphenol, 2-	0.009	mg/kg	J	320	4100	
Building 104 E	SVOCs	104E-IS1	Methylphenol, 3&4-	0.041	mg/kg		6.3	82	
Building 104 E	SVOCs	104E-IS1	Naphthalene	0.058	mg/kg		3.8	17	
Building 104 E	SVOCs	104E-IS1	Nitrosodiphenylamine, n-	0.085	mg/kg		110	470	
Building 104 E	SVOCs	104E-IS1	Pentachlorophenol	0.021	mg/kg		1	4	
Building 104 E	SVOCs	104E-IS1	Phenanthrene	4.2	mg/kg				
Building 104 E	SVOCs	104E-IS1	Phenol	0.062	mg/kg		1900	25000	
Building 104 E	SVOCs	104E-IS1	Phenyl Methyl Ketone (Acetophenone)	0.076	mg/kg		780	12000	
Building 104 E	SVOCs	104E-IS1	Pyrene	9.7	mg/kg		180	2300	
Building 104 E	SVOCs	104E-IS2	Acenaphthene	0.0017	mg/kg	J	360	4500	
Building 104 E	SVOCs	104E-IS2	Anthracene	0.0044	mg/kg	J	1800	23000	
Building 104 E	SVOCs	104E-IS2	Benz(a)anthracene	0.014	mg/kg		1.1	21	
Building 104 E	SVOCs	104E-IS2	Benzaldehyde	0.041	mg/kg		170	820	
Building 104 E	SVOCs	104E-IS2	Benzo(a)pyrene	0.014	mg/kg		0.11	2.1	
Building 104 E	SVOCs	104E-IS2	Benzo(b)Fluoranthene	0.018	mg/kg		1.1	21	
Building 104 E	SVOCs	104E-IS2	Benzo(ghi)perylene	0.016	mg/kg				
Building 104 E	SVOCs	104E-IS2	Benzo(k)Fluoranthene	0.0086	mg/kg		11	210	
Building 104 E	SVOCs	104E-IS2	Bis(2-ethylhexyl)phthalate	0.015	mg/kg		39	160	
Building 104 E	SVOCs	104E-IS2	Carbazole	0.0031	mg/kg	J			
Building 104 E	SVOCs	104E-IS2	Chrysene	0.014	mg/kg		110	2100	
Building 104 E	SVOCs	104E-IS2	Dibenzo(a,h)anthracene	0.0044	mg/kg	J	0.11	2.1	
Building 104 E	SVOCs	104E-IS2	Di-n-butyl phthalate	0.0038	mg/kg	J	630	8200	
Building 104 E	SVOCs	104E-IS2	Fluoranthene	0.03	mg/kg		240	3000	
Building 104 E	SVOCs	104E-IS2	Indeno(1,2,3-cd)pyrene	0.014	mg/kg		1.1	21	
Building 104 E	SVOCs	104E-IS2	Phenanthrene	0.015	mg/kg				
Building 104 E	SVOCs	104E-IS2	Phenyl Methyl Ketone (Acetophenone)	0.012	mg/kg		780	12000	
Building 104 E	SVOCs	104E-IS2	Pyrene	0.024	mg/kg		180	2300	
Building 104 F	Cyanide	104FCSSS1	Cyanide, Total	0.00043	mg/kg	B	2.3	15	
Building 104 F	Mercury	104FCSSS1	Mercury	0.046	mg/kg		1.1	4.6	0.154
Building 104 F	Metals	104FCSSS1	Aluminum	11000	mg/kg		7700	110000	54730
Building 104 F	Metals	104FCSSS1	Arsenic	5	mg/kg		0.68	3	12.3
Building 104 F	Metals	104FCSSS1	Barium	120	mg/kg		1500	22000	
Building 104 F	Metals	104FCSSS1	Beryllium	0.64	mg/kg		16	230	1.01
Building 104 F	Metals	104FCSSS1	Cadmium	0.37	mg/kg		70	800	3.84

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 104 F	Metals	104FCSSS1	Calcium	9400	mg/kg				
Building 104 F	Metals	104FCSSS1	Chromium	18	mg/kg		12000	180000	25.5
Building 104 F	Metals	104FCSSS1	Cobalt	8.5	mg/kg		2.3	35	13
Building 104 F	Metals	104FCSSS1	Copper	33	mg/kg		310	4700	59.1
Building 104 F	Metals	104FCSSS1	Iron	15000	mg/kg		5500	82000	35460
Building 104 F	Metals	104FCSSS1	Lead	35	mg/kg		400	800	363
Building 104 F	Metals	104FCSSS1	Magnesium	3300	mg/kg				
Building 104 F	Metals	104FCSSS1	Manganese	270	mg/kg		180	2600	1904
Building 104 F	Metals	104FCSSS1	Nickel	12	mg/kg		84	1200	27.9
Building 104 F	Metals	104FCSSS1	Potassium	670	mg/kg				
Building 104 F	Metals	104FCSSS1	Sodium	450	mg/kg				
Building 104 F	Metals	104FCSSS1	Vanadium	33	mg/kg		39	580	72
Building 104 F	Metals	104FCSSS1	Zinc	50	mg/kg		2300	35000	414
Building 104 F	Metals	104F-IS1	Lead	1080	mg/kg	J	400	800	363
Building 104 F	Metals	104F-IS2	Lead	8.38	mg/kg	J	400	800	363
Building 104 F	Phosphorous	104FCSSS1	Phosphorous	0.18	mg/kg		0.16	2.3	
Building 105 A/B/C/D	Cyanide	105BSS1	Cyanide, Total	0.41	mg/kg		2.3	15	
Building 105 A/B/C/D	Mercury	105ASS1	Mercury	0.063	mg/kg		1.1	4.6	0.154
Building 105 A/B/C/D	Mercury	105ASS2	Mercury	0.033	mg/kg	B	1.1	4.6	0.154
Building 105 A/B/C/D	Mercury	105BSS1	Mercury	0.019	mg/kg	B	1.1	4.6	0.154
Building 105 A/B/C/D	Mercury	105BSS2	Mercury	0.036	mg/kg	B	1.1	4.6	0.154
Building 105 A/B/C/D	Mercury	105CSS1	Mercury	0.19	mg/kg		1.1	4.6	0.154
Building 105 A/B/C/D	Mercury	105CSS2	Mercury	0.071	mg/kg		1.1	4.6	0.154
Building 105 A/B/C/D	Mercury	105DCSSS1	Mercury	0.019	mg/kg	B	1.1	4.6	0.154
Building 105 A/B/C/D	Metals	105ASS1	Aluminum	11000	mg/kg		7700	110000	54730
Building 105 A/B/C/D	Metals	105ASS1	Arsenic	4.9	mg/kg		0.68	3	12.3
Building 105 A/B/C/D	Metals	105ASS1	Barium	130	mg/kg		1500	22000	
Building 105 A/B/C/D	Metals	105ASS1	Beryllium	0.33	mg/kg		16	230	1.01
Building 105 A/B/C/D	Metals	105ASS1	Cadmium	0.11	mg/kg	B	70	800	3.84
Building 105 A/B/C/D	Metals	105ASS1	Calcium	2900	mg/kg				
Building 105 A/B/C/D	Metals	105ASS1	Chromium	18	mg/kg		12000	180000	25.5
Building 105 A/B/C/D	Metals	105ASS1	Cobalt	6	mg/kg		2.3	35	13
Building 105 A/B/C/D	Metals	105ASS1	Copper	14	mg/kg		310	4700	59.1
Building 105 A/B/C/D	Metals	105ASS1	Iron	16000	mg/kg		5500	82000	35460
Building 105 A/B/C/D	Metals	105ASS1	Lead	13	mg/kg		400	800	363
Building 105 A/B/C/D	Metals	105ASS1	Magnesium	2700	mg/kg				
Building 105 A/B/C/D	Metals	105ASS1	Manganese	450	mg/kg		180	2600	1904
Building 105 A/B/C/D	Metals	105ASS1	Nickel	14	mg/kg		84	1200	27.9
Building 105 A/B/C/D	Metals	105ASS1	Potassium	1200	mg/kg				
Building 105 A/B/C/D	Metals	105ASS1	Sodium	190	mg/kg				

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 105 A/B/C/D	Metals	105ASS1	Vanadium	32	mg/kg		39	580	72
Building 105 A/B/C/D	Metals	105ASS1	Zinc	58	mg/kg		2300	35000	414
Building 105 A/B/C/D	Metals	105ASS2	Aluminum	11000	mg/kg		7700	110000	54730
Building 105 A/B/C/D	Metals	105ASS2	Arsenic	7	mg/kg		0.68	3	12.3
Building 105 A/B/C/D	Metals	105ASS2	Barium	140	mg/kg		1500	22000	
Building 105 A/B/C/D	Metals	105ASS2	Beryllium	0.36	mg/kg		16	230	1.01
Building 105 A/B/C/D	Metals	105ASS2	Calcium	2900	mg/kg				
Building 105 A/B/C/D	Metals	105ASS2	Chromium	17	mg/kg		12000	180000	25.5
Building 105 A/B/C/D	Metals	105ASS2	Cobalt	7.1	mg/kg		2.3	35	13
Building 105 A/B/C/D	Metals	105ASS2	Copper	16	mg/kg		310	4700	59.1
Building 105 A/B/C/D	Metals	105ASS2	Iron	17000	mg/kg		5500	82000	35460
Building 105 A/B/C/D	Metals	105ASS2	Lead	10	mg/kg		400	800	363
Building 105 A/B/C/D	Metals	105ASS2	Magnesium	3200	mg/kg				
Building 105 A/B/C/D	Metals	105ASS2	Manganese	560	mg/kg		180	2600	1904
Building 105 A/B/C/D	Metals	105ASS2	Nickel	17	mg/kg		84	1200	27.9
Building 105 A/B/C/D	Metals	105ASS2	Potassium	1300	mg/kg				
Building 105 A/B/C/D	Metals	105ASS2	Sodium	620	mg/kg				
Building 105 A/B/C/D	Metals	105ASS2	Vanadium	28	mg/kg		39	580	72
Building 105 A/B/C/D	Metals	105ASS2	Zinc	44	mg/kg		2300	35000	414
Building 105 A/B/C/D	Metals	105BSS1	Aluminum	18000	mg/kg		7700	110000	54730
Building 105 A/B/C/D	Metals	105BSS1	Arsenic	6.3	mg/kg		0.68	3	12.3
Building 105 A/B/C/D	Metals	105BSS1	Barium	110	mg/kg		1500	22000	
Building 105 A/B/C/D	Metals	105BSS1	Beryllium	0.65	mg/kg		16	230	1.01
Building 105 A/B/C/D	Metals	105BSS1	Calcium	6300	mg/kg				
Building 105 A/B/C/D	Metals	105BSS1	Chromium	28	mg/kg		12000	180000	25.5
Building 105 A/B/C/D	Metals	105BSS1	Cobalt	11	mg/kg		2.3	35	13
Building 105 A/B/C/D	Metals	105BSS1	Copper	92	mg/kg		310	4700	59.1
Building 105 A/B/C/D	Metals	105BSS1	Iron	21000	mg/kg		5500	82000	35460
Building 105 A/B/C/D	Metals	105BSS1	Lead	90	mg/kg		400	800	363
Building 105 A/B/C/D	Metals	105BSS1	Magnesium	2700	mg/kg				
Building 105 A/B/C/D	Metals	105BSS1	Manganese	580	mg/kg		180	2600	1904
Building 105 A/B/C/D	Metals	105BSS1	Nickel	17	mg/kg		84	1200	27.9
Building 105 A/B/C/D	Metals	105BSS1	Potassium	1100	mg/kg				
Building 105 A/B/C/D	Metals	105BSS1	Sodium	630	mg/kg				
Building 105 A/B/C/D	Metals	105BSS1	Vanadium	39	mg/kg		39	580	72
Building 105 A/B/C/D	Metals	105BSS1	Zinc	66	mg/kg		2300	35000	414
Building 105 A/B/C/D	Metals	105BSS2	Aluminum	11000	mg/kg		7700	110000	54730
Building 105 A/B/C/D	Metals	105BSS2	Arsenic	4.7	mg/kg		0.68	3	12.3
Building 105 A/B/C/D	Metals	105BSS2	Barium	110	mg/kg		1500	22000	
Building 105 A/B/C/D	Metals	105BSS2	Beryllium	0.37	mg/kg		16	230	1.01

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 105 A/B/C/D	Metals	105BSS2	Cadmium	0.22	mg/kg		70	800	3.84
Building 105 A/B/C/D	Metals	105BSS2	Calcium	2700	mg/kg				
Building 105 A/B/C/D	Metals	105BSS2	Chromium	18	mg/kg		12000	180000	25.5
Building 105 A/B/C/D	Metals	105BSS2	Cobalt	5.5	mg/kg		2.3	35	13
Building 105 A/B/C/D	Metals	105BSS2	Copper	12	mg/kg		310	4700	59.1
Building 105 A/B/C/D	Metals	105BSS2	Iron	15000	mg/kg		5500	82000	35460
Building 105 A/B/C/D	Metals	105BSS2	Lead	8.1	mg/kg		400	800	363
Building 105 A/B/C/D	Metals	105BSS2	Magnesium	2800	mg/kg				
Building 105 A/B/C/D	Metals	105BSS2	Manganese	400	mg/kg		180	2600	1904
Building 105 A/B/C/D	Metals	105BSS2	Nickel	13	mg/kg		84	1200	27.9
Building 105 A/B/C/D	Metals	105BSS2	Potassium	890	mg/kg				
Building 105 A/B/C/D	Metals	105BSS2	Sodium	670	mg/kg				
Building 105 A/B/C/D	Metals	105BSS2	Vanadium	30	mg/kg		39	580	72
Building 105 A/B/C/D	Metals	105BSS2	Zinc	35	mg/kg		2300	35000	414
Building 105 A/B/C/D	Metals	105CSS1	Aluminum	10000	mg/kg		7700	110000	54730
Building 105 A/B/C/D	Metals	105CSS1	Arsenic	6.4	mg/kg		0.68	3	12.3
Building 105 A/B/C/D	Metals	105CSS1	Barium	110	mg/kg		1500	22000	
Building 105 A/B/C/D	Metals	105CSS1	Beryllium	0.39	mg/kg		16	230	1.01
Building 105 A/B/C/D	Metals	105CSS1	Cadmium	0.21	mg/kg		70	800	3.84
Building 105 A/B/C/D	Metals	105CSS1	Calcium	9000	mg/kg				
Building 105 A/B/C/D	Metals	105CSS1	Chromium	16	mg/kg		12000	180000	25.5
Building 105 A/B/C/D	Metals	105CSS1	Cobalt	8.7	mg/kg		2.3	35	13
Building 105 A/B/C/D	Metals	105CSS1	Copper	82	mg/kg		310	4700	59.1
Building 105 A/B/C/D	Metals	105CSS1	Iron	15000	mg/kg		5500	82000	35460
Building 105 A/B/C/D	Metals	105CSS1	Lead	19	mg/kg		400	800	363
Building 105 A/B/C/D	Metals	105CSS1	Magnesium	2400	mg/kg				
Building 105 A/B/C/D	Metals	105CSS1	Manganese	620	mg/kg		180	2600	1904
Building 105 A/B/C/D	Metals	105CSS1	Nickel	15	mg/kg		84	1200	27.9
Building 105 A/B/C/D	Metals	105CSS1	Potassium	890	mg/kg				
Building 105 A/B/C/D	Metals	105CSS1	Sodium	650	mg/kg				
Building 105 A/B/C/D	Metals	105CSS1	Vanadium	28	mg/kg		39	580	72
Building 105 A/B/C/D	Metals	105CSS1	Zinc	82	mg/kg		2300	35000	414
Building 105 A/B/C/D	Metals	105CSS2	Aluminum	9900	mg/kg		7700	110000	54730
Building 105 A/B/C/D	Metals	105CSS2	Arsenic	5.3	mg/kg		0.68	3	12.3
Building 105 A/B/C/D	Metals	105CSS2	Barium	100	mg/kg		1500	22000	
Building 105 A/B/C/D	Metals	105CSS2	Beryllium	0.33	mg/kg		16	230	1.01
Building 105 A/B/C/D	Metals	105CSS2	Calcium	4000	mg/kg				
Building 105 A/B/C/D	Metals	105CSS2	Chromium	17	mg/kg		12000	180000	25.5
Building 105 A/B/C/D	Metals	105CSS2	Cobalt	5.4	mg/kg		2.3	35	13
Building 105 A/B/C/D	Metals	105CSS2	Copper	34	mg/kg		310	4700	59.1

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 105 A/B/C/D	Metals	105CSS2	Iron	15000	mg/kg		5500	82000	35460
Building 105 A/B/C/D	Metals	105CSS2	Lead	15	mg/kg		400	800	363
Building 105 A/B/C/D	Metals	105CSS2	Magnesium	2800	mg/kg				
Building 105 A/B/C/D	Metals	105CSS2	Manganese	340	mg/kg		180	2600	1904
Building 105 A/B/C/D	Metals	105CSS2	Nickel	13	mg/kg		84	1200	27.9
Building 105 A/B/C/D	Metals	105CSS2	Potassium	820	mg/kg				
Building 105 A/B/C/D	Metals	105CSS2	Sodium	1300	mg/kg				
Building 105 A/B/C/D	Metals	105CSS2	Vanadium	28	mg/kg		39	580	72
Building 105 A/B/C/D	Metals	105CSS2	Zinc	69	mg/kg		2300	35000	414
Building 105 A/B/C/D	Metals	105DCSSS1	Aluminum	3600	mg/kg		7700	110000	54730
Building 105 A/B/C/D	Metals	105DCSSS1	Arsenic	3.6	mg/kg		0.68	3	12.3
Building 105 A/B/C/D	Metals	105DCSSS1	Barium	91	mg/kg		1500	22000	
Building 105 A/B/C/D	Metals	105DCSSS1	Calcium	310000	mg/kg				
Building 105 A/B/C/D	Metals	105DCSSS1	Chromium	9.3	mg/kg		12000	180000	25.5
Building 105 A/B/C/D	Metals	105DCSSS1	Cobalt	2.3	mg/kg		2.3	35	13
Building 105 A/B/C/D	Metals	105DCSSS1	Copper	4.4	mg/kg		310	4700	59.1
Building 105 A/B/C/D	Metals	105DCSSS1	Iron	5800	mg/kg		5500	82000	35460
Building 105 A/B/C/D	Metals	105DCSSS1	Lead	9.3	mg/kg		400	800	363
Building 105 A/B/C/D	Metals	105DCSSS1	Magnesium	4400	mg/kg				
Building 105 A/B/C/D	Metals	105DCSSS1	Manganese	420	mg/kg		180	2600	1904
Building 105 A/B/C/D	Metals	105DCSSS1	Nickel	8.9	mg/kg		84	1200	27.9
Building 105 A/B/C/D	Metals	105DCSSS1	Potassium	800	mg/kg				
Building 105 A/B/C/D	Metals	105DCSSS1	Selenium	2.3	mg/kg	B	39	580	0.777
Building 105 A/B/C/D	Metals	105DCSSS1	Sodium	580	mg/kg				
Building 105 A/B/C/D	Metals	105DCSSS1	Vanadium	10	mg/kg		39	580	72
Building 105 A/B/C/D	Metals	105DCSSS1	Zinc	23	mg/kg		2300	35000	414
Building 105 A/B/C/D	Metals	105-IS1	Lead	25.6	mg/kg	J	400	800	363
Building 105 A/B/C/D	Metals	105-IS2	Lead	139	mg/kg	J	400	800	363
Building 105 A/B/C/D	Metals	105-IS3	Lead	6.15	mg/kg	J	400	800	363
Building 105 A/B/C/D	Metals	105-IS4	Lead	42.3	mg/kg	J	400	800	363
Building 105 A/B/C/D	Metals	105-IS5	Lead	88.1	mg/kg	J	400	800	363
Building 105 A/B/C/D	Metals	105-IS6	Lead	9.28	mg/kg	J	400	800	363
Building 105 A/B/C/D	PCBs	105BSS1	Aroclor 1260	0.021	mg/kg	J	0.24	0.99	
Building 105 A/B/C/D	PCBs	105BSS2	Aroclor 1260	0.0097	mg/kg	J	0.24	0.99	
Building 105 A/B/C/D	PCBs	105DCSSS1	Aroclor 1260	0.029	mg/kg		0.24	0.99	
Building 105 A/B/C/D	Phosphorous	105ASS1	Phosphorous	420	mg/kg		0.16	2.3	
Building 105 A/B/C/D	Phosphorous	105ASS2	Phosphorous	700	mg/kg		0.16	2.3	
Building 105 A/B/C/D	Phosphorous	105BSS1	Phosphorous	120	mg/kg		0.16	2.3	
Building 105 A/B/C/D	Phosphorous	105BSS2	Phosphorous	440	mg/kg		0.16	2.3	
Building 105 A/B/C/D	Phosphorous	105CSS1	Phosphorous	310	mg/kg		0.16	2.3	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 105 A/B/C/D	Phosphorous	105CSS2	Phosphorous	450	mg/kg		0.16	2.3	
Building 105 A/B/C/D	Phosphorous	105DCSSS1	Phosphorous	230	mg/kg		0.16	2.3	
Building 105 A/B/C/D	SVOCs	105ASS1	Benz(a)anthracene	0.075	mg/kg	J	1.1	21	
Building 105 A/B/C/D	SVOCs	105ASS1	Benzo(a)pyrene	0.087	mg/kg	J	0.11	2.1	
Building 105 A/B/C/D	SVOCs	105ASS1	Chrysene	0.098	mg/kg	J	110	2100	
Building 105 A/B/C/D	SVOCs	105ASS1	Fluoranthene	0.2	mg/kg	J	240	3000	
Building 105 A/B/C/D	SVOCs	105BSS1	Benz(a)anthracene	0.14	mg/kg	J	1.1	21	
Building 105 A/B/C/D	SVOCs	105BSS1	Benzo(a)pyrene	0.13	mg/kg	J	0.11	2.1	
Building 105 A/B/C/D	SVOCs	105BSS1	Benzo(b)Fluoranthene	0.13	mg/kg	J	1.1	21	
Building 105 A/B/C/D	SVOCs	105BSS1	Benzo(k)Fluoranthene	0.14	mg/kg	J	11	210	
Building 105 A/B/C/D	SVOCs	105BSS1	Chrysene	0.14	mg/kg	J	110	2100	
Building 105 A/B/C/D	SVOCs	105BSS1	Fluoranthene	0.3	mg/kg	J	240	3000	
Building 105 A/B/C/D	SVOCs	105BSS1	Phenanthrene	0.17	mg/kg	J			
Building 105 A/B/C/D	SVOCs	105BSS1	Pyrene	0.24	mg/kg	J	180	2300	
Building 105 A/B/C/D	SVOCs	105BSS2	Chrysene	0.07	mg/kg	J	110	2100	
Building 105 E	Mercury	105ESS1	Mercury	0.041	mg/kg	B	1.1	4.6	0.154
Building 105 E	Mercury	105ESS2	Mercury	0.13	mg/kg		1.1	4.6	0.154
Building 105 E	Metals	105E-IS1	Lead	303	mg/kg	J	400	800	363
Building 105 E	Metals	105E-IS2	Lead	175	mg/kg	J	400	800	363
Building 105 E	Metals	105ESS1	Aluminum	12000	mg/kg		7700	110000	54730
Building 105 E	Metals	105ESS1	Arsenic	3.4	mg/kg		0.68	3	12.3
Building 105 E	Metals	105ESS1	Barium	72	mg/kg		1500	22000	
Building 105 E	Metals	105ESS1	Beryllium	0.38	mg/kg		16	230	1.01
Building 105 E	Metals	105ESS1	Cadmium	0.24	mg/kg		70	800	3.84
Building 105 E	Metals	105ESS1	Calcium	3100	mg/kg				
Building 105 E	Metals	105ESS1	Chromium	20	mg/kg		12000	180000	25.5
Building 105 E	Metals	105ESS1	Cobalt	6	mg/kg		2.3	35	13
Building 105 E	Metals	105ESS1	Copper	11	mg/kg		310	4700	59.1
Building 105 E	Metals	105ESS1	Iron	13000	mg/kg		5500	82000	35460
Building 105 E	Metals	105ESS1	Lead	11	mg/kg		400	800	363
Building 105 E	Metals	105ESS1	Magnesium	3000	mg/kg				
Building 105 E	Metals	105ESS1	Manganese	160	mg/kg		180	2600	1904
Building 105 E	Metals	105ESS1	Nickel	13	mg/kg		84	1200	27.9
Building 105 E	Metals	105ESS1	Potassium	760	mg/kg				
Building 105 E	Metals	105ESS1	Sodium	490	mg/kg				
Building 105 E	Metals	105ESS1	Vanadium	26	mg/kg		39	580	72
Building 105 E	Metals	105ESS1	Zinc	43	mg/kg		2300	35000	414
Building 105 E	Metals	105ESS2	Aluminum	9800	mg/kg		7700	110000	54730
Building 105 E	Metals	105ESS2	Arsenic	5.3	mg/kg		0.68	3	12.3
Building 105 E	Metals	105ESS2	Barium	160	mg/kg		1500	22000	

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 105 E	Metals	105ESS2	Beryllium	0.47	mg/kg		16	230	1.01
Building 105 E	Metals	105ESS2	Cadmium	0.5	mg/kg		70	800	3.84
Building 105 E	Metals	105ESS2	Calcium	3100	mg/kg				
Building 105 E	Metals	105ESS2	Chromium	24	mg/kg		12000	180000	25.5
Building 105 E	Metals	105ESS2	Cobalt	28	mg/kg		2.3	35	13
Building 105 E	Metals	105ESS2	Copper	28	mg/kg		310	4700	59.1
Building 105 E	Metals	105ESS2	Iron	14000	mg/kg		5500	82000	35460
Building 105 E	Metals	105ESS2	Lead	21	mg/kg		400	800	363
Building 105 E	Metals	105ESS2	Magnesium	2400	mg/kg				
Building 105 E	Metals	105ESS2	Manganese	940	mg/kg		180	2600	1904
Building 105 E	Metals	105ESS2	Nickel	22	mg/kg		84	1200	27.9
Building 105 E	Metals	105ESS2	Potassium	800	mg/kg				
Building 105 E	Metals	105ESS2	Silver	9.6	mg/kg		39	580	
Building 105 E	Metals	105ESS2	Sodium	400	mg/kg				
Building 105 E	Metals	105ESS2	Vanadium	26	mg/kg		39	580	72
Building 105 E	Metals	105ESS2	Zinc	46	mg/kg		2300	35000	414
Building 105 E	Phosphorous	105ESS1	Phosphorous	520	mg/kg		0.16	2.3	
Building 105 E	Phosphorous	105ESS2	Phosphorous	540	mg/kg		0.16	2.3	
Building 105 E	SVOCs	105ESS2	Benz(a)anthracene	0.19	mg/kg	J	1.1	21	
Building 105 E	SVOCs	105ESS2	Benzo(a)pyrene	0.18	mg/kg	J	0.11	2.1	
Building 105 E	SVOCs	105ESS2	Benzo(b)Fluoranthene	0.27	mg/kg	J	1.1	21	
Building 105 E	SVOCs	105ESS2	Benzo(k)Fluoranthene	0.21	mg/kg	J	11	210	
Building 105 E	SVOCs	105ESS2	Chrysene	0.29	mg/kg	J	110	2100	
Building 105 E	SVOCs	105ESS2	Di-n-butyl phthalate	0.76	mg/kg		630	8200	
Building 105 E	SVOCs	105ESS2	Fluoranthene	0.48	mg/kg		240	3000	
Building 105 E	SVOCs	105ESS2	Indeno(1,2,3-cd)pyrene	0.16	mg/kg	J	1.1	21	
Building 105 E	SVOCs	105ESS2	Phenanthrene	0.15	mg/kg	J			
Building 105 E	SVOCs	105ESS2	Pyrene	0.35	mg/kg	J	180	2300	
Building 105 F	Mercury	105FSS1	Mercury	0.023	mg/kg	B	1.1	4.6	0.154
Building 105 F	Mercury	105FSS2	Mercury	0.07	mg/kg		1.1	4.6	0.154
Building 105 F	Metals	105F-IS1	Lead	38.8	mg/kg		400	800	363
Building 105 F	Metals	105F-IS2	Lead	24.3	mg/kg		400	800	363
Building 105 F	Metals	105FSS1	Aluminum	15000	mg/kg		7700	110000	54730
Building 105 F	Metals	105FSS1	Arsenic	4.7	mg/kg		0.68	3	12.3
Building 105 F	Metals	105FSS1	Barium	70	mg/kg		1500	22000	
Building 105 F	Metals	105FSS1	Beryllium	0.6	mg/kg		16	230	1.01
Building 105 F	Metals	105FSS1	Calcium	3700	mg/kg				
Building 105 F	Metals	105FSS1	Chromium	20	mg/kg		12000	180000	25.5
Building 105 F	Metals	105FSS1	Cobalt	4.9	mg/kg		2.3	35	13
Building 105 F	Metals	105FSS1	Copper	11	mg/kg		310	4700	59.1

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

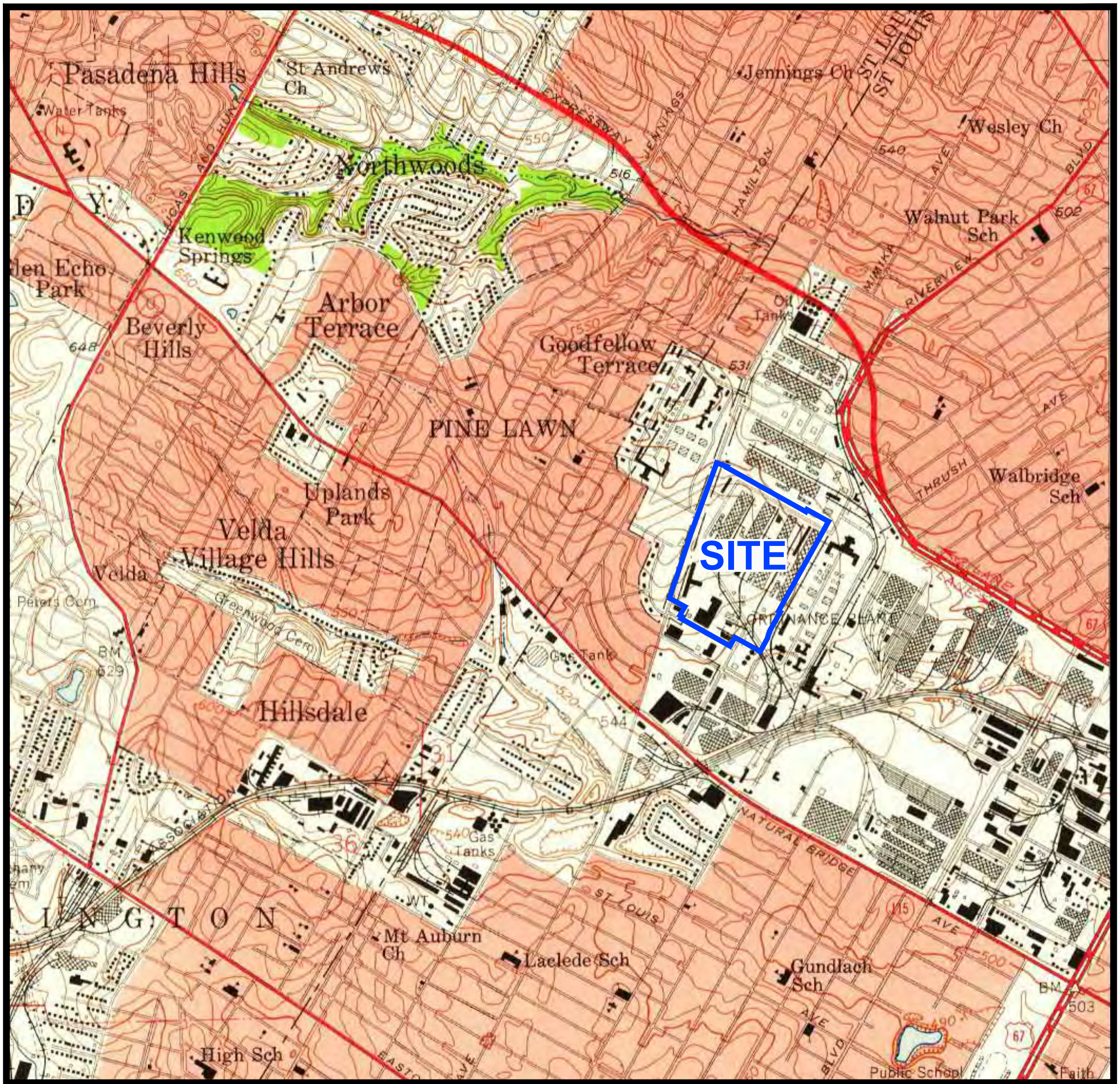
Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 105 F	Metals	105FSS1	Iron	15000	mg/kg		5500	82000	35460
Building 105 F	Metals	105FSS1	Lead	15	mg/kg		400	800	363
Building 105 F	Metals	105FSS1	Magnesium	2400	mg/kg				
Building 105 F	Metals	105FSS1	Manganese	200	mg/kg		180	2600	1904
Building 105 F	Metals	105FSS1	Nickel	12	mg/kg		84	1200	27.9
Building 105 F	Metals	105FSS1	Potassium	720	mg/kg				
Building 105 F	Metals	105FSS1	Sodium	1000	mg/kg				
Building 105 F	Metals	105FSS1	Vanadium	31	mg/kg		39	580	72
Building 105 F	Metals	105FSS1	Zinc	27	mg/kg		2300	35000	414
Building 105 F	Metals	105FSS2	Aluminum	12000	mg/kg		7700	110000	54730
Building 105 F	Metals	105FSS2	Arsenic	5.2	mg/kg		0.68	3	12.3
Building 105 F	Metals	105FSS2	Barium	84	mg/kg		1500	22000	
Building 105 F	Metals	105FSS2	Beryllium	0.51	mg/kg		16	230	1.01
Building 105 F	Metals	105FSS2	Cadmium	0.39	mg/kg		70	800	3.84
Building 105 F	Metals	105FSS2	Calcium	15000	mg/kg				
Building 105 F	Metals	105FSS2	Chromium	22	mg/kg		12000	180000	25.5
Building 105 F	Metals	105FSS2	Cobalt	14	mg/kg		2.3	35	13
Building 105 F	Metals	105FSS2	Copper	59	mg/kg		310	4700	59.1
Building 105 F	Metals	105FSS2	Iron	21000	mg/kg		5500	82000	35460
Building 105 F	Metals	105FSS2	Lead	100	mg/kg		400	800	363
Building 105 F	Metals	105FSS2	Magnesium	2300	mg/kg				
Building 105 F	Metals	105FSS2	Manganese	420	mg/kg		180	2600	1904
Building 105 F	Metals	105FSS2	Nickel	15	mg/kg		84	1200	27.9
Building 105 F	Metals	105FSS2	Potassium	780	mg/kg				
Building 105 F	Metals	105FSS2	Sodium	760	mg/kg				
Building 105 F	Metals	105FSS2	Vanadium	24	mg/kg		39	580	72
Building 105 F	Metals	105FSS2	Zinc	180	mg/kg		2300	35000	414
Building 105 F	Phosphorous	105FSS1	Phosphorous	220	mg/kg		0.16	2.3	
Building 105 F	Phosphorous	105FSS2	Phosphorous	320	mg/kg		0.16	2.3	
Building 105 F	SVOCs	105FSS2	Benz(a)anthracene	0.46	mg/kg		1.1	21	
Building 105 F	SVOCs	105FSS2	Benzo(a)pyrene	0.47	mg/kg		0.11	2.1	
Building 105 F	SVOCs	105FSS2	Benzo(b)Fluoranthene	0.63	mg/kg		1.1	21	
Building 105 F	SVOCs	105FSS2	Benzo(ghi)perylene	0.43	mg/kg				
Building 105 F	SVOCs	105FSS2	Benzo(k)Fluoranthene	0.51	mg/kg		11	210	
Building 105 F	SVOCs	105FSS2	Carbazole	0.097	mg/kg	J			
Building 105 F	SVOCs	105FSS2	Fluoranthene	1.2	mg/kg		240	3000	
Building 105 F	SVOCs	105FSS2	Indeno(1,2,3-cd)pyrene	0.39	mg/kg		1.1	21	
Building 105 F	SVOCs	105FSS2	Phenanthrene	0.6	mg/kg				
Building 105 F	SVOCs	105FSS2	Pyrene	1.1	mg/kg		180	2300	
Building 107	Metals	107-IS1	Lead	554	mg/kg		400	800	363

APPENDIX A-4
HISTORICAL DETECTIONS IN CRAWLSPACE SOIL
GOODFELLOW FEDERAL COMPLEX
ST. LOUIS, MISSOURI

Building	Analysis	Sample	Analyte	Result	Unit	Flag	Res Soil RSL	Ind Soil RSL	Background
Building 108 B	PCBs	108BLSSS1	Aroclor 1260	1.5	mg/kg		0.24	0.99	

APPENDIX B

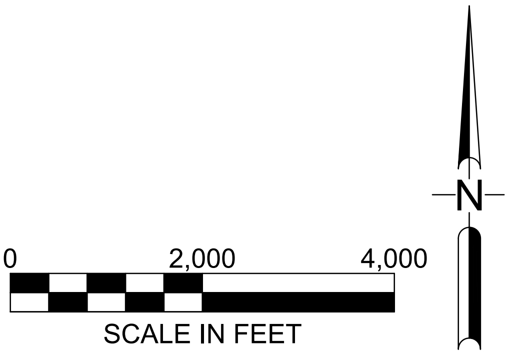
SITE MAPS WITH HISTORICAL INFORMATION



NOTES

1. Plan adapted from a 7.5 minute U.S.G.S. maps for Clayton, Missouri quadrangle, dated 1954.

2. Site is approximately 63 acres.



Drawn By: WAH	Ck'd By:	App'vd By:
Date: 2-12-20	Date:	Date:

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4300 Goodfellow Boulevard
St. Louis, Missouri

SITE LOCATION AND HISTORICAL TOPOGRAPHY

Project Number
J034500.01

FIGURE 1

(b) (7)(F)

→ To BLDG 208B

LEGEND

FENCE	—•—•—
FIRE HYDRANT	FH
NO PARKING	▨
SMOKING SHELTER	■
FORMER BUILDING LOCATION	⬚

Not to Scale

Goodfellow Federal Complex
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 2
Facility Layout Map with Historical Information

TETRA TECH

Date: 3/6/2015 Drawn By: Nick Wiederholt Project No: S1058.232.001

Source: SCS Engineers, Figure 2 - Site Plan, March, 2007.

X:\S\S1058\227\FH10\Figure2_030615.FH10

(b) (7)(F)

[redacted]

UTILITY SITE PLAN

NTS

PROPERTY OF THE UNITED STATES GOVERNMENT
FOR OFFICIAL USE ONLY
Do not remove this notice
Properly destroy documents when no longer needed

GSA
GENERAL SERVICES ADMINISTRATION
PUBLIC BUILDINGS SERVICE
HEARTLAND REGION
1500 E. BANNISTER RD.
KANSAS CITY, MO. 64131-3009

FIELD VERIFY ALL DIMENSIONS

SPACE LABEL KEY

EXAMPLE

01001	SPACE ID
500.00	AREA SqFt TOTAL
TTO	SPACE TYPE
1007	AGENCY BUREAU CODE
TX0006979	CBR NUMBER

LABEL CODES LEGEND

SPACE TYPES

ADP	AUTOMATED DATA PROCESSING
ANT	ANTENNAS
AUD	AUDITORIUM
CFT	CONFERENCE / TRAINING
CLD	CHILD CARE
CON	CONSTRUCTION
CRH	CIRCULATION HORIZONTAL
CRJ	COURTROOM JUDICIARY
CRV	CIRCULATION VERTICAL
CST	CUSTODIAL
FDS	FOOD SERVICE
FIT	FITNESS CENTER
HUT	HEALTH UNIT
INS	LIGHT INDUSTRIAL
JCC	JUDGE'S CHAMBERS US COURTS
JHR	JUDICIAL HEARING ROOM
LAB	LABORATORY
LND	LAND
MCH	MECHANICAL
PTL	PRIVATE TOILET
QRR	QUARTERS & RESIDENCE
STC	STRUCTURALLY CHANGED
STP	STRUCTURED PARKING
TFC	TENANT FLOOR CUT
TLT	TOILET
TTO	TOTAL OFFICE
WRH	WAREHOUSE
UFO	UNSUITABLE FOR OCCUPANCY

AUDIT RECORD

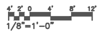
DATE	TYPE	PERFORMED BY

CONTRACT

SURVEY CON.	SFS ARCHITECTS
CON. NUMBER	XX-00X-00-XXX-0000
TASK NUMBER	X-00-00-XX-0000
SUB. DATE	00/00/0000
ORIG. SURVEY DATE	00/00/0000

KEY PLAN

GRAPHIC SCALE



BUILDING

NAME	FEDERAL CENTER SITE PLAN
STREET	4300 GOODFELLOW BLVD
CITY/ST./ZIP	ST. LOUIS MO. 63120-1703
BUILDING NO.	
FACILITY CODE	MOAF

DRAWING

DRAWING TITLE	XXXXX FLOOR ASSIGNMENT PLAN SPATIAL DATA MANAGEMENT
FLOOR NO.	
SHEET SIZE:	24 X 36
FILE NAME	0_00XXX.DWG
DRAWING NO.	0__ AP SITE
	DISCIPLINE SHEET TYPE SEQUENCE
	SHEET 001 OF 001

b) (7)(F)

[redacted]

PARKING ASSIGNMENTS

ARMY = ⧗
GSA = ⧓
SSA = ⧗
USDA =
VA = ⧗

FEDERAL CENTER
AISA FAC ENG

PARKING LOT PLAN

DRAWN BY
US ARMY CORPS OF ENGINEERS

DATE
1990

SCALE 1"= 60

NO

****DATE-TIME**** ***DESIGNFILE*SPECIFICATION***

APPENDIX C

SAMPLING AND ANALYSIS PLAN

(Field Sampling Plan and Quality Assurance Project Plan)

FINAL
FIELD SAMPLING PLAN
GOODFELLOW FEDERAL COMPLEX
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MISSOURI (MO0602AF)
CONTRACT NUMBER: GS-06P-15-GZ-D-7000
WORK ORDER NUMBER 29

Prepared for:

MR. ERIC GORMAN
GENERAL SERVICES ADMINISTRATION
PUBLIC BUILDINGS SERVICE
2300 MAIN STREET, 7TH FLOOR
KANSAS CITY, MISSOURI

Prepared by:

ETEGRA, INC.
1121 OLIVETTE EXECUTIVE PARKWAY, SUITE 100
ST. LOUIS, MISSOURI

With:

JUNIPER ENVIRONMENTAL, LLC
1 ALBY STREET
ALTON, ILLINOIS

AND:

GEOTECHNOLOGY, INC.
11816 LACKLAND ROAD, SUITE 150
ST. LOUIS, MISSOURI

Date:

FEBRUARY 9, 2021

TABLE OF CONTENTS

ILLUSTRATIONS

APPENDICES

1.0 SAMPLING OBJECTIVES

This Field Sampling Plan (FSP) provides a detailed description of field sampling and testing procedures for the Remedial Investigation (RI) at the approximately 64-acre Goodfellow Federal Complex (GFC - Site) in St. Louis, Missouri (Figures 1 and 2). Site background information is provided in the Remedial Investigation Work Plan (RIWP) and the Risk Assessment Work Plan (RAWP). Personnel implementing this FSP will be familiar with the referenced Plans.

The primary sampling objective is to collect sufficient data to assess risk to the potential human exposure scenarios listed in Section 3.2.1 of the Risk Assessment Work Plan (RAWP). The vertical and horizontal extent of the impacts at the GFC will be assessed to support the human health risk assessment process.

The organization of this FSP is to provide ease of implementation by giving sampling details that are specific to each of the following media to be sampled and tested.

- Groundwater
- Surface and subsurface soil

The chemicals of potential concern (COPC) to be tested for each media are explained in detail in the RAWP. The proposed sampling and testing is to supplement the existing testing data for the Site. The extensive existing Site data creates efficiencies for this RI as described in the RIWP Sections 3.0 and 4.0 and Appendix A. Several meetings and discussions about the RIWP and approach were conducted with representatives of the Missouri Department of Natural Resources (MDNR). Required modifications to the field sampling will be in coordination with MDNR representatives.

The sampling plan approach presented was discussed with MDNR representatives during the June 25 and 30, 2020 and further discussions during the December 11, 2020 teleconferences. As agreed during the December teleconference, the crawl spaces/tunnels will not be sampled during the RIWP investigation, as only releases under CERCLA will be addressed, and there are no mechanisms for releases, other than at Building 102B with previous DoD photolab. It was determined that the asbestos in the crawlspace/basements is a NESHAP issue, and not viewed as a CERCLA issue. Therefore, it was determined that GSA will work with the MDNR Air Pollution Control Program to address the asbestos issues as needed.

Previous concrete sampling at the Site identified targeted locations with PCB concentrations greater than 1 mg/kg (Appendix B). Most of the identified locations are associated with the locations of former PCB containing electric transformers or similar PCB containing equipment. Because these releases are not considered a CERCLA release. As agreed with MDNR, GSA will address the PCBs under the Toxic Substance Control Act (TSCA) with Environmental Protection

Agency, Region 7 oversight. However, PCB groundwater sampling will be addressed since TSCA may not evaluate the groundwater pathway. Water samples collected from the monitoring wells will be analyzed for PCBs (both Aroclor and Congeners).

2.0 SAMPLE LOCATION AND FREQUENCY

Substantial sampling and testing data were previously collected at the Site as summarized in detail in Sections 3.0 and 4.0 and Appendix A of the RIWP. The previous data was reviewed to assess proposed, initial sampling locations for the media of interest. Adjustments to the proposed sampling locations will be conducted, as needed, in coordination with MDNR representatives. For efficiency and when applicable, additional sampling beyond that provided herein will be performed in coordination with the MDNR based on the initial testing results. This approach will allow the required data to be collected, as appropriate. However, screening of data may allow for additional samples to be collected during a mobilization A description of the proposed sampling locations and frequency is below. A summary of the proposed sampling and testing is provided in Appendix C.

The sampling plan approach was discussed with MDNR representatives during the June 25 and 30, 2020 and refined during the December 11, 2020 teleconferences, which included MDNR's visual sample plan (VSP) software data output (11/30/2020 email correspondence). Additional exterior soil sampling, outside of that already included in the RIWP, was not advocated by the MDNR based on the VSP output as the proposed sample frequency across the site is dense enough to assess potential unknowns.

2.1 Groundwater

Sampling rationale for groundwater is detailed in the RIWP Section 4.0 and Appendix A. Groundwater will be assessed using 19 permanent monitoring wells installed at the proposed locations shown on Figure 3. All monitoring wells will be completed to competent bedrock. The perimeter spacing of the initial monitoring wells is approximately 500 feet. Sampling and testing of each monitoring well will occur within a few days after installation. Based on the initial testing data, additional monitoring well installation will be coordinated with MDNR representatives, as needed.

Proposed laboratory testing of groundwater samples includes volatile organics (VOCs), polycyclic aromatic hydrocarbons (PAHs), targeted metals, and polychlorinated biphenyls (PCBs). Dissolved metals testing will be included at a frequency of 20% of the groundwater samples collected for testing. Sampling for nitroaromatics, nitramines, and nitrate esters. EPA Method 8330B will be used for, at a minimum, and the screening analysis at the former powder bunkers (102G, 103 G, 104 H and 105 H) and at least one down- gradient well.

Soil gas samples will be collected if VOCs are found in the groundwater at concentrations that indicate the potential for vapor migration.

2.2 Surface and Subsurface Soil

Sampling rationale for surface and subsurface soil is detailed in the RIWP Section 4.0 and Appendix A. Surface and subsurface soil will be assessed using 71 soil borings installed at the proposed locations shown on Figures 4 and 5. One surface soil sample will be collected from each boring, comprised of material from 0 to 2 feet. One subsurface soil sample will be collected from each boring, comprised of a 2 to 3 feet soil interval exhibiting the most impact based on field screening and observations from the 2 to 10 feet depth interval. If impacted soil is present at 10 feet then the boring will be extended to the depth that the impact is no longer present based on field observations. If apparent impacts are not observed, a shallow subsurface soil interval will be sampled (e.g., 2 to 4 feet below land surface (bls)).

Proposed laboratory testing of soil samples includes VOCs PAHs, targeted metals, TPH (DRO, GRO, ORO ranges) and PCBs (both aroclor and congeners). Surficial soil samples will be tested for a subset of this list as shown on Figure 4 based on historical sampling. Soil testing of PCB congeners, as summarized in the RAWP and QAPP, will be performed on 10% of the surface soil samples with PCB analysis. VOCs will be added to the analysis list if VOC indicators are observed during sampling activities (e.g. high PID readings) (as described in Section 4.2).

Targeted sampling for petroleum contaminates (Building 115, lube oil buildings) and solvents (Building 122B, Building 110). Biased samples from areas where petroleum hydrocarbons were used/stored, in addition to petroleum maintenance/shop areas will also be sampled for solvents (VOCs). The former powder magazines/storage units, Building 110 (Tool and Gauge), Building 115 (Garage), Lead Shop (Building 112), and the underground storage tanks. Sampling for nitroaromatics, nitramines, and nitrate esters by EPA Method 8330B will be used for, at a minimum, and the screening analysis at the former powder bunkers (102G, 103 G, 104 H and 105 H) for at least one surface and subsurface sample per building at the potentially most highly contaminated locations. Additionally, since there have been no previous investigations along the northern parcel along with Buildings 208 B and 211 sampling in this area will include VOCs, PAHs, targeted metals, TPH (DRO, GRO, ORO ranges) , and PCBs,

3.0 SAMPLE DESIGNATION

Each sample will be sealed and labeled after collection. Sample labels will be completed using waterproof ink to provide legible permanent markings. A sample numbering system has been developed to provide easy identification of sample locations. Following are examples of sample numbers and explanations describing the numbering system. Sample designations are selected to facilitate effective use in the Site database. A summary is provided in Appendix C.

Groundwater

Sample ID – MW-1 10/20 (groundwater sample collected from Monitoring Well MW-1 during October 2020). Month and year designation provides a unique sample each time a monitoring well is sampled.

Surface and Subsurface Soil

Sample ID – B-1 6-8 (Soil sample collected from Soil Boring B-1 at a depth of 6 to 8 feet)

Quality Control Samples

Duplicate samples, equipment blank samples, and trip blank samples will use the following:

> D – Duplicate for the respective sample
>
> Note: Duplicate samples will be submitted to the laboratory as blind duplicates using a numbered series, e.g., Surf Soil Dup 1. For future data usability, the sample name in the project database will include the “-D” suffix after the sample location name.
> EB – Equipment rinsate blank collected prior to collecting the sample
> Trip Blank 10/01/2020 – Trip blank sample submitted on October 1, 2020.

Samples being designated for matrix spike and matrix spike duplicate (MS/MSD) analysis will include an identifier as part of the sample code and will be identified as such on the chain-of-custody in the comments section on the same row as the parent sample. In the event there is not enough sample, MS/MSD samples will be internal laboratory samples using whatever sample is available.

The following information will be listed on the label attached to each container:

1. Sample identification number.
2. Initials of collector.
3. Date and time of collection.
4. Preservative used in sample container.

The objective is to designate and label samples accurately to avoid miscommunication. The sample designations will allow the testing results to be effectively added to the Site database.

4.0 SAMPLING EQUIPMENT AND PROCEDURES

Before mobilization to the Site, several key planning steps are needed to ensure that the work is performed safely. As required by state law, the Missouri One Call System will be contacted to perform the location of public utilities. Note that locating public utilities on private property is not required by the One Call System participants. Coordination with GSA will be performed to review the utility locations on the GSA property. Following the review of utilities with GSA representatives, a private utility locating contractor will locate and mark the utilities that GSA is unable to clear. As an added precaution, if utility concerns remain after the above activities, then an air knife will be used to excavate the first 3 to 5 feet of material at suspect locations. In addition, traffic control procedures will be used at locations where sampling activities will affect a roadway or walking path.

A site-specific health and safety plan addressing site-specific and activity-specific hazards and emergency response information will be prepared and accepted by the GSA prior to the initiation of field sampling activities. Personnel implementing this FSP will review and understand the site-specific health and safety plan that will address safety aspects of the Site work activities.

To supplement the procedures indicated below, standard operating guidelines for the sampling activities are provided in Appendix A.

4.1 Monitoring Well Installation and Quarterly Groundwater Monitoring

- Mobilize personnel and equipment to the Site. The MDNR and tenants will be notified at least 10 working days prior to starting field activities.

- Construct a decontamination pad at an approved location. The decontamination pad will be constructed of lumber, tarps, poly sheeting, staples, and nails. Decontamination of drilling and sampling equipment will be performed after completing each boring and monitoring well and prior to starting the work. Decontamination materials will be collected and stored at the designated Site area prior to disposal permitting.

- Perform continuous soil sampling to the targeted monitoring well screen depth to assess saturated intervals. All monitoring wells will be completed to competent bedrock. Soil samples will be screened using a calibrated photoionization detector (PID) with measurements recorded on the boring log. The relatively low permeability soils at the Site will require that time is allowed for groundwater seepage into the borehole so that saturated intervals can be effectively identified. The goal is to target and screen the uppermost saturated zone which is expected to occur at a depth ranging from approximately 10 to 25 feet. Observed lithology and saturation will be used to determine screen placement. Groundwater occurrence is expected to be variable based on previous Site data.

- Install monitoring wells in accordance with Missouri 10 Code of State Regulations (CSR) 23 and screen in the uppermost saturated zone (Figure 3).

  - Monitoring wells will be completed to competent bedrock.
  - Monitoring wells will be constructed of two-inch diameter schedule 40 polyvinyl chloride (PVC) with 0.01-inch slotted screen. Ten-foot screen lengths are anticipated.
  - Install PVC screens pre-packed in the field or prior to delivery to the Site with filter pack sand comprised mainly of silica. Additional filter pack sand will be placed on the outside of the screen and two feet above the top of the screen.
  - Place bentonite chips and bentonite grout above the filter pack to the surface. Grout will be placed using a tremie pipe. The grout will be allowed to settle then approximately 6 to 12 inches of concrete will be added to the borehole.
  - A steel flush-mount cover will be placed on top of the concrete and centered in a 2.0-foot x 2.0-foot concrete pad that will complete the surface installation.

- Decontaminate drilling and sampling equipment with alconox and potable water after each well installation. Drill cuttings will be contained and permitted for disposal at an approved landfill. Decontamination materials will be collected and stored at the designated Site area prior to disposal permitting. The storage location of contained drill cuttings and decontamination materials will be in coordination with GSA.

- Evaluate the effectiveness of equipment cleaning procedures for non-disposable equipment by collecting and testing equipment blank rinsate samples. One equipment blank sample will be collected during each day of monitoring well installation. The equipment blank will be tested for VOCs, PAHs, PCBs, and targeted metals.

- Complete certification records for each well and submit with the applicable fees to the MDNR-Wellhead Protection Division within 60 days of monitoring well installation.

- Develop each monitoring well using a bailer or pump and surge block. Record depth to water measurements, watercolor, weather conditions, and field parameters (pH, temperature, and conductivity). Field data will be documented on a well development gauging form (Appendix A). A minimum of three well volumes will be removed or development will continue until no appreciable water remains in a monitoring well. A main goal of well development is to reduce sample turbidity. Several cycles of development may be needed to achieve reduced turbidity.

- Sample each monitoring well for the designated COPCs using low flow methods. Depth to groundwater measurements will be taken from each monitoring well prior to groundwater purging and sampling. An electronic indicator tape will be used to record depth to groundwater measurements from the top of well casing. Perform well purging prior to sampling to remove stagnant groundwater. Groundwater sampling and purging will be conducted using a low flow pump and disposable polyethylene tubing. Purge water will be monitored with a flow through cell. Parameters to be monitored during purging include pH, temperature, oxidation-reduction potential, conductivity, dissolved oxygen, and turbidity. The meter will be calibrated, as applicable, prior to use. Purging will be conducted until the above parameters stabilize or until a maximum of three well volumes are removed, or until the well is dry. If the well is dry, the sampler will wait for the well to produce additional water prior to sampling. Purge water will be contained and permitted for disposal at an approved facility.

- Collect groundwater samples and avoid excessive agitation of groundwater to reduce potential volatilization. Samples will be placed in new sample containers provided by the analytical testing laboratory. The sample collection order will be VOCs, PAHs, targeted metals, and PCBs. Applicable sample preservatives will be added to sample containers by laboratory personnel prior to shipment to the field. Sample documentation will include sample labels and chain-of-custody records.

- Evaluate the effectiveness of equipment cleaning procedures for non-disposable equipment by collecting and testing equipment blank rinsate samples. One equipment blank sample will be collected during each sampling event. A duplicate sample of one well will also be collected during each sampling event. The equipment blank and duplicate sample will be tested for VOCs, PAHs, PCBs, and targeted metals.

- Additional quarterly groundwater monitoring events will be performed in accordance with the groundwater sampling procedures described herein. At least one year of quarterly groundwater monitoring is anticipated. Based on analytical results, fewer events (e.g. results do not exceed risk levels) or more events (e.g., to assess trends in variable data) may be required. Data from sampling events performed prior to the preparation of the Remedial Investigation Report will be included in the report.

4.2 Soil Sampling (Exterior Soil Borings)

- Mobilize personnel and equipment to the Site. The MDNR and tenants will be notified at least 10 working days prior to starting field activities.

- Construct a decontamination pad at an approved location. The decon pad will be constructed of lumber, tarps, poly sheeting, staples, and nails. Decontamination of drilling and sampling equipment will be performed after each boring and monitoring well is completed and prior to starting the work. Decontamination materials will be collected and stored at the designated Site area prior to disposal permitting.

- Perform continuous soil sampling to 10 feet bls at each of the 71 soil boring locations on Figures 4 and 5 using direct push sampling equipment, hollow-stem augers or equivalent. Soil samples will be screened using a calibrated photoionization device (PID) with measurements recorded on the boring log.

- Collect surface (0 to 2 feet bls) and subsurface (2 to 10 feet bls) soil samples and place in new sample containers provided by the analytical testing laboratory. Applicable sample preservatives will be added to sample containers by laboratory personnel prior to shipment. Sample documentation will include sample labels and chain of custody records as discussed herein.

- Evaluate the effectiveness of equipment cleaning procedures for non-disposable equipment by collecting and testing equipment blank rinsate samples. One equipment blank sample will be collected during each day of sampling. Duplicate samples will be collected at a frequency of 5% (i.e., 1 in 20) of the soil samples collected for testing. The equipment blank and duplicate samples will be tested for VOCs, PAHs, PCBs, and targeted metals.

- Rinse drilling and sampling equipment with alconox and potable water after completing each soil boring. Decontamination materials and investigation derived waste (IDW) will be collected and stored at the designated Site area prior to disposal permitting.

- Contain drill cuttings and permit for disposal at an approved landfill. The storage location of contained drill cuttings will be in coordination with GSA.

- Certification records will be completed for each boring and submitted with the applicable fees to the MDNR-Wellhead Protection Division within 60 days of boring completion.

- Abandon borings using cement bentonite grout mixed in accordance with manufacturer's recommendations. Grout will be placed using tremie pipe in accordance with Missouri regulations (10 CSR 23-4). Asphalt patch will be placed at the surface in paved areas.

4.4 Routine Field Equipment

Routinely used field equipment and information that will be maintained for the project include:

- Gloves (nitrile, polyethylene, or equivalent);
- Decontamination final rinse water (distilled);
- Potable water
- Depth to water meter (capable of reading in 0.01 ft. increments);
- Ice;
- Bubble pack or foam insets to protect sample containers;
- Disposable bailers and new rope or string;
- Forms (chain of custody, field logbook etc.);
- Utility locate requests;
- Utility diagrams;
- A site map showing sampling locations, major landmarks, and topographic features;
- Well installation diagrams and boring logs;
- Waterproof marking pens;
- Calculator and necessary conversions to calculate the volume of purge water;
- Camera;
- Plastic sheeting for ground cover where needed;
- Calibrated buckets to measure the volume of purge water;
- Laboratory-provided sample containers and Chains of Custody, and
- Health and Safety Plan with map to hospital.

4.5 Surveying

A Missouri registered surveyor will determine the location and elevation of sampling locations. Locations will be determined within 0.1 foot, and elevations will be determined to within 0.01 foot. All coordinates and elevations will be referenced to North American Datum (NAD) 1983, and National Geodetic Vertical Datum (NGVD) 1929 or North American Vertical Datum (NAVD) 1988. Existing survey data will be used to assist with surveying efforts.

4.6 Waste Disposal

Various waste streams will be generated as a result of the proposed sampling activities. The wastes and preliminary disposal options are:

- Containerized soil - Disposal as a solid waste or special waste contingent on analytical testing data
- Containerized purge water – disposal permitting based on groundwater analytical data
- Containerized decontamination water – disposal permitted based on analytical testing data
- Personal Protective Equipment (PPE) – Dispose as solid waste

The goal is to characterize these waste streams for proper disposal. Representative sampling of these waste streams can often be conducted using composite sampling or by using analytical data for the waste stream that is generated (e.g., groundwater testing data for purge water disposal). The sampling of these waste streams will depend, in part, on the results of associated analytical testing and the requirements of the permitted disposal facility. Waste disposal will be in accordance with USEPA and MDNR regulations.

5.0 SAMPLE HANDLING AND ANALYSIS

5.1 QA/QC Samples

Quality assurance and quality control (QA/QC) samples will be collected. The QA/QC samples are an integral part of collecting valid data and are subject to the same handling and chain-of-custody as other samples.

Field duplicates, equipment blanks (EB), matrix spike (MS), and laboratory spike duplicate (MSD) samples will be analyzed to assess the quality of the data resulting from the field sampling program. Equipment blanks are collected during decontamination of sampling equipment and consist of a potable water rinsate sample. One equipment blank will be collected at a frequency of one per day of sampling and will be used to assess potential problems and to verify the effectiveness of decontamination procedures. Duplicate samples will be collected at a frequency of 5% (i.e., 1 per 20 samples) of the samples collected. Field and laboratory duplicate samples are analyzed to check for sampling and analytical reproducibility. A sampling summary detailing the QA/QC samples collected in the field is provided in Appendix C. Additional QA/QC information is provided in the QAPP (Worksheet #20).

5.2 Sample Containers, Preservatives, and Holding Times

Sample collection will be documented on the field sampling forms (e.g. boring logs, well sampling logs) provided in the applicable standard operating guidelines in Appendix A. Samples will be placed in containers prepared by the laboratory. Sample containers requiring preservatives will be prepared by the laboratory. Headspace will be avoided. Sample vials will contain the proper amount of preservative. Sample labels will be completed for each sample using waterproof ink. A summary of the sample containers, preservatives, and hold times is provided in Appendix C.

5.3 Sample Packaging, Handling, and Shipment

Samples shall be transported to the laboratory in sealed, insulated shipping containers, ice chests, or coolers. Teklab, Inc. in Collinsville, Illinois is the proposed laboratory, so we anticipate direct or courier delivery without the need for out-of-town shipping. The shipping containers will be sturdy, and if samples are contained in glass bottles, bottle dividers will be used to prevent breakage. Samples will be cooled with ice. Samples will be packed such that the temperature of the samples is maintained as close to 4ºC (39ºF) as possible from the time the samples are collected to the time the samples are received by the laboratory. The samples will be delivered to the laboratory as soon as practical, preferably within 24 hours of sample collection.

5.4 Chain-of-Custody Procedures

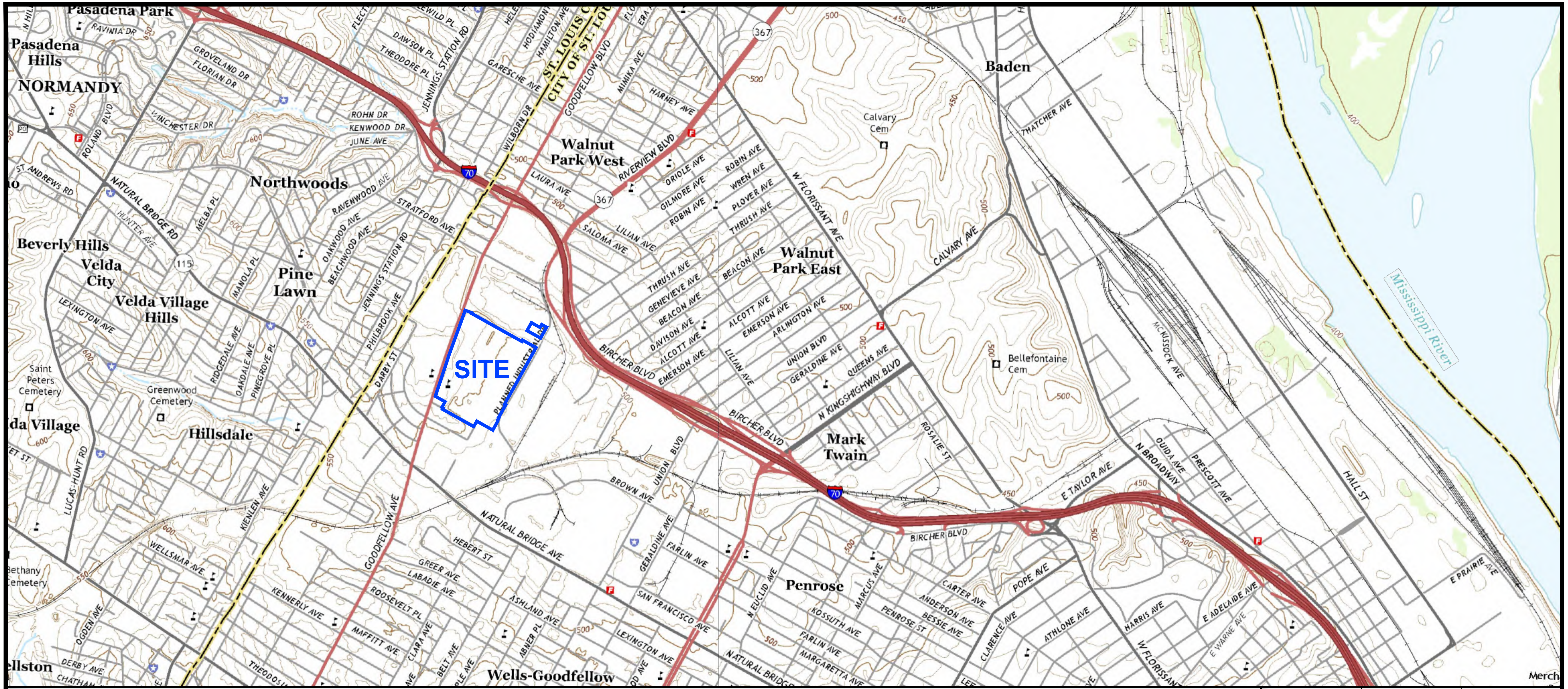
The field sampler will be responsible for the care and custody of the samples until they are transferred to the laboratory courier. As few people as possible will handle the samples.

A sample or evidence file is under your custody if it is:

- in your possession;
- in your view, after being in your possession;

- in your possession and you place it in a secure location; or
- in a designated, secure area.

Samples will be accompanied by a properly completed chain-of-custody form. Sample identification will be listed on the chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, the permanent laboratory, or to/from a secure storage area.



NOTES

1. Plan adapted from 7.5 minute U.S.G.S. maps for Clayton, Missouri and Granite City, Illinois-Missouri quadrangles, last revised in 2015.

2. Site is approximately 66 acres.

N

0 2,000 4,000

SCALE IN FEET

Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

etegra

juniper environmental

GEOTECHNOLOGY INC FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

SITE LOCATION AND TOPOGRAPHY

Project Number J034500.01

FIGURE 1

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

┼┼┼┼┼┼┼┼ Former Railroad Track Location (From 7.5 Minute U.S.G.S. Quadrangle Map for Clayton, Missouri Dated 1954)

N

0 250 500

SCALE IN FEET

Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

etegra

juniper environmental

GEOTECHNOLOGY INC FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

AERIAL SITE MAP

Project Number J034500.01	FIGURE 2

(b) (7)(F)

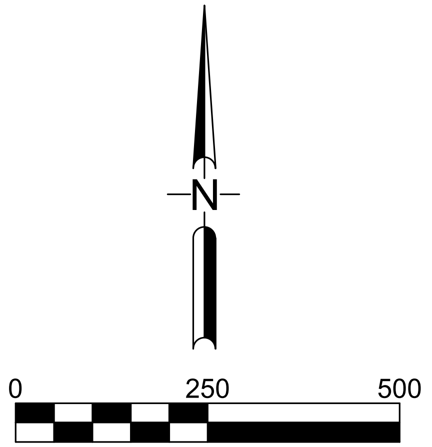
[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. All features are approximate.
3. This plan contains Controlled Unclassified Information (CUI).

LEGEND

▲ Proposed Permanent Groundwater Monitoring Well Location



SCALE IN FEET

Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

etegra

juniper
environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PROPOSED GROUNDWATER SAMPLE LOCATIONS

Project Number
J034500.01

FIGURE 3

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

PAHs METALS PCBs EXPLOSIVES TPH VOCs	Proposed Surface Soil Sample Location (to be Analyzed for Constituents shown Green, Constituents shown Red are Omitted from Analysis)

0 250 500

SCALE IN FEET

N

Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

etegra

juniper environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PROPOSED EXTERIOR SURFACE SOIL SAMPLING LOCATIONS

Project Number J034500.01	FIGURE 4

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

★ Proposed Subsurface Soil Sample Location

N

0 250 500

SCALE IN FEET

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PROPOSED EXTERIOR SUBSURFACE SOIL SAMPLING LOCATIONS

Project Number
J034500.01

FIGURE 5

APPENDIX A
Standard Operating Guidelines

ENV0002 Environmental Soil Logging and Sampling
ENV0003 Sample Shipping
ENV0004 Monitoring Well Installation and Development
ENV0005 Monitoring Well Gauging, Purging, and Sampling
ENV0009 Hazardous/Special Waste Manifesting
ENV0012 Field Log Book Use

STANDARD OPERATING GUIDELINE
ENV0002

Environmental Soil Logging and Sampling

March 2019

TABLE OF CONTENTS

APPENDICES

1.0 PURPOSE

Many variations of environmental soil logging exist. This Standard Operating Guideline (SOG) presents several typical drilling methods that are used. Environmental logging during a Phase II Environmental Sampling and Testing project typically consists of a combination of these drilling methods. Loggers and drillers should remember that how we leave the condition of a site is one of the biggest impressions we will make on our client and the public.

2.0 PRE-FIELD PROCEDURES

2.1 Drilling Group

A drill request form, copy of the proposal/scope of work with budget, directions to the site, a site map and any other client-specific information should be submitted to the head of the Drilling Group at least three days before drilling begins. In addition, a Utility Clearance Request must be submitted/phoned in to the appropriate parties. A copy of the Drill Request form is included in Appendix A. The drill request is also available on the Geotechnology intranet site.

2.2 Project Manager

The following items/information should be supplied by the Project Manager to the Logger:

- Copy of Drill Request form, directions to the site, and site map that includes proposed drilling locations.
- Project Number, Task Number, Project Name.
- Copy of the project proposal (including information about time/money budgeted for field activities and actions/notifications required in the event unforeseen conditions are encountered).
- Health and Safety Plan.
- Any non-standard PPE required for the task.
- Any significant site history not included in the proposal that is relevant to the drilling/logging.
- Site contact, client contact, site owner/representative contact.
- Order of borings to be drilled, if appropriate.
- Type of monitoring equipment needed, such as a photoionization detector (PID), water level indicator, survey equipment, etc.

- Sampling containers, labels, cooler, chain of custody, specified analytical testing laboratory, turnaround time, and billing information.
- Information concerning handling of spoils and decontamination water.
- Any client-related needs or expectations including schedule and communication procedures.

The Project Manager should review the results of all field work immediately upon completion, and discuss any abnormalities/inconsistencies with the Logger. Significant findings should be presented to the client prior to report preparation.

2.3 Logger

The Logger should bring the following materials to the jobsite in addition to any of the materials above supplied by the Project Manager:

- Environmental boring log field sheets;
- Sample cooler, containers, labels and chain-of-custody;
- Engineer’s tape measure;
- Cooler with ice and Ziploc bags;
- Daily logging checklists;
- Photoionization detector (PID);
- Appropriate PPE;
- Water level indicator (WLI);
- Alconox or other such cleaning agent, brush, bucket, water, etc.;
- Plastic sealing bags (Ziploc®);
- Drums and drum labels;
- Surveyor’s Tape or GPS unit for plotting boring locations;
- Environmental Equipment Log; and
- Pens, markers, pencils, knife, etc.

3.0 FIELD PROCEDURES

3.1 Pre-Drilling Activities

Prior to initiating drilling activities at the site, the following steps should be followed:

- Call utility locators a minimum of 48 hours prior to drilling (performed by Drilling Department).

- Contact the site contact concerning (typically by Project Manager:

    - Work to be performed including proposed drilling locations
    - Schedule
    - Contact information
    - What the site conditions will be when leaving the site
    - Contact's preference for certain areas of the site that need to be accessible during certain portions of the day and areas to be avoided
    - Contact’s preference for where drums or other waste will be temporarily stored.

- Upon arrival on the site, perform a site reconnaissance with the drill crew prior to drilling/air knifing to identify underground utility locations, overhead utilities, etc. **Mark all utility locations on the site plan.**

    - Look up and evaluate overhead utilities and other overhead features.
    - Yellow paint typically indicates gas lines.
    - Red paint typically indicates electric lines.
    - Orange paint typically indicates communication lines. Communication lines often have a marking somewhere along the line from the telephone company, such as AT&T.
    - Trenches are marked with two parallel lines connected by an X between them in the appropriate color.
    - Green paint typically indicates sewer lines.
    - In the St. Louis area, the Metropolitan Sewer District does not mark its utility lines. Look for sewer meters near streets and on buildings. Typically, the two are connected by the shortest path possible. Also check directions of sewers at inlet locations.
    - Blue paint typically indicates water lines. Locate off site manholes and/or water mains and line up with the location of anticipated on-site features.

- Conduct a tailgate Health and Safety meeting at the site with the drillers prior to drilling. We are responsible for the safety of our subcontractors but not the client’s representatives, agency, or insurance adjustor personnel. **Document the tailgate safety meeting using the fillable form on the Geotechnology intranet site.**
- Discuss the Scope of Work with the drillers prior to beginning drilling activities.

- Boring locations should be evaluated:

    - Boring locations should be at least 10 feet away from any overhead utility lines. A greater offset distance is required for higher voltage electrical lines.

    - Boring locations and pavement cutting should be at least 5 feet from any identified subsurface utilities. Drilling under the dispenser canopy at UST sites should be avoided.
    - Boring locations and pavement cutting should be at least 5 feet from a visual line connecting any two similar looking manhole covers.
    - Pavement in the vicinity of the proposed boring location should not indicate previous excavation (e.g. no pavement subsidence, differences in pavement texture, relief of patching.)
    - Boring locations are should be at least 10 feet from the underground storage tank (UST) pit.
    - Boring locations should be at least 15 feet from any pump island or other vapor recovery system.

3.2 Hand Auger Drilling/Air Knifing

Air knives (i.e., vacuum excavators) may be used for the first 4 to 5 feet of a boring in order to reduce the risk of hitting subterranean utilities with the drill rig. Hand augers may be used for shallow soil sampling. These methods do not use pressurized downhole mechanical means to advance the sampler. The hand auger bucket is typically approximately 6 inches deep and 3 inches in diameter.

If gravel, sand or other non-native fill material is encountered while hand augering, notify the Project Manager. The boring may need to be abandoned and offset.

Due to sloughing in the boring hole, each auger bucketful does not necessarily represent a 6-inch lift of in-situ soil. Therefore, typically a composite sample of several bucketfuls is considered a sample. For example, a sample from a depth of 0 to 2 feet might be considered a single sample when in fact it is comprised of 4 to 8 hand auger buckets. The boring log should reflect the entire composite sample interval. Hand auger samples are designated by the prefix “HA-” The auger bucket should be decontaminated between sampling intervals. Air knife-advanced boring samples should be designated with the standard grab prefix of “GB-”.

If drill augers are used prior to hand augering in order to cut through concrete/asphalt or other impenetrable surface, note the thickness of the pavement and subgrade in the boring log.

3.3 Direct Push Drilling and Geoprobe®

Direct push drilling quickly collects soil samples. The sampler is typically a 4-foot long, 2-inch diameter acetate tube inserted inside a straight metal shaft sampling tube. The tube is advanced by drill rig pressure on top of the tube and rod extensions.

The acetate sample tube is removed from the metal shaft to access the sample. The sampling device, including the acetate sampling tube and metal shaft, have been observed to store potential energy causing the acetate liner and sample to "eject" out of the metal shaft. Field personnel should not stand within the potential trajectory of the sampler.

A sample trough and cutting tool will be supplied by the drillers. It is the Logger's responsibility to open the sampler. Each sampler is considered one sample. However, the sample should be cut in half and each half stored in a separate sealed Ziploc bag. Each Ziploc bag represents 2 feet of sample. This helps assess the zone of impacted soil. Field screening tests should be performed on each of the two samples taken from the direct push sampler. Samples taken using direct push drilling are designated by the prefix "CS-" for Continuous Sampler.

For example, sample CS-2 might be from the interval 4-8 feet below land surface (bls), but two sets of field screening tests are conducted on the sample: one on 4-6 feet bls, the other on 6-8 feet bls.

3.4 Conventional Drilling

Due to drill rig availability or geotechnical/environmental combination drilling, conventional drilling may be used to obtain environmental samples. Typically, this method includes the use of hollow stem augers and split spoon samplers. Investigative derived waste materials are generated that must be tested, characterized, and stored on site for recovery/removal.

The typical split spoon sampler is 24 inches long. Samples may be taken in 18- or 24-inch sample runs. If the borings are strictly environmental, the split spoon sampler can be advanced in a similar fashion as the direct push sampler (in a 24-inch run, advanced continuously). However, for geotechnical purposes an automatic hammer is utilized. The number of blows that advances the sampler each of the six-inch intervals is recorded. If three 6-inch runs are used, the last two numbers are added together to give a Standard Penetration Test (SPT) number that corresponds to a consistency (such as soft, stiff, etc). If four 6-inch runs are used, the two middle numbers added together are the SPT number. This is an extra tool to help understand the in-situ soil conditions.

Split spoon samples are prefaced with the initials "SS-" in the boring log. The sample should be placed in a Ziploc bag and field tests performed. If a split spoon longer than 2 feet is used, the sample should be divided in half and separated into two sealed Ziploc® bags and field tests performed on both samples from the one sample interval. **The split spoon sampler should be decontaminated by the drillers between each sample interval.**

3.5 Soil Classification/Identification

Soil classification/identification is one of the most important tasks performed during environmental logging. Information can help to identify contamination, past site uses, and potential contaminant migration pathways.

- Geotechnology uses the Unified Soil Classification System (USCS) model for soil classifications and modifiers. A copy of the terms used in the USCS is included as Appendix C.

- Other modifiers that should be included in the field description of the soil include:

    - Color.
    - Mottling, which can be an indication of a high water table.
    - Estimated moisture: dry, moist, or wet. Dry soil should not leave water on your fingers, moist should have detectable water.
    - Silt or sand lenses encountered. Measure lenses and note where in the stratigraphic column they occur.
    - Fill material or native material.
    - Consistency (soft, hard, etc. utilizing thumb test or pocket penetrometer. This equivalency is included in Appendix B).
    - Unusual odors, liquids, or solids observed in the soil.
    - Unusual drilling problems such as grinding or rough drilling.

3.6 Field Screening

Field testing equipment can be used to assess the **relative** presence/absence of impact. Therefore, if field testing equipment is recalibrated or a new piece is exchanged, a few previously screened samples should be rescreened to assess the relative scale. Re-screened sample results should be noted on the boring log as well as the point at which the instrument was re-calibrated/exchanged.

Soil samples should be screened using a PID at 2 foot intervals or at changes in lithology. Samples should be kept in sealed containers (such as sealed Ziploc bags) until they are placed in the laboratory-provided containers. Place the tip of the PID in the bag for a maximum of 10 seconds or until the value stabilizes. Moisture may affect PID readings, as may temperature and the age of the contaminant. **The PID should be calibrated to an isobutylene standard of 100 parts per million (ppm) (for most sites) prior to use and at least once per day. PID calibration instructions can be viewed through the PID display screen or in the PID manual.**

Consistency is the key to good field testing. Samples can be held in a controlled environment until boring termination and then field tested, as long as the time between sample collection and testing is approximately the same for all samples. Otherwise, samples should be field tested shortly after collection.

In selecting a sample for laboratory analysis, first refer to the Scope of Services in the Work Plan. In general, the test with the highest field reading is sampled. Additional samples may be selected based on field screening results to define the vertical extent. Samples may also be collected at designated depths. If PID readings are not detected above background, a sample may be collected from the soil/water interface, the bottom of the boring, or a depth indicated by the Project Manager.

Be sure to keep track of all equipment used during the field project on the Environmental Equipment Log. This log is used to charge the Client for materials utilized during field work.

3.7 Collection of Soil Samples for Laboratory Analysis

Two kinds of samples can be taken: a grab sample or a composite sample. Grab samples are obtained from a single sample/interval. Composite samples are composed of soil from several sources in relatively equal amounts. Composite samples are typically used for waste characterization samples.

The following steps should be followed when collecting soil samples for analysis:

- New gloves should be used when packing the sample to avoid cross-contamination.

- Remove a sample container from the cooler, affix a label, and in indelible, waterproof ink write the sample I.D., the facility name, the sample collection date and time, the type of sample in the container, and the sample collector’s name/initials.

- If testing for multiple constituents, the following order of sample collection should be observed. Not all samples will be required on each sampling event. The order should remain consistent.

    - Volatile Organic Compounds (VOCs)
      Use soil core (i.e. 5035 extractor or Terracore®) provided by laboratory to collect the appropriate sample quantity.
    - Semi-Volatile Organic Compounds (SVOCs)
    - Base/Neutral and Acid Compounds (BNAs)
    - Polychlorinated biphenyl compounds (PCBs)
    - Total Organic Carbon (TOC)
    - Total Organic Halides (TOX)
    - Biochemical Oxygen Demand (BOD5)
    - Fecal Coliform

  - Oils
  - Metals and Mineral (Totals)
  - Metals and Minerals (Dissolved)
  - Cyanides
  - Chemical Oxygen Demand (COD)
  - Radionuclides

- Samples should be preserved by placing them in a cooler with sufficient ice to keep the temperature at 4°C.

3.8 Boring Logs

Boring logs are used to describe/classify soils during the time of exploration. An example of the environmental boring log is included as Appendix D.

The following information should be included on all environmental boring logs:

- Project name, project number, and task number.

- Name of boring.

- Ground surface elevation and datum used or NA.

- Date/Time started boring and Date/Time finished boring. This is important both to gauge time required to drill at that site for future projects and to justify to the client time spent in the field.

- Drill rig, samplers and auger size (if applicable) utilized

- Driller's name, logger's name.

- Whether or not groundwater was encountered and if so, at what depth, including perched groundwater zones.

- Name of sample.

- Sample names should begin with an abbreviation for the type of sampler utilized.

    - HA = Hand Auger Sample
    - CS = Continuous Sampler
    - SS = Split Spoon Sampler
    - GB = Grab Bag or Grab Sample

  All samples should be numbered consecutively, even if different samplers/drilling methods are utilized.

- Sample interval.

- Note which sample will be submitted to the laboratory for analysis.

- Classification of soil.

    - Classify using USCS - see Appendix C for USCS soil classifications and modifiers.
    - Color.
    - Consistency (soft, hard, etc. utilizing thumb test or pocket penetrometer).
    - Any unusual odors, liquids, solids, etc. observed in the soil.
    - Any unusual drilling problems such as grinding or rough drilling.

- Time sample collected.

- PID readings or results of any other field tests performed.

- Recovery of each sample interval.

- Stratigraphy-found at the bottom of the boring log and to be completed by the logger prior to submittal of logs to Project Manager. Only the logger at the site during drilling can accurately describe the stratigraphy encountered during the course of drilling.

- Termination depth and type of termination (boring termination, sampler refusal, auger refusal).

3.9 Decontamination

Contamination between samples can invalidate or provide inaccurate analytical information. To minimize this possibility, sampling equipment should be cleaned thoroughly (when using split spoon sampler) or discarded (when using continuous sampler with acetate disposable sleeve) between sample collection points or sites. Tools used in analyzing the samples, such as knives and pocket penetrometers, should also be decontaminated between samples. The Logger should also direct the drillers to decontaminate the augers between borings.

Materials for cleaning sampling equipment may include, depending on contaminants encountered/expected:

- Detergent (Liquinox or Alconox),
- Distilled water,
- Ethyl Alcohol (for petroleum products),
- Large wash pans/5-gallon buckets,
- Paper towels, and
- Brush(es).

Cleaning materials should be selected based on the contaminant to be removed. Primarily, the cleanser and solvent should be selected so that no chemical reaction with the contaminant is expected. Check with Project Manager for decontamination intervals and materials needed.

A general order for cleaning sampling equipment is to:

- Wash with warm detergent solution;
- Rinse several times with tap water;
- Rinse with distilled water;
- Drain excess water; and
- Allow to air-dry or dry with a stream of warm, dry air or wipe dry.

For samplers which have been used to sample petroleum products and oily residues, it may be necessary first to wipe the samplers with absorbent cloth to eliminate the residues. The equipment is then rinsed with an organic solvent such as petroleum naptha or trichloroethane followed by washing with the detergent solution and rinsed with distilled water.

If the cleaning process produces toxic fumes, adequate ventilation is important. If the washings are hazardous, washings should be stored in closed waste containers and disposed of properly in approved disposal sites. Clean samplers should be stored in clean and protected areas.

Both to avoid cross contamination and to protect yourself from contaminants, appropriate gloves should be worn at all times and changed frequently.

3.10 General Field Notes

Field Notes are extremely important during environmental logging. It is always better to record too many details than not enough. Information that should be in field notes includes:

- Time on-site;
- Weather;
- Personnel onsite, including logger, drillers, client representatives, and agency representatives;
- Discussions with the owner's representative, site manger or operator, agency or insurance adjustor personnel and drill crews;
- Work performed; and
- Copy of Daily Logging Checklist.

All field notes, chain of custody, summary logs, etc. should be transmitted to the Project Manager in a timely manner, preferably prior to sample shipment.

3.11 Completion of Field Activities

Prior to leaving the site, the Logger is responsible for communicating with the site contact/manager. The discussion should include a summary of the work performed and equipment that is being left on site (cones, barricades, etc), the reason and status for any materials left on-site (uncured concrete), the location of any drums or other waste containers, when additional field work will resume, and Geotechnology contact information. This information is summarized in the Daily Logging Checklist included in Appendix B.

Communicate with the drill crews exactly what is expected of them regarding the condition the site is left in. Loggers are expected to help out the drill crews, as needed, in order to complete site activities.

3.12 Backfill Procedures

The following procedures will be followed depending on the type of sampling conducted:

3.12.1 Air Knife

Drillers and loggers should be cognizant of the volume of material removed from the subsurface during air knife activities. The backfill should be clean material, including clean excavated material, well hydrated bentonite (preferably hydrated for a minimum of 3 hours) and finished at the surface with a 6" lift of concrete (FastSet or similar with a minimum cure time of 6 hours). Note, if the site owner/operator prefers cold asphalt patch, then a minimum 6" lift of asphalt should be installed and tamped tightly in place. Cure time for cold asphalt patch at the surface is 6 hours. A minimum of 3 orange cones or construction barricades should be placed immediately adjacent to the curing concrete/asphalt patch. The Driller and Logger should coordinate as to who will return to the site to inspect the surface finish and retrieve the cones/barricades.

3.12.2 Direct Push Technology, Geoprobe®, and Hollow Stem Auger Borings

Backfill should be well hydrated bentonite (preferably hydrated for a minimum of 3 hours) placed to within one foot of the ground surface. The surface should be finished with a 6” lift of concrete (FastSet or similar with a minimum cure time of 6 hours). Note, if the site owner/operator prefers cold asphalt patch, then a minimum 6” lift of asphalt should be installed and tamped tightly in place. Cure time for cold asphalt patch at the surface is 6 hours. A minimum of 3 orange cones or construction barricades should be placed immediately adjacent to the curing concrete/asphalt patch. The Driller and Logger should coordinate as to who will return to the site to inspect the surface finish and retrieve the cones/barricades.

3.12.3 Temporary Monitoring Wells

Temporary monitoring wells are sampled 24 hours after installation. Therefore, a steel plate specifically designed for open temporary monitoring wells is placed over the open hole once the temporary well is installed. After groundwater sampling and temporary well abandonment, well hydrated bentonite (preferably hydrated for a minimum of 3 hours) is placed to within one foot of the ground surface. The surface should be finished with a 6” lift of concrete (FastSet or similar with a minimum cure time of 6 hours). Note, if the site owner/operator prefers cold asphalt patch, then a minimum 6” lift of asphalt should be installed and tamped tightly in place. Cure time for cold asphalt patch at the surface is 6 hours. A minimum of 3 orange cones or construction barricades should be placed immediately adjacent to the curing concrete/asphalt patch. The Driller and Logger should coordinate as to who will return to the site to inspect the surface finish and retrieve the cones/barricades.

APPENDIX A

DRILL REQUEST FORM

GEOTECHNOLOGY INC
FROM THE GROUND UP

DRILLING REQUEST

Job Name: _____ Location: _____

Job & Task No.: _____ Project Manager: _____ Type Billing: Select One

GIVE ESTIMATIONS OF THE FOLLOWING

No. of Borings: _____ Total Footage: _____ Maximum Depth: _____ Depth to Rock: _____

Duration: _____ Duration ATV Required: ☐ Yes ☐ No NX Coring: ☐ Yes ☐ No

Earliest Start Date: _____ Latest Start Date: _____ Logger: _____

Work Hours: ☐ 8 Hour Day / 40 Hour Week ☐ 10 Hours Days ☐ OT Authorized to Meet Schedule

TOOLS & SUPPLIES REQUIRED:

☐ HSA Size (I.D.): Select One
☐ Rotary Wash Size: _____
☐ Split Spoons: Select One
☐ DPT (Tray/Liners/Cutter/Catchers)
☐ Shelby Tubes, Qty: _____
☐ Hand Auger, Length _____
☐ Asphalt Patch: _____
☐ Concrete Patch: _____
☐ Wood Plugs, Qty: _____
☐ Traffic Control, Type: _____
☐ Health & Safety Plan Attached: Select One
Distance to Site: _____ Miles
Water Availability: Select One
Utilities Cleared By: _____ (Date)

☐ Steamer
☐ Other Decon. Supplies Select One
☐ Screen: Size & Type: Select One
Amount: _____
☐ Bedrock well
☐ Riser: Size & Type: Select One
Amount: _____
☐ Well Cover: Type, Size: Select One
☐ Backfill: Select One _____
☐ 55-Gallon Drums, Qty: _____
☐ PPE Required, Type: Select
☐ Concrete Coring Machine or Diamond Core Bit Required, Specify: _____
☐ Missouri Certification/Registration Reports, No.: _____

Additional Comments / Instructions: _____

Drill requests (2 copies) are to be submitted to Drilling Manager a Minimum of 48 hours prior to earliest start date. Map showing site location must be attached. Route budget sheet to Drilling Manager.

Submitted By: ______________________ Date ______________________

APPENDIX B

DAILY LOGGING CHECKLIST

Project: ______________________ Logger: ______________________

Project No. ______________________ Crew: ______________________

Date: ______________________

Yes No **Upon Arrival On Site – Prior to Starting Field Activities**

☐ ☐ Communicate with Site Operator/Manager. Review scope of work including proposed boring locations, discussion of known utilities and contact information.

Site Operator/Manager Name: ______________________

Contact Information: ______________________

☐ ☐ Communicate with Driller. Review scope of work including proposed boring location of marked and known utilities and required boring/well construction backfill details.

Discussion: ______________________

____

Logger's Initials: ____________ Driller's Initials: ____________

☐ ☐ Communicate with regulatory, insurance adjustor and site operator personnel.

☐ ☐ Conduct tailgate health and safety meeting. Geotechnology and any subcontractors are required to sign the HASP.

Upon Departure From Site – Prior to Leaving

☐ ☐ Drums/IDW containers labeled.

☐ ☐ Borings/wells properly constructed, finished at the surface, and guarded with cones/barricades.

☐ ☐ Communicate with Site Operator/Manager regarding schedule, equipment left on site, conditions of borings/monitoring wells, acknowledgement Operator/Manager about site conditions, site cleanliness and Geotechnology contact information. Tell the Operator/Manager to call us immediately (John Bostwick 314-452-7716) if they see a hole slump or have any other problems.

☐ ☐ Call Geotechnology Project Manager prior to leaving site.

Comments: ______________________

____

____

____

____

____

____

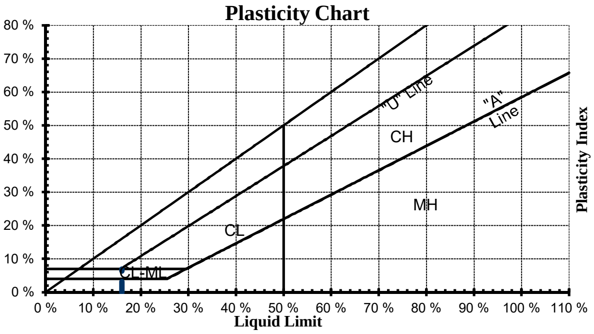
APPENDIX C

BORING LOG TERMS AND SYMBOLS

BORING LOG: TERMS AND SYMBOLS

LEGEND

CS	Continuous Sampler
GB	Grab Sample
NQ	NQ Rock Core
PST	Three-Inch Diameter Piston Tube Sample
SS	Split-Spoon Sample (Standard Penetration Test)
ST	Three-Inch Diameter Shelby Tube Sample
*	Sample Not Recovered
PL	Plastic Limit (ASTM D4318)
LL	Liquid Limit (ASTM D4318)
SV	Shear Strength from Field Vane (ASTM D2573)
UU	Shear Strength from Unconsolidated-Undrained Triaxial Compression Test (ASTM D2850)
QU	Shear Strength from Unconfined Compression Test (ASTM D2166)



SOIL GRAIN SIZE

US STANDARD SIEVE

12" 3" 3/4" 4 10 40 200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

300 76.2 19.1 4.76 2.00 0.42 0.074 0.005

SOIL GRAIN SIZE IN MILLIMETERS

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions			***Symbol***	***Description***
Coarse-Grained Soils (More than 50% Larger than No. 200 Sieve Size)	Gravel and Gravelly Soil	Clean Gravels Little or no Fines	GW	Well-Graded Gravel, Gravel- Sand Mixture
			GP	Poorly-Graded Gravel, Gravel-Sand Mixture
		Gravels with Appreciable Fines	GM	Silty Gravel, Gravel-Sand-Silt Mixture
			GC	Clayey-Gravel, Gravel-Sand-Clay Mixture
	Sand and Sandy Soils	Clean Sands Little or no Fines	SW	Well-Graded Sand, Gravelly Sand
			SP	Poorly-Graded Sand, Gravelly Sand
		Sands with Appreciable Fines	SM	Silty Sand, Sand-Silt Mixture
			SC	Clayey-Sand, Sand-Clay Mixture
Fine-Grained Soils (More than 50% Smaller than No. 200 Sieve Size)	Silts and Clays	Liquid Limit Less Than 50	ML	Silt, Sandy Silt, Clayey Silt, Slight Plasticity
			CL	Lean Clay, Sandy Clay, Silty Clay, Low to Medium Plasticity
			OL	Organic Silts or Lean Clays, Low Plasticity
	Silts and Clays	Liquid Limit Greater Than 50	MH	Silt, High Plasticity
			CH	Fat Clay, High Plasticity
			OH	Organic Clay, Medium to High Plasticity
	Highly Organic Soils		PT	Peat, Humus, Swamp Soil

STRENGTH OF COHESIVE SOILS

Consistency	***Undrained Shear Strength (tsf)***	***Unconfined Comp. Strength (tsf)***
Very Soft	less than 0.125	less then 0.25
Soft	0.125 to 0.25	0.25 to 0.5
Medium Stiff	0.25 to 0.5	0.5 to 1.0
Stiff	0.5 to 1.0	1.0 to 2.0
Very Stiff	1.0 to 2.0	2.0 to 3.0
Hard	greater than 2.0	greater than 4.0

DENSITY OF GRANULAR SOILS

Descriptive Term	***Approximate N_{60}-Value Range***
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	>50

N-Value (Blow Count) is the last two, 6-inch drive increments (i.e. 4/7/9, N = 7 + 9 = 16). Values are shown as a summation on the grid plot and shown in the Unit Dry Weight/SPT column.

RELATIVE COMPOSITION

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35 to 50%

OTHER TERMS

Layer - Inclusion greater than 3 inches thick.
Seam - Inclusion 1/8-inch to 3 inches thick
Parting - Inclusion less than 1/8-inch thick
Pocket - Inclusion of material that is smaller than sample diameter

GEOTECHNOLOGY INC
FROM THE GROUND UP

Relative composition and Unified Soil Classification System (USCS) designations are based on visual descriptions and are approximate only. If laboratory tests were performed to classify the soil, the USCS designation is shown in parenthesis.

APPENDIX D

BORING LOG/ WELL COMPLETION FORMS

ENVIRONMENTAL BORING LOG

Project Name: ____________ **Project Number:** ____________ **Task:** ________

Client: ____________ Location: ____________ **Sheet** ______ of ______

Boring Number: ____________ Surface Elevation: ____________ Completion Date: ____________

Utilities Clear: yes no Surface Material: ____________ Latitude: ____________

Drill Rig Type: ____________ Driller: ____________ Logger: ____________ Longitude: ____________

DRILLING DATA

	Size		Other	From	To		Sample Type	Length		Total Collected
Air Knife	yes		no			ft	Split Spoon (SS)		ft	
Hand Auger	2.25"	3.25"				ft	Shelby Tube (ST)		ft	
Hollow Stem	3.75"	4.25"				ft	Macrocore (CS)		ft	
Solid Stem	4"	6"				ft	Grab (GB)	NA	ft	
Direct Push	2.25"	3.25"				ft	Rock Core (NX2)		ft	
Mud Rotary	3.125"	4.125"				ft	Hand Auger (HA)		ft	
Air Rotary	6"	8"				ft	Other: ________		ft	

GROUNDWATER DATA

Not observed ☐ Initially Observed at: ________ ft

Measurement Obtained By: WLI Tape Log

Monitoring Well or Piezometer Installed: yes no

TERMINATION DATA

Total Boring Depth at: ________ ft bgs on ________

Auger refusal / term. at: ________ ft bgs on ________

Sampler refusal / term. at: ________ ft bgs on ________

FIELD BORING LOG DATA

Sample Type & No.	Sample Depth (ft) From	To	Field Description	Rec.	PID	GW Interval From	To

Depth (ft) From	To	**Stratigraphy** **Measure & record ALL overburden matl. i.e. topsoil, asphalt, concrete**	Remarks:

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MONITORING WELL LOG DIAGRAM

Project Name: ____________ **Project Number:** ________ **Task:** ____

Well Number: ________ Driller: ______ Logger: ______ Drill Rig: ________

Installation Date: ________ Developed Date: ________ Drill Method: ________

Riser: Ø ____ Length: ____ Type: ______ **Sand:** Type: ____________ Bags: ____

Screen: Ø ____ Length: ____ Slot: ______ **Seal:** Type: ____________ Bags: ____

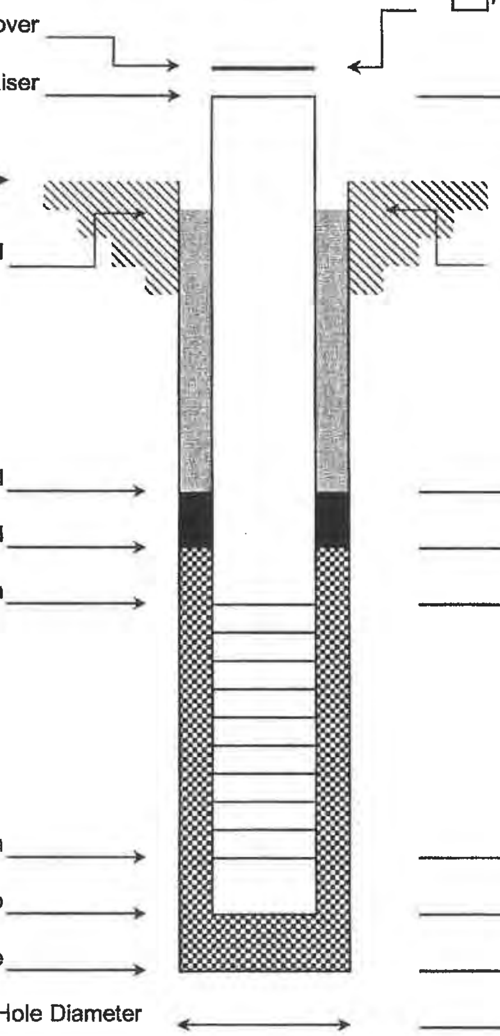
Cap: Ø ____ Length: ____ Type: Slip / Threaded **Backfill:** Type: ____________ Bags: ____

Cut-Off Length: (-) ____ Screen Slit to Slit Length: ______ Tremie Used: yes no

Total Length of Materials: ____ Backfill Below Bottom Cap?: yes no Material(s) Used: ________

Total Measured Depth From Top of Riser: ______ **(ft)**

☐ Flushmount
☐ Aboveground



Protective Cover

Top of Riser

______ **Finished Height (ft)** [or recess bls]

Ground Surface

0 (ft) Elevation: ______ ft

Top of Backfill ______ Depth (ft bls)

Top of Seal ______ Depth (ft bls)

Top of Sand ______ Depth (ft bls)

Top of Screen ______ Depth (ft bls)

Bottom of Screen ______ Depth (ft bls)

Bottom of Well Cap ______ **Depth (ft bls)**

Bottom of Hole ______ **Depth (ft) [Total depth of boring from log]**

Hole Diameter ______ Diameter (in)

Well Construction Notes: ****ALL MEASUREMENTS TO 0.01 FT****

GEOTECHNOLOGY INC
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GEOTECHNOLOGY INC
FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0003

Sample Shipping

March 2019

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1.0 PURPOSE AND SCOPE

The purpose of this SOG is to provide basic guidance for the proper preservation and shipping of environmental samples. The scope of this SOG is limited to general information concerning these procedures and does not include analytical laboratory-specific requirements.

2.0 PRE-SAMPLING INFORMATION

The following items/information should be supplied by the Project Manager to the engineer/scientist:

- Project name, project number, and task number.
- Copy of the project proposal (including information about time/money budgeted for field activities and possible extensions).
- Sampling containers, labels, cooler, Chain of Custody, and information about: where laboratory samples should be sent, type of analyses, turn around time, and billing information.

3.0 PROCEDURES

The engineer/scientist is responsible for obtaining, preserving, packaging and transporting the samples. The following steps should be observed:

- Perform sampling according to SOG ENV0002 or the project-specific work plan.
- Some samples require special handling such as:
    - VOCs are collected first and water samples should be added to the containers such that no air space is in the container or using a plunger to get a specific volume per laboratory requirements. For water samples, invert the container and observe if there are air bubbles that accumulate in the bottom of the container. If there are ANY air bubbles, discard the sample and obtain another sample. Be careful not to overfill the container as this may remove the preservation agent. For VOC soil samples, the container should be filled such that there is essentially zero headspace.
    - Metal and mineral groundwater samples shall be acidified to a pH less than 2 S.U. by addition of $HNO_{3.}$
    - Oils, TOC, TOX, COD and nitrogen samples shall be acidified to a pH less than 2 S.U. by the addition of H_2SO_4.
    - Cyanide samples shall be preserved in an alkaline environment with a pH greater than 12.5.4 by addition of NaOH.
    - TOX sample containers must be filled such that no air apace is present within the sample container.

- Sample containers should be stored on ice in a cooler until packaged/delivered to laboratory.

- All samples, shipped or delivered, shall be accompanied by a fully completed Chain of Custody record. The Chain of Custody is necessary by law to track the possession of potentially hazardous materials. The Chain of Custody must include the following information:

    - Name of environmental consultant (Geotechnology, Inc.)
    - Sampler's name
    - Project name/location/number
    - Date sampled
    - Sample names
    - Sample type/container size/number
    - Analysis to be performed
    - Billing information
    - Where to send results
    - Signature of sampler
    - The Chain of Custody may be in triplicate form. Alternatively, a copy should be made when the samples are shipped. One copy will be kept at Geotechnology, and a copy or the original with all the signatures will be sent to Geotechnology with the final analytical results.

- Samples shall be transported to the laboratory in sealed, insulated shipping containers, ice chests, or coolers. The shipping containers should be sturdy, and if samples are contained in glass bottles, cushioning such as bubblewrap or dividers should be used to separate the bottles.

- Samples will be packed in ice for proper preservation. The temperature of the samples is maintained as close to 4 degrees Celsius (39 degrees Fahrenheit) as possible from the time the samples are collected to the time the samples are received by the laboratory. **NOTE: Liquids must be secured within the cooler. Melting ice/water cannot be allowed to escape the cooler during shipment. If this happens, the delivery service will not deliver the cooler to the laboratory.** Prepare package appropriately as follows: First, place bubble wrap in the bottom of the cooler. Then, place a large, thick trash bag into the cooler. Contain the ice in one-gallon Ziploc bags and place ice into the trash bag. Place sample containers, wrapped in bubble wrap into the ice. Place more ice (contained in Ziploc bags) on top of the samples. Overlap bag so that water will not spill out during transport. Place Chain of Custody and Purchase Order into a Ziploc bag and place on top of the closed trash bag. Add bubblewrap, if necessary, to fill in extra space in the cooler.

- Samples should be shipped/delivered to the laboratory as soon as practical, preferably within 48 hours of sample collection. However, many of the labs do not have technicians on staff on Saturdays, so it is often best to place the samples in the refrigerators in Geotechnology's environmental equipment room if samples would arrive at the laboratory on Saturday. Keep the COC with the samples in the refrigerator. The samples should then be packaged for shipment on Monday. **NOTE: Do not prepare the cooler for shipment and then place it in the refrigerator for the weekend. The cooler is an insulator, and as such, the cool refrigerated air will not enter the cooler. If storing the samples in a cooler in the refrigerator, prop cooler lid open in order to allow refrigeration.**

- A Purchase Order must be prepared and submitted with the Chain of Custody if the bill is going to Geotechnology.

- Two Chain of Custody seals should be attached to the cooler if the laboratory is not picking up the samples. These should be attached over the entry points. The laboratory can tell if the cooler/samples may have been tampered with if these seals are broken upon arrival. Some laboratories supply Chain of Custody seals, but extra Chain of Custody seals are available if they do not. Then sign your name and the date you are sealing the cooler. Affix to the cooler such than the labels will break if the cooler is opened. Secure the labels with tape if needed.

- The cooler should be securely closed with packaging tape. The cooler should also be taped closed along potential water escape routes, such as along the edge of the lid and at any drainage spouts.

- A shipping/billing label should be securely fastened to the top or front of the cooler.

- Place the cooler at the front desk for shipping or laboratory pick up.

GEOTECHNOLOGY INC

FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0004

Monitoring Well Installation and Development

March 2019

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APPENDICES

1.0 PURPOSE AND SCOPE

The scope of this SOG is limited to installation of monitoring wells, measuring and logging appropriate parameters during monitoring well installation and monitoring well development.

2.0 PRE-FIELD PROCEDURES

2.1 Project Manager

A drill request form, directions to the site and a site map should be submitted to the head of the drilling department. In addition, a utility clearance request must be submitted/phoned in to the appropriate parties by the drilling department. A copy of the Drill Request form is included in Appendix A and is also available on the Geotechnology intranet site.

The following items/information should be supplied by the Project Manager to the Project Engineer/Scientist:

- Copy of Drill Request, directions to the site and site map that includes proposed drilling locations.
- Project Number, Task Number, Project Name.
- Copy of the project proposal (including information about time/money budgeted for field activities and actions/notifications required in the event unforeseen conditions are encountered).
- Health and Safety Plan.
- Any non-standard PPE required for the task.
- Any significant site history not included in the proposal that is relevant to the drilling/logging/installation/development.
- Site contact.
- Order of monitoring wells to be installed.
- Type of equipment needed.
- Information concerning what is to be done with any spoils generated.

The Project Manager should review the results of all field work immediately upon completion, and discuss any abnormalities/inconsistencies with the Project Engineer/Scientist. Significant findings should be presented to the client prior to report preparation.

2.2 Project Engineer/Scientist

The Project Engineer/Scientist should bring the following materials to the jobsite for monitoring well installation and development in addition to any of the materials above supplied by the Project Manager:

Monitoring Well Installation

- Boring Log Field Sheets/Monitoring Well Installation Logs (Appendix B).
- Appropriate PPE.
- Drum labels.
- Surveyor's Tape or GPS unit for plotting boring locations and for measuring well construction materials.
- Waste Log.
- Environmental Equipment Log (Copy is saved in STDPAR/ENVIRONMENTAL).
- Clipboard, pens, markers, pencils, knife.

Monitoring Well Development

- Well Gauging Data Sheets (included in Appendix C) and a copy of the completed Monitoring Well Installation Logs.
- Appropriate PPE.
- Drum labels.
- Water level or interface probe.
- Environmental Equipment Log (A copy is saved in STDPAR/ENVIRONMENTAL).
- Clipboard, pens, markers, pencils.
- Purging bailer and rope, or a pump, as directed by the Project Manager or listed in the project proposal.

- Buckets, brushes, and soap (such as Alconox) for decontamination.
- Tools: well head wrench, key for locking well cap, hammer, screw driver, turkey baster (for removing water pooled between well head and well cap), crescent wrench, pliers, scissors, knife.

3.0 FIELD PROCEDURES

3.1 Monitoring Well Installation

Monitoring well installation logs are used to record field measurements. A copy of the Monitoring Well Installation Log is included as Appendix B. Monitoring well locations should be measured from existing site features and sketched onto the site plan. If cuttings are generated and will be drummed, note the storage location, and the number of full drums, and be sure to label all drums appropriately.

The following information should be recorded on all monitoring well installation logs:

- Project Name, Project Number, and Project Task.
- Name of monitoring well.
- Ground surface elevation and datum used.
- Date monitoring well was installed.
- Auger size. The outer diameter of the auger is the diameter of the hole. Ask the driller for this dimension.
- Total depth of well to top of casing using tape or water level indicator.
- Bottom cap type, length, and diameter. On the Monitoring Well Installation Log, the bottom of hole is the depth of the hole and the bottom of the well starts at the bottom of the bottom cap.
- Screen type, length, and diameter.
- Casing type, length, and diameter.
- Length of cutoff. Typically, the casing is too long for the hole and is cut. Measure the amount of casing that is cut off.

- Survey in the top of the well cover and the top of casing using a laser level or standard optical survey equipment. If survey equipment is not available, estimate the distance from the ground surface to the top of casing and record it. A survey can be performed at a later date and the well dimensions re-calculated at that time.

- Depth to top of filter material (typically sand). The filter pack should be around the screened interval and typically two feet additional sand above the top of screen.

- Interval depth of the seal (typically two feet of bentonite).

- Type of flush mount or other well protection used.

- After top of casing (TOC) and ground surface (GS) have been surveyed, calculate elevations from depth measurements.

3.2 Monitoring Well Development

- Measure depth to water and total depth using a water level indicator.

- Calculate required 5 well volumes.

- Tie rope securely to bailer or set up a development pump at the well.

- Remove 5 well volumes or until well is dry. The water column should be surged repeatedly using the bailer or a surge block to attempt to remove fine-grained particles.

- Record approximate purged volume. Place the purged water in a drum or dispose of the purge water as noted in the project proposal.

- Decontaminate the PVC bailer or pump and use new rope for the next well, or use a new disposable bailer.

- Label drums and record number of drums and location.

- Record date of development on the Monitoring Well Installation Log.

APPENDIX A

DRILL REQUEST FORM

GEOTECHNOLOGY INC
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DRILLING REQUEST

Job Name: _____ Location: _____
Job & Task No.: _____ Project Manager: _____ Type Billing: Select One

GIVE ESTIMATIONS OF THE FOLLOWING

No. of Borings: _____ Total Footage: _____ Maximum Depth: _____ Depth to Rock: _____
Duration: _____ Duration ATV Required: ☐ Yes ☐No NX Coring: ☐Yes ☐No

Earliest Start Date: _____ Latest Start Date: _____ Logger: _____
Work Hours: ☐ 8 Hour Day / 40 Hour Week ☐ 10 Hours Days ☐ OT Authorized to Meet Schedule

TOOLS & SUPPLIES REQUIRED:

☐ HSA Size (I.D.): Select One
☐ Rotary Wash Size: _____
☐ Split Spoons: Select One
☐ DPT (Tray/Liners/Cutter/Catchers)
☐ Shelby Tubes, Qty: _____
☐ Hand Auger, Length _____
☐ Asphalt Patch: _____
☐ Concrete Patch: _____
☐ Wood Plugs, Qty: _____
☐ Traffic Control, Type: _____
☐ Health & Safety Plan Attached: Select One
Distance to Site: _____ Miles
Water Availability: Select One
Utilities Cleared By: _____ (Date)

☐ Steamer
☐ Other Decon. Supplies Select One
☐ Screen: Size & Type: Select One
Amount: _____
☐ Bedrock well
☐ Riser: Size & Type: Select One
Amount: _____
☐ Well Cover: Type, Size: Select One
☐ Backfill: Select One _____
☐ 55-Gallon Drums, Qty: _____
☐ PPE Required, Type: Select
☐ Concrete Coring Machine or Diamond Core Bit Required, Specify: _____
☐ Missouri Certification/Registration Reports, No.: _____

Additional Comments / Instructions: _____

Drill requests (2 copies) are to be submitted to Drilling Manager a Minimum of 48 hours prior to earliest start date. Map showing site location must be attached. Route budget sheet to Drilling Manager.

Submitted By: ____________________

Date ____________________

APPENDIX B

MONITORING WELL INSTALLATION LOG

MONITORING WELL LOG DIAGRAM

Project Name: ______________ **Project Number:** ________ **Task:** ____

Well Number: __________ Driller: ______ Logger: ______ Drill Rig: ________

Installation Date: ________ Developed Date: ________ Drill Method: ________

Riser: Ø ____ Length: ____ Type: ______ **Sand:** Type: __________ Bags: ____

Screen: Ø ____ Length: ____ Slot: ______ **Seal:** Type: __________ Bags: ____

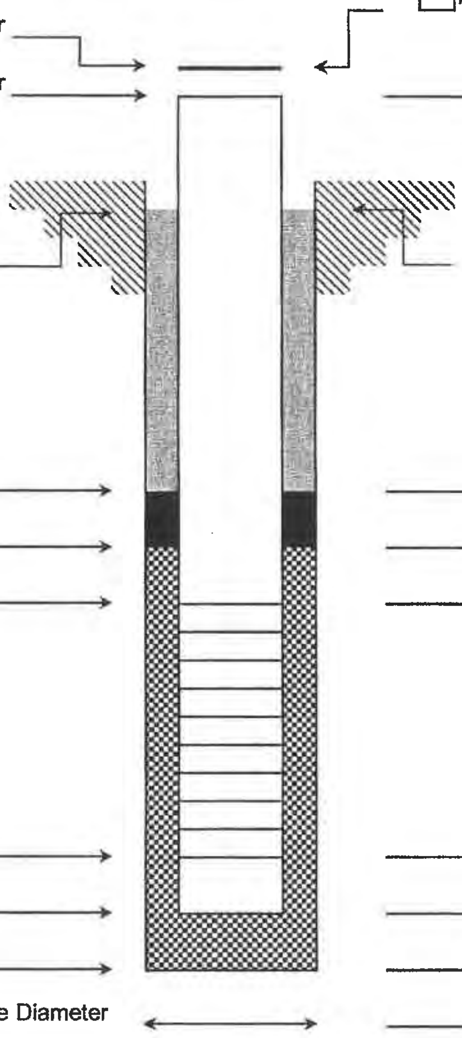
Cap: Ø ____ Length: ____ Type: Slip / Threaded **Backfill:** Type: __________ Bags: ____

Cut-Off Length: (-) ____ Screen Slit to Slit Length: ______ Tremie Used: yes no

Total Length of Materials: ____ Backfill Below Bottom Cap?: yes no Material(s) Used: ________

Total Measured Depth From Top of Riser: ______ **(ft)**

☐ Flushmount
☐ Aboveground



Protective Cover

Top of Riser ______ **Finished Height (ft)** [or recess bls]

Ground Surface 0 (ft) Elevation: ______ ft

Top of Backfill ______ Depth (ft bls)

Top of Seal ______ Depth (ft bls)

Top of Sand ______ Depth (ft bls)

Top of Screen ______ Depth (ft bls)

Bottom of Screen ______ Depth (ft bls)

Bottom of Well Cap ______ **Depth (ft bls)**

Bottom of Hole ______ **Depth (ft) [Total depth of boring from log]**

Hole Diameter ______ Diameter (in)

Well Construction Notes: ****ALL MEASUREMENTS TO 0.01 FT****

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FROM THE GROUND UP

APPENDIX C

WELL GAUGING DATA SHEET

PAGE _____ OF _____

WELL GAUGING/WATER SAMPLING LOG

GEOTECHNOLOGY INC
FROM THE GROUND UP

JOB NO. ____________________

JOB NAME ____________________

SITE LOCATION ____________________

PERSONNEL ____________________

					A	B	C	D	E	F								
Well No.	Date	Time	Desc. Of Meas. pt	Dia. Of Casing (in.)	Depth to Water (ft.)	Total Depth (ft.)	Water Column (ft.)	Gallons Per Foot * (Gal/ft.)	Gallons in Well (1 Well Vol.)	Three Well Vols. (Gal.)	Purged Volume (Gal.)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	pH (SU)	Temp. (°C)	S.C. (S/m)	Remarks

<u>*WELL CASING VOLUMES (GALLONS/FT.)</u>

1 1/4" = 0.06   2" = 0.16   3" = 0.37   4" = 0.65
8" = 2.59   1 1/2" = 0.09   2 1/2" = 0.26

<u>FORMULAS</u>

B - A = C   D * C = E
E x 3 = F

GEOTECHNOLOGY INC
FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0005

Monitoring Well Gauging, Purging, and Sampling

March 2019

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APPENDIX

1.0 PURPOSE

The purpose of this SOG is to provide guidance for the proper performance of environmental monitoring well gauging, purging, and sampling. Purging and sampling methods will vary based on site conditions and regulatory requirements. Procedures for installation of monitoring wells are presented in SOG ENV0004 – Monitoring Well Installation and Development.

2.0 PRE-FIELD PROCEDURES

2.1 Project Manager

The Project Manager is responsible for being familiar with the project proposal/work plan and Health and Safety Plan. The following items/information should be supplied by the Project Manager to the engineer/scientist and discussed prior to field mobilization.

- Project Name, Project Number, and Task Number;
- Copy of the project proposal/work plan (including information about field activities and actions/notifications required in the event unforeseen conditions are encountered);
- Site map;
- Copy of most recent groundwater sampling results;
- Health and Safety Plan;
- Non-standard PPE required for the task;
- Site history not included in the proposal that is relevant to the site;
- Site contact;
- Order of monitoring wells to be gauged, purged and sampled (typically least to most impacted);
- Type of monitoring equipment needed (water level indicator, pump, survey equipment, etc.);
- Sampling containers, labels, cooler, Chain of Custody, specified analytical testing laboratory turnaround time, billing information; and
- Information concerning handling of purged water.

The Project Manager should review all field work upon completion and discuss any abnormalities/inconsistencies with the engineer/scientist. Significant findings should be presented to the client prior to report preparation.

2.2 Engineer/Scientist

The engineer/scientist should bring the following materials to the jobsite in addition to any of the materials above supplied by the Project Manager.

- Appropriate PPE;
- Alconox or other appropriate cleaning agent, brush, bucket, water;
- Watch (timepiece);
- Drum labels;
- Surveyor’s Tape, and/or ruler;
- Environmental Equipment Log;
- Clipboard, pens, markers, pencils;
- Knife/scissors;
- Groundwater Gauging/Sampling Log;
- Waste Log;
- Rope/string;
- PVC bailer or submersible pump for purging;
- Disposable bailers (based on the size/number of wells to be sampled);
- If using low-flow sampling methods:
    - peristaltic pump and tubing (less than 30 feet);
    - electric submersible (Grunfos);
    - pneumatic (bladder pumps) for deeper wells.
- Water quality meter(s) and flow through cell (if using low-flow sampling methods);
- Laptop or other meter interface system (if using low-flow sampling methods);

- Buckets for purge water;
- Tools (pliers, drum wrench, well head wrench, key for locking well cap, hammer, screw driver, turkey baster);
- Water level indicator (or interface probe); and
- Drums/polytanks.

3.0 FIELD PROCEDURES

Gauging, purging and groundwater sampling typically occurs at least 24-48 hours after permanent wells have been developed, depending on the purpose and regulatory program. Temporary wells may or may not be subject to development procedures prior to sampling. Discuss with the Project Manager.

Appropriate PPE should be worn at all times and changed frequently to avoid cross contamination and to protect yourself from contaminants.

3.1 Gauging

- Fill out the Groundwater Gauging/Sampling Log (Appendix A).
- Lower the probe of the water level indicator (or interface probe) into well slowly until it indicates that water has been encountered.
- Record the water level as measured from the top of casing (TOC). Best from indicator mark or from north edge for consistent measurement level.
- Obtain the total depth measurement by lowering the probe to the bottom of the well and record the depth from TOC.
- Record information about the condition of the well. Indicate if well caps, locks, or pad require replacement.
- Decontaminate the water level indicator or interface probe between wells.

3.2 Purging

Purging can be performed by using a PVC bailer, disposable bailer, submersible pump, or a pump appropriate for low-flow methods per the following procedure:

- Sample wells in order of increasing contamination if practical unless otherwise stated by the project Work Plan or Project Manager.

- Calculate three well volumes after gauging and record on appropriate place on the gauging/sampling log (Appendix A).

- Remove water using either a bailer or a submersible pump until three well volumes have been removed or the well goes dry.

    - <u>Bailer</u> – Tie rope securely to the bailer. Lower the bailer <u>gently</u> into the well to avoid agitation that can cause volatilization of potential contaminants or turbidity issues. Retrieve the bailer when it is full of water.
    - <u>Submersible Pump</u> – Assemble pump per manufacturer's instructions and gently lower into well approximately center of screen or one foot off the bottom of the well.
    - <u>Low-Flow Methods</u> – See Section 3.4

- Place purge water into an on-site labeled drum.

- Record information on the Groundwater Gauging/Sampling Log (Appendix A).

3.3 Sampling Using a Disposable Bailer

- Remove a sample container from the cooler, affix a label, and in indelible, waterproof ink write the sample identification, the project name, the sample collection date and time, the type of sample in the container, and the sample collector's name/initials.

- Wearing disposable gloves, securely tie new string to the disposable bailer.

- Lower the bailer <u>gently</u> into the well to avoid agitation that can cause volatilization of potential contaminants or turbidity issues.

- Retrieve the bailer when it is full of water.

- The first sample collected will be for VOC's (if tested). Samples should be added to the containers such that no air space exists in the container. Add water until an inverted meniscus (bubble) is seen on top. Secure container cap. Invert the container and observe any air bubbles that may accumulate in the bottom of the container. If there are ANY air bubbles, add sample and reaffix the cap. Place containers in cooler on ice. Water containers typically arrive from the lab with a small amount of preservative in the bottom. Be careful not to overfill the container so the preservative is not lost. If the sample effervesces, call the laboratory for procedure.

- If testing for multiple constituents, the following order of sample collection should be observed. Although not all samples will be required on any given sampling trip, the order should remain consistent.

  - Volatile Organic Compounds (VOCs),
  - Semi-Volatile Organic Compounds (SVOCs),
  - Base/Neutral and Acid Compounds (BNAs),
  - Polychlorinated biphenyl compounds (PCBs),
  - Total Organic Carbon (TOC),
  - Total Organic Halides (TOX),
  - Biochemical Oxygen Demand (BOD5),
  - Fecal Coliform,
  - Oils,
  - Metals and Mineral (Totals),
  - Metals and Minerals (Dissolved),
  - Cyanides,
  - Chemical Oxygen Demand (COD), and
  - Radionuclides.

- Sample containers should then be stored on ice in a cooler until packaged/delivered to laboratory.

- Use new string and disposable bailer for each well to avoid cross-contamination.

- All samples, shipped or delivered, shall be accompanied by a Chain of Custody record. The Chain of Custody is required by law to track the possession of potentially hazardous materials. See SOG ENV0003 Sample Shipping for instructions on how to properly preserve, prepare, and transport the samples.

- Record pertinent information (generator, material stored, date) on drum label and affix to drums. Store drums on site until they are characterized and disposed of (must be <90 days).

3.4 Low Flow Purging and Sampling

Low flow purging and sampling is a method which is used to minimize stress (drawdown) to the groundwater/monitoring well system. In general, the advantages of low-flow purging and sampling include:

- Samples are more representative of the mobile load of contaminants present.
- Reduced disturbance of the water column in the monitoring well which reduces the amount of sampling artifacts.
- Reduced drawdown on the water-bearing formation.
- Less mixing of stagnant casing water with formation water.
- Reduced purge volume.

The general low flow purging/sampling procedure is as follows:

- Calibrate the low-flow sampling equipment sensor according to manufacturer's instructions daily prior to beginning work.
- Check the wellhead for damage or evidence of tampering, and record pertinent observations.
- Perform a water level measurements on all monitoring wells at the site. Follow the gauging procedures in Section 3.1.
- Purge/sample wells in order of increasing contamination, if practical, unless otherwise stated by the project Work Plan or Project Manager.
- Lower the water level indicator probe into the well until the air-water interface is reached. Measure and record the water level.
- Lower tubing or pumps slowly into the well with the intake at the midpoint of the saturated well screen length. Depending on the contaminants of concern, this may be adjusted to lower or upper third of the screen. Do not let the intake of the pump touch the bottom of the well. Skip this step if there is already a dedicated pump in the well.
- Connect the pump discharge tube to the flow-through cell. The discharge tube on the outflow side of the flow-through cell should be directed to a bucket or a 55-gallon drum.
- Place the water quality meters in the flow-through cell and attach the connections as needed to read real-time stabilization parameters.

- Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Flow rates of 100 to 500 mL/min are typical. Use a flow rate that does not form air pockets in the tubing.

- Monitor and record the water level and pumping rate every 1 to 5 minutes. Adjust the pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimum drawdown that can be achieved exceeds 0.3 feet, continue to purge until groundwater field parameters stabilize.

- Monitor the real-time output to assess when groundwater stabilization occurs. Typical stabilization parameters include pH, temperature, specific conductivity, dissolved oxygen and REDOX. Stabilization is achieved when three consecutive readings, taken at 3 to 5 minute intervals, are generally within the following limits unless the Work Plan states otherwise:

  - Dissolved oxygen: 10%
  - Specific conductivity: 3%
  - pH: +/- 0.2 unit
  - ORP: +/- 10 millivolts
  - Temp 0.5

- Once stabilization occurs, open the bypass valve on the upgradient side of the flow-through cell and collect the groundwater sample into the appropriate labeled containers. Water samples must be collected before water has passed through the flow-through cell.

- The first sample collected will be for VOC’s (if tested). Samples should be added to the containers such that no air space exists in the container. Add water until an inverted meniscus (bubble) is seen on top. Secure container cap. Invert the container and observe any air bubbles that may accumulate in the bottom of the container. If there are ANY air bubbles, add sample and reaffix the cap. Place containers in cooler on ice. Water containers typically arrive from the lab with a small amount of preservative in the bottom. Be careful not to overfill the container so the preservative is not lost. If the sample effervesces, call the laboratory for procedure.

- If testing for multiple constituents, the following order of sample collection should be observed. Although not all samples will be required on any given sampling trip, the order should remain consistent.

  - Volatile Organic Compounds (VOCs),
  - Semi-Volatile Organic Compounds (SVOCs),
  - Base/Neutral and Acid Compounds (BNAs),
  - Polychlorinated biphenyl compounds (PCBs),
  - Total Organic Carbon (TOC),
  - Total Organic Halides (TOX),
  - Biochemical Oxygen Demand (BOD5),
  - Fecal Coliform,
  - Oils,
  - Metals and Mineral (Totals),
  - Metals and Minerals (Dissolved),
  - Cyanides,
  - Chemical Oxygen Demand (COD), and
  - Radionuclides.

- Sample containers should then be stored on ice in a cooler until packaged/delivered to laboratory.

- All samples, shipped or delivered, shall be accompanied by a Chain of Custody record. The Chain of Custody is required by law to track the possession of potentially hazardous materials. See SOG ENV0003 Sample Shipping for instructions on how to properly preserve, prepare, and transport the samples.

- Before removing the tubing or pump, measure and record the water level in the well.

- Remove the pump, tubing and wiring from the well, and replace the well cover.

- Record pertinent information (generator, material stored, date) on drum label and affix to drums. Store drums on site until they are characterized and disposed of (<90 days).

3.5 Decontamination

Decontaminate probe, submersible pump, PVC bailer, and other non-dedicated equipment between wells. Contamination between samples can invalidate analytical information. To minimize this risk, sampling equipment should be cleaned thoroughly or discarded between sample collection points or sites.

A general order for cleaning sampling equipment is to:

- Wash with warm detergent solution.
- Rinse with potable water to remove detergent solution.
- Rinse with distilled water. The rinsate blank is collected into the appropriate container at this time (if applicable).
- Drain excess water.
- Allow to air-dry, dry with a stream of warm, dry air, or wipe dry.
- For samplers which have been used to sample petroleum products and oily residues, first wipe the samplers with absorbent cloth to eliminate the residues.

APPENDIX A

WELL GAUGING/WATER SAMPLING LOG

PAGE _____ OF _____

WELL GAUGING/WATER SAMPLING LOG

GEOTECHNOLOGY INC
FROM THE GROUND UP

JOB NO. ____________________

JOB NAME ____________________

SITE LOCATION ____________________

PERSONNEL ____________________

					A	B	C	D	E	F								
Well No.	Date	Time	Desc. Of Meas. pt	Dia. Of Casing (in.)	Depth to Water (ft.)	Total Depth (ft.)	Water Column (ft.)	Gallons Per Foot * (Gal/ft.)	Gallons in Well (1 Well Vol.)	Three Well Vols. (Gal.)	Purged Volume (Gal.)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	pH (SU)	Temp. (°C)	S.C. (S/m)	Remarks

***WELL CASING VOLUMES (GALLONS/FT.)**

1 1/4" = 0.06   2" = 0.16   3" = 0.37   4" = 0.65
8" = 2.59   1 1/2" = 0.09   2 1/2" = 0.26

FORMULAS

B - A = C   D * C = E
E x 3 = F

GEOTECHNOLOGY INC
FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0009

Hazardous/Special Waste Manifesting

March 2019

TABLE OF CONTENTS

APPENDICES

1.0 BACKGROUND

The definitions below are general and may deviate from those used in legislation associated with hazardous or special waste manifesting:

Designated Facility – a waste treatment, storage, or disposal facility (TSDF) which has received a permit from a regulatory authority.

Generator – any person/company whose act or process produces hazardous/special waste or whose act first causes a hazardous/special waste to become subject to regulation.

Hazardous Waste – a waste as defined in 40 CFR part 261 of RCRA. A waste is generally characterized as hazardous waste through analytical laboratory testing.

Manifest – a control and transport document that accompanies waste from its generation site to its treatment, storage, or disposal site.

RCRA – the Resource Conservation and Recovery Act, a body of federal legislation under which the EPA has established a national program to improve hazardous waste management by regulating hazardous wastes from "cradle to grave."

Special Waste – a waste that is not a regulated hazardous waste, but has physical or chemical characteristics that are different from municipal, demolition, construction and wood waste and which potentially requires special handling. A waste is generally characterized as special waste through analytical laboratory testing.

Transporter – a permitted person and company engaged in the off-site transportation of hazardous/special waste by air, rail, highway, or water.

The Manifest System*:*

Many regulatory agencies have adopted the manifest system to ensure that waste generated is designated for treatment, storage, or disposal, and arrives at TSDF. The requirements of the manifest system are intended to ensure that waste designated for delivery to an off-site TSDF reaches its destination. Thus, the manifest system serves as a self-enforcing mechanism that requires generators, transporters, and owner/operators of TSDFs to participate in an active waste tracking system.

The information contained on a manifest can help demonstrate that wastes have been handled in accordance with applicable regulations. A completed manifest provides:

- Detailed information on the types and amounts of hazardous/special waste shipped.
- A record of the firms or individuals involved in the shipment.

- Information on the storage, treatment or disposal of the waste(s) and confirmation that they reached their intended final destination.

In addition to tracking waste, the manifest often serves as a shipping document required by the Department of Transportation to accompany waste during transit.

Our Role in the Manifest System*:*
Geotechnology often represents clients who need to dispose of wastes. We can assist these clients with various generator requirements of the manifest system including:

- Characterizing waste
- Permitting waste for disposal
- Coordinating waste removal activities with transporters, designated facilities, and other contractors
- Completing the generator section of the manifest on behalf of the client
- Record keeping of waste removal, transport, and disposal activities

Representing generators in the waste manifest system has the potential to expand Geotechnology’s liability. Therefore care must be taken to properly adhere to applicable local, state, and federal regulations when manifesting hazardous/special waste.

2.0 PROCEDURES

2.1 Project Manager

The following items/information should be supplied by the Project Manager to the engineer/scientist:

- Project Name, Project Number, and Task Number;
- Copy of the project proposal (including information about time/money budgeted for field activities and possible extensions);
- Waste manifests and information about:
    - Generator, transporter, and disposal information, including USEPA and State ID numbers, if applicable;

  - U.S. DOT description from 49 CFR Part 172, including proper shipping name, hazard class, IO number, packaging group, and if shipment contains a reportable quantity of hazardous materials;
  - Type of containers, quantity, and EPA hazardous waste number;
  - Additional description of waste and handling codes;
  - Copy of disposal permit;
  - Special handling instructions; and
  - Whether or not to sign on behalf of the client (generator).

2.2 Engineer/Scientist

The engineer/scientist is responsible for observing waste removal activities, completing waste manifests, keeping a ledger of amount of waste removed, and obtaining additional waste manifests if needed. The following steps should be observed:

- Obtain information regarding waste removal activities from the parties involved including, equipment contractors, the transporter, the designated facility, and the client.
- Observe loading of wastes into the transporter's vehicle(s). Keep a log of amount of wastes leaving the site (see Appendix A).
- Complete the generator portions of the manifest for each shipment of hazardous/special waste. The engineer/scientist will need to make prior arrangements to have manifests ready for the transporter, or in some cases the transporter will provide manifests.
  - Each vehicle that leaves the site with hazardous/special waste must have a manifest.
  - If not already preprinted on the manifest, fill out the generators name, transporter, designated facility, description of the waste being transported, and the disposal permit number.
  - Sign and date for the generator. **NOTE:** In many cases Geotechnology employees should sign "on behalf" of the client. Communicate with the project manager to assess how or if to sign for the generator.
  - Manifests are generally in triplicate form with a copy for the generator, transporter, and designated facility. After completing the generator portions of the manifest, retain the generator copy and give the remaining forms to the transporter.

- Communicate with the Project Manager if the extent of the waste removal activities will be greater than initially budgeted, as soon as this is realized.

- Contact the transporter or designated facility following the waste removal activities to obtain copies of the complete manifests. The completed manifests will be signed by the generator, transporter(s), and the designated facility.

- Completed manifests and manifest log should be delivered to the Project Manager for record keeping.

APPENDIX A

MANIFEST DAILY LOG

MANIFEST DAILY FIELD LOG

Site: ____________________

Job #: ____________________

Date: ____________________

Representative(s): ____________________

Trucking Company(Abbrev): ____________________

Disposal Location: ____________________

Manifest Number	Truck Number - Trucking Co. Abbrev	Time Off-Site (approx)	Truck Size (cu yds, approx)	Tonnage (from landfill)

GEOTECHNOLOGY INC
FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0012

Field Log Book Use

March 2019

TABLE OF CONTENTS

Page

1.0 PURPOSE

The purpose of this guideline is to establish minimum requirements for the development, content, use, review, protection, and filing of field log books.

2.0 REFERENCES AND DEFINITIONS

2.1 References

- Site/Project specific Quality Assurance Program (QAP), Sampling and Analysis Plan (SAP), Work Plans or other appropriate documents.

- Geotechnology administrative procedures.

2.2 Definitions

Field log book
A bound log book with sequential numbered pages that is used to create a permanent, real-time record of activities and conditions, significant events, observations, and measurements which occur during each day of field activities. The minimum requirements for a log book are described in Section 5.

Log book type
Identification of log books will be by purpose or area of coverage. Examples include project, field manager/representative, soil sampling, groundwater sampling, well installation, well development, soil boring, calibration, decontamination, and health and safety.

Quality Control (QC) Review
The act of verifying the accuracy, completeness, legibility, consistency, and clarity of a field log book.

3.0 GENERAL

This procedure is written to include multiple functional positions; however, if the same person fills multiple positions, the coordination steps noted in the procedure are consolidated.

- Field log books will be bound with sequentially numbered pages. It is recommended that field log books include a table of contents, if applicable.

- The Project Manager will control the issue and use of log books.

- Field log books will be identified by a project name or number, by log book type (see 3.2.2), and if there is more than one log book for a project, by sequential number.

- Log book entries will be made in indelible ink, and will be clear, objective and legible.

- Changes to log book entries will be made by striking through the original entry in a manner which does not obliterate the original entry, and providing the initials of the person making the change and date the change was made.

- Dates will be recorded in the month/day/year format. Time will be recorded in the 24-hour (military) clock format (e.g., 1500 hours rather than 3:00 p.m.).

- The log book user will indicate unused portions of completed log book pages and completed log books in a positive, clearly recognizable manner. Typical methods include:

    - drawing a line through the unused area(s) and providing the initials of the person making the entry and date the entry was made.
    - writing a notation such as “INTENTIONALLY LEFT BLANK" and providing the initials of the person making the entry and date the entry was made.

- Log books will be copied on a frequency established by the Project Manager. The frequency will be appropriate to the risk of loss of the data contained in the log books. In addition, client requirements regarding log book copying and protection will be followed.

- It is recommended that log books not be shipped to and from the field; however, if needed, copies can be made to protect the data from loss.

- The types of entries and level of detail must comply with applicable laws, regulations and any client-specified requirements, as well as being consistent with the information requirements necessary for writing the report(s) for the project.

- The QC reviewer will be a person with a level of experience and knowledge comparative to the field team.

- QC review will be completed on a schedule decided by the Project Manager.

4.0 INSTRUCTION

4.1 Log Book Development

The Project Manager assesses the log book requirements for the project, including the types of entries required, number of log books needed, and the extent of use of pre-printed forms. Where pre-printed forms are used, they are considered project records and are to be treated as such and are either selected from existing examples or developed specifically for the project.

4.2 Log Book Control

- The Project Manager (or assigned personnel) will prepare the log book(s) for use by inscribing each log book with the identifying information.

- The Project Manager (or assigned personnel) will take control of the log book(s) and verify that the type and content meets the project requirements.

4.3 Log Book QC

- On the schedule established by the Project Manager, the QC reviewer checks each log book used is reviewed to verify the accuracy, completeness, legibility, consistency, and clarity of the log book.

- The QC reviewer indicates acceptance of the log book entries by writing their initials at the bottom of each page and writing in the date reviewed or other approved notification.

- If errors, omissions, or uncertainties are found, the QC Reviewer resolves them with the person responsible for making entries on that day in the log book. Corrections to any log book entries are made by striking through the original entry and providing the initials of the person making the change and date the change was made.

5.0 RECORDS

Log books and/or log book copies will be processed into the Geotechnology records system in accordance with administrative procedures and policies.

APPENDIX B

Previous PCB Concrete Sampling Locations

(b) (7)(F)

[redacted]

NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

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Legend

🟧	Core sample location (PCB)
▲	Dust sample location (Lead, Mercury)
DISA	Defense Information Systems Agency
PCB	Polychlorinated biphenyl

N

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 5B

Sample Location Map, Building 103 ABC - First Floor

TETRA TECH

(b) (7)(F)

[redacted]

NOTES

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Legend

- 🟧 Core sample location (PCB)
- ● Surface soil sample location (Lead, Mercury, Asbestos, SVOC)

PCB Polychlorinated biphenyl
SVOC Semi-volatile organic compounds

N

NOT TO SCALE

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4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 5C

Sample Location Map, Building 103 ABC - Basement

TETRA TECH

(b) (7)(F)

[redacted]

NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

- 🟧 Core sample location (PCB)
- △ Dust sample location (Lead, Mercury)
- ● Crawl space surface soil sample location (Lead, Asbestos, Mercury)
- PPE Personal protective equipment
- PCB Polychlorinated biphenyl

Source: General Services Administration, CAD Files, Received November 2011.

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Note: Crawlspace typically very damp;
PPE needed includes boot covers,
hard hat, eye protection, gloves

N

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St. Louis, Missouri

Figure 8

Sample Location Map, Building 103 F - First Floor

TETRA TECH

Date: 6/4/2013 Drawn By: Nick Wiederholt Project No: S1058.232.001

(b) (7)(F)

[redacted]

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧 Core sample location (PCB)

● Surface soil sample location (Lead, Asbestos)

PCB Polychlorinated biphenyl

N

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4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 9C (1 of 2)

Sample Location Map, Building 104 ABCD - Basement

TETRA TECH

Date: 6/4/2013 Drawn By: Nick Wiederholt Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

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Legend

🟧	Core sample location (PCB)
●	Surface soil sample location (Lead, Asbestos)
PCB	Polychlorinated biphenyl

Source: General Services Administration, CAD Files, Received November 2011.

NOT TO SCALE

NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

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St. Louis, Missouri

Figure 9C (2 of 2)

Sample Location Map, Building 104 ABCD - Basement

TETRA TECH

Date: 6/4/2013 Drawn By: Nick Wiederholt Project No: S1058.232.001

(b) (7)(F)

[redacted]

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

- ● Surface soil sample location (Lead, Asbestos)
- 🟧 Core sample location (PCB)
- PCB Polychlorinated biphenyl

N

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St. Louis, Missouri

Figure 12C (1 of 2)

Sample Location Map, Building 105 ABCD - Basement

TETRA TECH

Date: 6/3/2013 Drawn By: Nick Wiederholt Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

● Surface soil sample location (Lead, Asbestos)
🟧 Core sample location (PCB)
PCB Polychlorinated biphenyl

N

NOT TO SCALE

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Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 12C (2 of 2)

Sample Location Map, Building 105 ABCD - Basement

TETRA TECH

Date: 6/3/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧 Core sample location (PCB)

PCB Polychlorinated biphenyl

N

NOT TO SCALE

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St. Louis, Missouri

Figure 15

Sample Location Map, Building 105 L - First Floor

TETRA TECH

Date: 6/4/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

(b) (7)(F)

[redacted]

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NOTES

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Legend

🟧 Core sample location (PCB)

● Surface soil sample location (Asbestos)

PCB Polychlorinated biphenyl

NOT TO SCALE

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4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 16

Sample Location Map, Building 107 - Basement

TETRA TECH

Date: 6/4/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

(b) (7)(F)

[redacted]

Legend

🟧 Core sample location (PCB)

PCB Polychlorinated biphenyl

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

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4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 17
Sample Location Map, Building 108 A - First Floor

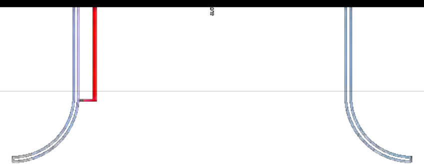
TETRA TECH

Date: 6/4/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

(b) (7)(F)

[redacted]



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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧 Core sample location (PCB)

△ Dust sample location (Lead)

PCB Polychlorinated biphenyl

N

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 19C

Sample Location Map, Building 110 - Basement

TETRA TECH

Date: 6/4/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

APPENDIX C

Sampling Summary

TABLE 3
SAMPLING SUMMARY
GOODFELLOW FEDERAL COMPLEX
REMEDIAL INVESTIGATION WORK PLAN

Monitoring Wells and Groundwater Sampling

Sample IDs	Sample Type	ID Notes	Sample Notes	Analysis	Containers	Preservation	Hold Time
MW-# MM/YY EB	Monitoring Well Installation Equipment Blank	# = Well ID(next well)	1/day during monitoring well installation.	VOCs	2, 40-mL VOA vials	TSP, pH > 11	14 days
		MM = 2-digit month	Collect as auger rinsate blank during drilling.	PAHs	1, 125-mL glass	Unpreserved	7 days
		YY = 2-digit year		PCBs	1, 1000-mL glass	Unpreserved	7 days
				Targeted Metals (Total)	1, 250-mL plastic or glass	HNO3, pH < 2	180 days
MW-# MM/YY EB	Groundwater Sampling Equipment Blank	# = Well ID(next well)	1/day during monitoring well installation.	VOCs	2, 40-mL VOA vials	TSP, pH > 11	14 days
		MM = 2-digit month	Collect as rinsate blank on decontaminated equipment.	PAHs	1, 125-mL glass	Unpreserved	7 days
		YY = 2-digit year		PCBs	1, 1000-mL glass	Unpreserved	7 days
				Targeted Metals (Total)	1, 250-mL plastic or glass	HNO3, pH < 2	180 days
MW-# MM/YY	Groundwater Sample	# = Well ID		VOCs	2, 40-mL VOA vials	TSP, pH > 11	14 days
		MM = 2-digit month		PAHs	1, 125-mL glass	Unpreserved	7 days
		YY = 2-digit year		PCBs	1, 1000-mL glass	Unpreserved	7 days
				Explosives	1, 1 qrt amber container	Unpreserved	7 days
				TPH DRO/GRO/total	1, 125 mL glass, 2, 40 mL/ 1	Unpreserved/TSP/H204	14 days
				Targeted Metals (Total)	1, 250-mL plastic or glass	HNO3, pH < 2	180 days
			Dissolved metals analysis at 20% of wells (Dissolved metals samples to be lab filtered).	Targeted Metals (Dissolved)	1, 250-mL plastic or glass	Unpreserved	180 days
MW-# MM/YY D	Groundwater Duplicate Sample	# = Well ID	Collect duplicates for 5% of wells	VOCs	2, 40-mL VOA vials	TSP, pH > 11	14 days
		MM = 2-digit month	(1 duplicate per 20 wells)	PAHs	1, 125-mL glass	Unpreserved	7 days
		YY = 2-digit year	**BLIND TO LAB:** GW Dup 1, 2…	PCBs	1, 1000-mL glass	Unpreserved	7 days
				Targeted Metals (Total)	1, 250-mL plastic or glass	HNO3, pH < 2	180 days

Soil Borings and Soil Sampling

Sample IDs	Sample Type	ID Notes	Sample Notes	Analysis	Containers	Preservation	Hold Time
B-# EB	Soil Boring Equipment Blank	# = Boring ID	1/day during soil boring activities.	VOCs	2, 40-mL VOA vials (5035)	TSP, pH > 11	14 days
			Collect as rinsate blank on decontaminated equipment.	PAHs	1, 125-mL glass	Unpreserved	7 days
				PCBs	1, 1000-mL glass	Unpreserved	7 days
				Targeted Metals	1, 250-mL plastic or glass	HNO3, pH < 2	180 days
B-# TD-BD B-# TD-BD D	Surficial Soil Sample Duplicate Surficial Soil Sample	# = Boring ID	Surficial soil is 0-2 feet below land surface.	PAHs	1, 8-oz wide-mouth glass	Unpreserved	14 days
		TD = Top of Sample Depth	Collect duplicates for 5% of samples	PCBs	1, 8-oz wide-mouth glass	Unpreserved	14 days
		BD = Bottom of Sample Depth	(1 duplicate per 20 samples)	Targeted Metals	1, 8-oz wide-mouth glass	Unpreserved	180 days
				TPH DRO/GRO/total	2, 8-oz wide-mouth glass, One 4 oz. glass jar; 1 MeOH vial and 2 TSP vials	Unpreserved/ meOH/TSP	14 days
				Explosives	1, 4 oz wide-mouth glass container	Unpreserved	14 days
				VOCs	2, 40-mL VOA vials (5035)	TSP, pH > 11	14 days
			BLIND TO LAB: Surf Soil Dup 1, 2…				
			PCB Congener analysis at 10% of samples	PCB Congeners	1, 8-oz amber glass	Unpreserved	365 days
B-# TD-BD	Surficial Soil Sample (VOCs)		targeted locations and If PID reading exceeds 50 ppm, analyze VOCs.	VOCs	2, 40-mL VOA vials (5035)	TSP, pH > 11	14 days
B-# TD-BD B-# TD-BD D	Subsurface Soil Sample Duplicate Subsurface Soil Sample	# = Boring ID	Subsurface soil is 2-10 feet below land surface.	PAHs	1, 8-oz wide-mouth glass	Unpreserved	14 days
		TD = Top of Sample Depth	Collect duplicates for 5% of samples	PCBs	1, 8-oz wide-mouth glass	Unpreserved	14 days
		BD = Bottom of Sample Depth	(1 duplicate per 20 samples)	Targeted Metals	1, 8-oz wide-mouth glass	Unpreserved	180 days
				Explosives	1, 4 oz wide-mouth glass container	Unpreserved	14 days
				TPH DRO/GRO/total	2, 8-oz wide-mouth glass, One 4 oz. glass jar; 1 MeOH vial and 2 TSP vials	Unpreserved/ meOH/TSP	14 days
			BLIND TO LAB: Sub Soil Dup 1, 2…				

TABLE 3
SAMPLING SUMMARY
GOODFELLOW FEDERAL COMPLEX
REMEDIAL INVESTIGATION WORK PLAN

Sample IDs	Sample Type	ID Notes	Sample Notes	Analysis	Containers	Preservation	Hold Time
B-# TD-BD	Subsurface Soil Sample (VOCs)		targeted locations and If PID reading exceeds 50 ppm, analyze VOCs.	VOCs	2, 40-mL VOA vials (5035)	TSP, pH > 11	14 days

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Submit one TRIP BLANK per cooler of VOC analysis. Name each sample "Trip Blank MM/DD/YYYY"
Preservation Note: Store samples on ice at temperatures above freezing and not to exceed 6 degrees Celsius.
Equipment blanks are collected after decontamination and prior to initiating the next exploration activity. Equipment blanks are named for the sampling location that follows the decontamination activities.

VOCs = Volatile organic compounds
PAHs = Polycyclic aromatic hydrocarbons (EPA list of 16 compounds)
PCBs = Polychlorinated biphenyls
Targeted Metals = Five metals (Sb, As, Cu, Pb, Zn)

FINAL QUALITY ASSURANCE PROJECT PLAN

GOODFELLOW FEDERAL COMPLEX
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MISSOURI (MO0602AF)
CONTRACT NUMBER: GS-06P-15-GZ-D-7000
WORK ORDER NUMBER 29

Prepared for:

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GENERAL SERVICES ADMINISTRATION
PUBLIC BUILDINGS SERVICE
2300 MAIN STREET, 7TH FLOOR
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1 ALBY STREET
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And:

GEOTECHNOLOGY, INC.
11816 LACKLAND ROAD, SUITE 150
ST. LOUIS, MISSOURI

Date:

FEBRUARY 9, 2021

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EXECUTIVE SUMMARY

This Quality Assurance Project Plan (QAPP) provides a description of the sampling and testing to be conducted under the Remedial Investigation Work Plan (RIWP) for the Goodfellow Federal Complex (GFC) in St. Louis, Missouri (Site – Figures 1 and 2). This QAPP was prepared in accordance with the Intergovernmental Data Quality Task Force's Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP).

This QAPP was prepared using the streamlined worksheet system put forth in Part 2A of the UFP-QAPP. Supplemental information is provided in the attached figures, tables, and appendices. This QAPP is prepared as a stand-alone guide to the processes that will be conducted under the RIWP; however, the content in the RIWP and the Field Sampling Plan (FSP) provides additional information including a history of the GFC and a narrative description of sampling processes.

QAPP Worksheet #1 & 2: Title and Approval Page
(UFP-QAPP Manual Section 2.1)
(EPA 2106-G-05 Section 2.2.1)

Quality Assurance Project Plan
Goodfellow Federal Complex
4300 Goodfellow Boulevard
St. Louis, Missouri (MO0602AF)
Contract Number: GS-06P-15-GZ-D-7000
Work Order Number 29

(b) (6) GSA Project Manager

(b) (6) Etegra Project Manager

(b) (6) Geotechnology Project Manager

(b) (6) Geotechnology Quality Manager

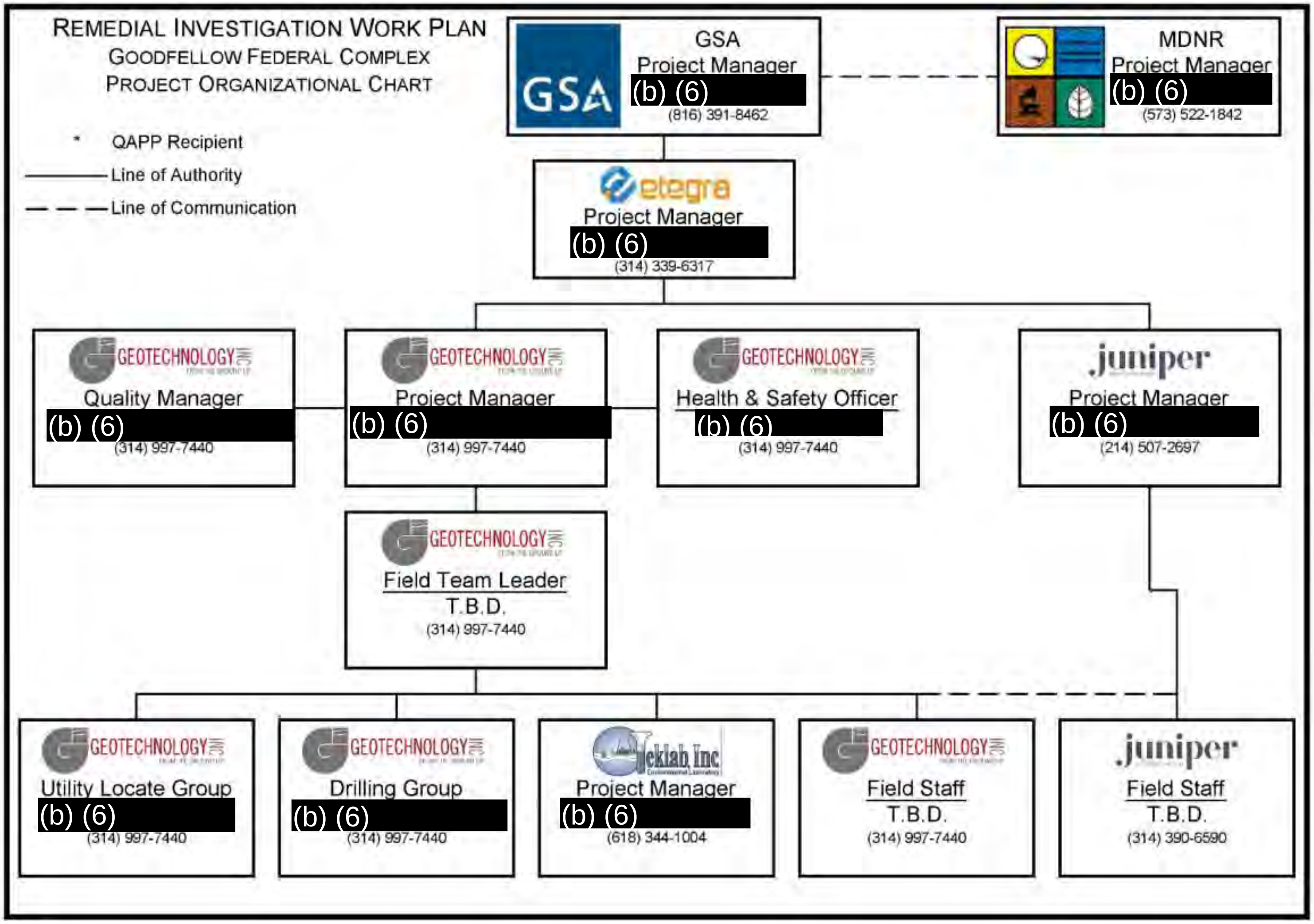
(b) (6) Juniper Project Manager

(b) (6) Teklab Project Manager

(b) (6) MDNR Project Manager

*Signatures indicate personnel have read and agree to implement this QAPP as written.

QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution
(UFP-QAPP Manual Sections 2.3 and 2.4)
(EPA 2106-G-05 Sections 2.2.3 and 2.2.4)



QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet

(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)

(EPA 2106-G-05 Sections 2.2.1 and 2.2.7)

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications
(b) (6)	Geotechnology Project Manager	B.S. Geology Eastern Illinois University M.S. Geology/Hydrogeology University of Georgia / 29 Years Environmental Consulting	Missouri Registered Geologist
[redacted]	Geotechnology Quality Manager	B.S. Geology University of Illinois at Champaign-Urbana / 27 Years Environmental Consulting	Missouri Registered Geologist
[redacted]	Juniper Risk Assessment Project Manager	B.S. Geology Texas A&M University / 28 Years Environmental Consulting	Texas Professional Geoscientist
[redacted]	Teklab Laboratory Project Manager	B.S. Earth Science Rice University M.S. Paleoceanography Brown University 7 years analytical laboratory experience	

Signatures are provided on Worksheets #1 & #2 of this document.

QAPP Worksheet #6: Communication Pathways
(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Regulatory agency interface	MDNR – Federal Facilities Section	(b) (6) [redacted]	(573) 522-1842	Conducted through or approved by the GSA Project Manager. Documentation to include emails, letters, or minutes of verbal communications.
Field progress reports	Geotechnology	[redacted]	(314) 997-7440	Email reports provided to the GSA Project Manager periodically during field activities, including at the start and end of each activity.
Stop work due to safety issues	Geotechnology	[redacted]	(314) 997-7440	Immediate communication to all members of the field team, Geotechnology Project Manager and Health & Safety Officer, and the GSA Project Manager. Document events in an incident report.
QAPP changes prior to field work	Geotechnology	[redacted]	(314) 997-7440	QAPP changes to be noted in an addendum distributed to the QAPP distribution list (Worksheets 4, 7, & 8).
QAPP changes during project execution	Geotechnology	[redacted]	(314) 997-7440	
Field corrective actions	Geotechnology	[redacted]	(314) 997-7440	Email report provided to affected members of the field team, Geotechnology Project Manager and Quality Manager.

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Sample receipt variances	Teklab	(b) (6) [redacted]	(618) 344-1004	Include in the sample receipt summary submitted to the Geotechnology Project Manager. Notify the field team leader and affected field team members.
Laboratory quality control variances	Teklab	[redacted]	(618) 344-1004	Include in the laboratory analytical report and the analytical data package submitted to the Geotechnology Project Manager.
Analytical corrective actions	Teklab	[redacted]	(618) 344-1004	Include in the laboratory analytical report and the analytical data package submitted to the Geotechnology Project Manager.
Data verification issues, e.g., incomplete records	Geotechnology	[redacted]	(314) 997-7440	Document in the Data Verification Summary to be included in the Remedial Investigation Report.
Data validation issues, e.g., non-compliance with procedures	Geotechnology	[redacted]	(314) 997-7440	Document in the Data Validation Summary to be included in the Remedial Investigation Report.
Data review corrective actions	Geotechnology	[redacted]	(314) 997-7440	Document in the Data Verification/Validation Summary to be included in the Remedial Investigation Report.

Note: In addition to the communication procedures described herein, corrective actions and variances will be described in the Remedial Investigation Report.

QAPP Worksheet #9: Project Planning Session Summary
(UFP-QAPP Manual Section 2.5.1 and Figures 9-12)
(EPA 2106-G-05 Section 2.2.5)

Minutes from important project planning sessions are provided in Appendix D.

QAPP Worksheet #10: Conceptual Site Model
(UFP-QAPP Manual Section 2.5.2)
(EPA 2106-G-05 Section 2.2.5)

10.1 Background Information

The Goodfellow Federal Complex (GFC) is approximately 64 acres and occupies a portion of the former St. Louis Ordnance Plant (SLOP) near the western boundary of the City of St. Louis, Missouri. The GFC is developed with buildings, utility tunnels, and a combined stormwater and sanitary sewer collection system.

10.1.1 Installation History

Construction of the SLOP began in January 1941 and was completed in May 1942. The St. Louis Ordnance Plant was the largest small-arms ammunition installation in the world and embodied three operating divisions. The GFC was known as Plant No. 1 and is located on the east side of Goodfellow Boulevard. The facility, a Government-Owned/Contractor Operated (GOCO) plant, produced small arms ammunition (.30 caliber and .50 caliber) and components for the 105-mm shells. Possible contaminants related to previous Site activities could include heavy metals such as lead, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), petroleum hydrocarbons, explosives, inorganics, and polychlorinated biphenyls (PCBs).

10.1.2 Physical Setting

The GFC is on the northern flank of the Ozark Plateau in the Dissected Till Plains Physiographic Province, which is characterized by gently rolling hills (Miller et al. 1974). From Goodfellow Boulevard, the Site generally slopes eastward toward the Mississippi River; the northernmost portion of the Site slopes more northeasterly, and the southernmost portion of the Site slopes more southeasterly.

The Mississippi River is approximately 2.5 miles east of the Site. Although drainage from the Site generally follows the topographic gradient toward the Mississippi River, surface water that leaves the Site is directed through the combined storm/sanitary sewers and a wastewater treatment facility before discharging into the Mississippi River (SCS Engineers [SCS] 2008). Based on the general topographic gradient, groundwater beneath the Site flows easterly toward the Mississippi River.

Ground surface at the Site is covered by fill, streets, parking lots, buildings, and other structures. Site surface soils are identified as Urban Land-Upland with 0- to 5-percent slopes (U.S. Department of Agriculture [USDA] 1979). The Urban Land designation applies to areas where structures, asphalt, concrete, and other impervious materials cover over 85 percent of the Site. Subsurface investigations at the Site have identified soils below the fill as predominantly silty clay or silty clay loam (Geotechnology, Inc. 2006; SCS 2008).

The climate in St. Louis County is characterized by cold winters, hot summers, and heavy rains in the spring and early summer (USDA 1979). Prevailing wind is from the south. Average annual temperature in St. Louis, Missouri, is 56°F, with monthly average temperatures ranging from 30°F in January to 79°F in July. Average annual precipitation is 37.1 inches, and average annual snowfall is approximately 19.8 inches (Weatherbase 2012).

10.2 Conceptual Site Model

A conceptual site model, or CSM, is a commonly-used tool for summarizing how potential contaminants are associated with sources, how they are released into the environment, and how receptors are exposed. This CSM considers exposures from across the site in the areas outside of the buildings.

10.2.1 Sources of Contamination

The sources of contamination include ammunition production and the general operation of the facility (e.g., fuel storage, transformers).

10.2.2 Primary Release Mechanism

The primary release mechanism is miscellaneous leaks and spills during the production of the ammunition and commercial operations since the ammunition production was ended.

10.2.3 Secondary Contaminant Migration

The secondary contaminant migration is through the soil column into the groundwater, volatilization of chemicals in the groundwater or soil, and mobilization of surface particulates.

10.2.4 Affected Media

Affected media are surface soil, subsurface soil, and groundwater.

10.2.5 Potential Receptors and Exposure Pathways

Potential receptors include hypothetical future residents, commercial/industrial workers, construction workers and trench workers. Potential receptors and pathways are illustrated on Figure 5 in the RWP.

10.2.6 Current and Future Land Use

Currently, the area is used for commercial businesses and the only current exposure scenarios are commercial and construction workers. The Site is fenced with 24-hour controlled site access. Approximately 80% of the Site is paved or has commercial buildings. The City of St. Louis Ordinance 66777 (https://www.stlouis-mo.gov/internal-apps/legislative/upload/Ordinances/ BOAPdf/66777x00.pdf) prohibits the use of groundwater as drinking water and also prohibits the drilling or installation of wells for potable water supply within the corporate limits of the City of St. Louis. Future land use will likely be commercial/industrial use.

QAPP Worksheet #11: Project/Data Quality Objectives
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

The following Data Quality Objective (DQO) selection process is based on the USEPA's 7-step DQO process.

1. Problem Statement. Potential impacts at the Site are present due to historic site activities associated with the former ordnance plant supporting World War II. In the 1960s and 1970s, the GSA converted to use as an office complex. Activities associated with tenants could have contributed to environmental impacts. Past site characterization activities have not defined the vertical and horizontal extent of the impacts to the extent necessary to assess human health risk associated with exposures to soil and groundwater. Available analytical data of sufficient quality will be supplemented by additional data collection to support a human health risk assessment as part of a Remedial Investigation and potentially property transfer.

2. Goals of the Study. The nature and extent of the contamination in soil and groundwater will be determined vertically and horizontally. Soil and groundwater data will be used to assess risk to the potential human exposure scenarios including hypothetical residential, current and future commercial/industrial workers and future construction workers. Chemicals of potential concern (COPCs) will be defined by the use of residential risk-based criteria (based on a risk level of 10-6 and hazard of 0.1). Nature and extent of COPCs in soil and groundwater will be determined using risk-based criteria (residential and commercial) and anthropogenic/background information for inorganics (metals) and Polycyclic Aromatic Hydrocarbons (PAHs).

   The primary sampling objective is to collect sufficient data to assess risk to the potential human exposure scenarios listed in Table 3 in Appendix D of the Risk Assessment Work Plan (RAWP). Potential exposure pathways, which are part of the CSM, are shown on Figure 5.

3. Information Inputs. Required information inputs will include:

   a. Analytical data for groundwater, surficial soil, subsurface soil, and crawlspace soil (previous testing only) to assess the nature and extent of impacts,

   b. Quality control data collected to assess the quality of the analytical data,

   c. A review of potential release mechanisms associated with past activities.

   d. Site geology and hydrology information collected during site characterization activities to support contaminant fate and transport and risk assessment, and

   e. Elevation information collected by a Missouri Professional Land Surveyor to support contaminant fate and transport and risk assessment.

4. Boundaries of the Study. The target receptors for this study will include current and future occupants of the GFC as well as including hypothetical residential, current and future commercial/industrial workers and future construction workers. COPCs will be defined as detections that exceed residential risk-based screening levels (10-6/0.1). Representative statistics will be developed if more than 50% of the samples are detections in an exposure area. The physical boundaries of the study will be the physical boundaries of the GFC depicted on Figures 1 and 2. Outdoor soils will be divided into surficial soils [0 to 2 feet below land surface (bls)] and subsurface soils (2-10 feet bls). Groundwater will be assessed in the uppermost aquifer encountered. Future quarterly groundwater monitoring is anticipated and will be coordinated with MDNR representatives..

5. Analytic Approach. Sampling locations are generally selected based on a gridded approach and refined using historic site data. The COPCs are described in the Sampling Design and Rationale (Worksheet #17). If analytical results exceed the risk-based screening levels based on residential and commercial exposure parameters and anthropogenic levels and professional judgement indicates that there is an unacceptable amount of uncertainty in the definition of the boundary of the COPCs, additional sampling will be performed to assess the extent of impacts. Performance or Acceptance Criteria. The analytical laboratory data package will satisfy a QA level 3. Data validation procedures will be in accordance with USEPA guidance. Data verification, data validation, and data usability assessments will be conducted in accordance with Worksheets #34 through #37 of this QAPP. Exposure point concentrations will be calculated using standard statistical methods if there are over 50% detections of a COPC in an exposure area. It is possible that contamination may exist that will not be defined based on the sampling design, but with the use of process knowledge (DOD and tenants), review of previously collected samples and the sampling design, it is unlikely that nature and extent of potential contamination will not be define across the facility.

6. Detailed Plan for Obtaining Data. The basis for the sampling design is provided in Worksheet #17. Worksheets #19, 20, 24-28, and 30 specify analysis design requirements. The sampling design will meet the performance criteria by the following:

    a. The QAPP and the associated Workplan includes the analytical methods to be used and the decision levels for each parameter being tested to obtain the desired cleanup objective. An accredited laboratory will prepare the samples and perform the analysis.

b. The proposed soil investigation and sample collection will be conducted in accordance with pertinent USEPA guidance. This includes, but is not limited to sample collection and analysis, decontamination procedures, and other QA/QC testing.
c. Systematic and grid sampling will be used to search for hot spots and to infer means, percentiles, or other parameters and will also be useful for estimating spatial patterns or trends over time (quarterly groundwater sampling). This design provides a practical and easy method for designating sample locations and ensures uniform coverage of the Site.
d. Exposure point concentrations will be calculated using standard statistical methods if there are over 50% detections of a COPC in an exposure area.
e. A sufficient number of samples for robust statistical analysis will be obtained (samples from at least 8 different locations so that a 95% UCL can be calculated, when possible).
f. To minimize measurement error, the following procedures will be utilized:
    1. Collect the samples in a standardized manner;
    2. Label each sample and transport it to the laboratory under chain-of- custody.
    3. Specify that the laboratory use accepted USEPA Methods and report the data using the proper unit;
    4. Specify that the laboratory participates in regular performance testing and is certified.
    5. Receive the analytical data from the laboratory in an electronic format to minimize transcription errors;
    6. Perform a quantitative and qualitative review (data validation) of the analytical data to verify the reliability of the data. Any qualified data need to be assessed for usability.
g. To minimize the sampling error, the following procedures will be employed:
    1. Utilize discrete sampling procedures to obtain representative confirmation samples; and
    2. Obtain a sufficient number of samples for robust statistical analysis (samples from at least 8 different locations so that a mean versus the 95% UCL can be calculated).
h. If analytical results exceed the risk-based screening levels based on residential and commercial exposure parameters and anthropogenic levels and professional judgement indicates that there is an unacceptable amount of uncertainty in the definition of the boundary of the COPCs, additional sampling will be performed to assess the extent of impacts.

QAPP Worksheet #12: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Data Quality Indicator (DQI)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria (MPC)
Overall Precision	Field Blind Duplicates (Field)	RPD ≤ 30% when analytes are detected in both samples ≥ sample-specific LOQ
Analytical Precision (laboratory)	Laboratory Control Sample Duplicates (Laboratory)	RPD ≤ 25%
Analytical Accuracy/Bias (laboratory)	Laboratory Control Samples (Laboratory)	Analyte-specific (See analytical SOP)
Analytical Accuracy/Bias (matrix interference)	Matrix Spike Duplicates (Laboratory)	Analyte-specific (See analytical SOP)
Overall accuracy/bias (contamination)	Equipment Blanks (Field)	No target analyte concentrations ≥ 1/2 LOQ
Overall accuracy/bias (contamination)	Trip Blanks (Laboratory/Field)	No target analyte concentrations ≥ 1/2 LOQ
Sensitivity	LOQ verification sample (spiked at LOQ) (Laboratory)	Recovery within ±25% of LOQ
Completeness	See Worksheet #34	See Worksheet #34

Reference: EPA National Functional Guidelines (NFGs) 2017
Existing data screened against method quality objectives, collection methods, aliquot sizes (ISM, if used), depths, and compositing methodology.

RPD = Relative Percent Difference
SOP = Standard Operating Procedure
LOQ = Limit of Quantitation

QAPP Worksheet #13: Secondary Data Uses and Limitations
(UFP-QAPP Manual Section 2.7)
(EPA 2106-G-05 Chapter 3: QAPP Elements For Evaluating Existing Data)

Data type	Source	Data Uses Relative to Current Project	Factors Affecting the Reliability of Data and Limitations on Data Use
Topographic	USGS	General topography	None known.
Background concentrations of metals in soil	URS, May 2004, *Site-Specific Environmental Baseline Survey, St. Louis Army Ammunition Plant, St. Louis, Missouri.*	Metals and PAH background values to inform risk assessment. Arsenic value will additionally be used for screening soil concentrations.	None known.
Past site uses	Historic reports, historical aerial photographs, and personnel interviews	Potential contaminants of concern	Incomplete record keeping practices during World War II.
Historic analytical data	Various – See RIWP Section 2.0	Analytical site data	Age of data and inconsistent QA/QC procedures during data collection.
Historic geotechnical data	Geotechnology, Inc., March 2010, *Subsurface Exploration, Proposed Cooling Tower, Federal Records Center, St. Louis, Missouri,* J017062.01. Geotechnology, Inc., June 2010, *Basement Subgrade Evaluation, Building 110, Federal Records Center, St. Louis, Missouri,* J017062.02.	Site-specific soil geotechnical information	Limited data collected (total of five boring locations)

QAPP Worksheet #14 & 16: Project Tasks & Schedule
(UFP-QAPP Manual Section 2.8.2)
(EPA 2106-G-05 Section 2.2.4)

Activity	Responsible Party	Planned Start date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Mobilization	Geotechnology	2021	1 day duration	Field notes	5 days after completion
Monitoring Well Installation	Geotechnology	1 day after Mobilization	14 days duration	Field notes	5 days after completion
Monitoring Well Development & Sampling	Geotechnology	1 day after Monitoring Well Installation	10 days duration	Field notes	5 days after completion
Soil Boring Installation & Sampling	Geotechnology	1 day after Monitoring Well Installation	45 days duration	Field notes	5 days after completion
Sample Analysis	Teklab	Upon receipt of samples – daily courier pickup	14 days after receipt of last sample	Report of Analyses/Data package	28 days after receipt of last sample
Validation	Geotechnology (subconsultant)	Upon receipt of data package	30 days duration	Validation Summary	30 days after receipt of data package
Usability Assessment	Geotechnology	Upon completion of Validation Summary	30 days duration	Usability Assessment Summary	60 days after receipt of data package
Summarize Data	Geotechnology	Upon completion of Usability Assessment	60 days duration	Draft RI Report	120 days after receipt of data package

Activity	Responsible Party	Planned Start date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Human Health Risk Assessment	Juniper	Upon completion of data summary	60 days duration	Draft Human Health Risk Assessment	180 days after receipt of data package

QAPP Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantifation Limits
(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(EPA 2106-G-05 Section 2.2.6)

Project action limits (PALs) and laboratory-specific detection and quantitation limits are provided in Table 1 (solid samples) and Table 2 (aqueous samples).

QAPP Worksheet #17: Sampling Design and Rationale
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Contaminants of Potential Concern

COPCs were selected based on detailed evaluation of previous sampling data collected at the GFC and historical uses of the property. Summary information including maps showing the proposed sampling for the media of concern and Database summary tables are provided in Appendix A-1 through A-5. The primary COPC include:

- Targeted Munitions[1] Related Metals: antimony, arsenic, copper, lead, and zinc: EPA Method 6010/7470
- PAHs EPA Method 8270
- VOCs: EPA Method 8260 (mainly groundwater)
- TPH: EPA Method 1664A; SW-846-8270C
- Explosives (Nitroaromatics, nitramines, and nitrate esters): EPA Method 8330B
- PCBs:
    - Arochlor analysis list per EPA Method 8082 and
    - Twelve dioxin-like congeners per EPA Method 1668 (10% of surface soil samples):
        - Non-ortho substituted PCBs: 77, 81, 126, and 169, and
        - Mono-ortho substituted PCBs: 105, 114, 118, 123, 156, 157, 167, and 189.

Work Plan Approach

The previous Site data was reviewed to assess proposed, initial sampling locations for the media of interest. Adjustments to the proposed sampling locations based on site observations will be conducted, as needed, in coordination with MDNR representatives. For efficiency and when applicable, additional sampling beyond that provided herein will be performed in coordination with the MDNR based on the initial testing results. This approach will allow the required data to be collected during one or more mobilizations to the Site, to the extent possible. A description of the proposed sampling locations and frequency is below. Additional sampling information is provided in the FSP and QAPP.

Groundwater

Groundwater will be assessed using 19 permanent monitoring wells installed at the proposed locations shown in Appendix A-1. The perimeter spacing of the initial monitoring wells is approximately 500 feet (i.e., one well / 3.5 acres). The proposed monitoring well network will provide adequate spatial coverage for initial characterization. We plan to sample and test each monitoring well within a few days after installation. Based on the initial testing data, additional monitoring well installation will be coordinated with MDNR representatives, as needed. This approach will allow the groundwater to be evaluated during one mobilization to the Site.

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[1] Technical Guidance for Military Munitions Response Actions, Manual No. 200-1-15, U.S. Army Corps of Engineers, October 30, 2018.

Proposed laboratory testing of groundwater samples includes VOCs, PAHs, five targeted metals, and PCBs. In addition, water from one downgradient well will also be analyzed for TPH, and explosives nitroaromatics, nitramines, and nitrate esters. Dissolved metals testing will be included at a frequency of 20% of the groundwater samples collected for testing.

Surface Soil

Surface and subsurface soil will be assessed using soil borings installed at the proposed locations shown in Appendix A-2. Surface soil samples will be comprised of material from 0 to 2 feet below the base of surface pavement or vegetative layer. 49 previous surface soil sampling locations were completed and results are summarized in Appendix A-2.

- Various constituents were analyzed including metals, PCBs, PAHs, VOCs, and asbestos. Each constituent was not analyzed at each location.
- Metals were detected at various locations above screening levels.
- PCBs were detected at one surface soil sampling location above industrial RSLs.
- PAHs were detected at seven surface soil sampling locations above residential RSLs and at one surface sampling location above industrial RSLs.
- Other detected constituents were below residential RSLs and/or background.

Based on historical site uses and existing data, the COPCs for surface soil samples are PCBs, PAHs, and five metals. The five metals were selected based on the commonly occurring metals for munitions sites (arsenic, antimony, copper, lead, and zinc) and previous testing results. In addition, target area samples will be collected for TPH, explosives, and VOCs. Soil testing of PCB congeners, as summarized in the RAWP and QAPP, will be performed on 10% of the exterior surface soil samples with sampling preference near areas exhibiting previous PCB detections. Surface soil sampling frequency will be a minimum of one sample per acre (approximately 200-foot spacing) across outdoor portions of the Site. Judgmental sampling will be implemented to optimize sampling locations at former building operations, transformer vaults and previous exceedance locations. Depths may also be adjusted deeper than 10 feet near transformers vault locations to target the likely zone of a potential release.

Subsurface Soil

A summary of subsurface soil sampling and testing and proposed subsurface soil sampling locations are provided in Appendix A -3. 59 previous subsurface soil sampling locations were completed.

- Various constituents were tested including metals, PCBs, PAHs, VOCs, pesticides, herbicides and asbestos.
- PAHs were detected in 3 of the subsurface soil sampling locations at concentrations above residential RSLs.
- Other tested constituents were below residential RSLs.
- Construction worker and trench worker are the primary exposure pathways for subsurface soil.

Although there have been 59 previous subsurface soil samples collected across the site, review of the subsurface maps shows a lack of sampling locations across the site for the site COPCs (PCBs, PAHs, and the five metals). This presents a subsurface soil data gap regarding potential extent and sufficient data for risk assessment. It is proposed that a subsurface sample be collected at each of the proposed surface soil boring locations and analyzed for PCBs, PAHs, and five metals, similar to the surface soil locations. In addition, target area samples will be collected for TPH, explosives, and VOCs.

A total of two soil samples per boring (surface and subsurface) are planned for collection. The subsurface soil sample will be collected within the 2 to 4-foot interval unless disturbed soils or other field observations dictate sample collection at a deeper depth. Subsurface soil samples will be monitored with a photoionization detector (PID). In addition to target sampling areas, soil samples exhibiting elevated PID readings will also be considered for VOC testing.

Crawlspace Surface Soil

As previously discussed, no additional samples will be collected in the crawlspaces as part of this investigation.

A summary of soil sampling and testing performed in the crawlspaces is in Appendix A-4.

- Various constituents were tested including explosives, metals, PCBs, PAHs, VOCs, and asbestos.
- Several metals were detected above screening levels.
- A few crawlspace soil samples exhibited exceedances of industrials RSLs for benzo(a)pyrene and PCBs.
- Asbestos was detected in crawlspace soil samples from each building that were tested for asbestos.

Surface Soil Near PCB Affected Concrete and Elevators

Previous concrete sampling at the Site identified targeted locations with PCB concentrations greater than 1 mg/kg (Appendix B). Most of the identified locations are associated with the locations of former PCB containing electric transformers or similar PCB containing equipment.

GSA will manage PCB releases, specifically from past transformer and elevator releases, under TSCA. However, this RIWP includes groundwater sampling and testing for PCBs (both Aroclor and Congeners). Due to weathering and environmental transformations, Aroclor mixtures may not maintain their original composition once they are released into the environment. Because of the different solubilities, volatilities, rates of uptake, degradation, and metabolism of the individual congeners that make up the mixtures, differences may exist between the source materials and the PCBs observed in the environment.

QAPP Worksheet #18: Sampling Locations and Methods
(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Sections 2.3.1 and 2.3.2)

Sample locations are provided on Figures 3-5 and Appendix B. Additional sampling information is provided in Table 3.

QAPP Worksheet #19 & 30: Sample Containers, Preservation, and Hold Times (UFP-QAPP Manual Section 3.1.2.2)(EPA 2106-G-05 Section 2.3.2)

Laboratory:	Teklab, Inc. 5445 Horseshoe Lake Road Collinsville, IL 62234 Emily Pohlman, Project Manager epohlman@teklabinc.com (618) 344-1004 Ext. 44
Accreditation:	MDNR Cert #930, Expires 31 January 2022
Back-up Laboratory:	ALS Environmental and Keystone Laboratories, Newton, IA
Sample Delivery Method:	Courier

Analyte/ Analyte Group	Matrix	Method/ SOP	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turn around
Volatile Organic Compounds	Soil	5035/8260C	2, 40-ml VOA vials w/ PTFE-faced silicone septum	TSP, pH > 11 0.1 to 6°C	14 Days	14 Days	28 Days
Volatile Organic Compounds	Groundwater	8260C	2, 40-ml VOA vials w/ PTFE-faced silicone septum	TSP, pH > 11 0.1 to 6°C	14 Days	14 Days	28 Days
Polycyclic Aromatic Hydrocarbons	Soil	8270C	1, 8-oz wide-mouth glass container	Unpreserved 0.1 to 6°C	14 Days	40 Days	28 Days
Polycyclic Aromatic Hydrocarbons	Groundwater	8270C	1, 125-mL glass container	Unpreserved 0.1 to 6°C	7 Days	40 days	28 Days

Analyte/ Analyte Group	Matrix	Method/ SOP	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turn around
Polychlorinated Biphenyls	Soil	8082	1, 8-oz wide-mouth glass container	Unpreserved 0.1 to 6°C	14 Days	40 Days	28 Days
Polychlorinated Biphenyls	Groundwater	8082	1, 1,000-mL glass container	Unpreserved 0.1 to 6°C	7 Days	40 Days	28 Days
Five Target Metals	Soil	6010B	1, 8-oz wide-mouth glass container	Unpreserved 0.1 to 6°C	6 Months	6 Months	28 Days
Five Target Metals (Totals)	Groundwater	6010B	1, 250-mL plastic or glass container	HNO_3, pH < 2 0.1 to 6°C	6 Months	6 Months	28 Days

Analyte/ Analyte Group	Matrix	Method/ SOP	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turn around
Five Target Metals (Dissolved, filtered at laboratory)	Groundwater	6010B	1, 250-mL plastic or glass container	Unpreserved	6 Months	6 Months	28 Days
Total Petroleum Hydrocarbons	Soil	SW-846-9071A_B	One 8 oz. glass jar; 4 degrees C	Unpreserved	28 days	28 days	14 days
Total Petroleum Hydrocarbons	Groundwater	EPA 1664A	One 1L glass jar; H2SO4-preserved; 4 degrees C	H2SO4	28 days	28 days	14 days
TPH-DRO/ORO	Soil	SW-846-8270C	One 8 oz. glass jar; 4 degrees C	Unpreserved	14 days	40 days	14 days
TPH-DRO/ORO	Groundwater	SW-846-8270C	One 125mL amber glass; 4 degrees C	Unpreserved	7 days	40 days	14 days
TPH-GRO	Soil	SW-846-8260B	One 4 oz. glass jar; 1 MeOH vial and 2 TSP vials (5035 collection); 4 degrees C	MeOH/TSP	14 days	14 days	14 days
TPH-GRO	Groundwater	SW-846-8260B	Two 40mL zero-headspace TSP vials; 4 degrees C	TSP	14 days	14 days	14 days

Analyte/ Analyte Group	Matrix	Method/ SOP	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turn around
Explosives-nitroaromatics, nitramines, and nitrate esters (Keystone Laboratories)	Soil	8330B	1, 4 oz wide-mouth glass container	Unpreserved 0.1 to 6°C	14 Days	40 Days	28 Days
Explosives-nitroaromatics, nitramines, and nitrate esters (Keystone Laboratories)	Groundwater	8330B	1, 1 quart amber container	Unpreserved 0.1 to 6°C	7 Days	40 Days	28 Days
PCB Congeners (ALS Environmental)	Soil	1613B	1, 4 oz amber glass container	Unpreserved 0.1 to 6°C	365 Days	365 Days	28 Days

QAPP Worksheet #20: Field QC Summary
(UFP-QAPP Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.5)

QC samples and analyses are described by the rate at which they will be performed.

Matrix	Analyte/ Analytical Group	Field Samples	Field Blind Duplicates	Matrix Spikes	Matrix Spike Duplicates	Equipment Blanks	Trip Blanks
Subsurface Soil	VOCs	Borings with PID readings ≥50 ppm and target sample locations	5% of samples	5% of samples	5% of samples	1/day of sampling	1/cooler of VOA
Subsurface Soil	PAHs, PCBs, Targeted Metals, TPH, nitroaromatics, nitramines, and nitrate, VOCs	Per Figure 5	5% of samples	5% of samples	5% of samples	1/day of sampling	0
Surficial Soil	VOCs	Borings with PID readings ≥50 ppm	5% of samples	5% of samples	5% of samples	1/day of sampling	1/cooler of VOA
Surficial Soil	PAHs, PCBs, Targeted Metals, TPH, nitroaromatics,	Per Figure 4	5% of samples	5% of samples	5% of samples	1/day of sampling	0

Matrix	Analyte/ Analytical Group	Field Samples	Field Blind Duplicates	Matrix Spikes	Matrix Spike Duplicates	Equipment Blanks	Trip Blanks
	nitramines, and nitrate						
Groundwater	VOCs, PAHs, PCBs, Targeted Metals, TPH, nitroaromatics, nitramines, and nitrate	Per Figure 3	5% of samples	5% of samples	5% of samples	Installation: 1/day, Sampling: 1/event	VOC only, 1/cooler of VOA

EB = Equipment Blank
TB = Trip Blank
VOA = Volatile Organic Analysis

QAPP Worksheet #21: Field SOPs
(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)

SOP # or reference	Title, Revision, and Date	Originating Organization	SOP option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
ENV0002	Environmental Soil Logging and Sampling, March 2019	Geotechnology	Hand Auger Drilling and Direct Push Drilling	N	
ENV0003	Sample Shipping, March 2019	Geotechnology	Sample shipment will be via laboratory courier from the GFC or Geotechnology's office.	N	
ENV0004	Monitoring Well Installation and Development, March 2019	Geotechnology	Well development by bailer or pump.	N	
ENV0005	Monitoring Well Gauging, Purging, and Sampling, March 2019	Geotechnology	Purging and sampling will use low-flow methodology with a peristaltic pump.	N	
ENV0009	Hazardous/Special Waste Manifesting, March 2019	Geotechnology		N	
ENV0012	Field Log Book Use, March 2019	Geotechnology		N	

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection (UFP-QAPP Manual Section 3.1.2.4) (EPA 2106-G-05 Section 2.3.6)

Field Equipment	Activity	SOP Reference	Title or position of responsible person	Frequency	Acceptance Criteria	Corrective Action
MiniRAE 3000 PID	Zero & Span Calibration	User Manual	Technical Staff	Daily	Zero: 0 ± 2 ppm Span: 100 ± 2 ppm	Restart instrument. Recalibrate instrument. If issues persist, rent a functioning instrument until issues are resolved.
Electronic Water Level Indicator	Test	User Manual	Technical Staff	Daily	Audible tone	Replace batteries. If issues persist, rent a functioning instrument until issues are resolved.
Hach 2100Q Portable Turbidimeter	Calibration	User Manual	Technical Staff	Weekly	Verification Standard: 10.0 ± 1.00 NTU	Restart instrument. Recalibrate instrument. If issues persist, rent a functioning instrument until issues are resolved.
Hach 2100Q Portable Turbidimeter	Verification	User Manual	Technical Staff	Daily	Verification Standard: 10.0 ± 1.00 NTU	Restart instrument. Recalibrate instrument. If issues persist, rent a functioning instrument until issues are resolved.
YSI Pro Plus: pH Probe	Calibration	User Manual	Scientific Field Coordinator	Monthly	Per User Manual	Restart instrument. Recalibrate instrument. If issues persist, rent a functioning instrument until issues are resolved.
YSI Pro Plus: pH Probe	Verification	User Manual	Technical Staff	Daily	pH 4.00 ± 0.10 S.U. pH 7.00 ± 0.10 S.U. pH 10.00 ± 0.10 S.U.	Restart instrument. Recalibrate instrument. If issues persist, rent a functioning instrument until issues are resolved.

Field Equipment	Activity	SOP Reference	Title or position of responsible person	Frequency	Acceptance Criteria	Corrective Action
YSI Pro Plus: ORP Probe	Calibration	User Manual	Scientific Field Coordinator	Monthly	Per User Manual	Restart instrument. Recalibrate instrument. If issues persist, rent a functioning instrument until issues are resolved.
YSI Pro Plus: Conductivity Probe	Calibration	User Manual	Scientific Field Coordinator	Monthly	Per User Manual	Restart instrument. Recalibrate instrument. If issues persist, rent a functioning instrument until issues are resolved.
YSI Pro Plus: Dissolved Oxygen Probe	Calibration	User Manual	Scientific Field Coordinator	Monthly	Per User Manual	Restart instrument. Recalibrate instrument. If issues persist, rent a functioning instrument until issues are resolved.

QAPP Worksheet #23: Analytical SOP's
(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project? Y/N
4310	Standard Operating Procedure for Volatile Organic Analysis by GC/MS, 4 March 2019, Revision S	Definitive	Soil & Groundwater, VOCs	GC/MS	N
4322	Standard Operating Procedure for Semi-Volatile Organic Analysis by GC/MS, 11 June 2014, Revision J	Definitive	Soil & Groundwater, PAHs	GC/MS	N
4220	Standard Operating Procedure for the Analysis of PCBs by Capillary Column GC, 22 November 2016, Revision J	Definitive	Soil, , & Groundwater, PCBs	Capillary Column GC	N
3039	Standard Operating Procedure, ICP Analysis, 17 December 2018, Revision G	Definitive	Soil & Groundwater, Metals	ICP-OES	N
BU-TM-1105	Determination of Congener Specific Chlorinated Biphenyls by High Resolution GCMS, 7 January 2019, v16	Definitive	Soil & Groundwater, Twelve PCB congeners	GC/MS	N

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project? Y/N
13AJU	Standard Operating Procedure, Determination of Explosives by HPLC with Ultraviolet Detection, 3 August 2017, Revision 7.	Definitive	Soil, Explosives	HPLC	N
4170, 4321, 4324	Standard Operating Procedure-TPH-DRO referencing method SW-846 8270C with 3511 prep.	Definitive	Soil & Groundwater	GC/MS	N
4130	TPH-GRO referencing method SW-846 8260B with 5030 and 5035 prep procedures	Definitive	Soil & Groundwater	GC/MS	N
2182	Standard Operating Procedure, Total Petroleum Hydrocarbons EPA 1664A	Definitive	Soil & Groundwater	GC/MS	N

QAPP Worksheet #24: Analytical Instrument Calibration (UFP-QAPP Manual Section 3.2.2) (EPA 2106-G-05 Section 2.3.6)

Instrument	Calibration Procedure	Calibration Range	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/position responsible for Corrective Action	SOP Reference
Teklab, Inc. Equipment	Per SOP	Per SOP	Per SOP	Per SOP	Per SOP	Per SOP	4310, 4322, 4220, 3039, 3060, 2094, and 2222.
ALS Canada Environmental Equipment	Per SOP	Per SOP	Per SOP	Per SOP	Per SOP	Per SOP	BU-TM-1105
Keystone Laboratories, Inc. Equipment	Per SOP	Per SOP	Per SOP	Per SOP	Per SOP	Per SOP	13AJU

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection (UFP-QAPP Manual Section 3.2.3)

(EPA 2106-G-05 Section 2.3.6)

Analytical instrument and equipment maintenance, testing, and inspection is discussed in the Teklab, Inc. Quality Assurance Manual, Revision 26, Effective 22 December 2017 provided in Appendix C.

QAPP Worksheet #26 & 27: Sample Handling, Custody, and Disposal (UFP-QAPP Manual Section 3.3)

(EPA 2106-G-05 Section 2.3.3)

Sampling Organization: Geotechnology, Inc.

Laboratory: Teklab, Inc., ALS,Environmental and Keystone Laboratory

Method of sample delivery (shipper/carrier): Daily Courier (Pickup at site or Geotechnology's office)

Note: PCB congener analysis is to be performed by ALS Environmental. Explosive analysis is to be performed by Keystone Laboratories.

Teklab will perform initial sample intake and will ship samples to ALS Environmental and Keystone Laboratories, who will then handle sample receipt, inspection, log in,

custody, storage, and eventual disposal for PCB congener samples.

Number of days from reporting until sample disposal: Aqueous: 30 days; Solids: 2 weeks

Activity	Organization and title or position of person responsible for the activity
Sample labeling	Geotechnology – Technical Staff
Chain-of-custody form completion	Geotechnology – Technical Staff
Packaging	Geotechnology – Technical Staff
Shipping coordination	Geotechnology – Technical Staff Teklab – Courier
Sample receipt, inspection, & log-in	Teklab – Laboratory Sample Custodian
Sample custody and storage	Teklab – Laboratory Sample Custodian
Sample disposal	Teklab – Laboratory Sample Custodian

QAPP Worksheet #28: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Analytical quality control and corrective action procedures will be in accordance with the laboratory's quality manual and standard operating procedure for the respective analysis. These documents are attached in Appendix C.

QAPP Worksheet #29: Project Documents and Records
(UFP-QAPP Manual Section 3.5.1)
(EPA 2106-G-05 Section 2.2.8)

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage location/archival**
Field logbook or data collection sheets	Technical Staff	Field Team Leader	Digital Project File
Chain-of-Custody Forms	Technical Staff	Field Team Leader	Digital Project File
Contractor Daily QC Reports	Field Team Leader	Geotechnology Project Manager	Digital Project File
Deviations	Field Team Leader	Geotechnology Project Manager	Digital Project File
Corrective Action Reports	Field Team Leader	Geotechnology Project Manager	Digital Project File
Correspondence	Geotechnology Project Manager	Etegra Project Manager	Digital Project File

Project Assessments

Record	Generation	Verification	Storage location/archival
Field audit checklists	Field Team Leader	Scientific Field Coordinator	Digital Project File
Data verification checklists	Field Team Leader	Geotechnology Project Manager	Digital Project File
Data validation report	Data Validation Subconsultant	Geotechnology Project Manager	Digital Project File
Data usability assessment report	Data Validation Subconsultant	Geotechnology Project Manager	Digital Project File

Laboratory Records

Record	Generation	Verification	Storage location/archival
Analytical Laboratory Report	Laboratory Project Manager	Laboratory Quality Assurance Officer	Digital Project File
Level 3 Data Package	Laboratory Quality Department	Laboratory Quality Assurance Officer	Digital Project File

	Laboratory Data Deliverables						
Record	**VOCs**	**PAHs**	**PCBs & PCB Congeners**	**TPH**	**Explosives**	**Targeted Metals**	
Narrative	X	X	X	X	X	X	
COC	X	X	X	X	X	X	
Summary Results	X	X	X	X	X	X	
QC Results	X	X	X	X	X	X	
Tentatively Identified Compounds		X					

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action
(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)
(EPA 2106-G-05 Sections 2.4 and 2.5.5)

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Assessment Deliverable	Deliverable due date
Readiness Review	Geotechnology Quality Manager	One assessment one week prior to mobilization	Readiness Review Memorandum	24 hours following assessment
Field Sampling TSA	Geotechnology Quality Manager or designee	One each on first day of monitoring well installation, groundwater sampling, soil borings, sampling event.	TSA Memorandum	24 hours following assessment

Assessment Response and Corrective Action:

Assessment Type	Responsibility for responding to assessment findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsible for monitoring Corrective Action implementation
Readiness Review	Geotechnology Project Manager	Readiness Review Corrective Action Response	24 hours from receipt of Readiness Review Memorandum	As directed by Geotechnology Project Manager	Geotechnology Quality Manager
Field Sampling TSA	Field Leader	Field Sampling Corrective Action Response	24 hours from receipt of Memorandum	Field Leader	Geotechnology Project Manager

TSA = Technical Systems Audit

QAPP Worksheet #34: Data Verification and Validation Inputs (UFP-QAPP Manual Section 5.2.1 and Table 9) (EPA 2106-G-05 Section 2.5.1)

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)
Planning Documents/Records			
1	Approved QAPP	X	
2	Contract	X	
4	Field SOPs	X	
5	Laboratory SOPs	X	
Field Records			
6	Field logbooks and data sheets	X	X
7	Equipment calibration records	X	X
8	Chain-of-Custody Forms	X	X
9	Sampling diagrams/surveys	X	X
10	Boring logs	X	X
11	Well Construction Diagrams	X	X
12	Relevant Correspondence	X	X
13	Change orders/deviations	X	X
1	Field audit reports	X	X
1	Field corrective action reports	X	X
Analytical Data Package			
15	Cover sheet (laboratory identifying information)	X	X
16	Case narrative	X	X

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)
17	Internal laboratory chain-of-custody (not included)		
18	Sample receipt records	**X**	**X**
19	Sample chronology (i.e. dates and times of receipt, preparation, & analysis)	**X**	**X**
20	Communication records (not included)		
21	MDL/PQL establishment and verification	**X**	**X**
22	Standards Traceability (not included)		
23	Instrument calibration records (not included)		
24	Definition of laboratory qualifiers	**X**	**X**
25	Results reporting forms	**X**	**X**
26	QC sample results	**X**	**X**
27	Corrective action reports (if needed)	**X**	**X**
28	Raw data (not included)		
29	Electronic data deliverable	**X**	**X**

QAPP Worksheet #35: Data Verification Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Field logbook and data sheets	QAPP	Verify that records are present and complete for each day of field activities. Verify that all planned samples including field QC samples were collected and that sample collection locations are documented. Verify that meteorological data were provided for each day of field activities. Verify that changes/exceptions are documented and were reported in accordance with requirements. Verify that any required field monitoring was performed and results are documented.	Daily - Project Manager At conclusion of field activities - Project QA Manager
Chain-of-custody forms	QAPP	Verify the completeness of chain-of-custody records. Examine entries for consistency with the field logbook. Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). Verify that all required signatures and dates are present. Check for transcription errors.	Daily - Field Leader At conclusion of field activities – Geotechnology Project Manager

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Laboratory Deliverable	QAPP	Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the chains-of-custody to verify that results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present.	Before release – Teklab Project Manager Upon receipt – Geotechnology Project Manager
Audit Reports, Corrective Action Reports	QAPP	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	Geotechnology Quality Manager

QAPP Worksheet #36
Data Validation Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

A Level 2 data validation will be conducted consistent with the MPCs identified in Worksheet #12 of this QAPP. Data validation will be subcontracted by Geotechnology to a qualified and specialized firm. The data validation procedure will identify data as acceptable or apply qualifiers to indicate limited usability. Analytical data will be validated by entities external to the data generator. Each analytical report will be reviewed for compliance with the applicable method and for the quality of the data reported. Field duplicates, trip blanks, field blanks, equipment blanks MS/MSD will also be reviewed for quality. The data validation outputs will be compiled in a Validation Summary for inclusion in the Remedial Investigation Report. The Validation Summary will be used to inform a Data Usability Assessment as described in Worksheet #37 of this QAPP.

Validation Summary	Level II Validation
General Overview	
Field Documentation (COCs)	X
Laboratory Check-Ins (Temp. IDs, Analyses, etc.)	X
Holding Times	X
Blanks	
Method, Trip, Rinsate	X
Initial Calibration Blank, Continuing Calibration Blank	
Accuracy - Spike Recoveries	
Surrogates	X
Internal Standards	
Laboratory Control Spikes/Blind Spikes	X
Matrix Spikes	X
Post Digestion (metals)	
Interference Check Standard (metals)	
Continuing Calibration Verification	
Precision - RPDs	
Laboratory Control Spike/Blind Spike Duplicates	X
Matrix Spike Duplicates	X
Laboratory Duplicates	X
Field Duplicates	X
Reporting Limits/Dilutions	X
Column confirmation check	

Instrument QC	
Initial Calibration Curve Instrument Tuning/Performance Check Retention Time Check	
Database	
All data to be maintained in an Access database.	X

QAPP Worksheet #37: Data Usability Assessment (UFP-QAPP Manual Section 5.2.3 including Table 12) (EPA 2106-G-05 Sections 2.5.2, 2.5.3, and 2.5.4)

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

Geotechnology Project Manager
Juniper Project Manager
Geotechnology Quality Manager
Geotechnology Field Team Leader

Describe how the usability assessment will be documented:

Summarize the data usability assessment process including statistics, equations, and computer algorithms that will be used to analyze the data:

Step 1	**Review the project's objectives and sampling design** Review the DQOs and MPCs to make sure they are still applicable. Review the sampling design for consistency with stated objectives.
Step 2	**Review the data verification and data validation outputs** Review available QA reports, including the data verification and data validation reports. Perform basic calculations and summarize the data (using graphs, maps, tables, etc.). Look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant PT sample results, and SOP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.

Step 3	**Verify the assumptions of the selected statistical method** Verify whether underlying assumptions for selected statistical methods are valid. Common assumptions include the distributional form of the data, independence of the data, dispersion characteristics, homogeneity, etc. Depending on the robustness of the statistical method, minor deviations from assumptions usually are not critical to statistical analysis and data interpretation. If serious deviations from assumptions are discovered, then another statistical method may need to be selected.
Step 4	**Implement the statistical method** Implement the specified statistical procedures for analyzing the data and review underlying assumptions. For decision projects that involve hypothesis testing (e.g., “concentrations of lead in groundwater are below the action level”) consider the consequences for selecting the incorrect alternative; for estimation projects (e.g., establishing a boundary for surface soil contamination), consider the tolerance for uncertainty in measurements.
Step 5	**Document data usability and draw conclusions** Determine if the data can be used as intended, considering implications of deviations and corrective actions. Discuss data quality indicators. Assess the performance of the sampling design and Identify limitations on data use. Update the conceptual site model and document conclusions. Prepare the data usability summary report which can be in the form of text and/or a table.

TABLE 1
PROJECT ACTION LIMITS AND LABORATORY DETECTION/QUANTITATION LIMITS - SOLID SAMPLES
GOODFELLOW FEDERAL COMPLEX
REMEDIAL INVESTIGATION WORK PLAN

Analyte	Category	Test	PAL	PAL Reference	PQL Goal	PQL	MDL
Antimony	Metal	SW6010B	10	Technology Limit	10	5	1.23
Arsenic	Metal	SW6010B	12.3	URS 2008 UTL	12.3	2.5	0.97
Copper	Metal	SW6010B	310	RSL (Res, 0.1)	2.5	0.5	0.21
Lead	Metal	SW6010B	400	RSL (Res, 0.1)	7.5	1.5	0.59
Zinc	Metal	SW6010B	2300	RSL (Res, 0.1)	15	3	1.1
Aroclor 1016	PCB	SW8082	0.41	RSL (Res, 0.1)	0.12	0.0375	0.0045
Aroclor 1221	PCB	SW8082	0.2	RSL (Res, 0.1)	0.12	0.0375	0.0042
Aroclor 1232	PCB	SW8082	0.17	RSL (Res, 0.1)	0.12	0.0375	0.0036
Aroclor 1242	PCB	SW8082	0.23	RSL (Res, 0.1)	0.12	0.0375	0.0039
Aroclor 1248	PCB	SW8082	0.23	RSL (Res, 0.1)	0.12	0.0375	0.003
Aroclor 1254	PCB	SW8082	0.12	RSL (Res, 0.1)	0.12	0.0375	0.0045
Aroclor 1260	PCB	SW8082	0.24	RSL (Res, 0.1)	0.12	0.0375	0.0055
PCB-77	PCB Congeners	1668C	0.038	RSL (Res, 0.1)	0.000025	0.000005	0.0000014
PCB-81	PCB Congeners	1668C	0.012	RSL (Res, 0.1)	0.000025	0.000005	0.0000018
PCB-126	PCB Congeners	1668C	0.000036	RSL (Res, 0.1)	0.000025	0.000005	0.0000016
PCB-169	PCB Congeners	1668C	0.00012	RSL (Res, 0.1)	0.000025	0.000005	0.0000015
PCB-105	PCB Congeners	1668C	0.12	RSL (Res, 0.1)	0.000025	0.000005	0.0000017
PCB-114	PCB Congeners	1668C	0.12	RSL (Res, 0.1)	0.000025	0.000005	0.0000015
PCB-118	PCB Congeners	1668C	0.12	RSL (Res, 0.1)	0.00005	0.00001	0.000003
PCB-123	PCB Congeners	1668C	0.12	RSL (Res, 0.1)	0.000025	0.000005	0.0000017
PCB-156	PCB Congeners	1668C	0.12	RSL (Res, 0.1)	0.00005	0.00001	0.0000023
PCB-157	PCB Congeners	1668C	0.12	RSL (Res, 0.1)	0.00005	0.00001	0.0000023
PCB-167	PCB Congeners	1668C	0.12	RSL (Res, 0.1)	0.000025	0.000005	0.0000013
PCB-189	PCB Congeners	1668C	0.13	RSL (Res, 0.1)	0.000025	0.000005	0.0000013
Acenaphthene	SVOC	SW8270C	360	RSL (Res, 0.1)	0.17	0.034	0.01
Acenaphthylene	SVOC	SW8270C	4180	MDNR RBTL (Surf)	0.17	0.034	0.011
Anthracene	SVOC	SW8270C	1800	RSL (Res, 0.1)	0.17	0.034	0.005
Benzo(a)anthracene	SVOC	SW8270C	1.1	RSL (Res, 0.1)	0.17	0.034	0.011
Benzo(a)pyrene	SVOC	SW8270C	0.11	RSL (Res, 0.1)	0.11	0.034	0.006
Benzo(b)fluoranthene	SVOC	SW8270C	1.1	RSL (Res, 0.1)	0.17	0.034	0.006
Benzo(g,h,i)perylene	SVOC	SW8270C	1720	MDNR RBTL (Surf)	0.17	0.034	0.01
Benzo(k)fluoranthene	SVOC	SW8270C	11	RSL (Res, 0.1)	0.17	0.034	0.005
Chrysene	SVOC	SW8270C	110	RSL (Res, 0.1)	0.17	0.034	0.012
Dibenzo(a,h)anthracene	SVOC	SW8270C	0.11	RSL (Res, 0.1)	0.11	0.034	0.009
Fluoranthene	SVOC	SW8270C	240	RSL (Res, 0.1)	0.17	0.034	0.012
Fluorene	SVOC	SW8270C	240	RSL (Res, 0.1)	0.17	0.034	0.01
Indeno(1,2,3-cd)pyrene	SVOC	SW8270C	1.1	RSL (Res, 0.1)	0.17	0.034	0.008
Naphthalene	SVOC	SW8270C	3.8	RSL (Res, 0.1)	0.17	0.034	0.01
Phenanthrene	SVOC	SW8270C	2170	MDNR RBTL (Surf)	0.17	0.034	0.011
Pyrene	SVOC	SW8270C	180	RSL (Res, 0.1)	0.17	0.034	0.012
1,1,1,2-Tetrachloroethane	VOC	SW8260B	2	RSL (Res, 0.1)	0.01	0.002	0.00056
1,1,1-Trichloroethane	VOC	SW8260B	810	RSL (Res, 0.1)	0.01	0.002	0.00029
1,1,2,2-Tetrachloroethane	VOC	SW8260B	0.6	RSL (Res, 0.1)	0.01	0.002	0.00038
1,1,2-Trichloro-1,2,2-trifluoroethane	VOC	SW8260B	670	RSL (Res, 0.1)	0.01	0.002	0.00086
1,1,2-Trichloroethane	VOC	SW8260B	0.15	RSL (Res, 0.1)	0.025	0.005	0.00032
1,1-Dichloro-2-propanone	VOC	SW8260B	NE	NE	0.25	0.05	0.00698
1,1-Dichloroethane	VOC	SW8260B	3.6	RSL (Res, 0.1)	0.01	0.002	0.00054
1,1-Dichloroethene	VOC	SW8260B	23	RSL (Res, 0.1)	0.01	0.002	0.00019
1,1-Dichloropropene	VOC	SW8260B	NE	NE	0.01	0.002	0.00041
1,2,3-Trichlorobenzene	VOC	SW8260B	6.3	RSL (Res, 0.1)	0.01	0.002	0.00061
1,2,3-Trichloropropane	VOC	SW8260B	0.0051	RSL (Res, 0.1)	0.0051	0.002	0.00072
1,2,3-Trimethylbenzene	VOC	SW8260B	34	RSL (Res, 0.1)	0.01	0.002	0.00067
1,2,4-Trichlorobenzene	VOC	SW8260B	5.8	RSL (Res, 0.1)	0.01	0.002	0.00048
1,2,4-Trimethylbenzene	VOC	SW8260B	30	RSL (Res, 0.1)	0.01	0.002	0.00063
1,2-Dibromo-3-chloropropane	VOC	SW8260B	0.01	Technology Limit	0.01	0.005	0.00079
1,2-Dibromoethane	VOC	SW8260B	0.036	RSL (Res, 0.1)	0.01	0.002	0.00011
1,2-Dichlorobenzene	VOC	SW8260B	180	RSL (Res, 0.1)	0.01	0.002	0.00033
1,2-Dichloroethane	VOC	SW8260B	0.46	RSL (Res, 0.1)	0.01	0.002	0.00015
1,2-Dichloropropane	VOC	SW8260B	1.6	RSL (Res, 0.1)	0.01	0.002	0.00021
1,3,5-Trimethylbenzene	VOC	SW8260B	27	RSL (Res, 0.1)	0.01	0.002	0.00052
1,3-Dichlorobenzene	VOC	SW8260B	148	MDNR RBTL (Sub)	0.01	0.002	0.00052
1,3-Dichloropropane	VOC	SW8260B	160	RSL (Res, 0.1)	0.01	0.002	0.00028
1,4-Dichlorobenzene	VOC	SW8260B	2.6	RSL (Res, 0.1)	0.01	0.002	0.00046
1-Chlorobutane	VOC	SW8260B	310	RSL (Res, 0.1)	0.01	0.002	0.00038
2,2-Dichloropropane	VOC	SW8260B	NE	NE	0.01	0.002	0.0002
2-Butanone	VOC	SW8260B	2700	RSL (Res, 0.1)	0.125	0.025	0.00325
2-Chlorotoluene	VOC	SW8260B	160	RSL (Res, 0.1)	0.01	0.002	0.00043
2-Hexanone	VOC	SW8260B	20	RSL (Res, 0.1)	0.125	0.025	0.00204
2-Nitropropane	VOC	SW8260B	0.1	Technology Limit	0.1	0.05	0.00456
4-Chlorotoluene	VOC	SW8260B	160	RSL (Res, 0.1)	0.01	0.002	0.00054

TABLE 1
PROJECT ACTION LIMITS AND LABORATORY DETECTION/QUANTITATION LIMITS - SOLID SAMPLES
GOODFELLOW FEDERAL COMPLEX
REMEDIAL INVESTIGATION WORK PLAN

Analyte	Category	Test	PAL	PAL Reference	PQL Goal	PQL	MDL
4-Methyl-2-pentanone	VOC	SW8260B	3300	RSL (Res, 0.1)	0.125	0.025	0.0022
Acetone	VOC	SW8260B	6100	RSL (Res, 0.1)	0.125	0.025	0.01073
Acrolein	VOC	SW8260B	0.1	Technology Limit	0.1	0.05	0.0207
Acrylonitrile	VOC	SW8260B	0.25	RSL (Res, 0.1)	0.025	0.005	0.00097
Allyl chloride	VOC	SW8260B	0.17	RSL (Res, 0.1)	0.01	0.002	0.00026
Benzene	VOC	SW8260B	1.2	RSL (Res, 0.1)	0.005	0.001	0.00027
Bromobenzene	VOC	SW8260B	29	RSL (Res, 0.1)	0.01	0.002	0.00039
Bromochloromethane	VOC	SW8260B	15	RSL (Res, 0.1)	0.01	0.002	0.00031
Bromodichloromethane	VOC	SW8260B	0.29	RSL (Res, 0.1)	0.01	0.002	0.0003
Bromoform	VOC	SW8260B	19	RSL (Res, 0.1)	0.025	0.005	0.00037
Bromomethane	VOC	SW8260B	0.68	RSL (Res, 0.1)	0.05	0.01	0.00131
Carbon disulfide	VOC	SW8260B	77	RSL (Res, 0.1)	0.01	0.002	0.00172
Carbon tetrachloride	VOC	SW8260B	0.65	RSL (Res, 0.1)	0.01	0.002	0.00021
Chlorobenzene	VOC	SW8260B	28	RSL (Res, 0.1)	0.01	0.002	0.00035
Chloroethane	VOC	SW8260B	1400	RSL (Res, 0.1)	0.05	0.01	0.00155
Chloroform	VOC	SW8260B	0.32	RSL (Res, 0.1)	0.01	0.002	0.00034
Chloromethane	VOC	SW8260B	11	RSL (Res, 0.1)	0.05	0.01	0.00123
cis-1,2-Dichloroethene	VOC	SW8260B	16	RSL (Res, 0.1)	0.01	0.002	0.00022
cis-1,3-Dichloropropene	VOC	SW8260B	0.224	MDNR RBTL (Sub)	0.01	0.002	0.00025
Cyclohexanone	VOC	SW8260B	2800	RSL (Res, 0.1)	0.25	0.05	0.01836
Dibromochloromethane	VOC	SW8260B	8.3	RSL (Res, 0.1)	0.01	0.002	0.0003
Dibromomethane	VOC	SW8260B	2.4	RSL (Res, 0.1)	0.01	0.002	0.00023
Dichlorodifluoromethane	VOC	SW8260B	8.7	RSL (Res, 0.1)	0.05	0.01	0.00157
Ethyl ether	VOC	SW8260B	1600	RSL (Res, 0.1)	0.01	0.002	0.00031
Ethyl methacrylate	VOC	SW8260B	180	RSL (Res, 0.1)	0.01	0.002	0.00042
Ethylbenzene	VOC	SW8260B	5.8	RSL (Res, 0.1)	0.01	0.002	0.00056
Hexachlorobutadiene	VOC	SW8260B	1.2	RSL (Res, 0.1)	0.01	0.002	0.0004
Hexachloroethane	VOC	SW8260B	1.8	RSL (Res, 0.1)	0.01	0.002	0.00038
Iodomethane	VOC	SW8260B	NE	NE	0.05	0.01	0.00312
Isopropylbenzene	VOC	SW8260B	190	RSL (Res, 0.1)	0.01	0.002	0.00056
m,p-Xylenes	VOC	SW8260B	NE	NE	0.02	0.004	0.0012
Methacrylonitrile	VOC	SW8260B	0.75	RSL (Res, 0.1)	0.025	0.005	0.00102
Methyl Methacrylate	VOC	SW8260B	440	RSL (Res, 0.1)	0.025	0.005	0.00065
Methyl tert-butyl ether	VOC	SW8260B	47	RSL (Res, 0.1)	0.01	0.002	0.00026
Methylacrylate	VOC	SW8260B	15	RSL (Res, 0.1)	0.025	0.005	0.00062
Methylene chloride	VOC	SW8260B	35	RSL (Res, 0.1)	0.05	0.01	0.00689
Naphthalene	VOC	SW8260B	3.8	RSL (Res, 0.1)	0.025	0.005	0.0012
n-Butylbenzene	VOC	SW8260B	390	RSL (Res, 0.1)	0.01	0.002	0.00055
n-Heptane	VOC	SW8260B	2.2	RSL (Res, 0.1)	0.1	0.02	0.0007
n-Hexane	VOC	SW8260B	61	RSL (Res, 0.1)	0.1	0.02	0.00347
Nitrobenzene	VOC	SW8260B	5.1	RSL (Res, 0.1)	0.25	0.05	0.03306
n-Propylbenzene	VOC	SW8260B	380	RSL (Res, 0.1)	0.01	0.002	0.00045
o-Xylene	VOC	SW8260B	65	RSL (Res, 0.1)	0.02	0.004	0.00054
Pentachloroethane	VOC	SW8260B	7.7	RSL (Res, 0.1)	0.025	0.005	0.0003
p-Isopropyltoluene	VOC	SW8260B	1100	MDNR RBTL (Sub)	0.01	0.002	0.0006
Propionitrile	VOC	SW8260B	NE	NE	0.25	0.05	0.00682
sec-Butylbenzene	VOC	SW8260B	780	RSL (Res, 0.1)	0.01	0.002	0.0005
Styrene	VOC	SW8260B	600	RSL (Res, 0.1)	0.01	0.002	0.00058
tert-Butylbenzene	VOC	SW8260B	780	RSL (Res, 0.1)	0.01	0.002	0.00046
Tetrachloroethene	VOC	SW8260B	8.1	RSL (Res, 0.1)	0.01	0.002	0.00045
Tetrahydrofuran	VOC	SW8260B	1800	RSL (Res, 0.1)	0.05	0.01	0.00131
Toluene	VOC	SW8260B	490	RSL (Res, 0.1)	0.01	0.002	0.00035
trans-1,2-Dichloroethene	VOC	SW8260B	160	RSL (Res, 0.1)	0.01	0.002	0.00018
trans-1,3-Dichloropropene	VOC	SW8260B	0.224	MDNR RBTL (Sub)	0.01	0.002	0.00027
Trichloroethene	VOC	SW8260B	0.41	RSL (Res, 0.1)	0.01	0.002	0.0003
Trichlorofluoromethane	VOC	SW8260B	2300	RSL (Res, 0.1)	0.025	0.005	0.00039
Vinyl acetate	VOC	SW8260B	91	RSL (Res, 0.1)	0.25	0.05	0.00102
Vinyl chloride	VOC	SW8260B	0.059	RSL (Res, 0.1)	0.01	0.002	0.00032

PAL = Project Action Limit
PQL = Practical Quantitation Limit
MDL = Minimum Detection Limit
Values reported in units of mg/kg.
RSL = USEPA Regional Screening Level, THQ = 0.1, TR = 1E-06
MDNR RBTL (Surf) = Missouri Department of Natural Resources Risk-Based Target Level for Residential Sites, Surficial Soils
MDNR RBTL (Sub) = Missouri Department of Natural Resources Risk-Based Target Level for Residential Sites, Subsurface Soils
NE = Limit not established.

TABLE 2
PROJECT ACTION LIMITS AND LABORATORY DETECTION/QUANTITATION LIMITS - AQUEOUS SAMPLES
GOODFELLOW FEDERAL COMPLEX
REMEDIAL INVESTIGATION WORK PLAN

Analyte	Category	Test	PAL	PAL Reference	PQL Goal	PQL	MDL
Antimony	Metal	E200.7	6	MCL	0.25	0.05	0.0068
Arsenic	Metal	E200.7	10	MCL	0.125	0.025	0.0087
Copper	Metal	E200.7	1300	MCL	0.025	0.005	0.0013
Lead	Metal	E200.7	15	MCL	0.075	0.015	0.004
Zinc	Metal	E200.7	4.69	MDNR RBTL (Ingest)	0.05	0.01	0.005
Aroclor 1016	PCB	SW8082	0.0172	VISL	0.005	0.001	0.0002
Aroclor 1221	PCB	SW8082	0.002	Technology Limit	0.002	0.001	0.00016
Aroclor 1232	PCB	SW8082	0.002	Technology Limit	0.002	0.001	0.00012
Aroclor 1242	PCB	SW8082	0.00101	VISL	0.00101	0.001	0.00013
Aroclor 1248	PCB	SW8082	0.002	Technology Limit	0.002	0.001	0.00016
Aroclor 1254	PCB	SW8082	0.00125	VISL	0.00125	0.001	0.00022
Aroclor 1260	PCB	SW8082	0.002	Technology Limit	0.002	0.001	0.0001
Acenaphthene	SVOC	SW8270C	1610	MDNR RBTL (Inhal)	0.05	0.01	0.001
Acenaphthylene	SVOC	SW8270C	2060	MDNR RBTL (Inhal)	0.05	0.01	0.001
Anthracene	SVOC	SW8270C	2290	MDNR RBTL (Inhal)	0.05	0.01	0.001
Benzo(a)anthracene	SVOC	SW8270C	0.133	VISL	0.05	0.01	0.001
Benzo(a)pyrene	SVOC	SW8270C	0.2	MCL	0.05	0.01	0.001
Benzo(b)fluoranthene	SVOC	SW8270C	7.65	MDNR RBTL (Inhal)	0.05	0.01	0.001
Benzo(g,h,i)perylene	SVOC	SW8270C	218000	MDNR RBTL (Inhal)	0.05	0.01	0.001
Benzo(k)fluoranthene	SVOC	SW8270C	937	MDNR RBTL (Inhal)	0.05	0.01	0.001
Chrysene	SVOC	SW8270C	81.7	MDNR RBTL (Inhal)	0.05	0.01	0.001
Dibenzo(a,h)anthracene	SVOC	SW8270C	985	MDNR RBTL (Inhal)	0.05	0.01	0.001
Fluoranthene	SVOC	SW8270C	14200	MDNR RBTL (Inhal)	0.05	0.01	0.001
Fluorene	SVOC	SW8270C	3010	MDNR RBTL (Inhal)	0.05	0.01	0.001
Indeno(1,2,3-cd)pyrene	SVOC	SW8270C	596	MDNR RBTL (Inhal)	0.05	0.01	0.001
Naphthalene	SVOC	SW8270C	0.1	Technology Limit	0.1	0.01	0.001
Phenanthrene	SVOC	SW8270C	1190	MDNR RBTL (Inhal)	0.05	0.01	0.001
Pyrene	SVOC	SW8270C	17300	MDNR RBTL (Inhal)	0.05	0.01	0.001
1,1,1,2-Tetrachloroethane	VOC	SW8260B	0.00699	VISL	0.004	0.002	0.00022
1,1,1-Trichloroethane	VOC	SW8260B	1.13	VISL	0.01	0.002	0.00033
1,1,2,2-Tetrachloroethane	VOC	SW8260B	0.00582	VISL	0.004	0.002	0.0001
1,1,2-Trichloro-1,2,2-trifluoroethane	VOC	SW8260B	0.0351	VISL	0.025	0.005	0.00036
1,1,2-Trichloroethane	VOC	SW8260B	0.00105	VISL	0.001	0.0005	0.0001
1,1-Dichloro-2-propanone	VOC	SW8260B	NE	NE	0.15	0.03	0.00273
1,1-Dichloroethane	VOC	SW8260B	0.0114	VISL	0.01	0.002	0.00039
1,1-Dichloroethene	VOC	SW8260B	0.0276	VISL	0.01	0.002	0.00038
1,1-Dichloropropene	VOC	SW8260B	NE	NE	0.01	0.002	0.0001
1,2,3-Trichlorobenzene	VOC	SW8260B	NE	NE	0.01	0.002	0.00018
1,2,3-Trichloropropane	VOC	SW8260B	0.00411	VISL	0.004	0.002	0.00017
1,2,3-Trimethylbenzene	VOC	SW8260B	0.0794	VISL	0.01	0.002	0.00014
1,2,4-Trichlorobenzene	VOC	SW8260B	0.00752	VISL	0.004	0.002	0.00024
1,2,4-Trimethylbenzene	VOC	SW8260B	0.0475	VISL	0.01	0.002	0.0001
1,2-Dibromo-3-chloropropane	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.00034
1,2-Dibromoethane	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.00012
1,2-Dichlorobenzene	VOC	SW8260B	0.5	VISL	0.01	0.002	0.00022
1,2-Dichloroethane	VOC	SW8260B	0.00355	VISL	0.003	0.002	0.00011
1,2-Dichloropropane	VOC	SW8260B	0.00577	VISL	0.004	0.002	0.00011
1,3,5-Trimethylbenzene	VOC	SW8260B	0.0333	VISL	0.01	0.002	0.00014
1,3-Dichlorobenzene	VOC	SW8260B	43.6	MDNR RBTL (Inhal)	0.01	0.002	0.0001
1,3-Dichloropropane	VOC	SW8260B	NE	NE	0.01	0.002	0.0001
1,4-Dichlorobenzene	VOC	SW8260B	0.00488	VISL	0.004	0.002	0.00014
1-Chlorobutane	VOC	SW8260B	NE	NE	0.025	0.005	0.0001
2,2-Dichloropropane	VOC	SW8260B	NE	NE	0.01	0.002	0.0001
2-Butanone	VOC	SW8260B	354	VISL	0.05	0.01	0.00112
2-Chloroethyl vinyl ether	VOC	SW8260B	NE	NE	0.025	0.005	0.00045
2-Chlorotoluene	VOC	SW8260B	17.1	MDNR RBTL (Inhal)	0.01	0.002	0.0001
2-Hexanone	VOC	SW8260B	1.46	VISL	0.05	0.01	0.0004
2-Nitropropane	VOC	SW8260B	0.02	Technology Limit	0.02	0.01	0.00229
4-Chlorotoluene	VOC	SW8260B	0.0666	MDNR RBTL (Inhal)	0.01	0.002	0.0001
4-Methyl-2-pentanone	VOC	SW8260B	94.9	VISL	0.05	0.01	0.00043
Acetone	VOC	SW8260B	3370	VISL	0.05	0.01	0.00244
Acetonitrile	VOC	SW8260B	6.82	VISL	0.05	0.01	0.00142
Acrolein	VOC	SW8260B	0.04	Technology Limit	0.04	0.02	0.00214
Acrylonitrile	VOC	SW8260B	0.0117	VISL	0.01	0.005	0.00025
Allyl chloride	VOC	SW8260B	0.01	Technology Limit	0.01	0.005	0.00021
Benzene	VOC	SW8260B	0.00246	VISL	0.001	0.0005	0.00005
Bromobenzene	VOC	SW8260B	0.125	VISL	0.01	0.002	0.00017
Bromochloromethane	VOC	SW8260B	0.106	VISL	0.01	0.002	0.00016
Bromodichloromethane	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.0001
Bromoform	VOC	SW8260B	0.214	VISL	0.01	0.002	0.0001

TABLE 2
PROJECT ACTION LIMITS AND LABORATORY DETECTION/QUANTITATION LIMITS - AQUEOUS SAMPLES
GOODFELLOW FEDERAL COMPLEX
REMEDIAL INVESTIGATION WORK PLAN

Analyte	Category	Test	PAL	PAL Reference	PQL Goal	PQL	MDL
Bromomethane	VOC	SW8260B	0.01	Technology Limit	0.01	0.005	0.00101
Carbon disulfide	VOC	SW8260B	0.177	VISL	0.01	0.002	0.00046
Carbon tetrachloride	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.0001
Chlorobenzene	VOC	SW8260B	0.0702	VISL	0.01	0.002	0.0001
Chloroethane	VOC	SW8260B	3.13	VISL	0.01	0.002	0.00021
Chloroform	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.00021
Chloromethane	VOC	SW8260B	0.0331	VISL	0.025	0.005	0.00018
Chloroprene	VOC	SW8260B	0.01	Technology Limit	0.01	0.005	0.00012
cis-1,2-Dichloroethene	VOC	SW8260B	70	MCL	0.01	0.002	0.00015
cis-1,3-Dichloropropene	VOC	SW8260B	0.596	MDNR RBTL (Inhal)	0.01	0.002	0.00012
cis-1,4-Dichloro-2-butene	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.00018
Cyclohexanone	VOC	SW8260B	404	VISL	0.1	0.02	0.016
Dibromochloromethane	VOC	SW8260B	80	MCL	0.01	0.002	0.00017
Dibromomethane	VOC	SW8260B	0.0199	VISL	0.01	0.002	0.00016
Dichlorodifluoromethane	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.00015
Ethyl acetate	VOC	SW8260B	2.13	VISL	0.05	0.01	0.00107
Ethyl ether	VOC	SW8260B	NE	NE	0.025	0.005	0.00017
Ethyl methacrylate	VOC	SW8260B	2.76	VISL	0.025	0.005	0.00029
Ethylbenzene	VOC	SW8260B	0.00609	VISL	0.006	0.002	0.0001
Hexachlorobutadiene	VOC	SW8260B	0.01	Technology Limit	0.01	0.005	0.00027
Hexachloroethane	VOC	SW8260B	0.01	Technology Limit	0.01	0.005	0.00025
Iodomethane	VOC	SW8260B	NE	NE	0.025	0.005	0.0026
Isopropylbenzene	VOC	SW8260B	0.179	VISL	0.01	0.002	0.00012
m,p-Xylenes	VOC	SW8260B	NE	NE	0.01	0.002	0.00018
Methacrylonitrile	VOC	SW8260B	0.495	VISL	0.025	0.005	0.00051
Methyl Methacrylate	VOC	SW8260B	10.1	VISL	0.025	0.005	0.00023
Methyl tert-butyl ether	VOC	SW8260B	0.664	VISL	0.01	0.002	0.0001
Methylacrylate	VOC	SW8260B	0.417	VISL	0.025	0.005	0.00025
Methylene chloride	VOC	SW8260B	0.685	VISL	0.01	0.002	0.00087
Naphthalene	VOC	SW8260B	0.01	Technology Limit	0.01	0.005	0.00036
n-Butyl acetate	VOC	SW8260B	NE	NE	0.01	0.002	0.00028
n-Butylbenzene	VOC	SW8260B	8.76	MDNR RBTL (Inhal)	0.01	0.002	0.00011
n-Heptane	VOC	SW8260B	0.01	Technology Limit	0.01	0.005	0.0002
n-Hexane	VOC	SW8260B	0.01	Technology Limit	0.01	0.005	0.00154
Nitrobenzene	VOC	SW8260B	0.151	VISL	0.1	0.05	0.01
n-Propylbenzene	VOC	SW8260B	0.452	VISL	0.01	0.002	0.0001
o-Xylene	VOC	SW8260B	0.0873	VISL	0.01	0.002	0.0001
Pentachloroethane	VOC	SW8260B	NE	NE	0.025	0.005	0.00036
p-Isopropyltoluene	VOC	SW8260B	98.5	MDNR RBTL (Inhal)	0.01	0.002	0.0001
Propionitrile	VOC	SW8260B	NE	NE	0.05	0.01	0.00092
sec-Butylbenzene	VOC	SW8260B	6.23	MDNR RBTL (Inhal)	0.01	0.002	0.0001
Styrene	VOC	SW8260B	1.65	VISL	0.01	0.002	0.00014
tert-Butylbenzene	VOC	SW8260B	9.43	MDNR RBTL (Inhal)	0.01	0.002	0.00011
Tetrachloroethene	VOC	SW8260B	0.00972	VISL	0.0025	0.0005	0.0001
Tetrahydrofuran	VOC	SW8260B	109	VISL	0.025	0.005	0.00081
Toluene	VOC	SW8260B	3.16	VISL	0.01	0.002	0.0001
trans-1,2-Dichloroethene	VOC	SW8260B	100	MCL	0.01	0.002	0.0001
trans-1,3-Dichloropropene	VOC	SW8260B	0.596	MDNR RBTL (Inhal)	0.01	0.002	0.00012
trans-1,4-Dichloro-2-butene	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.00017
Trichloroethene	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.00018
Trichlorofluoromethane	VOC	SW8260B	5.36	MDNR RBTL (Inhal)	0.025	0.005	0.00013
Vinyl acetate	VOC	SW8260B	1.61	VISL	0.025	0.005	0.00033
Vinyl chloride	VOC	SW8260B	0.004	Technology Limit	0.004	0.002	0.0001

PAL = Project Action Limit
PQL = Practical Quantitation Limit
MDL = Minimum Detection Limit
Values reported in units of mg/L.
VISL = USEPA Vapor Intrusion Screening Level for residential sites using default inputs
MCL = USEPA Maximum Contaminant Level for drinking water
MDNR RBTL (Inhal) = Missouri Department of Natural Resources Risk-Based Target Level for Residential Sites, Inhalation Pathway
MDNR RBTL (Ingest) = Missouri Department of Natural Resources Risk-Based Target Level for Residential Sites, Ingestion Pathway
NE = Limit not established.

TABLE 3
SAMPLING SUMMARY
GOODFELLOW FEDERAL COMPLEX
REMEDIAL INVESTIGATION WORK PLAN

Monitoring Wells and Groundwater Sampling

Sample IDs	Sample Type	ID Notes	Sample Notes	Analysis	Containers	Preservation	Hold Time
MW-# MM/YY EB	Monitoring Well Installation Equipment Blank	# = Well ID(next well)	1/day during monitoring well installation.	VOCs	2, 40-mL VOA vials	TSP, pH > 11	14 days
		MM = 2-digit month	Collect as auger rinsate blank during drilling.	PAHs	1, 125-mL glass	Unpreserved	7 days
		YY = 2-digit year		PCBs	1, 1000-mL glass	Unpreserved	7 days
				Targeted Metals (Total)	1, 250-mL plastic or glass	HNO3, pH < 2	180 days
MW-# MM/YY EB	Groundwater Sampling Equipment Blank	# = Well ID(next well)	1/day during monitoring well installation.	VOCs	2, 40-mL VOA vials	TSP, pH > 11	14 days
		MM = 2-digit month	Collect as rinsate blank on decontaminated equipment.	PAHs	1, 125-mL glass	Unpreserved	7 days
		YY = 2-digit year		PCBs	1, 1000-mL glass	Unpreserved	7 days
				Targeted Metals (Total)	1, 250-mL plastic or glass	HNO3, pH < 2	180 days
MW-# MM/YY	Groundwater Sample	# = Well ID		VOCs	2, 40-mL VOA vials	TSP, pH > 11	14 days
		MM = 2-digit month		PAHs	1, 125-mL glass	Unpreserved	7 days
		YY = 2-digit year		PCBs	1, 1000-mL glass	Unpreserved	7 days
				Explosives	1, 1 qrt amber container	Unpreserved	7 days
				TPH DRO/GRO/total	1, 125 mL glass, 2, 40 mL/ 1	Unpreserved/TSP/H204	14 days
				Targeted Metals (Total)	1, 250-mL plastic or glass	HNO3, pH < 2	180 days
			Dissolved metals analysis at 20% of wells (Dissolved metals samples to be lab filtered).	Targeted Metals (Dissolved)	1, 250-mL plastic or glass	Unpreserved	180 days
MW-# MM/YY D	Groundwater Duplicate Sample	# = Well ID	Collect duplicates for 5% of wells	VOCs	2, 40-mL VOA vials	TSP, pH > 11	14 days
		MM = 2-digit month	(1 duplicate per 20 wells)	PAHs	1, 125-mL glass	Unpreserved	7 days
		YY = 2-digit year	**BLIND TO LAB:** GW Dup 1, 2…	PCBs	1, 1000-mL glass	Unpreserved	7 days
				Targeted Metals (Total)	1, 250-mL plastic or glass	HNO3, pH < 2	180 days

Soil Borings and Soil Sampling

Sample IDs	Sample Type	ID Notes	Sample Notes	Analysis	Containers	Preservation	Hold Time
B-# EB	Soil Boring Equipment Blank	# = Boring ID	1/day during soil boring activities.	VOCs	2, 40-mL VOA vials (5035)	TSP, pH > 11	14 days
			Collect as rinsate blank on decontaminated equipment.	PAHs	1, 125-mL glass	Unpreserved	7 days
				PCBs	1, 1000-mL glass	Unpreserved	7 days
				Targeted Metals	1, 250-mL plastic or glass	HNO3, pH < 2	180 days
B-# TD-BD	Surficial Soil Sample	# = Boring ID	Surficial soil is 0-2 feet below land surface.	PAHs	1, 8-oz wide-mouth glass	Unpreserved	14 days
B-# TD-BD D	Duplicate Surficial Soil Sample	TD = Top of Sample Depth	Collect duplicates for 5% of samples	PCBs	1, 8-oz wide-mouth glass	Unpreserved	14 days
		BD = Bottom of Sample Depth	(1 duplicate per 20 samples)	Targeted Metals	1, 8-oz wide-mouth glass	Unpreserved	180 days
				TPH DRO/GRO/total	2, 8-oz wide-mouth glass, One 4 oz. glass jar; 1 MeOH vial and 2 TSP vials	Unpreserved/ meOH/TSP	14 days
				Explosives	1, 4 oz wide-mouth glass container	Unpreserved	14 days
				VOCs	2, 40-mL VOA vials (5035)	TSP, pH > 11	14 days
			BLIND TO LAB: Surf Soil Dup 1, 2…				
			PCB Congener analysis at 10% of samples	PCB Congeners	1, 8-oz amber glass	Unpreserved	365 days
B-# TD-BD	Surficial Soil Sample (VOCs)		targeted locations and If PID reading exceeds 50 ppm, analyze VOCs.	VOCs	2, 40-mL VOA vials (5035)	TSP, pH > 11	14 days
B-# TD-BD	Subsurface Soil Sample	# = Boring ID	Subsurface soil is 2-10 feet below land surface.	PAHs	1, 8-oz wide-mouth glass	Unpreserved	14 days
B-# TD-BD D	Duplicate Subsurface Soil Sample	TD = Top of Sample Depth	Collect duplicates for 5% of samples	PCBs	1, 8-oz wide-mouth glass	Unpreserved	14 days
		BD = Bottom of Sample Depth	(1 duplicate per 20 samples)	Targeted Metals	1, 8-oz wide-mouth glass	Unpreserved	180 days
				Explosives	1, 4 oz wide-mouth glass container	Unpreserved	14 days
				TPH DRO/GRO/total	2, 8-oz wide-mouth glass, One 4 oz. glass jar; 1 MeOH vial and 2 TSP vials	Unpreserved/ meOH/TSP	14 days
			BLIND TO LAB: Sub Soil Dup 1, 2…				

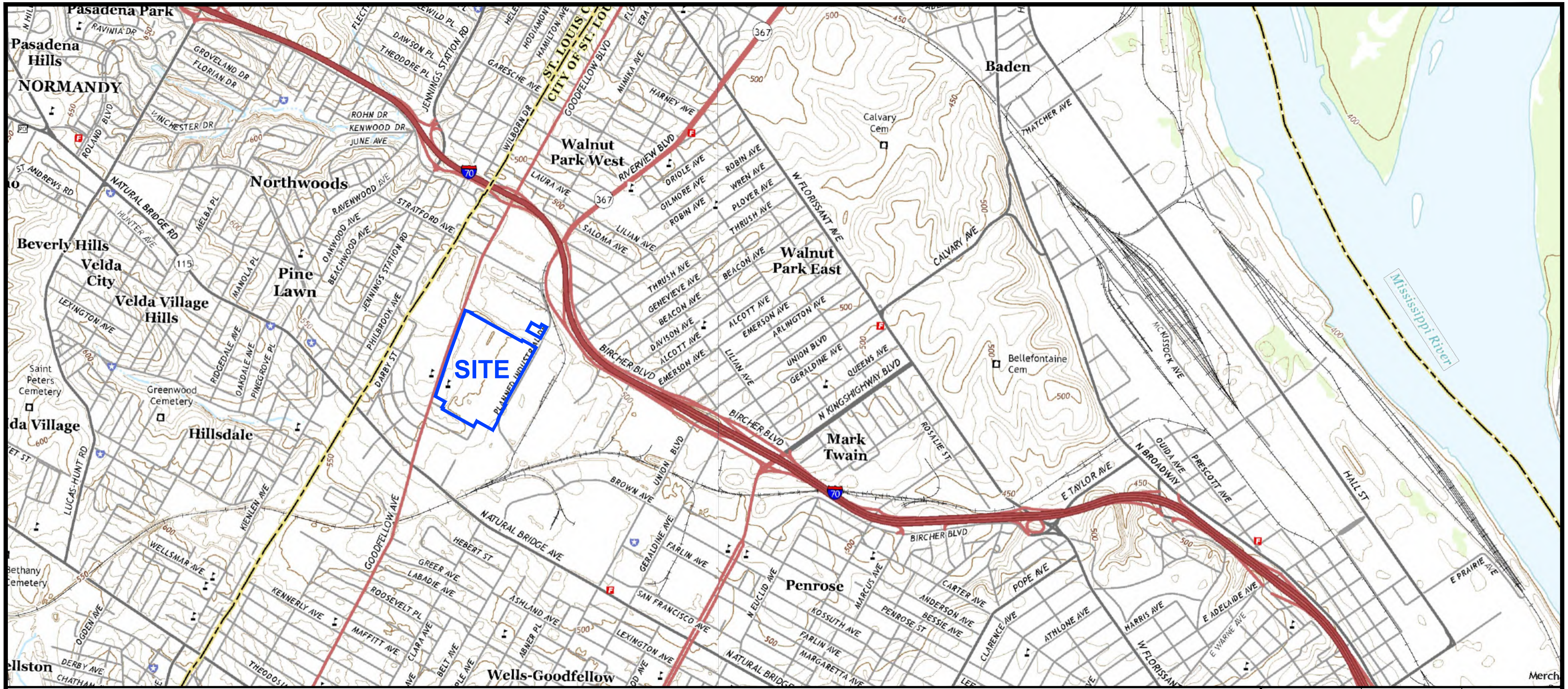
TABLE 3
SAMPLING SUMMARY
GOODFELLOW FEDERAL COMPLEX
REMEDIAL INVESTIGATION WORK PLAN

Sample IDs	Sample Type	ID Notes	Sample Notes	Analysis	Containers	Preservation	Hold Time
B-# TD-BD	Subsurface Soil Sample (VOCs)		targeted locations and If PID reading exceeds 50 ppm, analyze VOCs.	VOCs	2, 40-mL VOA vials (5035)	TSP, pH > 11	14 days

---

Submit one TRIP BLANK per cooler of VOC analysis. Name each sample "Trip Blank MM/DD/YYYY"
Preservation Note: Store samples on ice at temperatures above freezing and not to exceed 6 degrees Celsius.
Equipment blanks are collected after decontamination and prior to initiating the next exploration activity. Equipment blanks are named for the sampling location that follows the decontamination activities.

VOCs = Volatile organic compounds
PAHs = Polycyclic aromatic hydrocarbons (EPA list of 16 compounds)
PCBs = Polychlorinated biphenyls
Targeted Metals = Five metals (Sb, As, Cu, Pb, Zn)



NOTES

1. Plan adapted from 7.5 minute U.S.G.S. maps for Clayton, Missouri and Granite City, Illinois-Missouri quadrangles, last revised in 2015.

2. Site is approximately 66 acres.

N

0 2,000 4,000

SCALE IN FEET

Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

etegra

juniper environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

SITE LOCATION AND TOPOGRAPHY

Project Number
J034500.01

FIGURE 1

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

++++++++ Former Railroad Track Location
(From 7.5 Minute U.S.G.S. Quadrangle
Map for Clayton, Missouri Dated 1954)

N

0 250 500

SCALE IN FEET

Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

AERIAL SITE MAP

Project Number
J034500.01

FIGURE 2

(b) (7)(F)

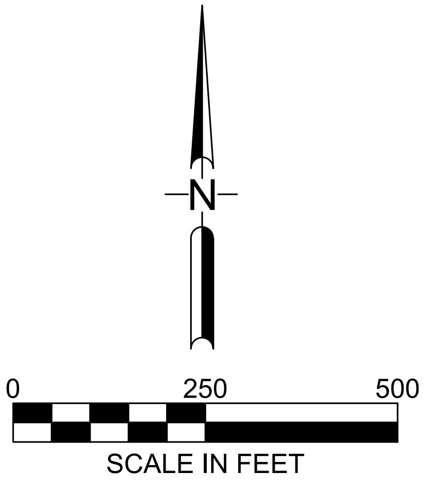
[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. All features are approximate.
3. This plan contains Controlled Unclassified Information (CUI).

LEGEND

▲ Proposed Permanent Groundwater Monitoring Well Location



Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

etegra

juniper environmental

GEOTECHNOLOGY INC
FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PROPOSED GROUNDWATER SAMPLE LOCATIONS

Project Number
J034500.01

FIGURE 3

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

PAHs METALS PCBs EXPLOSIVES TPH VOCs	Proposed Surface Soil Sample Location (to be Analyzed for Constituents shown Green, Constituents shown Red are Omitted from Analysis)

0 250 500

SCALE IN FEET

N

Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

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GEOTECHNOLOGY INC FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PROPOSED EXTERIOR SURFACE SOIL SAMPLING LOCATIONS

Project Number J034500.01

FIGURE 4

(b) (7)(F)

[redacted]

NOTES

1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments and drawings prepared by Tetra Tech, Inc.
2. This plan contains Controlled Unclassified Information (CUI).

LEGEND

★ Proposed Subsurface Soil Sample Location

N

0 250 500

SCALE IN FEET

Drawn By: WAH	Ck'd By:	App'vd By:
Date: 1-27-21	Date:	Date:

etegra

juniper environmental

GEOTECHNOLOGY INC FROM THE GROUND UP

St. Louis Federal Center
4300 Goodfellow Boulevard
St. Louis, Missouri

PROPOSED EXTERIOR SUBSURFACE SOIL SAMPLING LOCATIONS

Project Number
J034500.01

FIGURE 5

APPENDIX A

Standard Operating Procedures

STANDARD OPERATING GUIDELINE
ENV0002

Environmental Soil Logging and Sampling

March 2019

TABLE OF CONTENTS

APPENDICES

1.0 PURPOSE

Many variations of environmental soil logging exist. This Standard Operating Guideline (SOG) presents several typical drilling methods that are used. Environmental logging during a Phase II Environmental Sampling and Testing project typically consists of a combination of these drilling methods. Loggers and drillers should remember that how we leave the condition of a site is one of the biggest impressions we will make on our client and the public.

2.0 PRE-FIELD PROCEDURES

2.1 Drilling Group

A drill request form, copy of the proposal/scope of work with budget, directions to the site, a site map and any other client-specific information should be submitted to the head of the Drilling Group at least three days before drilling begins. In addition, a Utility Clearance Request must be submitted/phoned in to the appropriate parties. A copy of the Drill Request form is included in Appendix A. The drill request is also available on the Geotechnology intranet site.

2.2 Project Manager

The following items/information should be supplied by the Project Manager to the Logger:

- Copy of Drill Request form, directions to the site, and site map that includes proposed drilling locations.
- Project Number, Task Number, Project Name.
- Copy of the project proposal (including information about time/money budgeted for field activities and actions/notifications required in the event unforeseen conditions are encountered).
- Health and Safety Plan.
- Any non-standard PPE required for the task.
- Any significant site history not included in the proposal that is relevant to the drilling/logging.
- Site contact, client contact, site owner/representative contact.
- Order of borings to be drilled, if appropriate.
- Type of monitoring equipment needed, such as a photoionization detector (PID), water level indicator, survey equipment, etc.

- Sampling containers, labels, cooler, chain of custody, specified analytical testing laboratory, turnaround time, and billing information.

- Information concerning handling of spoils and decontamination water.

- Any client-related needs or expectations including schedule and communication procedures.

The Project Manager should review the results of all field work immediately upon completion, and discuss any abnormalities/inconsistencies with the Logger. Significant findings should be presented to the client prior to report preparation.

2.3 Logger

The Logger should bring the following materials to the jobsite in addition to any of the materials above supplied by the Project Manager:

- Environmental boring log field sheets;

- Sample cooler, containers, labels and chain-of-custody;

- Engineer's tape measure;

- Cooler with ice and Ziploc bags;

- Daily logging checklists;

- Photoionization detector (PID);

- Appropriate PPE;

- Water level indicator (WLI);

- Alconox or other such cleaning agent, brush, bucket, water, etc.;

- Plastic sealing bags (Ziploc®);

- Drums and drum labels;

- Surveyor's Tape or GPS unit for plotting boring locations;

- Environmental Equipment Log; and

- Pens, markers, pencils, knife, etc.

3.0 FIELD PROCEDURES

3.1 Pre-Drilling Activities

Prior to initiating drilling activities at the site, the following steps should be followed:

- Call utility locators a minimum of 48 hours prior to drilling (performed by Drilling Department).

- Contact the site contact concerning (typically by Project Manager:

    - Work to be performed including proposed drilling locations
    - Schedule
    - Contact information
    - What the site conditions will be when leaving the site
    - Contact's preference for certain areas of the site that need to be accessible during certain portions of the day and areas to be avoided
    - Contact’s preference for where drums or other waste will be temporarily stored.

- Upon arrival on the site, perform a site reconnaissance with the drill crew prior to drilling/air knifing to identify underground utility locations, overhead utilities, etc. **Mark all utility locations on the site plan.**

    - Look up and evaluate overhead utilities and other overhead features.
    - Yellow paint typically indicates gas lines.
    - Red paint typically indicates electric lines.
    - Orange paint typically indicates communication lines. Communication lines often have a marking somewhere along the line from the telephone company, such as AT&T.
    - Trenches are marked with two parallel lines connected by an X between them in the appropriate color.
    - Green paint typically indicates sewer lines.
    - In the St. Louis area, the Metropolitan Sewer District does not mark its utility lines. Look for sewer meters near streets and on buildings. Typically, the two are connected by the shortest path possible. Also check directions of sewers at inlet locations.
    - Blue paint typically indicates water lines. Locate off site manholes and/or water mains and line up with the location of anticipated on-site features.

- Conduct a tailgate Health and Safety meeting at the site with the drillers prior to drilling. We are responsible for the safety of our subcontractors but not the client’s representatives, agency, or insurance adjustor personnel. **Document the tailgate safety meeting using the fillable form on the Geotechnology intranet site.**
- Discuss the Scope of Work with the drillers prior to beginning drilling activities.

- Boring locations should be evaluated:
    - Boring locations should be at least 10 feet away from any overhead utility lines. A greater offset distance is required for higher voltage electrical lines.
    - Boring locations and pavement cutting should be at least 5 feet from any identified subsurface utilities. Drilling under the dispenser canopy at UST sites should be avoided.
    - Boring locations and pavement cutting should be at least 5 feet from a visual line connecting any two similar looking manhole covers.
    - Pavement in the vicinity of the proposed boring location should not indicate previous excavation (e.g. no pavement subsidence, differences in pavement texture, relief of patching.)
    - Boring locations are should be at least 10 feet from the underground storage tank (UST) pit.
    - Boring locations should be at least 15 feet from any pump island or other vapor recovery system.

3.2 Hand Auger Drilling/Air Knifing

Air knives (i.e., vacuum excavators) may be used for the first 4 to 5 feet of a boring in order to reduce the risk of hitting subterranean utilities with the drill rig. Hand augers may be used for shallow soil sampling. These methods do not use pressurized downhole mechanical means to advance the sampler. The hand auger bucket is typically approximately 6 inches deep and 3 inches in diameter.

If gravel, sand or other non-native fill material is encountered while hand augering, notify the Project Manager. The boring may need to be abandoned and offset.

Due to sloughing in the boring hole, each auger bucketful does not necessarily represent a 6-inch lift of in-situ soil. Therefore, typically a composite sample of several bucketfuls is considered a sample. For example, a sample from a depth of 0 to 2 feet might be considered a single sample when in fact it is comprised of 4 to 8 hand auger buckets. The boring log should reflect the entire composite sample interval. Hand auger samples are designated by the prefix "HA-" The auger bucket should be decontaminated between sampling intervals. Air knife-advanced boring samples should be designated with the standard grab prefix of "GB-".

If drill augers are used prior to hand augering in order to cut through concrete/asphalt or other impenetrable surface, note the thickness of the pavement and subgrade in the boring log.

3.3 Direct Push Drilling and Geoprobe®

Direct push drilling quickly collects soil samples. The sampler is typically a 4-foot long, 2-inch diameter acetate tube inserted inside a straight metal shaft sampling tube. The tube is advanced by drill rig pressure on top of the tube and rod extensions.

The acetate sample tube is removed from the metal shaft to access the sample. The sampling device, including the acetate sampling tube and metal shaft, have been observed to store potential energy causing the acetate liner and sample to “eject” out of the metal shaft. Field personnel should not stand within the potential trajectory of the sampler.

A sample trough and cutting tool will be supplied by the drillers. It is the Logger’s responsibility to open the sampler. Each sampler is considered one sample. However, the sample should be cut in half and each half stored in a separate sealed Ziploc bag. Each Ziploc bag represents 2 feet of sample. This helps assess the zone of impacted soil. Field screening tests should be performed on each of the two samples taken from the direct push sampler. Samples taken using direct push drilling are designated by the prefix “CS-” for Continuous Sampler.

For example, sample CS-2 might be from the interval 4-8 feet below land surface (bls), but two sets of field screening tests are conducted on the sample: one on 4-6 feet bls, the other on 6-8 feet bls.

3.4 Conventional Drilling

Due to drill rig availability or geotechnical/environmental combination drilling, conventional drilling may be used to obtain environmental samples. Typically, this method includes the use of hollow stem augers and split spoon samplers. Investigative derived waste materials are generated that must be tested, characterized, and stored on site for recovery/removal.

The typical split spoon sampler is 24 inches long. Samples may be taken in 18- or 24-inch sample runs. If the borings are strictly environmental, the split spoon sampler can be advanced in a similar fashion as the direct push sampler (in a 24-inch run, advanced continuously). However, for geotechnical purposes an automatic hammer is utilized. The number of blows that advances the sampler each of the six-inch intervals is recorded. If three 6-inch runs are used, the last two numbers are added together to give a Standard Penetration Test (SPT) number that corresponds to a consistency (such as soft, stiff, etc). If four 6-inch runs are used, the two middle numbers added together are the SPT number. This is an extra tool to help understand the in-situ soil conditions.

Split spoon samples are prefaced with the initials “SS-” in the boring log. The sample should be placed in a Ziploc bag and field tests performed. If a split spoon longer than 2 feet is used, the sample should be divided in half and separated into two sealed Ziploc® bags and field tests performed on both samples from the one sample interval. **The split spoon sampler should be decontaminated by the drillers between each sample interval.**

3.5 Soil Classification/Identification

Soil classification/identification is one of the most important tasks performed during environmental logging. Information can help to identify contamination, past site uses, and potential contaminant migration pathways.

- Geotechnology uses the Unified Soil Classification System (USCS) model for soil classifications and modifiers. A copy of the terms used in the USCS is included as Appendix C.

- Other modifiers that should be included in the field description of the soil include:

    - Color.
    - Mottling, which can be an indication of a high water table.
    - Estimated moisture: dry, moist, or wet. Dry soil should not leave water on your fingers, moist should have detectable water.
    - Silt or sand lenses encountered. Measure lenses and note where in the stratigraphic column they occur.
    - Fill material or native material.
    - Consistency (soft, hard, etc. utilizing thumb test or pocket penetrometer. This equivalency is included in Appendix B).
    - Unusual odors, liquids, or solids observed in the soil.
    - Unusual drilling problems such as grinding or rough drilling.

3.6 Field Screening

Field testing equipment can be used to assess the **relative** presence/absence of impact. Therefore, if field testing equipment is recalibrated or a new piece is exchanged, a few previously screened samples should be rescreened to assess the relative scale. Re-screened sample results should be noted on the boring log as well as the point at which the instrument was re-calibrated/exchanged.

Soil samples should be screened using a PID at 2 foot intervals or at changes in lithology. Samples should be kept in sealed containers (such as sealed Ziploc bags) until they are placed in the laboratory-provided containers. Place the tip of the PID in the bag for a maximum of 10 seconds or until the value stabilizes. Moisture may affect PID readings, as may temperature and the age of the contaminant. **The PID should be calibrated to an isobutylene standard of 100 parts per million (ppm) (for most sites) prior to use and at least once per day. PID calibration instructions can be viewed through the PID display screen or in the PID manual.**

Consistency is the key to good field testing. Samples can be held in a controlled environment until boring termination and then field tested, as long as the time between sample collection and testing is approximately the same for all samples. Otherwise, samples should be field tested shortly after collection.

In selecting a sample for laboratory analysis, first refer to the Scope of Services in the Work Plan. In general, the test with the highest field reading is sampled. Additional samples may be selected based on field screening results to define the vertical extent. Samples may also be collected at designated depths. If PID readings are not detected above background, a sample may be collected from the soil/water interface, the bottom of the boring, or a depth indicated by the Project Manager.

Be sure to keep track of all equipment used during the field project on the Environmental Equipment Log. This log is used to charge the Client for materials utilized during field work.

3.7 Collection of Soil Samples for Laboratory Analysis

Two kinds of samples can be taken: a grab sample or a composite sample. Grab samples are obtained from a single sample/interval. Composite samples are composed of soil from several sources in relatively equal amounts. Composite samples are typically used for waste characterization samples.

The following steps should be followed when collecting soil samples for analysis:

- New gloves should be used when packing the sample to avoid cross-contamination.

- Remove a sample container from the cooler, affix a label, and in indelible, waterproof ink write the sample I.D., the facility name, the sample collection date and time, the type of sample in the container, and the sample collector’s name/initials.

- If testing for multiple constituents, the following order of sample collection should be observed. Not all samples will be required on each sampling event. The order should remain consistent.

    - Volatile Organic Compounds (VOCs)
      Use soil core (i.e. 5035 extractor or Terracore®) provided by laboratory to collect the appropriate sample quantity.
    - Semi-Volatile Organic Compounds (SVOCs)
    - Base/Neutral and Acid Compounds (BNAs)
    - Polychlorinated biphenyl compounds (PCBs)
    - Total Organic Carbon (TOC)
    - Total Organic Halides (TOX)
    - Biochemical Oxygen Demand (BOD5)
    - Fecal Coliform

  - Oils
  - Metals and Mineral (Totals)
  - Metals and Minerals (Dissolved)
  - Cyanides
  - Chemical Oxygen Demand (COD)
  - Radionuclides

- Samples should be preserved by placing them in a cooler with sufficient ice to keep the temperature at 4°C.

3.8 Boring Logs

Boring logs are used to describe/classify soils during the time of exploration. An example of the environmental boring log is included as Appendix D.

The following information should be included on all environmental boring logs:

- Project name, project number, and task number.
- Name of boring.
- Ground surface elevation and datum used or NA.
- Date/Time started boring and Date/Time finished boring. This is important both to gauge time required to drill at that site for future projects and to justify to the client time spent in the field.
- Drill rig, samplers and auger size (if applicable) utilized
- Driller's name, logger's name.
- Whether or not groundwater was encountered and if so, at what depth, including perched groundwater zones.
- Name of sample.

- Sample names should begin with an abbreviation for the type of sampler utilized.
    - HA = Hand Auger Sample
    - CS = Continuous Sampler
    - SS = Split Spoon Sampler
    - GB = Grab Bag or Grab Sample

  All samples should be numbered consecutively, even if different samplers/drilling methods are utilized.

- Sample interval.

- Note which sample will be submitted to the laboratory for analysis.

- Classification of soil.
    - Classify using USCS - see Appendix C for USCS soil classifications and modifiers.
    - Color.
    - Consistency (soft, hard, etc. utilizing thumb test or pocket penetrometer).
    - Any unusual odors, liquids, solids, etc. observed in the soil.
    - Any unusual drilling problems such as grinding or rough drilling.

- Time sample collected.

- PID readings or results of any other field tests performed.

- Recovery of each sample interval.

- Stratigraphy-found at the bottom of the boring log and to be completed by the logger prior to submittal of logs to Project Manager. Only the logger at the site during drilling can accurately describe the stratigraphy encountered during the course of drilling.

- Termination depth and type of termination (boring termination, sampler refusal, auger refusal).

3.9 Decontamination

Contamination between samples can invalidate or provide inaccurate analytical information. To minimize this possibility, sampling equipment should be cleaned thoroughly (when using split spoon sampler) or discarded (when using continuous sampler with acetate disposable sleeve) between sample collection points or sites. Tools used in analyzing the samples, such as knives and pocket penetrometers, should also be decontaminated between samples. The Logger should also direct the drillers to decontaminate the augers between borings.

Materials for cleaning sampling equipment may include, depending on contaminants encountered/expected:

- Detergent (Liquinox or Alconox),
- Distilled water,
- Ethyl Alcohol (for petroleum products),
- Large wash pans/5-gallon buckets,
- Paper towels, and
- Brush(es).

Cleaning materials should be selected based on the contaminant to be removed. Primarily, the cleanser and solvent should be selected so that no chemical reaction with the contaminant is expected. Check with Project Manager for decontamination intervals and materials needed.

A general order for cleaning sampling equipment is to:

- Wash with warm detergent solution;
- Rinse several times with tap water;
- Rinse with distilled water;
- Drain excess water; and
- Allow to air-dry or dry with a stream of warm, dry air or wipe dry.

For samplers which have been used to sample petroleum products and oily residues, it may be necessary first to wipe the samplers with absorbent cloth to eliminate the residues. The equipment is then rinsed with an organic solvent such as petroleum naptha or trichloroethane followed by washing with the detergent solution and rinsed with distilled water.

If the cleaning process produces toxic fumes, adequate ventilation is important. If the washings are hazardous, washings should be stored in closed waste containers and disposed of properly in approved disposal sites. Clean samplers should be stored in clean and protected areas.

Both to avoid cross contamination and to protect yourself from contaminants, appropriate gloves should be worn at all times and changed frequently.

3.10 General Field Notes

Field Notes are extremely important during environmental logging. It is always better to record too many details than not enough. Information that should be in field notes includes:

- Time on-site;
- Weather;
- Personnel onsite, including logger, drillers, client representatives, and agency representatives;
- Discussions with the owner's representative, site manger or operator, agency or insurance adjustor personnel and drill crews;
- Work performed; and
- Copy of Daily Logging Checklist.

All field notes, chain of custody, summary logs, etc. should be transmitted to the Project Manager in a timely manner, preferably prior to sample shipment.

3.11 Completion of Field Activities

Prior to leaving the site, the Logger is responsible for communicating with the site contact/manager. The discussion should include a summary of the work performed and equipment that is being left on site (cones, barricades, etc), the reason and status for any materials left on-site (uncured concrete), the location of any drums or other waste containers, when additional field work will resume, and Geotechnology contact information. This information is summarized in the Daily Logging Checklist included in Appendix B.

Communicate with the drill crews exactly what is expected of them regarding the condition the site is left in. Loggers are expected to help out the drill crews, as needed, in order to complete site activities.

3.12 Backfill Procedures

The following procedures will be followed depending on the type of sampling conducted:

3.12.1 Air Knife

Drillers and loggers should be cognizant of the volume of material removed from the subsurface during air knife activities. The backfill should be clean material, including clean excavated material, well hydrated bentonite (preferably hydrated for a minimum of 3 hours) and finished at the surface with a 6" lift of concrete (FastSet or similar with a minimum cure time of 6 hours). Note, if the site owner/operator prefers cold asphalt patch, then a minimum 6" lift of asphalt should be installed and tamped tightly in place. Cure time for cold asphalt patch at the surface is 6 hours. A minimum of 3 orange cones or construction barricades should be placed immediately adjacent to the curing concrete/asphalt patch. The Driller and Logger should coordinate as to who will return to the site to inspect the surface finish and retrieve the cones/barricades.

3.12.2 Direct Push Technology, Geoprobe®, and Hollow Stem Auger Borings

Backfill should be well hydrated bentonite (preferably hydrated for a minimum of 3 hours) placed to within one foot of the ground surface. The surface should be finished with a 6” lift of concrete (FastSet or similar with a minimum cure time of 6 hours). Note, if the site owner/operator prefers cold asphalt patch, then a minimum 6” lift of asphalt should be installed and tamped tightly in place. Cure time for cold asphalt patch at the surface is 6 hours. A minimum of 3 orange cones or construction barricades should be placed immediately adjacent to the curing concrete/asphalt patch. The Driller and Logger should coordinate as to who will return to the site to inspect the surface finish and retrieve the cones/barricades.

3.12.3 Temporary Monitoring Wells

Temporary monitoring wells are sampled 24 hours after installation. Therefore, a steel plate specifically designed for open temporary monitoring wells is placed over the open hole once the temporary well is installed. After groundwater sampling and temporary well abandonment, well hydrated bentonite (preferably hydrated for a minimum of 3 hours) is placed to within one foot of the ground surface. The surface should be finished with a 6” lift of concrete (FastSet or similar with a minimum cure time of 6 hours). Note, if the site owner/operator prefers cold asphalt patch, then a minimum 6” lift of asphalt should be installed and tamped tightly in place. Cure time for cold asphalt patch at the surface is 6 hours. A minimum of 3 orange cones or construction barricades should be placed immediately adjacent to the curing concrete/asphalt patch. The Driller and Logger should coordinate as to who will return to the site to inspect the surface finish and retrieve the cones/barricades.

APPENDIX A

DRILL REQUEST FORM

GEOTECHNOLOGY INC
FROM THE GROUND UP

DRILLING REQUEST

Job Name: _____ Location: _____
Job & Task No.: _____ Project Manager: _____ Type Billing: Select One

---

GIVE ESTIMATIONS OF THE FOLLOWING

No. of Borings: _____ Total Footage: _____ Maximum Depth: _____ Depth to Rock: _____
Duration: _____ Duration ATV Required: ☐ Yes ☐ No NX Coring: ☐ Yes ☐ No

---

Earliest Start Date: _____ Latest Start Date: _____ Logger: _____
Work Hours: ☐ 8 Hour Day / 40 Hour Week ☐ 10 Hours Days ☐ OT Authorized to Meet Schedule

---

TOOLS & SUPPLIES REQUIRED:

☐ HSA Size (I.D.): Select One
☐ Rotary Wash Size: _____
☐ Split Spoons: Select One
☐ DPT (Tray/Liners/Cutter/Catchers)
☐ Shelby Tubes, Qty: _____
☐ Hand Auger, Length _____
☐ Asphalt Patch: _____
☐ Concrete Patch: _____
☐ Wood Plugs, Qty: _____
☐ Traffic Control, Type: _____
☐ Health & Safety Plan Attached: Select One
Distance to Site: _____ Miles
Water Availability: Select One
Utilities Cleared By: _____ (Date)

☐ Steamer
☐ Other Decon. Supplies Select One
☐ Screen: Size & Type: Select One
Amount: _____
☐ Bedrock well
☐ Riser: Size & Type: Select One
Amount: _____
☐ Well Cover: Type, Size: Select One
☐ Backfill: Select One _____
☐ 55-Gallon Drums, Qty: _____
☐ PPE Required, Type: Select
☐ Concrete Coring Machine or Diamond Core Bit Required, Specify: _____
☐ Missouri Certification/Registration Reports, No.: _____

Additional Comments / Instructions: _____

Drill requests (2 copies) are to be submitted to Drilling Manager a Minimum of 48 hours prior to earliest start date.
Map showing site location must be attached. Route budget sheet to Drilling Manager.

Submitted By: ____________________

Date ____________________

Revised 5.10.11

APPENDIX B

DAILY LOGGING CHECKLIST

Project: ______________________ Logger: ______________________

Project No. ______________________ Crew: ______________________

Date: ______________________

Yes No **Upon Arrival On Site – Prior to Starting Field Activities**

☐ ☐ Communicate with Site Operator/Manager. Review scope of work including proposed boring locations, discussion of known utilities and contact information.

Site Operator/Manager Name: ______________________

Contact Information: ______________________

☐ ☐ Communicate with Driller. Review scope of work including proposed boring location of marked and known utilities and required boring/well construction backfill details.

Discussion: ______________________

____

Logger's Initials: ____________ Driller's Initials: ____________

☐ ☐ Communicate with regulatory, insurance adjustor and site operator personnel.

☐ ☐ Conduct tailgate health and safety meeting. Geotechnology and any subcontractors are required to sign the HASP.

Upon Departure From Site – Prior to Leaving

☐ ☐ Drums/IDW containers labeled.

☐ ☐ Borings/wells properly constructed, finished at the surface, and guarded with cones/barricades.

☐ ☐ Communicate with Site Operator/Manager regarding schedule, equipment left on site, conditions of borings/monitoring wells, acknowledgement Operator/Manager about site conditions, site cleanliness and Geotechnology contact information. Tell the Operator/Manager to call us immediately (John Bostwick 314-452-7716) if they see a hole slump or have any other problems.

☐ ☐ Call Geotechnology Project Manager prior to leaving site.

Comments: ______________________

____

____

____

____

____

____

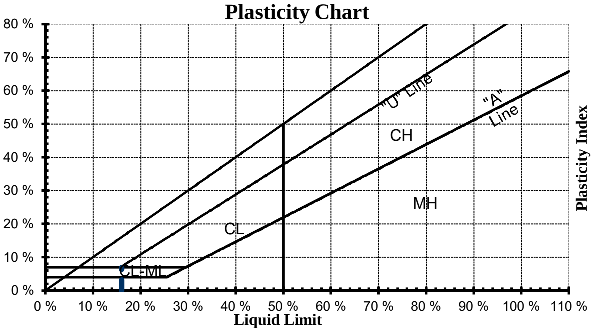
APPENDIX C

BORING LOG TERMS AND SYMBOLS

BORING LOG: TERMS AND SYMBOLS

LEGEND

CS	Continuous Sampler
GB	Grab Sample
NQ	NQ Rock Core
PST	Three-Inch Diameter Piston Tube Sample
SS	Split-Spoon Sample (Standard Penetration Test)
ST	Three-Inch Diameter Shelby Tube Sample
*	Sample Not Recovered
PL	Plastic Limit (ASTM D4318)
LL	Liquid Limit (ASTM D4318)
SV	Shear Strength from Field Vane (ASTM D2573)
UU	Shear Strength from Unconsolidated-Undrained Triaxial Compression Test (ASTM D2850)
QU	Shear Strength from Unconfined Compression Test (ASTM D2166)



SOIL GRAIN SIZE

US STANDARD SIEVE

12" 3" 3/4" 4 10 40 200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

300 76.2 19.1 4.76 2.00 0.42 0.074 0.005

SOIL GRAIN SIZE IN MILLIMETERS

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions			***Symbol***	***Description***
Coarse-Grained Soils (More than 50% Larger than No. 200 Sieve Size)	Gravel and Gravelly Soil	Clean Gravels Little or no Fines	GW	Well-Graded Gravel, Gravel- Sand Mixture
			GP	Poorly-Graded Gravel, Gravel-Sand Mixture
		Gravels with Appreciable Fines	GM	Silty Gravel, Gravel-Sand-Silt Mixture
			GC	Clayey-Gravel, Gravel-Sand-Clay Mixture
	Sand and Sandy Soils	Clean Sands Little or no Fines	SW	Well-Graded Sand, Gravelly Sand
			SP	Poorly-Graded Sand, Gravelly Sand
		Sands with Appreciable Fines	SM	Silty Sand, Sand-Silt Mixture
			SC	Clayey-Sand, Sand-Clay Mixture
Fine-Grained Soils (More than 50% Smaller than No. 200 Sieve Size)	Silts and Clays	Liquid Limit Less Than 50	ML	Silt, Sandy Silt, Clayey Silt, Slight Plasticity
			CL	Lean Clay, Sandy Clay, Silty Clay, Low to Medium Plasticity
			OL	Organic Silts or Lean Clays, Low Plasticity
	Silts and Clays	Liquid Limit Greater Than 50	MH	Silt, High Plasticity
			CH	Fat Clay, High Plasticity
			OH	Organic Clay, Medium to High Plasticity
	Highly Organic Soils		PT	Peat, Humus, Swamp Soil

STRENGTH OF COHESIVE SOILS

Consistency	***Undrained Shear Strength (tsf)***	***Unconfined Comp. Strength (tsf)***
Very Soft	less than 0.125	less then 0.25
Soft	0.125 to 0.25	0.25 to 0.5
Medium Stiff	0.25 to 0.5	0.5 to 1.0
Stiff	0.5 to 1.0	1.0 to 2.0
Very Stiff	1.0 to 2.0	2.0 to 3.0
Hard	greater than 2.0	greater than 4.0

DENSITY OF GRANULAR SOILS

Descriptive Term	***Approximate N_{60}-Value Range***
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	>50

N-Value (Blow Count) is the last two, 6-inch drive increments (i.e. 4/7/9, N = 7 + 9 = 16). Values are shown as a summation on the grid plot and shown in the Unit Dry Weight/SPT column.

RELATIVE COMPOSITION

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35 to 50%

OTHER TERMS

Layer - Inclusion greater than 3 inches thick.
Seam - Inclusion 1/8-inch to 3 inches thick
Parting - Inclusion less than 1/8-inch thick
Pocket - Inclusion of material that is smaller than sample diameter

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FROM THE GROUND UP

Relative composition and Unified Soil Classification System (USCS) designations are based on visual descriptions and are approximate only. If laboratory tests were performed to classify the soil, the USCS designation is shown in parenthesis.

APPENDIX D

BORING LOG/ WELL COMPLETION FORMS

ENVIRONMENTAL BORING LOG

Project Name: ____________________ **Project Number:** __________ **Task:** ______

Client: ____________________ Location: ______________ **Sheet** ______ of ______

Boring Number: __________ Surface Elevation: __________ Completion Date: __________

Utilities Clear: yes no Surface Material: __________ Latitude: __________

Drill Rig Type: __________ Driller: __________ Logger: __________ Longitude: __________

DRILLING DATA

	Size		Other	From	To		Sample Type	Length		Total Collected
Air Knife	yes		no			ft	Split Spoon (SS)		ft	
Hand Auger	2.25"	3.25"				ft	Shelby Tube (ST)		ft	
Hollow Stem	3.75"	4.25"				ft	Macrocore (CS)		ft	
Solid Stem	4"	6"				ft	Grab (GB)	NA	ft	
Direct Push	2.25"	3.25"				ft	Rock Core (NX2)		ft	
Mud Rotary	3.125"	4.125"				ft	Hand Auger (HA)		ft	
Air Rotary	6"	8"				ft	Other: __________		ft	

GROUNDWATER DATA

Not observed ☐ Initially Observed at: ______ ft

Measurement Obtained By: WLI Tape Log

Monitoring Well or Piezometer Installed: yes no

TERMINATION DATA

Total Boring Depth at: ______ ft bgs on __________

Auger refusal / term. at: ______ ft bgs on __________

Sampler refusal / term. at: ______ ft bgs on __________

FIELD BORING LOG DATA

Sample	Sample Depth (ft)		Field Description	Rec.	PID	GW Interval	
Type & No.	From	To				From	To

Depth (ft)		Stratigraphy	Remarks:
From	To	Measure & record ALL overburden matl. i.e. topsoil, asphalt, concrete	

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MONITORING WELL LOG DIAGRAM

Project Name: ______ **Project Number:** ______ **Task:** ______

Well Number: ______ Driller: ______ Logger: ______ Drill Rig: ______

Installation Date: ______ Developed Date: ______ Drill Method: ______

Riser: Ø ______ Length: ______ Type: ______ **Sand:** Type: ______ Bags: ______

Screen: Ø ______ Length: ______ Slot: ______ **Seal:** Type: ______ Bags: ______

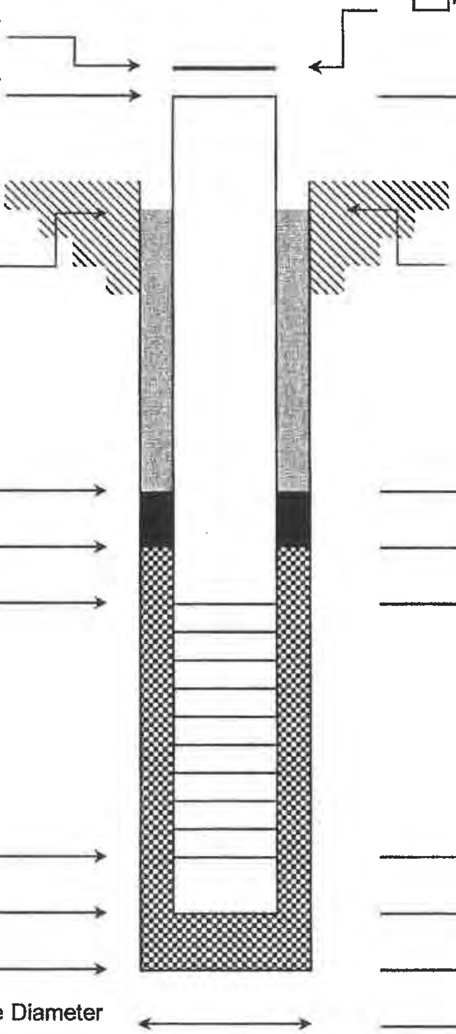
Cap: Ø ______ Length: ______ Type: Slip / Threaded **Backfill:** Type: ______ Bags: ______

Cut-Off Length: (-) ______ Screen Slit to Slit Length: ______ Tremie Used: yes no

Total Length of Materials: ______ Backfill Below Bottom Cap?: yes no Material(s) Used: ______

Total Measured Depth From Top of Riser: ______ **(ft)**

☐ Flushmount
☐ Aboveground



Protective Cover

Top of Riser ______ **Finished Height (ft)** [or recess bls]

Ground Surface 0 (ft) Elevation: ______ ft

Top of Backfill ______ Depth (ft bls)

Top of Seal ______ Depth (ft bls)

Top of Sand ______ Depth (ft bls)

Top of Screen ______ Depth (ft bls)

Bottom of Screen ______ Depth (ft bls)

Bottom of Well Cap ______ **Depth (ft bls)**

Bottom of Hole ______ **Depth (ft) [Total depth of boring from log]**

Hole Diameter ______ Diameter (in)

Well Construction Notes: ****ALL MEASUREMENTS TO 0.01 FT****

GEOTECHNOLOGY INC
FROM THE GROUND UP

GEOTECHNOLOGY INC
FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0003

Sample Shipping

March 2019

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE

The purpose of this SOG is to provide basic guidance for the proper preservation and shipping of environmental samples. The scope of this SOG is limited to general information concerning these procedures and does not include analytical laboratory-specific requirements.

2.0 PRE-SAMPLING INFORMATION

The following items/information should be supplied by the Project Manager to the engineer/scientist:

- Project name, project number, and task number.
- Copy of the project proposal (including information about time/money budgeted for field activities and possible extensions).
- Sampling containers, labels, cooler, Chain of Custody, and information about: where laboratory samples should be sent, type of analyses, turn around time, and billing information.

3.0 PROCEDURES

The engineer/scientist is responsible for obtaining, preserving, packaging and transporting the samples. The following steps should be observed:

- Perform sampling according to SOG ENV0002 or the project-specific work plan.
- Some samples require special handling such as:
    - VOCs are collected first and water samples should be added to the containers such that no air space is in the container or using a plunger to get a specific volume per laboratory requirements. For water samples, invert the container and observe if there are air bubbles that accumulate in the bottom of the container. If there are ANY air bubbles, discard the sample and obtain another sample. Be careful not to overfill the container as this may remove the preservation agent. For VOC soil samples, the container should be filled such that there is essentially zero headspace.
    - Metal and mineral groundwater samples shall be acidified to a pH less than 2 S.U. by addition of $HNO_{3.}$
    - Oils, TOC, TOX, COD and nitrogen samples shall be acidified to a pH less than 2 S.U. by the addition of H_2SO_4.
    - Cyanide samples shall be preserved in an alkaline environment with a pH greater than 12.5.4 by addition of NaOH.
    - TOX sample containers must be filled such that no air apace is present within the sample container.

- Sample containers should be stored on ice in a cooler until packaged/delivered to laboratory.

- All samples, shipped or delivered, shall be accompanied by a fully completed Chain of Custody record. The Chain of Custody is necessary by law to track the possession of potentially hazardous materials. The Chain of Custody must include the following information:

    - Name of environmental consultant (Geotechnology, Inc.)
    - Sampler's name
    - Project name/location/number
    - Date sampled
    - Sample names
    - Sample type/container size/number
    - Analysis to be performed
    - Billing information
    - Where to send results
    - Signature of sampler
    - The Chain of Custody may be in triplicate form. Alternatively, a copy should be made when the samples are shipped. One copy will be kept at Geotechnology, and a copy or the original with all the signatures will be sent to Geotechnology with the final analytical results.

- Samples shall be transported to the laboratory in sealed, insulated shipping containers, ice chests, or coolers. The shipping containers should be sturdy, and if samples are contained in glass bottles, cushioning such as bubblewrap or dividers should be used to separate the bottles.

- Samples will be packed in ice for proper preservation. The temperature of the samples is maintained as close to 4 degrees Celsius (39 degrees Fahrenheit) as possible from the time the samples are collected to the time the samples are received by the laboratory. **NOTE: Liquids must be secured within the cooler. Melting ice/water cannot be allowed to escape the cooler during shipment. If this happens, the delivery service will not deliver the cooler to the laboratory.** Prepare package appropriately as follows: First, place bubble wrap in the bottom of the cooler. Then, place a large, thick trash bag into the cooler. Contain the ice in one-gallon Ziploc bags and place ice into the trash bag. Place sample containers, wrapped in bubble wrap into the ice. Place more ice (contained in Ziploc bags) on top of the samples. Overlap bag so that water will not spill out during transport. Place Chain of Custody and Purchase Order into a Ziploc bag and place on top of the closed trash bag. Add bubblewrap, if necessary, to fill in extra space in the cooler.

- Samples should be shipped/delivered to the laboratory as soon as practical, preferably within 48 hours of sample collection. However, many of the labs do not have technicians on staff on Saturdays, so it is often best to place the samples in the refrigerators in Geotechnology's environmental equipment room if samples would arrive at the laboratory on Saturday. Keep the COC with the samples in the refrigerator. The samples should then be packaged for shipment on Monday. **NOTE: Do not prepare the cooler for shipment and then place it in the refrigerator for the weekend. The cooler is an insulator, and as such, the cool refrigerated air will not enter the cooler. If storing the samples in a cooler in the refrigerator, prop cooler lid open in order to allow refrigeration.**

- A Purchase Order must be prepared and submitted with the Chain of Custody if the bill is going to Geotechnology.

- Two Chain of Custody seals should be attached to the cooler if the laboratory is not picking up the samples. These should be attached over the entry points. The laboratory can tell if the cooler/samples may have been tampered with if these seals are broken upon arrival. Some laboratories supply Chain of Custody seals, but extra Chain of Custody seals are available if they do not. Then sign your name and the date you are sealing the cooler. Affix to the cooler such than the labels will break if the cooler is opened. Secure the labels with tape if needed.

- The cooler should be securely closed with packaging tape. The cooler should also be taped closed along potential water escape routes, such as along the edge of the lid and at any drainage spouts.

- A shipping/billing label should be securely fastened to the top or front of the cooler.

- Place the cooler at the front desk for shipping or laboratory pick up.

GEOTECHNOLOGY INC
FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0004

Monitoring Well Installation and Development

March 2019

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APPENDICES

1.0 PURPOSE AND SCOPE

The scope of this SOG is limited to installation of monitoring wells, measuring and logging appropriate parameters during monitoring well installation and monitoring well development.

2.0 PRE-FIELD PROCEDURES

2.1 Project Manager

A drill request form, directions to the site and a site map should be submitted to the head of the drilling department. In addition, a utility clearance request must be submitted/phoned in to the appropriate parties by the drilling department. A copy of the Drill Request form is included in Appendix A and is also available on the Geotechnology intranet site.

The following items/information should be supplied by the Project Manager to the Project Engineer/Scientist:

- Copy of Drill Request, directions to the site and site map that includes proposed drilling locations.
- Project Number, Task Number, Project Name.
- Copy of the project proposal (including information about time/money budgeted for field activities and actions/notifications required in the event unforeseen conditions are encountered).
- Health and Safety Plan.
- Any non-standard PPE required for the task.
- Any significant site history not included in the proposal that is relevant to the drilling/logging/installation/development.
- Site contact.
- Order of monitoring wells to be installed.
- Type of equipment needed.
- Information concerning what is to be done with any spoils generated.

The Project Manager should review the results of all field work immediately upon completion, and discuss any abnormalities/inconsistencies with the Project Engineer/Scientist. Significant findings should be presented to the client prior to report preparation.

2.2 Project Engineer/Scientist

The Project Engineer/Scientist should bring the following materials to the jobsite for monitoring well installation and development in addition to any of the materials above supplied by the Project Manager:

Monitoring Well Installation

- Boring Log Field Sheets/Monitoring Well Installation Logs (Appendix B).
- Appropriate PPE.
- Drum labels.
- Surveyor's Tape or GPS unit for plotting boring locations and for measuring well construction materials.
- Waste Log.
- Environmental Equipment Log (Copy is saved in STDPAR/ENVIRONMENTAL).
- Clipboard, pens, markers, pencils, knife.

Monitoring Well Development

- Well Gauging Data Sheets (included in Appendix C) and a copy of the completed Monitoring Well Installation Logs.
- Appropriate PPE.
- Drum labels.
- Water level or interface probe.
- Environmental Equipment Log (A copy is saved in STDPAR/ENVIRONMENTAL).
- Clipboard, pens, markers, pencils.
- Purging bailer and rope, or a pump, as directed by the Project Manager or listed in the project proposal.

- Buckets, brushes, and soap (such as Alconox) for decontamination.
- Tools: well head wrench, key for locking well cap, hammer, screw driver, turkey baster (for removing water pooled between well head and well cap), crescent wrench, pliers, scissors, knife.

3.0 FIELD PROCEDURES

3.1 Monitoring Well Installation

Monitoring well installation logs are used to record field measurements. A copy of the Monitoring Well Installation Log is included as Appendix B. Monitoring well locations should be measured from existing site features and sketched onto the site plan. If cuttings are generated and will be drummed, note the storage location, and the number of full drums, and be sure to label all drums appropriately.

The following information should be recorded on all monitoring well installation logs:

- Project Name, Project Number, and Project Task.
- Name of monitoring well.
- Ground surface elevation and datum used.
- Date monitoring well was installed.
- Auger size. The outer diameter of the auger is the diameter of the hole. Ask the driller for this dimension.
- Total depth of well to top of casing using tape or water level indicator.
- Bottom cap type, length, and diameter. On the Monitoring Well Installation Log, the bottom of hole is the depth of the hole and the bottom of the well starts at the bottom of the bottom cap.
- Screen type, length, and diameter.
- Casing type, length, and diameter.
- Length of cutoff. Typically, the casing is too long for the hole and is cut. Measure the amount of casing that is cut off.

- Survey in the top of the well cover and the top of casing using a laser level or standard optical survey equipment. If survey equipment is not available, estimate the distance from the ground surface to the top of casing and record it. A survey can be performed at a later date and the well dimensions re-calculated at that time.

- Depth to top of filter material (typically sand). The filter pack should be around the screened interval and typically two feet additional sand above the top of screen.

- Interval depth of the seal (typically two feet of bentonite).

- Type of flush mount or other well protection used.

- After top of casing (TOC) and ground surface (GS) have been surveyed, calculate elevations from depth measurements.

3.2 Monitoring Well Development

- Measure depth to water and total depth using a water level indicator.

- Calculate required 5 well volumes.

- Tie rope securely to bailer or set up a development pump at the well.

- Remove 5 well volumes or until well is dry. The water column should be surged repeatedly using the bailer or a surge block to attempt to remove fine-grained particles.

- Record approximate purged volume. Place the purged water in a drum or dispose of the purge water as noted in the project proposal.

- Decontaminate the PVC bailer or pump and use new rope for the next well, or use a new disposable bailer.

- Label drums and record number of drums and location.

- Record date of development on the Monitoring Well Installation Log.

APPENDIX A

DRILL REQUEST FORM

GEOTECHNOLOGY INC
FROM THE GROUND UP

DRILLING REQUEST

Job Name: _____ Location: _____
Job & Task No.: _____ Project Manager: _____ Type Billing: Select One

GIVE ESTIMATIONS OF THE FOLLOWING

No. of Borings: _____ Total Footage: _____ Maximum Depth: _____ Depth to Rock: _____
Duration: _____ Duration ATV Required: ☐ Yes ☐ No NX Coring: ☐ Yes ☐ No

Earliest Start Date: _____ Latest Start Date: _____ Logger: _____
Work Hours: ☐ 8 Hour Day / 40 Hour Week ☐ 10 Hours Days ☐ OT Authorized to Meet Schedule

TOOLS & SUPPLIES REQUIRED:

☐ HSA Size (I.D.): Select One
☐ Rotary Wash Size: _____
☐ Split Spoons: Select One
☐ DPT (Tray/Liners/Cutter/Catchers)
☐ Shelby Tubes, Qty: _____
☐ Hand Auger, Length _____
☐ Asphalt Patch: _____
☐ Concrete Patch: _____
☐ Wood Plugs, Qty: _____
☐ Traffic Control, Type: _____
☐ Health & Safety Plan Attached: Select One
Distance to Site: _____ Miles
Water Availability: Select One
Utilities Cleared By: _____ (Date)

☐ Steamer
☐ Other Decon. Supplies Select One
☐ Screen: Size & Type: Select One
Amount: _____
☐ Bedrock well
☐ Riser: Size & Type: Select One
Amount: _____
☐ Well Cover: Type, Size: Select One
☐ Backfill: Select One _____
☐ 55-Gallon Drums, Qty: _____
☐ PPE Required, Type: Select
☐ Concrete Coring Machine or Diamond Core Bit Required, Specify: _____
☐ Missouri Certification/Registration Reports, No.: _____

Additional Comments / Instructions: _____

Drill requests (2 copies) are to be submitted to Drilling Manager a Minimum of 48 hours prior to earliest start date. Map showing site location must be attached. Route budget sheet to Drilling Manager.

Submitted By: _______________ Date _______________

APPENDIX B

MONITORING WELL INSTALLATION LOG

MONITORING WELL LOG DIAGRAM

Project Name: ______ **Project Number:** ______ **Task:** ______

Well Number: ______ Driller: ______ Logger: ______ Drill Rig: ______

Installation Date: ______ Developed Date: ______ Drill Method: ______

Riser: Ø ______ Length: ______ Type: ______ **Sand:** Type: ______ Bags: ______

Screen: Ø ______ Length: ______ Slot: ______ **Seal:** Type: ______ Bags: ______

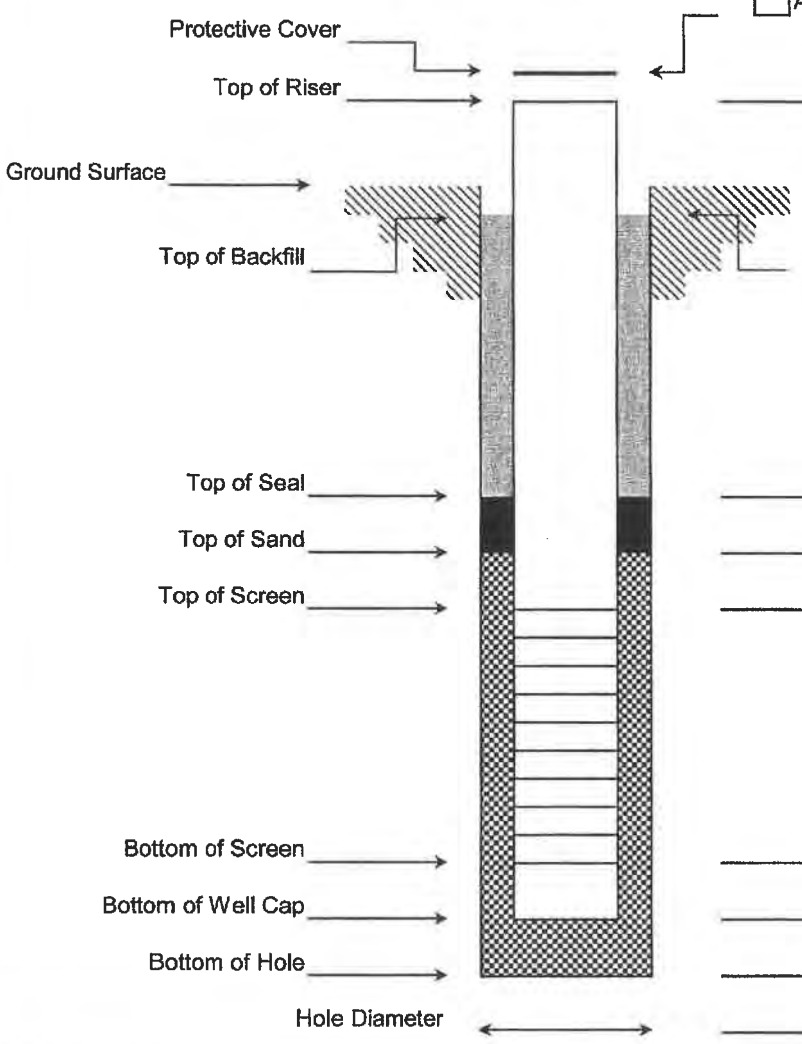
Cap: Ø ______ Length: ______ Type: Slip / Threaded **Backfill:** Type: ______ Bags: ______

Cut-Off Length: (-) ______ Screen Slit to Slit Length: ______ Tremie Used: yes no

Total Length of Materials: ______ Backfill Below Bottom Cap?: yes no Material(s) Used: ______

Total Measured Depth From Top of Riser: ______ **(ft)**

☐ Flushmount
☐ Aboveground



______ **Finished Height (ft)** [or recess bls]

0 (ft) Elevation: ______ ft

______ Depth (ft bls)

______ Depth (ft bls)

______ Depth (ft bls)

______ Depth (ft bls)

______ Depth (ft bls)

______ **Depth (ft bls)**

______ **Depth (ft) [Total depth of boring from log]**

______ Diameter (in)

Well Construction Notes: ****ALL MEASUREMENTS TO 0.01 FT****

GEOTECHNOLOGY INC
FROM THE GROUND UP

APPENDIX C

WELL GAUGING DATA SHEET

PAGE _____ OF _____

WELL GAUGING/WATER SAMPLING LOG

GEOTECHNOLOGY INC
FROM THE GROUND UP

JOB NO. ____________________

JOB NAME ____________________

SITE LOCATION ____________________

PERSONNEL ____________________

					A	B	C	D	E	F								
Well No.	Date	Time	Desc. Of Meas. pt	Dia. Of Casing (in.)	Depth to Water (ft.)	Total Depth (ft.)	Water Column (ft.)	Gallons Per Foot * (Gal/ft.)	Gallons in Well (1 Well Vol.)	Three Well Vols. (Gal.)	Purged Volume (Gal.)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	pH (SU)	Temp. (°C)	S.C. (S/m)	Remarks

***WELL CASING VOLUMES (GALLONS/FT.)**

1 1/4" = 0.06   2" = 0.16   3" = 0.37   4" = 0.65
8" = 2.59   1 1/2" = 0.09   2 1/2" = 0.26

FORMULAS

B - A = C   D * C = E
E x 3 = F

std par/Well Gauge Multi Parameter Log 2018 new logo.xls

GEOTECHNOLOGY INC
FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0005

Monitoring Well Gauging, Purging, and Sampling

March 2019

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APPENDIX

1.0 PURPOSE

The purpose of this SOG is to provide guidance for the proper performance of environmental monitoring well gauging, purging, and sampling. Purging and sampling methods will vary based on site conditions and regulatory requirements. Procedures for installation of monitoring wells are presented in SOG ENV0004 – Monitoring Well Installation and Development.

2.0 PRE-FIELD PROCEDURES

2.1 Project Manager

The Project Manager is responsible for being familiar with the project proposal/work plan and Health and Safety Plan. The following items/information should be supplied by the Project Manager to the engineer/scientist and discussed prior to field mobilization.

- Project Name, Project Number, and Task Number;
- Copy of the project proposal/work plan (including information about field activities and actions/notifications required in the event unforeseen conditions are encountered);
- Site map;
- Copy of most recent groundwater sampling results;
- Health and Safety Plan;
- Non-standard PPE required for the task;
- Site history not included in the proposal that is relevant to the site;
- Site contact;
- Order of monitoring wells to be gauged, purged and sampled (typically least to most impacted);
- Type of monitoring equipment needed (water level indicator, pump, survey equipment, etc.);
- Sampling containers, labels, cooler, Chain of Custody, specified analytical testing laboratory turnaround time, billing information; and
- Information concerning handling of purged water.

The Project Manager should review all field work upon completion and discuss any abnormalities/inconsistencies with the engineer/scientist. Significant findings should be presented to the client prior to report preparation.

2.2 Engineer/Scientist

The engineer/scientist should bring the following materials to the jobsite in addition to any of the materials above supplied by the Project Manager.

- Appropriate PPE;
- Alconox or other appropriate cleaning agent, brush, bucket, water;
- Watch (timepiece);
- Drum labels;
- Surveyor’s Tape, and/or ruler;
- Environmental Equipment Log;
- Clipboard, pens, markers, pencils;
- Knife/scissors;
- Groundwater Gauging/Sampling Log;
- Waste Log;
- Rope/string;
- PVC bailer or submersible pump for purging;
- Disposable bailers (based on the size/number of wells to be sampled);
- If using low-flow sampling methods:
    - peristaltic pump and tubing (less than 30 feet);
    - electric submersible (Grunfos);
    - pneumatic (bladder pumps) for deeper wells.
- Water quality meter(s) and flow through cell (if using low-flow sampling methods);
- Laptop or other meter interface system (if using low-flow sampling methods);

- Buckets for purge water;
- Tools (pliers, drum wrench, well head wrench, key for locking well cap, hammer, screw driver, turkey baster);
- Water level indicator (or interface probe); and
- Drums/polytanks.

3.0 FIELD PROCEDURES

Gauging, purging and groundwater sampling typically occurs at least 24-48 hours after permanent wells have been developed, depending on the purpose and regulatory program. Temporary wells may or may not be subject to development procedures prior to sampling. Discuss with the Project Manager.

Appropriate PPE should be worn at all times and changed frequently to avoid cross contamination and to protect yourself from contaminants.

3.1 Gauging

- Fill out the Groundwater Gauging/Sampling Log (Appendix A).
- Lower the probe of the water level indicator (or interface probe) into well slowly until it indicates that water has been encountered.
- Record the water level as measured from the top of casing (TOC). Best from indicator mark or from north edge for consistent measurement level.
- Obtain the total depth measurement by lowering the probe to the bottom of the well and record the depth from TOC.
- Record information about the condition of the well. Indicate if well caps, locks, or pad require replacement.
- Decontaminate the water level indicator or interface probe between wells.

3.2 Purging

Purging can be performed by using a PVC bailer, disposable bailer, submersible pump, or a pump appropriate for low-flow methods per the following procedure:

- Sample wells in order of increasing contamination if practical unless otherwise stated by the project Work Plan or Project Manager.

- Calculate three well volumes after gauging and record on appropriate place on the gauging/sampling log (Appendix A).

- Remove water using either a bailer or a submersible pump until three well volumes have been removed or the well goes dry.

  - <u>Bailer</u> – Tie rope securely to the bailer. Lower the bailer <u>gently</u> into the well to avoid agitation that can cause volatilization of potential contaminants or turbidity issues. Retrieve the bailer when it is full of water.
  - <u>Submersible Pump</u> – Assemble pump per manufacturer's instructions and gently lower into well approximately center of screen or one foot off the bottom of the well.
  - <u>Low-Flow Methods</u> – See Section 3.4

- Place purge water into an on-site labeled drum.

- Record information on the Groundwater Gauging/Sampling Log (Appendix A).

3.3 Sampling Using a Disposable Bailer

- Remove a sample container from the cooler, affix a label, and in indelible, waterproof ink write the sample identification, the project name, the sample collection date and time, the type of sample in the container, and the sample collector's name/initials.

- Wearing disposable gloves, securely tie new string to the disposable bailer.

- Lower the bailer <u>gently</u> into the well to avoid agitation that can cause volatilization of potential contaminants or turbidity issues.

- Retrieve the bailer when it is full of water.

- The first sample collected will be for VOC's (if tested). Samples should be added to the containers such that no air space exists in the container. Add water until an inverted meniscus (bubble) is seen on top. Secure container cap. Invert the container and observe any air bubbles that may accumulate in the bottom of the container. If there are ANY air bubbles, add sample and reaffix the cap. Place containers in cooler on ice. Water containers typically arrive from the lab with a small amount of preservative in the bottom. Be careful not to overfill the container so the preservative is not lost. If the sample effervesces, call the laboratory for procedure.

- If testing for multiple constituents, the following order of sample collection should be observed. Although not all samples will be required on any given sampling trip, the order should remain consistent.

  - Volatile Organic Compounds (VOCs),
  - Semi-Volatile Organic Compounds (SVOCs),
  - Base/Neutral and Acid Compounds (BNAs),
  - Polychlorinated biphenyl compounds (PCBs),
  - Total Organic Carbon (TOC),
  - Total Organic Halides (TOX),
  - Biochemical Oxygen Demand (BOD5),
  - Fecal Coliform,
  - Oils,
  - Metals and Mineral (Totals),
  - Metals and Minerals (Dissolved),
  - Cyanides,
  - Chemical Oxygen Demand (COD), and
  - Radionuclides.

- Sample containers should then be stored on ice in a cooler until packaged/delivered to laboratory.

- Use new string and disposable bailer for each well to avoid cross-contamination.

- All samples, shipped or delivered, shall be accompanied by a Chain of Custody record. The Chain of Custody is required by law to track the possession of potentially hazardous materials. See SOG ENV0003 Sample Shipping for instructions on how to properly preserve, prepare, and transport the samples.

- Record pertinent information (generator, material stored, date) on drum label and affix to drums. Store drums on site until they are characterized and disposed of (must be <90 days).

3.4 Low Flow Purging and Sampling

Low flow purging and sampling is a method which is used to minimize stress (drawdown) to the groundwater/monitoring well system. In general, the advantages of low-flow purging and sampling include:

- Samples are more representative of the mobile load of contaminants present.
- Reduced disturbance of the water column in the monitoring well which reduces the amount of sampling artifacts.
- Reduced drawdown on the water-bearing formation.
- Less mixing of stagnant casing water with formation water.
- Reduced purge volume.

The general low flow purging/sampling procedure is as follows:

- Calibrate the low-flow sampling equipment sensor according to manufacturer's instructions daily prior to beginning work.
- Check the wellhead for damage or evidence of tampering, and record pertinent observations.
- Perform a water level measurements on all monitoring wells at the site. Follow the gauging procedures in Section 3.1.
- Purge/sample wells in order of increasing contamination, if practical, unless otherwise stated by the project Work Plan or Project Manager.
- Lower the water level indicator probe into the well until the air-water interface is reached. Measure and record the water level.
- Lower tubing or pumps slowly into the well with the intake at the midpoint of the saturated well screen length. Depending on the contaminants of concern, this may be adjusted to lower or upper third of the screen. Do not let the intake of the pump touch the bottom of the well. Skip this step if there is already a dedicated pump in the well.
- Connect the pump discharge tube to the flow-through cell. The discharge tube on the outflow side of the flow-through cell should be directed to a bucket or a 55-gallon drum.
- Place the water quality meters in the flow-through cell and attach the connections as needed to read real-time stabilization parameters.

- Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Flow rates of 100 to 500 mL/min are typical. Use a flow rate that does not form air pockets in the tubing.

- Monitor and record the water level and pumping rate every 1 to 5 minutes. Adjust the pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimum drawdown that can be achieved exceeds 0.3 feet, continue to purge until groundwater field parameters stabilize.

- Monitor the real-time output to assess when groundwater stabilization occurs. Typical stabilization parameters include pH, temperature, specific conductivity, dissolved oxygen and REDOX. Stabilization is achieved when three consecutive readings, taken at 3 to 5 minute intervals, are generally within the following limits unless the Work Plan states otherwise:

  - Dissolved oxygen: 10%
  - Specific conductivity: 3%
  - pH: +/- 0.2 unit
  - ORP: +/- 10 millivolts
  - Temp 0.5

- Once stabilization occurs, open the bypass valve on the upgradient side of the flow-through cell and collect the groundwater sample into the appropriate labeled containers. Water samples must be collected before water has passed through the flow-through cell.

- The first sample collected will be for VOC’s (if tested). Samples should be added to the containers such that no air space exists in the container. Add water until an inverted meniscus (bubble) is seen on top. Secure container cap. Invert the container and observe any air bubbles that may accumulate in the bottom of the container. If there are ANY air bubbles, add sample and reaffix the cap. Place containers in cooler on ice. Water containers typically arrive from the lab with a small amount of preservative in the bottom. Be careful not to overfill the container so the preservative is not lost. If the sample effervesces, call the laboratory for procedure.

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    - Volatile Organic Compounds (VOCs),
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    - Polychlorinated biphenyl compounds (PCBs),
    - Total Organic Carbon (TOC),
    - Total Organic Halides (TOX),
    - Biochemical Oxygen Demand (BOD5),
    - Fecal Coliform,
    - Oils,
    - Metals and Mineral (Totals),
    - Metals and Minerals (Dissolved),
    - Cyanides,
    - Chemical Oxygen Demand (COD), and
    - Radionuclides.

- Sample containers should then be stored on ice in a cooler until packaged/delivered to laboratory.

- All samples, shipped or delivered, shall be accompanied by a Chain of Custody record. The Chain of Custody is required by law to track the possession of potentially hazardous materials. See SOG ENV0003 Sample Shipping for instructions on how to properly preserve, prepare, and transport the samples.

- Before removing the tubing or pump, measure and record the water level in the well.

- Remove the pump, tubing and wiring from the well, and replace the well cover.

- Record pertinent information (generator, material stored, date) on drum label and affix to drums. Store drums on site until they are characterized and disposed of (<90 days).

3.5 Decontamination

Decontaminate probe, submersible pump, PVC bailer, and other non-dedicated equipment between wells. Contamination between samples can invalidate analytical information. To minimize this risk, sampling equipment should be cleaned thoroughly or discarded between sample collection points or sites.

A general order for cleaning sampling equipment is to:

- Wash with warm detergent solution.
- Rinse with potable water to remove detergent solution.
- Rinse with distilled water. The rinsate blank is collected into the appropriate container at this time (if applicable).
- Drain excess water.
- Allow to air-dry, dry with a stream of warm, dry air, or wipe dry.
- For samplers which have been used to sample petroleum products and oily residues, first wipe the samplers with absorbent cloth to eliminate the residues.

APPENDIX A

WELL GAUGING/WATER SAMPLING LOG

PAGE _____ OF _____

WELL GAUGING/WATER SAMPLING LOG

GEOTECHNOLOGY INC
FROM THE GROUND UP

JOB NO. ______________________

JOB NAME ______________________

SITE LOCATION ______________________

PERSONNEL ______________________

					A	B	C	D	E	F								
Well No.	Date	Time	Desc. Of Meas. pt	Dia. Of Casing (in.)	Depth to Water (ft.)	Total Depth (ft.)	Water Column (ft.)	Gallons Per Foot * (Gal/ft.)	Gallons in Well (1 Well Vol.)	Three Well Vols. (Gal.)	Purged Volume (Gal.)	Turbidity (NTU)	ORP (mV)	DO (mg/L)	pH (SU)	Temp. (°C)	S.C. (S/m)	Remarks

***WELL CASING VOLUMES (GALLONS/FT.)**

1 1/4" = 0.06   2" = 0.16   3" = 0.37   4" = 0.65
8" = 2.59   1 1/2" = 0.09   2 1/2" = 0.26

FORMULAS

B - A = C   D * C = E
E x 3 = F

std par/Well Gauge Multi Parameter Log 2018 new logo.xls

GEOTECHNOLOGY INC
FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0009

Hazardous/Special Waste Manifesting

March 2019

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APPENDICES

1.0 BACKGROUND

The definitions below are general and may deviate from those used in legislation associated with hazardous or special waste manifesting:

> *Designated Facility* – a waste treatment, storage, or disposal facility (TSDF) which has received a permit from a regulatory authority.
>
> *Generator* – any person/company whose act or process produces hazardous/special waste or whose act first causes a hazardous/special waste to become subject to regulation.
>
> *Hazardous Waste* – a waste as defined in 40 CFR part 261 of RCRA. A waste is generally characterized as hazardous waste through analytical laboratory testing.
>
> *Manifest* – a control and transport document that accompanies waste from its generation site to its treatment, storage, or disposal site.
>
> *RCRA* – the Resource Conservation and Recovery Act, a body of federal legislation under which the EPA has established a national program to improve hazardous waste management by regulating hazardous wastes from "cradle to grave."
>
> *Special Waste* – a waste that is not a regulated hazardous waste, but has physical or chemical characteristics that are different from municipal, demolition, construction and wood waste and which potentially requires special handling. A waste is generally characterized as special waste through analytical laboratory testing.
>
> *Transporter* – a permitted person and company engaged in the off-site transportation of hazardous/special waste by air, rail, highway, or water.

The Manifest System*:*

Many regulatory agencies have adopted the manifest system to ensure that waste generated is designated for treatment, storage, or disposal, and arrives at TSDF. The requirements of the manifest system are intended to ensure that waste designated for delivery to an off-site TSDF reaches its destination. Thus, the manifest system serves as a self-enforcing mechanism that requires generators, transporters, and owner/operators of TSDFs to participate in an active waste tracking system.

The information contained on a manifest can help demonstrate that wastes have been handled in accordance with applicable regulations. A completed manifest provides:

- Detailed information on the types and amounts of hazardous/special waste shipped.
- A record of the firms or individuals involved in the shipment.

- Information on the storage, treatment or disposal of the waste(s) and confirmation that they reached their intended final destination.

In addition to tracking waste, the manifest often serves as a shipping document required by the Department of Transportation to accompany waste during transit.

Our Role in the Manifest System*:*
Geotechnology often represents clients who need to dispose of wastes. We can assist these clients with various generator requirements of the manifest system including:

- Characterizing waste
- Permitting waste for disposal
- Coordinating waste removal activities with transporters, designated facilities, and other contractors
- Completing the generator section of the manifest on behalf of the client
- Record keeping of waste removal, transport, and disposal activities

Representing generators in the waste manifest system has the potential to expand Geotechnology's liability. Therefore care must be taken to properly adhere to applicable local, state, and federal regulations when manifesting hazardous/special waste.

2.0 PROCEDURES

2.1 Project Manager

The following items/information should be supplied by the Project Manager to the engineer/scientist:

- Project Name, Project Number, and Task Number;
- Copy of the project proposal (including information about time/money budgeted for field activities and possible extensions);
- Waste manifests and information about:
  - Generator, transporter, and disposal information, including USEPA and State ID numbers, if applicable;

- U.S. DOT description from 49 CFR Part 172, including proper shipping name, hazard class, IO number, packaging group, and if shipment contains a reportable quantity of hazardous materials;

- Type of containers, quantity, and EPA hazardous waste number;

- Additional description of waste and handling codes;

- Copy of disposal permit;

- Special handling instructions; and

- Whether or not to sign on behalf of the client (generator).

2.2 Engineer/Scientist

The engineer/scientist is responsible for observing waste removal activities, completing waste manifests, keeping a ledger of amount of waste removed, and obtaining additional waste manifests if needed. The following steps should be observed:

- Obtain information regarding waste removal activities from the parties involved including, equipment contractors, the transporter, the designated facility, and the client.

- Observe loading of wastes into the transporter’s vehicle(s). Keep a log of amount of wastes leaving the site (see Appendix A).

- Complete the generator portions of the manifest for each shipment of hazardous/special waste. The engineer/scientist will need to make prior arrangements to have manifests ready for the transporter, or in some cases the transporter will provide manifests.

  - Each vehicle that leaves the site with hazardous/special waste must have a manifest.

  - If not already preprinted on the manifest, fill out the generators name, transporter, designated facility, description of the waste being transported, and the disposal permit number.

  - Sign and date for the generator. **NOTE:** In many cases Geotechnology employees should sign “on behalf” of the client. Communicate with the project manager to assess how or if to sign for the generator.

  - Manifests are generally in triplicate form with a copy for the generator, transporter, and designated facility. After completing the generator portions of the manifest, retain the generator copy and give the remaining forms to the transporter.

- Communicate with the Project Manager if the extent of the waste removal activities will be greater than initially budgeted, as soon as this is realized.

- Contact the transporter or designated facility following the waste removal activities to obtain copies of the complete manifests. The completed manifests will be signed by the generator, transporter(s), and the designated facility.

- Completed manifests and manifest log should be delivered to the Project Manager for record keeping.

APPENDIX A

MANIFEST DAILY LOG

MANIFEST DAILY FIELD LOG

Site: ____________________

Job #: ____________________

Date: ____________________

Representative(s): ____________________

Trucking Company(Abbrev): ____________________

Disposal Location: ____________________

Manifest Number	Truck Number - Trucking Co. Abbrev	Time Off-Site (approx)	Truck Size (cu yds, approx)	Tonnage (from landfill)

GEOTECHNOLOGY INC
FROM THE GROUND UP

STANDARD OPERATING GUIDELINE
ENV0012

Field Log Book Use

March 2019

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this guideline is to establish minimum requirements for the development, content, use, review, protection, and filing of field log books.

2.0 REFERENCES AND DEFINITIONS

2.1 References

- Site/Project specific Quality Assurance Program (QAP), Sampling and Analysis Plan (SAP), Work Plans or other appropriate documents.

- Geotechnology administrative procedures.

2.2 Definitions

Field log book
A bound log book with sequential numbered pages that is used to create a permanent, real-time record of activities and conditions, significant events, observations, and measurements which occur during each day of field activities. The minimum requirements for a log book are described in Section 5.

Log book type
Identification of log books will be by purpose or area of coverage. Examples include project, field manager/representative, soil sampling, groundwater sampling, well installation, well development, soil boring, calibration, decontamination, and health and safety.

Quality Control (QC) Review
The act of verifying the accuracy, completeness, legibility, consistency, and clarity of a field log book.

3.0 GENERAL

This procedure is written to include multiple functional positions; however, if the same person fills multiple positions, the coordination steps noted in the procedure are consolidated.

- Field log books will be bound with sequentially numbered pages. It is recommended that field log books include a table of contents, if applicable.

- The Project Manager will control the issue and use of log books.

- Field log books will be identified by a project name or number, by log book type (see 3.2.2), and if there is more than one log book for a project, by sequential number.

- Log book entries will be made in indelible ink, and will be clear, objective and legible.

- Changes to log book entries will be made by striking through the original entry in a manner which does not obliterate the original entry, and providing the initials of the person making the change and date the change was made.

- Dates will be recorded in the month/day/year format. Time will be recorded in the 24-hour (military) clock format (e.g., 1500 hours rather than 3:00 p.m.).

- The log book user will indicate unused portions of completed log book pages and completed log books in a positive, clearly recognizable manner. Typical methods include:

    - drawing a line through the unused area(s) and providing the initials of the person making the entry and date the entry was made.
    - writing a notation such as “INTENTIONALLY LEFT BLANK" and providing the initials of the person making the entry and date the entry was made.

- Log books will be copied on a frequency established by the Project Manager. The frequency will be appropriate to the risk of loss of the data contained in the log books. In addition, client requirements regarding log book copying and protection will be followed.

- It is recommended that log books not be shipped to and from the field; however, if needed, copies can be made to protect the data from loss.

- The types of entries and level of detail must comply with applicable laws, regulations and any client-specified requirements, as well as being consistent with the information requirements necessary for writing the report(s) for the project.

- The QC reviewer will be a person with a level of experience and knowledge comparative to the field team.

- QC review will be completed on a schedule decided by the Project Manager.

4.0 INSTRUCTION

4.1 Log Book Development

The Project Manager assesses the log book requirements for the project, including the types of entries required, number of log books needed, and the extent of use of pre-printed forms. Where pre-printed forms are used, they are considered project records and are to be treated as such and are either selected from existing examples or developed specifically for the project.

4.2 Log Book Control

- The Project Manager (or assigned personnel) will prepare the log book(s) for use by inscribing each log book with the identifying information.

- The Project Manager (or assigned personnel) will take control of the log book(s) and verify that the type and content meets the project requirements.

4.3 Log Book QC

- On the schedule established by the Project Manager, the QC reviewer checks each log book used is reviewed to verify the accuracy, completeness, legibility, consistency, and clarity of the log book.

- The QC reviewer indicates acceptance of the log book entries by writing their initials at the bottom of each page and writing in the date reviewed or other approved notification.

- If errors, omissions, or uncertainties are found, the QC Reviewer resolves them with the person responsible for making entries on that day in the log book. Corrections to any log book entries are made by striking through the original entry and providing the initials of the person making the change and date the change was made.

5.0 RECORDS

Log books and/or log book copies will be processed into the Geotechnology records system in accordance with administrative procedures and policies.

APPENDIX B

Previous PCB Concrete Sampling Locations

(b) (7)(F)

[redacted]

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧	Core sample location (PCB)
▲	Dust sample location (Lead, Mercury)
DISA	Defense Information Systems Agency
PCB	Polychlorinated biphenyl

N

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 5B

Sample Location Map, Building 103 ABC - First Floor

TETRA TECH

(b) (7)(F)

[redacted]

NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

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Legend

🟧	Core sample location (PCB)
●	Surface soil sample location (Lead, Mercury, Asbestos, SVOC)
PCB	Polychlorinated biphenyl
SVOC	Semi-volatile organic compounds

N

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 5C

Sample Location Map, Building 103 ABC - Basement

TETRA TECH

(b) (7)(F)

[redacted]

NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧	Core sample location (PCB)
△	Dust sample location (Lead, Mercury)
○	Crawl space surface soil sample location (Lead, Asbestos, Mercury)
PPE	Personal protective equipment
PCB	Polychlorinated biphenyl

Source: General Services Administration, CAD Files, Received November 2011.

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Note: Crawlspace typically very damp;
PPE needed includes boot covers,
hard hat, eye protection, gloves

N

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 8

Sample Location Map, Building 103 F - First Floor

TETRA TECH

Date: 6/4/2013 | Drawn By: Nick Wiederholt | Project No: S1058.232.001

(b) (7)(F)

[redacted]

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧	Core sample location (PCB)
●	Surface soil sample location (Lead, Asbestos)
PCB	Polychlorinated biphenyl

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 9C (2 of 2)

Sample Location Map, Building 104 ABCD - Basement

TETRA TECH

Date: 6/4/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

(b) (7)(F)

[redacted]

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧	Core sample location (PCB)
●	Surface soil sample location (Lead, Asbestos)
PCB	Polychlorinated biphenyl

N

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 9C (1 of 2)

Sample Location Map, Building 104 ABCD - Basement

TETRA TECH

Date: 6/4/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

(b) (7)(F)

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

● Surface soil sample location (Lead, Asbestos)

🟧 Core sample location (PCB)

PCB Polychlorinated biphenyl

N

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 12C (2 of 2)

Sample Location Map, Building 105 ABCD - Basement

TETRA TECH

Date: 6/3/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

(b) (7)(F)

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NOTES

🟧	Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

●	Surface soil sample location (Lead, Asbestos)
🟧	Core sample location (PCB)
PCB	Polychlorinated biphenyl

N

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 12C (1 of 2)

Sample Location Map, Building 105 ABCD - Basement

TETRA TECH

Date: 6/3/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧	Core sample location (PCB)
PCB	Polychlorinated biphenyl

N

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 15

Sample Location Map, Building 105 L - First Floor

TETRA TECH

Date: 6/4/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧 Core sample location (PCB)

● Surface soil sample location (Asbestos)

PCB Polychlorinated biphenyl

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 16

Sample Location Map, Building 107 - Basement

TETRA TECH

Date: 6/4/2013 Drawn By: Nick Wiederholt Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

(b) (7)(F)

[redacted]

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Legend

🟧 Core sample location (PCB)
PCB Polychlorinated biphenyl

NOT TO SCALE

NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 17

Sample Location Map, Building 108 A - First Floor

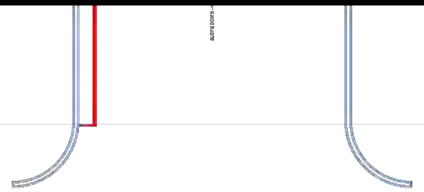
TETRA TECH

Date: 6/4/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

(b) (7)(F)

[redacted]



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NOTES

🟧 Highlighted Locations Exhibit PCB Concentrations > 1 mg/kg

Legend

🟧 Core sample location (PCB)

△ Dust sample location (Lead)

PCB Polychlorinated biphenyl

NOT TO SCALE

Goodfellow Federal Center
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 19C

Sample Location Map, Building 110 - Basement

TETRA TECH

Date: 6/4/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

Source: General Services Administration, CAD Files, Received November 2011.

APPENDIX C

Laboratory Quality Manuals and Standard Operating Procedures

Teklab, Inc.
Quality Assurance Manual

Corporate HQ Collinsville
5445 Horseshoe lake Road
Collinsville, IL 62234
Phone (618) 344 1004
Fax: (618) 344 1005
Fax (217) 698-1005

Corporate	**Signature**	**Date**
John H. Riley - *Chief Executive /Marketing Officer - Ext.30*	(b) (6) [redacted]	12/15/17
James S. Riley – *President/CFO/Technical Manager – Ext. 15*	[redacted]	12/15/17
Laurie Langdon – *Laboratory Director – Ext. 45*	[redacted]	12/15/17
Elizabeth Hurley – *Director of Customer Service Ext. 33*	[redacted]	12/15/17
Stacy A. Mathis – *Quality Assurance Officer-Ext.13*	[redacted]	12/15/17
Claire T. Bogner – *Quality Assurance Officer-Ext.13*	[redacted]	12/14/17

Teklab Air Laboratory
1355 N. Bluff road
Collinsville, IL 62234
Phone (618) 344 7697

Heather Riley – Director of Operations/Analyst (b) (6) [redacted] 12/19/17

See Table of Contents for major organizational units covered by this quality manual.

Table of Contents

Appendix A	Ethics and Data Integrity Policy
Appendix B	Organizational Charts
Appendix C	Floor Plan
Appendix D	Lab Certifications
Appendix E	Data Qualifiers
Appendix F	Equipment list

Section 1 - INTRODUCTION AND SCOPE

(TNI V1:M2 – Sections 1,2,3)

Teklab is an Environmental/Chemical testing laboratory. Consultants, landfills, municipalities, industry and state and federal government routinely use Teklab's services. A wide variety of analyses are performed on air, drinking water, aqueous samples, solid samples, and non-aqueous liquids in accordance with environmental regulations such as drinking water standards, NPDES permits, pre and post treatment standards, RCRA, UST/LUST standards and TCLP. Air Testing is a new service added in 2009.

This manual dictates Teklab's Quality Assurance Program. It is designed to ensure the precision, accuracy and completeness of all data generated for every client. This document describes the specific protocols which will be followed for sampling, sample handling and storage, chain of custody, and laboratory (and field) analysis. All Teklab, Inc. organizational units are subject to this manual.

Teklab, Inc. will protect Clients' confidential information and proprietary rights, as directed by local, state or federal laws. All confidential information and/or proprietary rights claimed by any Client and/or Vendor must be clearly identified in writing, prior to initiation of any business activity. Teklab, Inc. will voluntarily treat information generated by Teklab, Inc. (analytical results, sampling information, associated quality control results, etc.) as confidential in nature only without the fear of retribution. That is, Teklab, Inc. will not accept any liability for the inappropriate or accidental release of information, unless specifically agreed to under mutually binding contractual obligations. See Teklab, Inc. NELAP Policy Client Confidential Information for additional information and procedures.

All QA/QC procedures are in accordance with applicable professional technical standards, U.S. Environmental Protection Agency and Illinois Environmental Protection Agency requirements. Teklab uses only methods mandated by legal requirements, recognized published methods or methods developed and validated by Teklab. Methods are not used for reporting results unless competence for each particular matrix is demonstrated.

(b) (6) [redacted]	12/15/17	(b) (6) [redacted]	12/15/17
Chief Executive Officer	Date	President	Date

Teklab, Inc.
5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
(618) 344-1004

SIC Code 8734
(b) (4) [redacted]
CEC Number 02-695-3349

1.1 Teklab Inc

Teklab prominently displays its most recent TNI accreditation certificate in the customer service/sample reception area of the laboratory. The most recent NELAP accredited fields of testing are also available in Appendix D of this manual, on the Teklab server and on the company website (www.teklabinc.com). Any reports or general literature such as catalogs, advertising, business solicitations, proposals, quotations, or other materials that use the accrediting authorities name or the TNI/NELAP logo, do not imply endorsement by the accrediting authority and must be accompanied by at least the phrase "NELAP Accredited" and the laboratory accreditation number.

Teklab is a full service environmental/chemical-testing laboratory. Seven basic analytical departments exist: air (volatile and semi-volatile), volatile organic, semi-volatile organic, automated inorganic, wet chemistry, metals, and microbiology analysis. Semi-volatile and metals departments are further divided into instrumental and sample preparation. Volatile air analysis is performed at the Teklab Air Laboratory. See Quality Manual Appendix B for Teklab's Organizational Charts.

Technicians prepare samples for analysis and analysts perform the analysis. Due to personnel and fiscal restraints, Teklab personnel may operate as both technician and analyst.

The purpose of this Quality Manual is to outline the management system for Teklab Inc. The Teklab Inc Quality Manual defines the policies, procedures, and documentation that assure analytical services continually meet a defined standard of quality that is designed to provide clients with data of known and documented quality and, where applicable, demonstrate regulatory compliance.

This Quality Manual also sets the standard under which all laboratory operations are performed, including the laboratory's organization, objectives, and operating philosophy. It has been prepared to assure compliance with the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis (EL-V1-M1 through M7-ISO-2009). This Standard is consistent with ISO/IEC 17025:2005 requirements that are relevant to the scope of environmental testing services and thus, the laboratory operates a quality system in conformance with ISO/IEC 17025:2005(E). In addition, the policies and procedures outlined are compliant with the various accreditation and certification programs listed in Appendix D.

1.2 Scope of Testing

The laboratory's scope of analytical testing services includes those listed in Appendix D – Laboratory Certifications.

1.3 Table of Contents, References and Appendices

The Table of Contents starts on Page 2 of this Quality Manual and the Appendices start after Section 29.

The Teklab Inc Quality Manual uses the references included in Modules 1-7 in the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis.

1.4 Acronyms

Quality control terms are generally defined within the Section that describes the activity.

1.4.1 Acronyms

A list of acronyms used in this document and their definitions are:

AB - Accreditation Body
ADOC - Annual Demonstration of Capability
CCB - continuing calibration blank
CCV – Continuing calibration verification
COC – Chain of custody
EPA – Environmental Protection Agency
FoPT - Fields of Proficiency Testing
g/L – grams per liter
GC/MS – gas chromatography/mass spectrometry
ICB - initial calibration blank
ICP – inductively coupled plasma
ICV – Initial calibration verification
IDOC – Initial Demonstration of Capability
LCS – Laboratory control sample
MBLK - Method Blank
MDL – method detection limit
mg/Kg – milligrams per kilogram
mg/L – milligrams per liter
MS – matrix spike
MSD – matrix spike duplicate
NELAP – National Environmental Laboratory Accreditation Program
NIST – National Institute of Standards and Technology
PQL – Practical Quantitation Limit
PT – Proficiency Test(ing)
PTOB - Proficiency Testing Oversight Body
PTPA - Proficiency Testing Provider Accreditor
QA – Quality Assurance
QC – Quality Control
RL – Reporting limit
RPD – Relative percent difference
RSD – Relative standard deviation
SOPs – Standard operating procedures
SQL - - Structured Query Language
std – standard
TNI - The NELAC Institute
ug/L – micrograms per liter

1.5 Management of the Quality Manual

The Quality Department is responsible for maintaining the currency of the Quality Manual.

The Quality Manual is reviewed at least annually by the Quality Department to ensure it reflects current practices and meets the requirements of any applicable regulations or client specifications. When sections of the manual are updated, the revision number is increased by one and the effective date is updated. The cover sheet and the first page of Section 1 of the Quality Manual must also be re-signed. To ensure consistency, the table of contents is updated whenever a Section is updated.

The Quality Manual is considered confidential within Teklab Inc and may not be altered in anyway except by approval of the Quality Department. If it is distributed to external users, it is for the purpose of reviewing Teklab Inc's management system and may not be used for any other purpose without written permission.

Section 2 - ORGANIZATION

(TNI V1:M2 – Section 4.1)

The laboratory is a legally identifiable organization. Teklab Inc's Tax ID number is noted in section 1 of this Quality Manual. The laboratory is responsible for carrying out testing activities that meet the requirements of the TNI Standard, the ISO/EIC 17025 Standard, and that meet the needs of the client. Through application of the policies and procedures outlined in this Section and throughout the Quality Manual:

- The laboratory ensures that it is impartial and that personnel are free from undue commercial, financial, or other undue pressures that might influence their technical judgment.

- Management and technical personnel have the authority and resources to carry out their duties and have procedures to identify and correct departures from the laboratory's management system.

- Personnel understand the relevance and importance of their duties as related to the maintenance of the laboratory's management system.

- Ethics and data integrity procedures ensure personnel do not engage in activities that diminish confidence in the laboratory's capabilities (see Appendix A, Section 3 "Management" and Section 17 "Data Integrity Investigations" for more information on data integrity).

- Confidentiality is maintained.

- The laboratory will report changes in ownership, significant personnel, laboratory name, or location to the accreditation authority within 30 days of occurrence.

2.1 Organization

Teklab Inc. is a full-service environmental commercial laboratory established in 1982. A variety of laboratory services are provided to serve industries specializing in air, drinking water, wastewater, sludge, soil, oil, and special waste testing. The following listed service centers are owned and operated by Teklab, Inc. Teklab operates in Collinsville, Illinois (Corporate Headquarters and Air Laboratory), Springfield, Illinois (Service center), Downers Grove, Illinois (Service center) and Lenexa, Kansas (Service Center).

<u>Service Centers:</u>

1. Springfield Service Center
   3920 Pintail Suite A
   Springfield, IL 62711
   (217)698-1004

The Springfield Service Center (SFSC) opened February 9th, 2009. The Springfield Service Center serves as a bottle order collection and sample drop off point for our clients in Central Illinois. This service center also has a sample courier service for bottle or air canister delivery and sample pick-up.

2. Kansas City Service Center
   8421 Nieman Road
   Lenexa, KS 66214
   (913)541-1998

The Kansas City/Lenexa Service Center opened its doors in the summer of 2007. The Kansas City Service Center serves as a bottle order collection and sample drop off point for our clients in Western Missouri and Eastern Kansas. This service center also has a sample courier service for bottle delivery and sample pick-up.

3. Downers Grove Service Center
   1319 Butterfield Road, Suite 502
   Downer's Grove, IL 60515
   (630)800-8639

The Chicago Area Service Center opened in July of 2015 and serves as a bottle order collection and sample drop off point for our clients throughout the Chicago Metropolitan Area

We are committed to providing the services our customers require, and as customer needs change, so will the analysis we perform.

The laboratory's organizational charts can be found in Appendix B of this Quality Manual. Additional information regarding responsibilities, authority and interrelationship of personnel who manage, perform or verify testing is included in Section 3 –"Management Roles and Responsibilities" and Section 18 – "Personnel and Training". These Sections also include information on supervision, training, technical management, job descriptions, quality personnel, and appointment of deputies for key managerial personnel.

The laboratory has the resources and authority to operate a management system that is capable of identifying departures from that system and from procedures during testing, and initiates actions to minimize or prevent departures.

2.2 Conflict of Interest and Undue Pressure

Teklab is organized so that confidence in its independence of judgment and integrity are maintained at all times. It has processes to ensure that its personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work. Teklab has a proactive program for prevention and detection of improper, unethical or illegal actions.

All new employees are trained during orientation and all personnel are trained, at least annually, on data integrity, ethical behavior, legal responsibilities and conflict of interest. Each Teklab job description includes an agreement with the employee that they are aware of their ethical responsibilities and will avoid any conflict of interest. See Teklab Inc. NELAP Policy Ethics, Legal Responsibility, & Conflict of Interest for topics discussed during training.

Section 3 - MANAGEMENT

(TNI V1:M2 – Section 4.2)

The laboratory maintains a management system that is appropriate to the scope of its activities.

3.1 Management Requirements

Top management includes the CEO, President, Chief Financial Officer, Chief Marketing Officer, Laboratory Director, Technical Manager (however named), Quality Officers and Supervisors.

Management's commitment to good professional practice and to the quality of its products is defined in the Quality Policy statement in Section 3.3.

Management has overall responsibility for the technical operations and the authority needed to generate the required quality of laboratory operations. Management ensures communication within the organization to maintain an effective management system and to communicate the importance of meeting customer, statutory, and regulatory requirements. Management assures that the system documentation is known and available so that appropriate personnel can implement their part. When changes to the management system occur or are planned, managers ensure that the integrity of the system is maintained.

Management is responsible for carrying out testing activities that meet the requirements of the TNI Standard, the ISO/IEC 17025 Standard and the needs of the client.

Management implements, maintains, and improves the management system, and identifies noncompliance with the management system of procedures. Managers initiate actions to prevent or minimize noncompliance (See Section 12 "Improvement, Section 13 "Corrective Action and Section14 "Preventive Action").

Management ensures technical competence of personnel operating equipment, performing tests, evaluating results, or signing reports, and limits authority to perform laboratory functions to those appropriately trained and/or supervised. See Section 18 "Personnel" for details on personnel requirements.

Management is responsible for defining the minimal level of education, qualifications, experience, and skills necessary for all positions in the laboratory and assuring that technical staff have demonstrated capability in their assigned tasks.

Training is kept up to date as described in Section 18 – "Personnel" by periodic review of training records and through employee performance review.

Management has specific responsibility for maintenance of the management system. This includes defining roles and responsibilities of personnel, approving documents, providing required training, providing a procedure for confidential reporting of data integrity issues, and periodically reviewing data, procedures, and documentation. The assignment of responsibilities, authorities, and interrelationships of the personnel who manage, perform, or verify work affecting the quality of environmental tests is documented in employee job descriptions and section 18 of this Quality Manual.

Management ensures that audit findings and corrective actions are completed within required time frames.

Designated deputies are appointed by management during the absence of the Technical Manager if the absence is for more than 15 days.

3.2 Management Roles and Responsibilities

3.2.1 Corporate: Chief Executive Officer / Chief Marketing Officer

3.2.1.1 Responsibilities

- Establishes current and long range goals, objectives, plans and policies.
- Plans, coordinates and controls the daily operation of the organization through organization's managers.
- Dispenses advice, guidance, direction and authorization to carry out major plans, standards and procedures, consistent with established policies.
- Meets with organization's other executives to ensure that operations are being executed in accordance with the organization's policies.
- Oversees the adequacy and soundness of the organization's financial structure.
- Plans and directs all investigations and negotiations pertaining to mergers, joint ventures, acquisition of businesses or the sale of major assets.

- Establishes and maintains an effective system of communication throughout the organization.
- Represents the organization with major customers, shareholders, the financial community and the public.
- Establishes strategic marketing plans to achieve corporate objectives for products and services.
- Develops, executes and directs comprehensive marketing plans and programs, both short and long range, to support sales and revenue objectives of the organization.
- Plans and oversees advertising and promotions activities.
- Designates, directs, advises and evaluates Teklab's sales staff.
- Works with Teklab's Project Management and Customer Service Departments to be a liaison for the customers, communicate customer needs and to develop and promote outstanding customer service.
- Establishes and maintains relationships with industry influencers and key community and strategic partners.

3.2.2 Corporate: Laboratory Director

The Laboratory Director provides the resources necessary to implement and maintain an effective quality and data integrity program.

3.2.2.1 Responsibilities

- Directs laboratory resources to accomplish company mission.
- Monitors standards of performance in quality control and quality assurance of laboratory practice.
- Monitors the validity of the analyses performed and data generated to assure reliable data.
- Directs laboratory in good automated lab practices.
- Directs production standards of laboratory
- Works with the IT department regarding all aspects of Teklab's Laboratory Information Management System.
- Responsible for an in depth understanding of methodology and regulatory requirements.
- Works with the Technical Manager to coordinate method development, solve LIMS related issues, interpret test results and troubleshoot analytical/instrumentation issues.
- Provides technical assistance to laboratory personnel.
- Ensures availability of laboratory resources.
- Involved with instrument optimization and maintenance.
- When absent for a period of time exceeding 15 consecutive calendar days, the President will temporarily perform this function.

3.2.3 Corporate: President/Chief Financial Officer

3.2.3.1 Responsibilities

- Establishes current and long range goals, objectives, plans and policies, subject to approval by the Board of Directors.
- Manages the operations of the laboratory through subordinate managers to ensure that the current and long range goals, objectives, plans and policies are met in a financially responsible manner.
- Dispenses advice, guidance, direction, and authorization to carry out major plans, standards and procedures, consistent with established policies and Board approval.
- Oversees the adequacy and soundness of the organization's financial structure.
- Determines agencies and suppliers of record, and negotiates contract terms and conditions for major services and suppliers.
- Directs company finance and purchasing.
- Represents the organization with major customers, shareholders, the financial community and the public.
- Designates, directs, advises and evaluates the laboratory Supervisors to achieve timely data reporting, while maintaining high safety and quality standards.
- Assists in the planning and implantation of safety policies and procedures in compliance with local, state and federal Occupational Safety and Health Administration (OSHA) rules and regulations.
- Directs, advises and coordinates personnel in their role in the analytical and operational activities of the laboratory to safely produce high quality data as quickly as possible.
- Identifies, analyzes and resolves, and/or assists personnel in solving operational problems.
- Ensures that laboratory resources are available.
- Handles difficult or highly technical situations with clients as needed.
- When absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director will temporarily perform this function.
- If this absence exceeds 35 consecutive calendar days, the primary accreditation body shall be notified in writing.

3.2.4 Corporate: Technical Manager

3.2.4.1 Responsibilities

- Responsible for standards of performance in quality control/quality assurance, the validity of the methodologies and technologies of the analyses performed and the data generated in the laboratory to assure reliable data
- Provides technical assistance to laboratory personnel
- Oversees Teklab's QA/QC program to maintain quality assurance following TNI quality systems requirements. Some of these functions include, but are not limited to, quality control, document control, accreditations, audits, data integrity, data validation and report review.

- Oversees Teklab's Training program.
- Responsible for in depth understanding of methodology and regulatory requirements.
- Oversees method research, development, reviews, implementation and updates. Responsible for implementing and approving standard operating procedures as related to methods.
- Involved with instrument optimization and maintenance.
- When absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director will temporarily perform this function.
- If this absence exceeds 35 consecutive calendar days, the primary accreditation body shall be notified in writing.

The Technical Manager (however named) or designee:

1. is not the technical manager of more than one accredited environmental laboratory.
2. is a full-time laboratory staff member and supervises laboratory operations and data reporting.
3. meets the general and education requirements and qualifications found in Sections 4.1.7.2 and 5.2.6.1 of the TNI Standard - EL-V1M2-2009.

The Technical Manager's proof of experience in the fields of accreditation may be found on the Teklab Server in Employees Electronic Training File.

3.2.5 Corporate: Quality Officer

The Quality Officer (or designee) is responsible for the oversight and review of quality control data, and is independent from laboratory operations. The Quality Officer's training and proof of experience in QA/QC procedures, knowledge of analytical methods, and the laboratory's management system are available in employee training record files, which are stored on the Teklab Inc server.

3.2.5.1 Responsibilities

- Perform and maintain Certificate/Accreditation functions
- Provide QA/QC expertise to staff and supervisors
- Supervise and/or maintain performance testing program
- Supervise and /or prepare and maintain Quality Manual
- Notify laboratory supervisors of quality system deficiencies and monitor Corrective actions
- Supervise and/or perform test data validation and data entry
- Supervise and/or perform Level 2, 3 and Level 4 quality control data review
- Responsible for in depth understanding of methodology and regulatory requirements
- Approve and/or prepare laboratory Standard Operating Procedures
- Perform internal QA/QC audits
- Respond to corrective actions from both internal and external audits
- Supervise and/or maintain method related QA/QC documentation according to the 2009 TNI standard
- Perform Quality Assurance Unit (QAU) duties as defined in GALP

- Supervise and/or maintain document control and data archiving

3.2.6 Corporate: Director of Customer Service

3.2.6.1 Responsibilities

- Responsible for designating and supervising project managers and customer service specialists
- Provides initial and ongoing orientation, safety and quality training of direct reports
- Analyzes and resolves, or assists workers in resolving customer service problems
- Establishes or adjusts department work procedures to meeting testing schedules
- Identifies and either provides on the job training or seeks training opportunities to ensure that project management and customer service quality meets TNI standards
- Confers with Laboratory Supervisors to achieve timely data reporting to clients, while maintaining the high safety and quality standards
- Confers with the Chief Marketing Officer on customer service and project related needs or issues and to keep abreast of the status of future and potential workload

3.2.7 Collinsville Air laboratory: Director of Operations/Analyst

3.2.7.1 Responsibilities

- Responsible for standards of performance in quality control/quality assurance, the validity of the methodologies and technologies of the analyses performed and the data generated in the laboratory to assure reliable data.
- Designates, directs, advises and evaluates Teklab's QA/QC program to maintain quality assurance following TNI quality systems requirements. Some of these functions include, but are not limited to, quality control, data integrity, data validation and report review.
- Responsible for in depth understanding of methodology and regulatory requirements.
- Oversees method research, development, reviews, implementation and updates. Responsible for implementing and approving standard operating procedures as related to methods.
- Involved with instrument optimization and maintenance.
- Provide QA/QC expertise to staff
- Maintain method related QA/QC documentation according to the 2009 TNI standard
- Identifies, analyzes and resolves, and/or assists personnel in solving operational problems.
- Ensures that laboratory resources are available.
- Handles difficult or highly technical situations with clients as needed.

- When absent for a period of time exceeding 15 consecutive calendar days, the Corporate Laboratory Director or the President will temporarily perform this function.
- If his/her absence exceeds 35 consecutive calendar days, the primary accreditation body shall be notified in writing.

3.3 Quality Policy

Management's commitment to quality and to the management system is stated in the Quality Policy below, which is upheld through the application of related policies and procedures described in the laboratory's Quality Manual, SOPs and policies.

Teklab's Management is committed to ensuring compliance with the TNI Standard and shall strive to continually improve the effectiveness of the Management System. Teklab's overall Quality objective is adhere to good professional practices and to develop and implement procedures for field sampling, chain of custody, laboratory analysis and reporting, that will provide results that are legally defensible in a court of law. Specific procedures for sampling, chain of custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventive maintenance of equipment and corrective actions are described in the applicable 1000 series SOPs and other sections of this manual. The purpose of this section is to address the overall objectives that produce accurate, precise, complete, representative and comparable data. The Teklab QA/QC program is communicated and monitored by Teklab's Quality Department.

The Teklab QA/QC program must provide technicians, analysts, and managers with the direction and information necessary to consistently produce reliable and valid analytical data. These results are best attained by rigorously following the validated standard operating procedures and this Quality Manual. This Quality Manual has been developed by Teklab and is available to each Department in an electronic format.

SOP reading is completed at least annually. New laboratory employees are required to read method SOPs once per quarter for six quarters. SOP reading is tracked using controlled reading forms or in controlled Department databases. Employees note the revision and date read for each SOP. Documentation of reading provides evidence that employees have read, understood, and are using the latest version of Teklab Inc. SOPs.

New employees will read the Teklab Quality Manual in their first year of employment. Other laboratory personnel will read the Quality manual when a revision is made.

Teklab provides all employees with on-the-job training specific to their job assignment. Safety, Quality and Ethics training are provided upon hiring and in ongoing programs. Every Teklab employee must ensure that the generation and reporting of quality analytical data is a fundamental priority. All employees are trained annually on ethical principles and procedures surrounding the data that is generated. The laboratory maintains a strict policy of client confidentiality. Off site training is provided on an as needed basis. The following is a partial listing of the types of training provided by Teklab:

- Safety
- Technical training specific to job assignment
- Data Integrity, Ethics and Conflict of Interest
- NELAP quality systems

3.4 Ethics and Data Integrity System

The laboratory has an Ethics and Data Integrity policy that is included in Appendix A. The laboratory's Ethics and Data Integrity program, training and investigations are discussed in Section 17 – "Data Integrity Investigations". Slides of Teklab's Data Integrity Training can be found in the Quality Documents folder on the Teklab Server.

3.5 Documentation of Management/Quality System

The management system is defined through the policies and procedures provided in this Quality Manual and written laboratory Standard Operating Procedures (SOPs) and policies.

3.5.1 Quality Manual (TNI 2009 V1M2 4.2.8.3)

The Quality Manual contains the following required items:

3.5.1.1 document title;

3.5.1.2 laboratory's full name and address;

3.5.1.3 name, address (if different from above), and telephone number of individual(s) responsible for the laboratory;

3.5.1.4 identification of all major organizational units which are to be covered by this quality manual and the effective date of the version;

3.5.1.5 identification of the laboratory's approved signatories;

3.5.1.6 the signed and dated concurrence (with appropriate names and titles), of all responsible parties including the quality Officer(s), technical Manager(s), and the laboratory director;

3.5.1.7 the objectives of the management system and contain or reference the laboratory's policies and procedures;

3.5.1.8 the laboratory's official quality policy statement, which shall include management system objectives and management's commitment to ethical laboratory practices and to upholding the requirements of this Standard; and

3.5.1.9 a table of contents, and applicable lists of references, glossaries and appendices.

This Quality Manual contains or references all required elements as defined by the TNI Standard - V1:M2, Section 4.2.8.4.

3.5.2 Standard Operating Procedures (SOPs)

The laboratory has documented procedures for making and controlling revisions to SOPs. The following information is included on each page of the SOPs:

- SOP number;
- Revision date;
- Revision letter;
- Current page number and total pages of a section.

The effective date of the SOP is the date the SOP is signed by a Quality Officer or other approving authority. Standard operating procedures (SOPs) represent all phases of current laboratory operations and are available to all personnel. They contain sufficient detail to allow someone with similar qualifications to perform the procedures. There are two types of SOPs used in the laboratory:

1) test method SOPs, which have specific requirements as outlined below
2) general use SOPs which document general procedures.

See SOP1010 for more information on SOPs.

Each accredited analyte or method has an SOP. Sometimes an SOP is a copy of a method, and any additions are clearly described. The laboratory's test method SOPs are listed in SOP1010. SOPs should contain or reference the following information where applicable.

i. identification of the method;
ii. applicable matrix or matrices;
iii. limits of detection and quantitation;
iv. scope and application, including parameters to be analyzed;
v. summary of the method;
vi. definitions;
vii. interferences;
viii. safety;
ix. equipment and supplies;
x. reagents and standards;
xi. sample collection, preservation, shipment and storage;
xii. quality control;
xiii. calibration and standardization;
xiv. procedure;
xv. data analysis and calculations;
xvi. method performance;
xvii. pollution prevention;
xviii. data assessment and acceptance criteria for quality control measures;
xix. corrective actions for out-of-control data;
xx. contingencies for handling out-of-control or unacceptable data;
xxi. waste management;
xxii. references; and
xxiii. any tables, diagrams, flowcharts and validation data.

3.5.3 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is based upon whichever policy the most strict (if applicable); otherwise the order is as follows:

- Quality Manual
- SOPS
- Reference Methods
- Policies

Section 4 - DOCUMENT CONTROL

(TNI V1:M2 – Section 4.3)

A controlled document is one that is uniquely identified, issued, tracked, and kept current as part of the management system.

An approved document is one that has been reviewed, and either signed and dated, or acknowledged in writing or by secure electronic means by the issuing authority (ies).

Retired documents are documents that have been superseded by more recent versions or are no longer needed.

Documents can be "SOPs, policy statements, specifications, calibration tables, charts, textbooks, posters, notices, memoranda, software, etc. These may be on various media, whether hard copy or electronic, and they may be digital, analog, photographic or written." (TNI 2009 V1M2 4.3.1). See section 5 for information on control of records.

Procedures for document control and management include controlling, distributing, reviewing, and accepting modifications. The purpose of document control is to preclude the use of invalid and/or obsolete documents.

4.1 Controlled Documents

Documents are reviewed at least annually to ensure their contents are suitable and in compliance with the current management system requirements, and accurately describe current procedures.

Approved copies of documents are available to staff at all locations where operations are essential to the effective functions of the laboratory. Superseded or obsolete paper and electronic documents must be promptly removed from all points of issue and archived following the procedures in SOP 1291. SOPs are located on the Teklab Inc server in the Quality Documents folder. A copy of the current SOP for any analysis is in the appropriate laboratory section performing that analysis. The Quality Department maintains the original Microsoft Word copy of the most current SOP revision and retired revisions of all SOPs.

Controlled internal documents are uniquely identified with :
1) revision date
2) revision letter

Plus the following for SOPs and the Teklab Quality Manual:

3) unique identification (text or number)
4) page number
5) the total number of pages (or a mark to indicate the end of the document)
6) the signatures of the approving authority

SOPs and the Teklab QAM are reviewed annually. To comply with KEDP and ODEQ requirements, the review date of method SOPs is noted on the PDF copy of each. A review date is not required when an SOP is revised in the same year. Review dates are tracked in the Training Database located in the Quality folder on the Teklab Server.

SOPs may be prepared by anyone at Teklab, Inc. All SOPs are prepared in a standard layout containing the same sections (See SOP1010). Documents must be reviewed, revised (as appropriate) and approved for use prior to issue by an "approving authority" which is one of the following staff - Quality Officer, Laboratory Management or Laboratory Supervisor. See SOP 1010 "SOPs and Controlled Documents" for guidelines. Where a laboratory's quality manual contains the necessary requirements, a separate SOP or policy is not required.

A master list of SOPs, which includes SOP number, SOP title, revision and review dates is maintained by the Quality Department and is updated each time a revision is made to an SOP or an SOP is reviewed. The master list is stored in the Quality Department's Training Database, located on the Teklab Inc server. The Controlled Document database, located on the Teklab server, tracks QA manual and other controlled document revisions and can be modified to track any controlled document when required.

The current QA manual is accessible to laboratory personnel via the Quality Documents folder on the Teklab Inc server.

Photocopies of controlled documents or reprints of electronic documents made out with the QA Department are not controlled. As such, it is the responsibility of the document holder to ensure that they have the most current revision.

4.1.1 Changes to Controlled Documents

4.1.1.1 Paper Document Changes

Document changes are approved by an approving authority (Section 4.1 lists approving authorities). Modifications to paper documents that require a revision change shall be clearly written on the document and given to the Quality Department for review. Once the review is complete, the document can be approved and signed by an approving authority. The document will then be processed by the Quality Department and issued to the relevant departments.

Changes that are not process modifications but clarifications (also called minor revisions) may be performed without changing the revision letter of the document. The Quality department shall be notified of any minor revisions. The modified document shall then copied and distributed to the applicable department/s, and obsolete documents shall be removed from all points off use and noted as such in the master list of controlled documents. Minor amendments/modifications to documents are incorporated into a new revision and reissued when the document is reviewed and updated on or before its scheduled review cycle.

A reason for the minor modification or change is written on the document itself and is provided as historical information. This is not required if the reason for the modification is evident (e.g. to correct a spelling error).

4.1.1.2 Electronic Document Changes

A Microsoft Word copy of the document (if available) may be requested from the Quality Department. The document will be emailed to the reviewer and should be downloaded to the C Drive of their personal computer before making any changes. All editing must be tracked following the guidelines in SOP 1010. The final document must then be emailed back to the Quality Department. Revised 1000 series SOPs are reviewed by the Quality Department and Method SOPs are reviewed by technical reviewers; such as the Technical Manager or the Quality Training Officer. Once the document has passed review, it can be approved and signed by an approving authority. When signed, the document will then be processed by the Quality Department and issued to the relevant areas of the laboratory.

Intermediate revisions can be made directly into PDF copies of SOPs or the Quality Manual located in the Quality Documents folder. These revisions must be approved by either the Department Supervisor or a member of the Quality Department.

Changes to documents are processed following the guidelines in SOP 1010.

4.2 Obsolete Documents

All invalid or obsolete documents are removed from general distribution, or otherwise prevented from unintended use. The master copy of an obsolete document is marked with the word “retired”, a retired date and is archived in accordance with SOP 1291 “Record Retention and Access”. Archived documents may be in paper or electronic format. All copies of obsolete documents must be removed from point of use and destroyed. Documents must be securely stored for at least five years before being destroyed. If documents have been scanned and stored on the Teklab Inc Server, related hard copies can be destroyed at the discretion of the applicable department. Storage boxes are maintained in the Teklab storage area until archived to an off-site storage facility. Both the on-site and off-site storage areas have all access documented in an access log maintained at the respective sites. Both storage facilities are protected against fire, theft, loss, environmental deterioration, and vermin. Electronic records are protected from electronic or magnetic sources in a fire proof safe. Details of all stored (and labeled) storage boxes (current and destroyed) are recorded in a Microsoft Access Database by the Quality Department for tracking purposes. Controlled electronic documents are stored on the Teklab server indefinitely (where applicable). The Teklab server is backed up on a daily basis. Two Iomega storage units, that can be located via the Teklab Inc network, are also available to archive documentation. Each has a built in raid configuration to provide data redundancy.

Note: See section 5 of this QA manual for specific guidelines on the control and archival of laboratory records.

In the event that the laboratory goes out of business, documents will be maintained at the off-site storage facility until they can be securely destroyed. If the laboratory transfers ownership, records and documentation shall be transferred to the new ownership. In the event the laboratory transfers geographic location, records and documentation shall be maintained at the off-site storage facility until the records can be securely destroyed.

Section 5 - CONTROL OF RECORDS

(TNI V1:M2 – Section 4.13)

Records may be on any form of media, including electronic and hard copy. Records allow for the historical reconstruction of laboratory activities related to sample-handling and analysis. See Section 4 for information on control of documents.

5.1 Records Maintained

The laboratory maintains a record keeping system that facilitates the retrieval of working files and archived records for inspection and verification purposes by the NELAP accrediting authority.

The laboratory documents and maintains records related to all procedures and activities to which a sample is subjected, including:

a) Identity of personnel involved in sampling, preparation and testing;

b) Sample preservation, including but not limited to: sample container and compliance with holding times;

c) Sample identification code, receipt, log-in, acceptance or rejection;

d) Sample storage and tracking, including: shipping receipts, transmittal form, and internal routing and assignment records;

e) Sample preparation including: cleanup and separation procedures, extract or digestate identification codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;

f) Sample analysis;

g) Standard and reagent origin, receipt, preparation and use;

h) Equipment receipt, use specification, operating conditions and preventative maintenance

i) Calibration criteria, frequency and acceptance criteria

j) Method performance criteria including quality control requirements

k) Quality control protocols and assessment;

l) All automated sample handling systems;

m) Calculations and statistical formulae used by the laboratory,

n) written procedures for all calculations are available for review;

o) representative calculations are available and indicate that routine calculations are consistent with the written procedures;

p) all raw data and supporting information needed to recreate calculations are available for review;

q) the appropriate number of significant figures are carried out through all recorded data and calculations; and

r) the least precise step is identified in the calculations and the number of significant figures is an accurate reflection of the actual tolerances of the instrument or equipment used in this step.

s) Procedures to verify that the reported data is free from transcription and calculation errors;

t) Data handling, including but not limited to: reduction, review, confirmation, interpretation, assessment or validation, and reporting;

u) QC measurements, including procedures to select samples on which to perform QC measurements, and assessment of method performance;

v) Requirements specified in sample acceptance and receipt section of this manual;

w) Electronic records, including but not limited to; copies of final reports, PT studies, bench sheets, instrument strip charts or printouts, data calculations, and data reports for five years or for as long as is required by the applicable regulatory program, whichever is greater. These records include an input summary and copy of the PT study final reports from the PT vendor used by the laboratory;

x) Data review and cross-checking forms

y) All information necessary to produce unequivocal, accurate records that document the laboratory activities associated with the sample receipt, preparation, analysis and reporting; and

z) Procedures that maintain an unequivocal link with the unique field identification and the laboratory identification code assigned each sample.

5.2 Records Management and Storage

The laboratory maintains a record management system for control of laboratory records. See SOP# 1010, 1060, 1290 and 1291 for more information on tracking, reporting and storage.

Data is recorded immediately and legibly in permanent ink (data generated by automated data collections systems is recorded electronically.) Corrections are initialed and dated with the reason noted for corrections other than transcription errors. A single line strikeout is used to make corrections so that the original record is not obliterated.

Excel data sheets used for data entry in the laboratory are coded to allow tracking and automatic documentation of all changes made within that file. The worksheet containing the tracking information is stored within the workbook for the life of the file.

Electronic corrections in LIMS are tracked via SQL files which log all changes made. SQL files are retained securely on the Teklab server for at least 5 years.

Teklab servers are backed up daily Monday to Friday, with the exception of the website server, which is backed up when changes are made to the website. A backup of all servers is maintained onsite and at a remote data center. All offsite backups are encrypted using 256 bit AES. The key is stored at our MSP. The SQL database is backed up incrementally every hour except for a maintenance window from 1:30am to 6:00am at which time a full backup is run.

Where computers or automated equipment is used for the capture, processing, manipulation, recording, reporting, storage or retrieval of test data, the laboratory:

- Maintains computer and automated equipment to ensure proper functioning and provide environmental and operating conditions necessary to maintain the integrity of calibration and test data
- Performs software and hardware testing
- Establishes and implements procedures for the maintenance of security of data, including the prevention of unauthorized access to, and the unauthorized amendment of, computer records and
- Maintains hard copy or write protected backup copies of records that are stored or generated by computers.

The laboratory controls access to all programs that are used to acquire, process, record or report data. All programs have limited access and are dependent on the security permissions that are assigned to each employee. An employee is granted access depending on his/her responsibilities and job description.

Records, including electronic records, are easy to retrieve, legible, and protected from deterioration or damage; held secure and in confidence; and are available to accrediting bodies for a minimum of five years or as required by regulation or contract. Records that are stored only on electronic media are supported by the hardware and software necessary for their retrieval. Access to protected records is limited to applicable department personnel. Procedures for identification, access, filing, storage, maintenance and disposal of quality and technical records can be found in SOPs 1010, 1060 and 1291. Quality records shall include reports from internal audits as well as records of corrective and preventive actions.

The laboratory maintains the record management system for control of all applicable information, in an organized, chronological order. Hard copy records are segregated by type (i.e. laboratory data packets, Teklab Reports etc.), in chronological order, and placed in storage boxes. The exterior of the storage box indicates the contents. Storage boxes are maintained in the Teklab storage area until archived to an off-site storage facility. Additional information regarding control of data is included in Section 21.5 – "Control of Data".

Paper records must be safely stored, held secure, and in confidence to the client. All information necessary for the historical reconstruction of the data must be maintained. Non-drinking water records must be retained for 5 years from generation of last entry in records. Drinking water chemical analysis records from public water systems serving at least 25 persons or having at least 15 service connections must be maintained for 10 years from the generation of the last entry in the records. Lead and copper drinking water records for must be maintained for 12 years from generation of last entry. Per Louisiana regulations all air analysis records must be kept for at least 10 years. Records may be stored longer at client request.

Metals and Inorganics data is scanned and kept on the server per the regulation retention times noted above. Hard copies of scanned Metals and Inorganics data are kept for one year. VOA and Organics data is electronically generated and is stored on the Teklab Server for at least five years.

Data for all other environmental analyses that are associated with the laboratory's accreditation is stored for a minimum of five years, unless otherwise specified in another regulation. Pertaining to all suppliers from whom it obtains support services or supplies required for test, for a minimum of five years.

In the event that the laboratory transfers ownership or goes out of business, records are maintained or transferred according to client instructions. Appropriate regulatory and state legal requirements concerning laboratory records shall be followed.

5.3 Legal Chain of Custody Records

Evidentiary sample data are used as legal evidence. Procedures for evidentiary samples are outlined below and can also be found in SOP1065.

The laboratory establishes and maintains the following basic requirements for evidentiary chain-of-custody:

- The evidentiary chain-of-custody records accounting for an unbroken possession of the sample while it is in the laboratory's custody.

- The evidentiary chain-of-custody records include signatures of all individuals who were involved with physically handling the samples and the time of day and calendar date that the sample was physically transferred from one individual to the next individual or to and from a controlled access storage area. A sample is considered to be in someone's custody only if it is in one's actual physical possession, if it is in one's view, after being in one's physical possession, or if it is kept in a secured area restricted to authorized personnel only.
- A minimum number of persons shall be involved in sample handling.
- The laboratory limits the number of documents that are required to establish evidentiary chain-of-custody.
- The evidentiary chain-of-custody forms remain with the samples during transport or shipment.
- The laboratory controls access to all evidentiary samples and sub-samples, and documents this control as described in the Sample Acceptance and Receipt section of this manual.
- Transfer of samples, sub-samples, digestates or extracts to another laboratory is subject to all of the requirements for evidentiary chain-of-custody.
- The laboratory ensures that sample containers that are shipped, are sealed in such a manner so that tampering by unauthorized personnel is immediately evident. If any seals are not intact, the laboratory notes this on the chain-of custody.
- The laboratory ensures that, if required, individual sample containers are sealed in such a way as to prevent tampering.
- The laboratory maintains records of sample disposal practices including, where appropriate, the date of sample or sub-sample disposal and the name of the responsible person.
- The disposal of the physical sample occurs only with the concurrence of the affected legal authority, sample data user and submitter of the sample.
- The laboratory documents and retains a record of all conditions of disposal and all correspondence between all parties concerning the final disposition of the physical sample.
- The sample records indicate the date of disposal, the nature of disposal (such as depleted, sample manifested to a hazardous waste facility, sample returned to client), and the identity of the individual who performed the task.
- The laboratory has waste collection, storage, recycling, and disposal procedures and policies as part of their SOPs. Where disposal practices are included as part of an approved test method, the laboratory strictly follows the approved test method's disposal practices. While more specific disposal criteria are not an aspect of this manual, the laboratory applies appropriate Federal, state, and local disposal practices as a part of good laboratory practices.

Section 6 – REVIEW OF REQUESTS, TENDERS AND CONTRACTS

(TNI V1:M2 – Section 4.4)

The review of all new work assures that requirements are clearly defined, the laboratory has adequate resources and capability, and the test method is applicable to the customer's needs. This process ensures that all work will be given adequate attention and avoid shortcuts that may compromise data quality.

Contracts for new work may be formal bids, signed documents; verbal, or electronic. The client's requirements, including the methods to be used, must be clearly defined, documented and understood. The review must also cover any work that will be subcontracted by the laboratory.

See SOP1015 for details on Review of Requests, Tenders and Contracts and SOP 1100 for Subcontracting guidelines.

Section 7 - PURCHASING SERVICES AND SUPPLIES

(TNI V1:M2 – Section 4.6)

The laboratory ensures that purchased supplies and services that affect the quality of environmental tests are of the required quality by using approved suppliers and products.

7.1 Procedure for Purchasing

Supplies and Services that affect the quality of environmental tests are purchased by the Chief Financial Officer, who also reviews and approves the suppliers of services and supplies.

Purchase orders are automatically assigned unique order numbers and are generated from the LIMS. The Vendor section of the LIMS contains information that adequately describes the services and supplies ordered. Order details are stored under each vendor/supplier and allows for tracking and evaluation of past purchases.

Clipboards with Supply Order Forms are available in all departments of the laboratory. The form contains information such as the department, date (the date the item was added to the form), a description of the item and a priority code. Priority codes run from 1 (need immediately) to 3 (order within the next 2 weeks). Priority code 4 is reserved for special request/new items. When an item is ordered, the order date is noted beside the applicable item. A copy of the form is then given to the Customer Service department. When the goods are delivered to Teklab, the Customer Service department can use the Supply Order Form to expedite the distribution of supplies to the relevant departments. The laboratory strives to maintain an adequate supply of critical items to ensure continued analysis without interruption.

Purchased supplies that affect the quality of tests are inspected for breakage, leaks or any other damage when received. The supplies are stored according to manufacturer's recommendations, laboratory SOPs or test method specifications. See SOP1260 for information on supply receipt procedures.

Copies of calibration documentation (e.g. weight calibrations, NIST thermometer calibrations, balance maintenance/calibrations) are kept on file by the Quality Department. Certificate of Analysis details are logged into the LIMS. A copy of the certificate is scanned and linked to information in the LIMS by the relevant department or a member of the

Quality Department. See Section 23 "Reagents and Standards" and SOP1250 for more information.

7.2 Approval of Suppliers

The Chief Financial Officer maintains a list of approved suppliers in the Teklab LIMS. Vendors that are no longer used are inactivated through the same system.

Evaluation Procedure
Evaluation and selection of suppliers/ vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products/services, the quality of their service, their past history and competitive pricing. To ensure that critical consumables and equipment conform to specified requirements, all purchases from specific vendors are approved by a member of the management staff.

If problems with supplies (or services) arise after the product has entered the laboratory, the deficiency information can be relayed by the relevant department directly to the Chief Financial Officer or via Teklab's weekly management meetings. Critical deficiencies (that impact safety or the quality of data) must be relayed to the Chief Financial Officer as soon as possible. All returns are dealt with on a case by case basis.

Section 8 - SUBCONTRACTING OF ENVIRONMENTAL TESTS

(TNI V1:M2 – Section 4.5)

8.1 Procedure

When Teklab must subcontract analysis due to workload, need for further expertise, temporary incapacity, or on a continuing basis, work is placed with a laboratory accredited under NELAP for the test to be performed or with a laboratory that meets the applicable statutory and regulatory requirements for performing the tests and submitting the results of test performed. All subcontracted analyses and the name of the subcontracted laboratory are documented in the case narrative of the final report. Any non-NELAP accredited work does not have the letters "NELAP" in the qualifier column. The intent to subcontract analysis is specified in the project quote when Teklab intends to subcontract any part of a project. When possible, Teklab will advise the client in writing of any subcontracted analysis. Teklab maintains a register of all subcontractors that it uses for environmental tests and a record of the evidence of compliance for each. A record of subcontracted analysis is retained at Teklab and is archived in accordance with this manual. Teklab will ensure that the subcontract laboratory is provided all necessary information to meet the same commitments made to the client by the primary laboratory.

See SOP1100 for Subcontracting procedures and guidelines and SOP 1015 for review of requests, tenders and contracts.

Section 9 - SERVICE TO THE CLIENT

(TNI V1:M2 – Section 4.7)

The laboratory collaborates with clients and/or their representatives in clarifying their requests and in monitoring laboratory performance related to their work. Each request is reviewed to determine the nature of the request and the laboratory's ability to comply with the request within the confines of prevailing statutes and/or regulations without risk to the confidentiality of other clients.

9.1 Client Confidentiality

Teklab Inc's confidentiality policy is to not divulge or release any information to a third party without proper authorization. Third party requests for data and information are referred to the client. Data and records identified as proprietary, privileged, or confidential are exempt from disclosure.

All electronic data (storage or transmissions) are kept confidential, based on technology and laboratory limitations, as required by client or regulation.

Teklab, Inc. will protect Clients' confidential information and proprietary rights, as directed by local, state or federal laws. All confidential information and/or proprietary rights claimed by any Client and/or Vendor must be clearly identified in writing, prior to initiation of any business activity. Teklab, Inc. will voluntarily treat information generated by Teklab, Inc. (analytical results, sampling information, associated quality control results, etc.) as confidential in nature only without the fear of retribution. That is, Teklab, Inc. will not accept any liability for the inappropriate or accidental release of information, unless specifically agreed to under mutually binding contractual obligations. See Teklab, Inc. NELAP Policy Client Confidential Information for additional information and procedures.

Teklab quality training includes training on procedures for protecting clients' confidential information. Clients' names or client's sample identifications are not listed in any laboratory data packets. Information in the laboratory data packets is identified with Teklab generated laboratory identifications only. Printed records containing client information are shredded before disposal. See Teklab Inc. NELAP Policy Client Confidential Information for policy and procedural details discussed during training.

9.2 Client Support

Communication with the client, or their representative, is maintained to provide proper instruction and modification for testing. Technical staff are available to discuss any technical questions or concerns the client may have.

The client, or their representative, may be provided reasonable access to laboratory areas to witness testing.

Delays or major deviations to testing are communicated to the client immediately, where possible, by email or phone by the applicable Project Manager, a member of the Customer Service Team or the Chief Marketing Officer.
Teklab will provide the client with all requested information pertaining to the analysis of their samples.

9.3 Client Feedback

The laboratory seeks both negative and positive feedback following the completion of projects and/or periodically for ongoing projects. Feedback provides acknowledgement, corrective actions where necessary, and opportunities for continuous improvement. Methods of receiving feedback may include conversations with customers (phone or email), website and email questionnaires.

Negative customer feedback is documented as a customer complaint (see Section 10 – "Complaints").

Section 10 - COMPLAINTS

(TNI V1:M2 – Section 4.8)

The purpose of this section is to ensure that customer complaints are addressed and corrected, and done so in a timely manner. This includes requests to verify results or analytical data. Complaints provide the laboratory an opportunity to not only improve client satisfaction but also laboratory operations.

Customer complaints are dealt with on a case by case basis. All customer complaints are documented by the person receiving the complaint and addressed to the responsible manager. Complaints concerning areas such as turnaround time or pricing, are handled solely at the discretion of Teklab management. The Technical Manager, Quality Officer or Teklab Management handle all QA/QC complaints. An investigation determines the validity of the complaint. If it is determined that the complaint has merit, the procedures outlined in Section 13 – Corrective Action are utilized. If it is determined that a complaint is without merit, it is documented, and the client is contacted by the appropriate Project Manager.

A complaint such as a concern that data is repeatedly late should be reviewed for preventive action (see Section 14 – "Preventive Action") to minimize a future occurrence.

The laboratory has a documented policy and procedures for the resolution of complaints received from clients or other parties about the laboratory's activities.
The laboratory audits the laboratory activities as required in this manual resulting from a complaint, or any other circumstance that impacts the laboratory's compliance with:

1. The laboratory's policies and procedures;

2. The requirements of this manual; and

3. The quality of the laboratory's tests.

The laboratory documents and maintain records of the complaint/s, the laboratory's subsequent actions, and any corrective actions and/or revised reports.

Section 11 - CONTROL OF NON-CONFORMING ENVIRONMENTAL TESTING WORK

(TNI V1:M2 – Section 4.9)

Non-conforming work is work that does not meet acceptance criteria or requirements. Non-conformances can include departures from standard operating procedures, test methods or unacceptable quality control results (see Section 26 – "Quality Assurance for Environmental Testing"). Identification of non-conforming work can come via customer complaints, quality control, instrument calibration, evaluating consumable materials, staff observation, final report review, management reviews and internal and external audits.

11.1 Exceptionally Permitting Departures from Documented Policies and Procedures

Requests for departures from laboratory procedures are approved by the Technical Manager or his/her designee and documented on a case by case basis with the applicable analytical data or final report. Planned departures from procedures or policies do not require audits or investigations.

If a client requests a departure from laboratory procedures, the laboratory does not have to consider that departure as a nonconformance that requires corrective action. However, that nonconformance must be documented as a nonconformance (or however named) that was approved by management.

11.2 Non-Conforming Work

The laboratory policy for control of non-conforming work is to identify the non-conformance and take appropriate action. All employees have the authority to stop work on samples when any aspect of the process does not conform to laboratory requirements.

The responsibilities and authorities for the management of non-conforming work are detailed in SOP#1280 and Section 13 "Corrective Actions". The procedure for investigating and taking appropriate corrective actions for non-conforming work are also described in Section 13. Section 13.3 outlines the procedures for Technical Corrective Actions. Formal corrective action procedures must be followed for non-conforming work that could reoccur (beyond expected random QC failures) or where there is doubt about the laboratory's compliance to its own policies and procedures.

The investigation and associated corrective actions for non-conforming work involving alleged violations of the company's Ethics and Data Integrity policies must follow the procedures outlined in Section 17 – "Data Integrity Investigations".

The reporting of non-conforming work involving alleged violations of the company's Ethics and Data Integrity policies must be reported to a member of the Management Team. Procedures described in Section 17 – "Data Integrity Investigations" are followed.

The laboratory evaluates the significance of the non-conforming work, and takes corrective action immediately. The customer is notified if their data has been impacted. The laboratory allows the release of non-conforming data only with approval of the Technical Manager or his/her designate on a case-by-case basis. Non-conforming data is clearly identified in the final report (see Section 27 – "Reporting the Results").

The discovery of a nonconformance for results that have already been reported to the customer must be immediately evaluated for significance of the nonconformance, its acceptability to the customer, and determination of the appropriate corrective action.

See Section 13 "Corrective Action" and SOP1280 for details on managing non-conforming work.

11.3 Stop Work Procedures

Laboratory supervisors, the Quality Department, and the Management team have authorization to halt non-conforming work at any time. Samples are not analyzed until the problem causing the deviation is corrected. If applicable, the system is monitored until 10 consecutive data points are within control chart limits. After corrective actions successfully eliminate the problem, the corrective actions taken, individual(s) involved, samples affected, and date are noted on corrective action forms and in the appropriate logbooks. Only the Technical Manager (or their designee) can authorize the resumption of affected tests. See section 13 for more information on Corrective Actions.

Section 12- IMPROVEMENT

(TNI V1:M2 – Section 4.10)

Improvement in the overall effectiveness of the laboratory management system is a result of the implementation of the various aspects of the laboratory's management system: quality policy and objectives (Section 3 – "Management"); internal auditing practices (Section 15 – "Internal Audits"); the review and analysis of data (Section 26 – "Quality Assurance for Environmental Testing"); the corrective action (Section 13 – "Corrective Action") and preventive action (Section 14 – "Preventive Action") process; and the annual management review of the quality management system (Section 16 – "Management Reviews") where the various aspects of the management/quality system are summarized, and evaluated and plans for improvement are developed.

Section 13 - CORRECTIVE ACTION

(TNI V1:M2 – Section 4.11)

Corrective action is the action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence. Deficiencies cited in external assessments, internal quality audits, data reviews, customer feedback/complaints, control of nonconforming work or managerial reviews are documented and require corrective action. Corrective actions taken are appropriate for the magnitude of the problem and the degree of risk.

The following section dictates the decision process, procedures and initiation process for corrective actions. It identifies the data used to determine if a problem exists and the actions to be taken.

13.1 General Procedure

The laboratory uses the LIMS database to document and track corrective actions. See SOP#1280 for more information on Corrective Actions.

All deficiencies are first investigated to identify root cause and a corrective action plan is then developed and implemented if deemed necessary. The implementation is also monitored for effectiveness. Teklab technicians, analysts, and supervisors are responsible for initiating corrective actions on routine data reviews where a nonconformance is found that could reoccur (beyond expected random QC failures) or where there is doubt about the compliance of the laboratory to its own policies and procedures. Project Management and the QA Department must be informed immediately if the problem will or may affect client sample results.

Department supervisors are responsible for implementing the corrective action and tracking analysis until the system is in control again. Corrective actions may be entered into the LIMS by any Teklab Personnel. The final corrective action is reviewed by the Quality Department for completeness. The Technical Manager and Quality Officer must approve and close out the completed corrective action in LIMS.

13.1.1 Cause Analysis

When failures due to systematic errors have been identified, the first step is an investigation to determination of the root cause(s) of the problem. When there are non-systematic errors, where the initial cause is readily identifiable or an expected random failures (e.g. failed quality control), a formal root cause investigation is not required.

13.1.2 Selection and Implementation of Corrective Actions

After the root cause(s) has been defined (where applicable), a corrective action plan is then selected and implemented (see Section 13.3 "Technical Corrective Actions" and SOP1280 "Corrective Actions and Root Cause Analysis").

Where uncertainty arises regarding the best approach for analysis of issues that require corrective action, applicable personnel will recommend corrective actions that are appropriate to the magnitude and risk of the problem and that will most likely eliminate the problem and prevent recurrence

Teklab Management and the Quality Department shall ensure that corrective actions are discharged within the agreed upon time frame. Corrective Action records are maintained in the LIMS database. The records contain details of both the root cause(s) investigation and the corrective action plan. PDF copies of all signed corrective action reports are stored on the Teklab server.

13.1.3 Monitoring of Corrective Action

The Quality Department and Department supervisors (where applicable) will monitor implementation and documentation of the corrective action to assure that the corrective actions were effective. Internal audits may also be used to verify the effectiveness of corrective actions. See SOP 1280 for more information on monitoring corrective actions.

13.2 Additional Audits

Where the identification of non-conformances or departures from normal lab procedures cast doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with the TNI Standard, the laboratory ensures that the appropriate areas of activity are audited in accordance with Section 15 – "Internal Audits" as soon as possible.

13.3 Technical Corrective Action

Sample data associated with a failed quality control are evaluated for the need to be reanalyzed or qualified. Unacceptable quality control results are documented, and if the evaluation requires root cause analysis, the cause and solution are recorded (see Section 11 "Control of Nonconforming Environmental Testing Work"*)*.
Analysts routinely implement corrective actions for data with unacceptable QC measures. First level correction may include re-analysis without further assessment. If the test method SOP addresses the specific actions to take, they are followed. Otherwise, corrective actions start with assessment of the cause of the problem.

Corrective action procedures for non-systematic errors or expected random failures are detailed in SOP#1280. All corrective actions are stored in the LIMS and on completion are stored in PDF format on the Teklab server. Corrective actions for non-conformances that may reoccur (beyond expected random QC failures) or where there is concern that the laboratory is not in compliance with its own policies and procedures require that a Corrective Action to be completed (see Section 13.1).

Whenever possible, samples are only reported if all quality control measures are acceptable. If a sample associated with unacceptable quality control measures must be reported, the deviation is clearly documented in the case or sample narrative of the final report. Whenever possible, corrective actions are undertaken to bring the system back in control.

Supervisors, the Quality Department and/or Management may review Corrective Action responses and suggest improvements, alternative approaches, and procedures where needed.

13.4 Data Evaluation

Teklab tracks the precision and accuracy of each analysis through the use of control charts. These control charts are based on the Relative Percent Difference (RPD), Laboratory Control Sample recoveries (LCS) and Matrix Spike recoveries (MSR). The RPD, LCS and MSR are calculated for each run of analysis. Independently verified Quality Control Samples (QC samples) also are used to determine if the analysis is in control. If the data exceeds the control chart or manufacturer specified limits, the analysis is checked for calibration, standard quality and analytical technique, and the analysis is stopped and corrective action taken.

Section 14 - PREVENTIVE ACTION

(TNI V1:M2 – Section 4.12)

The preventive action plan establishes the process to investigate and track potential non-conformances in Teklab Inc's Quality Management System. The foundation of preventive action is written and accessible documentation of actions taken and subsequent monitoring to determine that preventive actions have been implemented and documented.

Preventive Action Plan

Preventive action plans are part of a proactive process for improvement rather than a reaction to problems or complaints. Preventive action includes the utilization of measurable quality objectives and requirements such as validation and review processes, audits (internal and external), management review, feedback and complaints, and quality system requirements to detect, analyze and remove potential causes of non-conformance. All personnel have the authority to offer suggestions for improvements and to recommend preventive actions, however management is responsible for the actual implementation of preventive action.

The preventive action proactive process consists of:

- reviewing potential problems; deciding the potential cause of the problems;
- deciding the course of action to eliminate the problem from occurring;
- implementing the plan; and then ensuring or verifying the action solved the problem and/or is effective over time.
- Once identified, Preventive action plans are initiated by starting a corrective action in the LIMS.

Monitoring the effectiveness of the preventive action includes, but not limited to, the following:

- control charts;
- performance studies;
- training;
- customer input;
- employee suggestions and input;
- audits;
- management reviews;
- staff meetings
- Scheduled instrument maintenance

Needed improvements and/or potential sources of non-conformance (either technical or Quality related) are identified. If preventive action is required, action plans shall be developed, implemented and monitored to reduce the likelihood of the occurrence of such non-conformances and to take advantage of the opportunities for improvement. A corrective action in the LIMS shall be initiated once a potential nonconformity is identified. Preventive actions shall be monitored by the supervisor of the relevant department (or their designee); the Quality Department and management. Weekly Management meetings, as part of the management review program, will also monitor the status of preventive action plans. The Quality Assurance Officer is responsible for follow-up and ensuring the action plans are completed.

Teklab's laboratory management reviews the Quality Assurance Plan to ensure its continuing suitability, effectiveness, and compliance with TNI Standards at least annually. This review is documented and includes at least the following:

- Quarterly reports from the quality department concerning the quality system and its testing and calibration activities
- Resources and training
- Reports from any management and supervisory personnel
- Outcomes of any recent internal audits
- Assessments by external bodies
- Results of interlaboratory comparisons or proficiency tests
- Changes in the volume or type of work undertaken
- Feedback from clients
- Complaints
- Corrective and preventative actions

The outcome of this review is to introduce any necessary changes or improvements in the quality system and laboratory operations. A record of this review, its findings and the resulting actions/changes is maintained in the management review file and is archived in accordance with this manual.

A preventative maintenance program is maintained for each instrument. Any equipment found to be out of calibration or indicating problems is taken out of service until the problems are corrected. Records are maintained which document preventive maintenance and repairs to instrumentation and general laboratory equipment. Equipment failures or problems are noted as follows: the nature of the problem, corrective actions taken, the person performing corrective actions and the date. See Section 22 and SOP 1210 for additional information on equipment maintenance.

LIMS Preventive Action

Teklab has a preventive system to plan and test deployments of LIMS modifications to avoid or minimize the potential disruption associated with a LIMS failure.

- Production database: the live LIMS database used throughout the laboratory
- Development database: allows the application programmer to evaluate modifications to the LIMS without affecting live data. These changes are then re-evaluated through test databases.
- Test database: Test databases do not use real time data. They are distributed, by the applications programmer, to designated members of staff. These databases allow modifications to be assessed for potential conflicts and/or errors before updates are finally integrated into the production LIMS.

Section 15 - AUDITS

(TNI V1:M2 – Section 4.14)

15.1 Internal Audits

Audits measure laboratory performance and verify compliance with the TNI Standard, certification requirements, and management system requirements; including analytical methods, SOPs, the Quality Manual, ethics policies, data integrity, and other laboratory policies.

Audits provide management with an on-going assessment of the management system. They are also instrumental in identifying areas where improvement in the management system will increase the reliability of data. Results of the audits (and any associated corrective actions) are reported to the Teklab Board of Directors at least annually.

On a weekly basis,, Teklab, Inc. management, reviews the day to day implementation of policies and procedures that affect the Quality System (see section 16 Management Review and Section 14 Preventive Action).

It is the responsibility of the Quality Officer to plan and organize audits as required by the schedule and requested by management. These audits are carried out by trained and qualified personnel who are, wherever resources permit, independent of the activity to be audited.

These annual audits examine the above stated items as well as the following:

- Personnel training
- SOPs
- Log-In and chain of custody procedures
- Housekeeping
- Balance and micropipette calibrations
- Refrigerator, oven and incubator temperatures
- Fume hood operation and face velocity determinations
- Reagent, solvent and standard documentation
- Instrument maintenance logs
- Corrective action procedures and reports
- Data collection, reduction, validation and reporting
- Waste disposal

The Quality Officer, or their representative, is also responsible for incorporation and/or documentation of changes, including but not limited to, changes in the approved test methods, changes in laboratory equipment, or changes in laboratory personnel. The area audited, the audit findings, and corrective actions are recorded. Audits are reviewed after completion to assure that corrective actions were implemented and effective.

In addition to scheduled internal audits, it may sometimes be necessary to conduct special audits as a follow-up to corrective actions, PT results, complaints, regulatory audits or alleged data integrity issues. These audits or investigations address specific issues. Review of their effectiveness may occur during the next scheduled audit unless findings are observed that cast doubt on the validity of data; in which case the review must take place as soon as possible.

15.2 External Audits

Management shall ensure that all areas of the laboratory are accessible to auditors as applicable and that appropriate personnel are available to assist in conducting the audit.

All records must be made available to Teklab's Accreditation Bodies.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, on-site auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information.

15.3 Performance Audits

Performance audits may be Proficiency Test Samples, internal single-blind samples, double-blind samples through a provider or client, or anything that tests the performance of the analyst and method.

Proficiency Test Samples are discussed in Section 26 – "Quality Assurance for Environmental Testing".

15.4 System Audits

The Laboratory's management system is audited though scheduled management reviews. Refer to Section 16 "Management Review" for more information.

15.5 Handling Audit Findings

Internal or external audit findings are responded to within an agreed time frame. The response may include action plans that could not be completed within the response time frame. A completion date is established by management for each action item and included in the response.

The development and implementation of corrective actions for findings is the joint responsibility of the Quality Department and the relevant Department supervisor (where applicable). Corrective actions are documented through the corrective action process described in Section 13 – "Corrective Actions".

Where the results of the internal audit indicate that operations or procedures are not in compliance, corrective actions must be taken. These corrective actions may include termination of all applicable analysis until the source of the problem can be identified and corrected. Laboratory supervisors, the Quality Department, and the Management team have authorization to halt non-conforming work at any time. All affected samples must be identified and clients whose samples were affected must be notified, in writing, within one week of the problem identification. The analysis cannot be resumed until the problem is demonstrated to be corrected (by the analysis of samples of known concentration), the reason for the problem and all corrective actions are documented and the Technical Manager (or their designee) approves the resumption of analysis. All investigations that result in findings of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. See Section 17 (Data Integrity Investigation) for additional procedures for handling inappropriate activity.

Section 16 - MANAGEMENT REVIEWS

(TNI V1:M2 – Section 4.15)

16.1 Management Review Topics

The following are reviewed (where applicable) to ensure their suitability and effectiveness:

16.2 Procedure

Laboratory management shall continuously review the Quality Assurance Plan to ensure its ongoing suitability, effectiveness, and compliance with NELAP/TNI Standards. The review process includes (but is not limited to) the following:

- Customer service meetings
- Weekly management meeting – attended by management, supervisors, department representatives including the QA department. Minutes of these meetings are recorded by a member of the management team.
- Board of Director meetings

Staff meetings are part of the overall quality system and provide comprehensive departmental interaction that can aid in the planning and co-ordination of activities that may have a laboratory wide impact. Suggested improvements to the quality system, as well as potential sources of non-conformance are discussed as part of the laboratory Preventive Action Plan. The results of these meetings are documented and are incorporated into the laboratory planning system and include the goals, objectives and action plans for the coming year.

Management shall also receive monthly reports from the Quality Department regarding the status of Quality issues including (but not limited to) safety checks, current corrective actions and required laboratory SOP reading. When an ongoing problem is identified in the Quality System that requires attention; it is forwarded to management who assists the Quality Department in monitoring the problem and ensures the issue is resolved in a timely manner where possible.

Section 17 - DATA INTEGRITY

(TNI V1:M2 – Section 4.16)

In addition to covering data integrity investigations, this Section covers all topics related to ethics and data integrity policies, procedures and training.

Teklab Inc is committed to ensuring the integrity of its data and providing valid data of known and documented quality to its clients. The elements in Teklab's Ethics and Data Integrity program include:

- Documented data integrity procedures signed and dated by top management.
- An Ethics and Data Integrity Statement (included in job description) signed by all management and staff upon hiring.
- An Ethics and Data Integrity Statement signed after annual data integrity training. Teklab's Ethics and Data Integrity Policy can be found in the Quality Documents folder on the Teklab Server.
- Appendix A of this Quality Manual.
- Procedures for confidential reporting of alleged data integrity issues.
- An audit program that monitors data integrity (see Section 15 – "Audits") and procedures for handling data integrity investigations and client notifications.

17.1 Ethics and Data Integrity Procedures

The Ethics and Data Integrity Policy provides an over view of the program. Written procedures that are considered part of the Ethics and Data Integrity program include:

- Teklab's Ethics and Data Integrity Policy: "Ethics, Legal Responsibility, & Conflict of Interest" (Appendix A)
- Corrective action procedures (SOP#1280 and Section 13 of this QAM)
- Procedure for Data Integrity Investigations (See Section 17.4 Investigations)
- Data Integrity training procedures (See Section 17.2 Training)
- Internal audit procedures (SOP#1270 and See Section 15 of this QAM)

17.2 Training

Data integrity training is provided as a formal part of new employee orientation and a refresher is given annually for all employees. Training courses in data integrity, ethical and legal responsibilities, include the potential punishments and penalties for improper, unethical or illegal actions. Attendance for required training is mandatory and is monitored through a signature attendance sheet.

Evidence must be on file that each employee has read, acknowledged and understood their personal, ethical and legal responsibilities including the potential punishments and penalties for improper, unethical or illegal actions.

Data integrity training emphasizes the importance of proper written narration on the part of the analyst with respect to those cases where analytical data may be useful, but are in one sense or another partially deficient. Topics covered are provided in writing and provided to all trainees.

17.3 Confidential Reporting of Ethics and Data Integrity Issues

Confidential reporting of data integrity issues is assured through the following procedures:

- Teklab Inc's Ethics and Data Integrity Policy ("Ethics, Legal Responsibility, & Conflict of Interest" see Appendix A)
- Procedures for reporting Data integrity and Ethics issues outlined in initial and ongoing annual training. Training slides are available in the Quality Documents folder on the Teklab server.

17.4 Investigations

All investigations resulting from data integrity issues are conducted confidentially. They are documented and notifications are made to clients who received any negatively affected data that did not meet the client's data quality requirements. Procedures for investigation are detailed below:

- Any Teklab personnel who learn of a non-compliance related incident through the reporting protocol should immediately inform a member of Teklab Management verbally or in writing.
- Any ethical matters discussed with management personnel will remain confidential within Teklab's management. In cases involving possible violations of the law or TNI regulations, Teklab may be required to reveal information to the proper authorities.
- Teklab management is responsible for determining the seriousness of the incident.
- Teklab's management team shall thoroughly investigate each incident and retain all evidence and records.
- Investigation Documentation Includes:
  - Date of investigative Report
  - Date Incident First Reported
  - Date of Incident Occurrence
  - Type of Issue / Incident
  - Full Description of Issue

- Description of Investigation
- Description of Resolution

Section 18 – PERSONNEL AND TRAINING

(TNI V1:M2 – Section 5.2)

Teklab Inc employs competent personnel based on education, training, experience and demonstrated skills as required. The laboratory's organization chart can be found in Appendix B.

18.1 Overview

All personnel are responsible for complying with all quality and data integrity policies and procedures that are relevant to their area of responsibility.

All personnel who are involved in activities related to sample analysis, evaluation of results or who sign test reports, must demonstrate competency in their area of responsibility. Appropriate supervision is given to any personnel in training and the trainer is accountable for the quality of the trainees work. Personnel are qualified to perform the tasks they are responsible for based on education, training, experience and demonstrated skills as required for their area of responsibility.

The laboratory provides goals with respect to education, training and skills of laboratory staff. These goals are outlined in the 1031 SOP and the employee's job description. Training needs are identified at the time of employment and when personnel are moved to a new position or new responsibilities are added. Ongoing training, as needed, is also provided to personnel in their current jobs. The effectiveness of the training must be evaluated before the training is considered complete.

A log of names, initials, and signatures for all individuals who are responsible for signing or initialing any laboratory records is maintained and stored in hard copy by the Quality Department.

18.2 Job Descriptions

Job descriptions are available for all positions that manage, perform, or verify work affecting data quality, and are located in each employee's electronic training file located on the Teklab Inc Server. These files are stored securely. An overview of top management's responsibilities is included in Section 3 – "Management".

18.3 Training

All personnel must perform a successful Initial Demonstration of Capability prior to initiation of assigned analysis (See SOP#1031 for IDOC and Certification Statement Requirements).

All new personnel are trained on their applicable analysis by an experienced Teklab employee. Additional training needs for each individual are determined through review of their resume and work experience and one on one interaction with the individual's supervisor and/or trainer. All personnel must successfully complete an IDOC prior to termination of training. Ongoing training is determined on a case by case basis by the individual's supervisor or a representative of the Quality Department. See SOP#1031 and Section 19 of this QA Manual for more information on IDOCs/ADOCs.

The Quality Department is responsible for tracking all initial introductory training. Department Supervisors are responsible for initiating, coordinating and monitoring on the job training for analysts within their department. Training records maintained by the Quality Department are stored securely on the Teklab Inc Server and include personnel qualifications, education, experience and training pursuant to the requirements set forth in sections 4, 5 and 19 of this Quality manual. Training files are considered up-to-date when the following items are present:

- Certification that the employee has completed initial safety and quality training.
- Documentation of Initial Demonstration of Capability (IDOC).
- Certification that the employee has read, understood, and is using the latest version of the laboratory's in-house quality documentation, which relates to their job responsibilities.
- Certification that the technician has read, understood and agreed to perform the most recent version of the approved standard operating procedure.
- Documentation of academic education and of training courses or workshops on specific equipment, analytical techniques, or laboratory procedures.
- Job description signed by the employee that includes an agreement that they are aware of their ethical and legal responsibilities and will avoid any conflict of interest.
- Documentation of Annual Demonstration of Capability (ADOC) on applicable methods.

18.3.1 Ethical/Legal Responsibilities and Conflict of Interest

Teklab is organized so that confidence in its independence of judgment and integrity are maintained at all times and has processes to ensure that its personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work. Teklab has a proactive program for prevention and detection of improper, unethical or illegal actions. See Appendix A for Teklab's Ethics and Data Integrity Policy and Section 17 for more on Data Integrity.

All new personnel are trained during orientation and all personnel are trained, at least annually, on data integrity, ethical behavior, legal responsibilities and conflict of interest. Each Teklab job description includes an agreement with the employee that they are aware of their ethical responsibilities and will avoid any conflict of interest. See also Teklab Inc. NELAP Policy Ethics, Legal Responsibility, & Conflict of Interest for policy discussed during training.

Teklab Inc's legally responsible parties are the signatories in Section 1 (Introduction and Scope) of the Quality Manual.

18.3.2 Training for New Staff

All new staff members are given introductory training and orientation upon arrival. The training is documented on a training attendance sheet that outlines what was covered during the training sessions.

Training topics include (but not limited to):

- Data Integrity training
- Safety training
- Quality training

Initial Laboratory Training:

- All documentation involved with a new and unfamiliar task is read and understood by the trainee. Reading forms are initial and dated by the employee confirming that they have read and understood the material.
- Training is under the direct supervision of a qualified analyst.
- During the time the analyst is in training, the trainee may sign laboratory notebooks, logbooks, worksheets, etc. But they must be co-signed by the trainer who is responsible for the data generated.
- The trainee demonstrates competency in the new task before they can operate independently. The competency for a test method is accomplished by a successful IDOC as defined in Section 19 of this Quality Manual.
- Training documentation is maintained in the employees training record, which is stored electronically on the Teklab Inc server.

18.3.3 Ongoing Training

The employee attests, through signature, that they have read, understood, and agree to perform the latest version of any SOPs or policies that the analyst is responsible for following:

- Annual refresher Data Integrity Training.
- Annually, the analyst shows continued proficiency in each method they perform (see Section 19 on IDOC s and ADOCs)
- Attending training related to job function as applicable.
- Maintaining training documentation in the employees training record.
- Monthly Safety training.
- Monthly Quality training.

18.3.4 Education/Experience

Job descriptions for all Teklab personnel are maintained by the quality department. Each employee must read and sign their job description upon hiring or changing positions within the laboratory. The signed job descriptions are placed in each employees training file.

18.3.4.1

The laboratory ownership shall designate at least one individual as LABORATORY DIRECTOR. The laboratory director shall have overall responsibility for the operation of the laboratory. The laboratory director shall also:

1. Hold a minimum of a bachelor's degree in chemistry or a related science or have completed enough course work in chemistry to equal a minor in chemistry or have at least 10 years non- academic analytical experience
2. The laboratory director shall be an employee of the laboratory and on-site at least 50% of the time.

18.3.4.2

The laboratory ownership shall designate at least one individual as the Technical Manager (or however named). These persons shall also:

1. Hold a bachelor's degree in the chemical, environmental, biological sciences, physical sciences or engineering, with at least twenty-four (24) college semester credit hours in chemistry
2. Have at least two (2) years of experience in the environmental analysis of representative inorganic or organic analytes for which the laboratory seeks or maintains accreditation. A master's or doctoral degree in one of the above disciplines may be substituted for one (1) year of experience.
3. Have a general knowledge of the analytical methods for which data review is performed.

See the TNI Standard V1M2 Section 5.2.6.2 for a list of Technical Manager qualification exceptions.

18.3.4.3

The laboratory ownership shall designate at least one individual as the Quality Officer. These persons shall also:

1) Hold a bachelor's degree in chemistry or related sciences or have completed enough course work to equal a major in science; and/or
2) Have a minimum of one year experience as an analyst in a laboratory and/or
3) Have documented training in quality assurance and quality control (QA/QC) and at least 3yrs of experience in a Quality Assurance setting
4) Where applicable, have functions independent from laboratory operations;
5) Have a general knowledge of the analytical methods for which data review is performed;
6) Be an employee of the laboratory, but free from outside or managerial influence, so that they may objectively perform assessments and evaluate data

18.3.4.4
The laboratory director and/or ownership shall designate at least one individual as LABORATORY SUPERVISOR. The laboratory supervisor(s) shall:

1) Hold a minimum of a bachelor's degree in chemistry or related sciences or have completed enough course work in chemistry to equal a major in chemistry, or;
2) Have had a minimum of five years experience in the analyses pertaining to the applicable fields of testing,;

The laboratory ownership may designate a laboratory supervisor as laboratory director. The Laboratory director/supervisor must fulfill the requirements of sections 18.3.4.1 and 18.3.4.4 above.

18.3.4.5
The laboratory director or supervisors shall designate the ANALYSTS. Analysts shall:

1) Hold a bachelor's degree in chemistry or related sciences or have completed enough course work in chemistry to equal a major in chemistry; or
2) Have had a minimum of two years experience in the analysis pertaining to the applicable fields of testing for which the laboratory is accredited; or
3) For those instruments listed in 18.3.4.6 below:
    A) either:
        i) have satisfactorily completed a minimum of four hours training that is offered by the equipment manufacturer, a professional organization, a university or another qualified training facility; or
        ii) served a two-week period of apprenticeship under an experienced analyst; and
    B) After appropriate training pursuant to subsection 18.3.4.5(3A), perform the Initial Demonstration of Capability (IDOC) study as specified in Section 19 of this Quality Manual and the TNI 2009 Standard (See SOP1031 for IDOC procedure); and
    C) Have on file annual documentation indicating one of the following:
        - Acceptable performance on a blind sample,
        - Another Initial demonstration of capability (IDOC),
        - four consecutive in-control laboratory control samples,
        - a documented process of analyst review using quality control (QC) samples
        - a certification that the technician has read, understood and agreed to perform the most recent version of the method, the approved method or standard operating procedure.

        Such documentation shall demonstrate that the required training is up-to-date.
4) Be an employee of the laboratory, contract employee, or contracted temporary agency staff; and

The Technical Manager or supervisors may designate individuals as ANALYSTS-IN-TRAINING. Analysts-in-training must at least meet the requirements in subsection 18.3.4.5.1 or 18.3.4.5.2 and be in the process of meeting the requirements of subsection 18.3.4.5 (3a). A laboratory supervisor, analyst or data auditor shall review and verify all data produced by analysts-in-training.

18.3.4.6

Analyses performed utilizing Automated Colorimetric (AC), Gas Chromatograph (GC), Gas Chromatograph/Mass Spectrometer (GC-MS), Inductively Coupled Plasma (ICP), Inductively Coupled Plasma Mass Spectrometer (ICP-MS), are only acceptable for the purposes of this manual when performed by a laboratory employee who meets the requirements in subsection 18.3.4.5 above.

18.3.4.7

A TECHNICIAN is a person who holds a minimum of a high school diploma or its equivalent. Any exceptions to this must be noted in the technicians job description. A technician must:

1) either:
    - A) Have satisfactorily completed a minimum of four hours training that is offered by the equipment manufacturer, a professional organization, a university or qualified training facility; or
    - B) Served a two-week period of apprenticeship under an experienced analyst or technician;
2) After appropriate training pursuant to subsection 18.3.4.7(1), perform the Initial Demonstration of Capability (IDOC) study as specified in Section 19 of this Quality Manual and the TNI 2009 Standard (See SOP1031 for IDOC procedure); and;
3) Have on file annual documentation indicating one of the following:
    - Acceptable performance on a blind sample,
    - another Initial Demonstration of Capability (IDOC),
    - four consecutive in-control laboratory control samples,
    - a documented process of analyst review using quality control (QC) samples
    - a certification that the technician has read, understood and agreed to perform the most recent version of the method, the approved method or standard operating procedure.

   Such documentation shall demonstrate that the required training is up-to-date.

18.3.4.8

A person may be allowed to serve in any capacity as defined in subsections 18.3.4.1 through 18.3.4.7 when the person does not meet the training, educational, or experience requirements for the position under one of the following conditions:

A) Experience as an offset for educational requirements (one year of experience performing the applicable duties equals one year of education);

B) Education as an offset for experience requirements (one year of applicable education beyond a bachelor's degree equals one year of experience);

C) For analysts and technicians, have six months laboratory experience as offset for the training and apprenticeship requirements set forth in 18.3.4.5 or 18.3.4.7 as applicable. Laboratory experience must be in the analytical technique for which the offset is requested.

D) For analysts and technicians, demonstration of ability to properly perform representative test procedures.

Section 19 - IDOC & ADOC

(TNI V1:M4 – Section 1.6)

19.1 Initial Demonstration of Capability (IDOC)

The IDOC is a procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

Before reporting any data with a given method, a satisfactory IDOC is performed. Thereafter, each analyst demonstrates continuing proficiency through the procedures outlined in Annual Demonstration of Capability below.

Each analyst performs an IDOC prior to initiation of assigned sample analysis, unless the IDOC is not applicable to the approved test method, such as total volatile solids, pH, color, odor, temperature, dissolved oxygen or turbidity. Thereafter, continuing demonstration of method performance is accomplished per the QCI for the method. IDOC studies are repeated whenever there is a change in analyst, instrument type, or approved test method that requires a change to the procedure in the SOP.

Teklab documents the completion of each demonstration of capability on a certification statement form. IDOCs are stored in the Teklab LIMS, and documented in the Employee Training Database (on the Teklab server), and in the employee’s electronic training files which are stored on the Teklab Inc Server. All records related to the demonstration are retained.

IDOCs (Demonstration of Capability) are performed:

- Before using any method
- Each time there is a change in instrument type, personnel or *method and
- If the laboratory or analysts has not performed the method in a twelve-month period.
- When an analyte not currently found on the laboratory’s list of accredited analytes is added to an existing accredited method, an IDOC shall be performed for that analyte

*Changes in method are assessed by the Technical Manager (or their designee) and the applicable laboratory Supervisor. Changed deemed as significant require an IDOC to be performed.

The IDOC(s) for each analyst is stored in the Teklab LIMS, and documented in the Employee Training Database, in the employee’s electronic training file and on employee electronic Demonstration of Capability (DOC) Forms which are all stored on the Teklab Inc Server. The DOC identifies the analyst(s) involved in preparation and/or analysis; matrix; analyte(s), class of analyte(s), or measured parameter(s); the method(s) performed; the laboratory-specific SOP used for analysis; and the date(s) of analysis. The LIMS and server copy of the IDOC also contain a summary of the results used to calculate the mean recovery and standard deviations.

All raw data, preparation records, and calculations for each IDOC are retained and are available for review.

IDOC procedures are outlined in SOP#1031 - IDOCs and ADOCs

Interim Data Generation
Data produced by analysts and instrument operators while in the process of obtaining the required training or experience is acceptable when reviewed and validated by a fully qualified analyst or the immediate supervisor.

19.2 Annual Demonstration of Capability (ADOC)

After the initial demonstration of capability is completed, on-going proficiency is maintained and demonstrated at least annually. Each analyst is expected to consistently meet the QC requirements of the method, the laboratory SOP, client requirements and/or the TNI Standard. ADOCs are documented in the Employee Training Database (by the Quality Department), and in the employee's electronic training files which are stored on the Teklab Inc Server. All records related to the demonstration are retained.

Teklab can use the following procedures to demonstrate ongoing DOC:

a) acceptable performance of a blind sample (single blind to the analyst);
  Note: Successful analysis of a blind performance sample on a similar method using the same technology (e.g., GC/MS volatiles by purge and trap for Methods 524.2, 624 or 5030/8260) would only require documentation for one of the tests.
b) another initial DOC;
c) at least four (4) consecutive laboratory control samples with acceptable levels of precision and accuracy. The laboratory shall determine the acceptable limits for precision and accuracy prior to analysis. The laboratory shall tabulate or be able to readily retrieve four (4) consecutive passing LCSs for each method for each analyst each year;
d) a documented process of analyst review using QC samples. QC samples can be reviewed to identify patterns for individuals or groups of analysts and determine if corrective action or retraining is necessary;
e) if a) through d) are not technically feasible, then analysis of real-world samples with results within a predefined acceptance criteria (as defined by the laboratory or method) shall be performed.

Section 20 - ACCOMODATIONS AND ENVIRONMENTAL CONDITIONS

(TNI V1:M2 – Section 5.3)

20.1 Environmental

Prior to the initiation of new work, the laboratory management reviews the work to ensure that it has the appropriate facilities and resources to accomplish the work. Management also provides adequate workspaces to ensure an unencumbered work area for performing the approved test methods.

The laboratory is designed, operated and arranged so that incompatible analyses are separated and the potential for sample contamination is minimized. Such environmental conditions include:

- The volatile organic laboratory has a separate ventilation system. Access to the volatile organic laboratory is limited to use only as necessary. Air volatile analysis is isolated at a separate facility located at the Teklab Air Laboratory.

- The microbiology lab has access restricted to only microbiology and quality assurance department personnel. All fecal coliform analyses are performed at a separate time from any other microbiology analysis, with proper disinfection of the area between analysis times.

- The laboratory has one exhaust hood for sample receipt, three for inorganic analysis, one for metals prep, and three for organic prep. Organic analysis also has three fume absorbers.

Environmental conditions are monitored as required by the relevant specifications, methods and procedures or where they influence the quality of the results. Environmental tests are stopped and corrective actions are taken and documented when the environmental conditions jeopardize the results of environmental tests.

New laboratory facilities shall be designed, operated and arranged so that all of the specifications of this section are met.

20.2 Work Areas

Teklab's facilities are maintained to permit the production of analytical data that meets the data quality of objectives of the applicable environmental regulation. Areas that affect the quality of laboratory activities are defined as any area within the physical boundaries of the building, except for the restrooms, lunch room and all hallways.

Good housekeeping is stressed. Employees must keep work spaces, instrumentation, and equipment clean and unencumbered.

The laboratory procedure for good housekeeping includes such measures as
- A part-time janitor
- periodic dedicated clean up days
- employees responsible for cleanliness of their own work area

20.3 Floor Plan

Floor plans can be found in Appendix C of this QA Manual.

20.4 Building Security

Areas that affect the quality of laboratory activities are secure areas and access is limited to Teklab, Inc. employees, anyone else entering these areas must be escorted by a Teklab, Inc. employee. Access to the laboratory facilities, during non-business hours, is controlled through a monitored building alarm system. The parking lot is also under video surveillance.

Section 21 - ENVIRONMENTAL METHODS AND METHOD VALIDATION

(TNI V1:M2 – Section 5.4 and Sections 1.4, 1.5 and 1.6 of Technical Modules TNI V1:M 3-7)

Methods and/or procedures are available for all activities associated with the analysis of the sample including preparation and testing. For purposes of this Section, “method” refers to both the sample preparation and determinative methods.

All methods are in accordance with applicable professional technical standards, U.S. & Illinois EPA requirements. Teklab uses only methods mandated by legal requirements, recognized published methods or methods developed and validated by Teklab. Methods are not used for reporting results until competence for each matrix is demonstrated. Personnel are not permitted to depart from approved procedures without the proper validations and approval of the Technical Manager and/or the Quality Assurance Officer, and approval of the client.

All analytical methods performed at Teklab have internally written Standard Operating Procedures (SOPs) or are copies of published methods, with any changes or selected options documented. Methods are based on the applicable reference method or methods (i.e. SW846, EPA 600, Standard Methods, NIOSH, IDPH, etc.).

Before being put into use, a test method is confirmed by a method validation process.

21.1 Method Selection

The laboratory selects methods that are appropriate to the customer needs. When the regulatory authority mandates or promulgates methods for a specific purpose, only those methods will be used.

If a method proposed by a customer is considered to be inappropriate or out-of-date, the customer is informed and the issue resolved before proceeding with analysis of any samples (see Section 6 – Review of Requests, Tenders and Contracts). If a method is not specified by the customer, an appropriate method will be selected using the process outlined below:

When a method is not specified by the customer, or the proposed method is inappropriate, the laboratory will select a method that is appropriate to the end use of the data. The laboratory selects methods that are appropriate to the customer needs. The customer will be informed of the selected method and must approve its use before being used to report data. When the regulatory authority mandates or promulgates methods for a specific purpose, only those methods will be used (see Section 6 – Review of Requests, Tenders and Contracts).

If there is not a regulatory requirement for the parameter/method combination, the parameter/method combination need not be validated as a non-reference method if it can be analyzed by another similar reference method of the same matrix and technology. (TNI V1 M4 1.4 - Method Selection)

21.2 Method Validation

Method Validation (MV) studies are used to verify the analytical procedure at different concentrations. An MV study is performed for each new analysis or test method and whenever a modification in methodology occurs that could affect the quantitation range of the analysis. MV studies include the determination of the following:

- Method detection limit – The method detection limit (MDL) is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results This number is used in LIMS and appears on final reports. The MDL is used to accommodate variances in multiple instrument MDL determinations and to minimize ongoing adjustments to the reporting limits.

- MDL_s - The method detection limit based on spiked samples

- MDL_b - The MDL based on method blanks

- PQL (practical quantitation limit) – The lowest level or concentration of an analyte that can be reported with a specific degree of confidence. For test methods utilizing a calibration curve, the PQL is equivalent to the lowest calibration standard. The PQL must be greater than the MDL and no greater than ten times the MDL. If regulatory limits are provided by the client, the PQL must be equal to or less than these.

- RL (Reporting Limit) – The PQL multiplied by any dilution or preparation factors. The RL appears on the final report. If a CRQL (client requested quantitation limit) exists for the sample and is greater than the final RL, the RL can be replaced with the CRQL at the client's request.

- MV (Method Validation Study) – The initial test method and/or instrument requirements of TNI and/or the referenced test method to validate that the laboratory is capable of achieving the required qualitative and quantitative detection and the required precision and accuracy of the method

See SOP 1030 'Method Detection Limits & Method Validation Studies' for detailed procedures on MDLs.

Selectivity

Selectivity is evaluated by following the checks established within each method. Examples are mass spectral tuning, second column confirmation, ICP inter-element interference checks, chromatograph retention time windows, instrument blanks, spectrochemical absorption or fluorescence profiles, co-precipitation evaluations, electrode response factors, and correlation coefficients. The acceptance criteria for mass spectral tuning is documented in the appropriate method SOP.

21.3 Estimation of Uncertainty of Measurement

Estimation and uncertainty of measurement are provided to clients upon request.

- If the standardized test method contains guidance to the uncertainty of evaluation, the method guidance is used for determination.
- If the standardized test method gives a typical uncertainty of measurement for test results this figure is quoted, provided there was full compliance with the test method in the performance of the test.
- If a standardized method implicitly includes the uncertainty of measurement in the test results, the results are reported accordingly.

Otherwise the estimation of uncertainty of measurement will be reported as follows:

The confidence interval for the test method determined from the standard deviation of Laboratory Control samples or QC samples utilized by the laboratory in determining batch acceptance for the test method will be provided with the data as a statement of uncertainty of measurement. If the sample measurement is near the reporting limit or detectable limit, additional information will be given on the variability of low level data. A statement of sample homogeneity will also be included, as well as any other sample related factors that may have lead to uncertainty of measurement.

In cases where the test method precludes rigorous, metrologically and statistically valid calculation of uncertainty of measurement, all the components of uncertainty of measurement are identified, a reasonable estimation on uncertainty is made, and the result is reported with explanation on the uncertainty.

21.5 Control Charts

Control charts are used to monitor the accuracy and precision of the procedures used at Teklab. They are used to determine what types of bias, if any, are occurring in analysis and to determine when an analysis or procedure is out of control.

PRECISION CONTROL CHARTS:
The precision control chart checks the duplicity of our methodologies. It uses the relative percent difference (RPD) between duplicate analyses.

ACCURACY CONTROL CHARTS:
The accuracy control chart checks the percent recovery of our methodologies. These check the percent recovery from LCSs and MSRs (Matrix Spike recoveries). This control chart cannot be made until at least twenty observations are made using samples of a known concentration. The Shewhart X-bar type chart is used for this measurement. The center line is the mean %R, the UWL and LWL (Upper and Lower Warning Limits) are calculated and plotted at +/- 2*sd; this represents a limit within which 95% of all subsequent %R calculations should fall, to ensure that the analysis/methodology is under control. The UCL and LCL (Upper and Lower Control Limits) are +/- 3*sd; this represents a limit within which 99% of all subsequent %R calculations should fall to ensure that the analysis/methodology is under control.

FREQUENCY AND CONSTRUCTION OF CONTROL CHARTS:
Data for accuracy and precision control charts will be updated continuously via the LIMS. The need to monitor a control chart for a particular analysis will be evident to the department supervisor if the quality control indicators for the test are not falling around the mean of the upper and lower control limits for the test. Data used to create control chart limits must be thoroughly reviewed for obvious outliers before inclusion in the control chart data set. Laboratory control limits for accuracy and precision will be updated as needed, with approval from the Technical Manager.

INTERPRETATION OF CONTROL CHARTS:
The control charts are used to trend results and look for problems or bias in the way an analysis is run. If a condition exists which indicates an out of control process or process bias, as defined by typical analysis of Shewhart control charts (example: Seven points on same side of an X-bar chart or a point above or below the UCL or LCL), a significant event will have occurred. In that event the Quality Assurance Officer, Technical Manager and any needed technicians or analysts will conduct an investigation to determine the cause or causes of the event and corrective action shall be implemented. After determination of a significant event, the applicable control charts will be updated with every new data point until the analysis is once again in control. A minimum of 10 data points will be plotted before the analysis can be said to be in control, once again.

21.6 Control of Data

To ensure that data are protected from inadvertent changes or unintentional destruction, the laboratory uses procedures to check calculations and data transfers (both manual and automated). See Section 5 – Control of Records for more information.

Note: Employees should not save important documents to the C Drive of their PCs, as information may be lost if the computer's hard drive fails. Documents should either be saved to designated folders on the F Drive or user-defined U Drives; both of which are located on the Teklab Server.

21.6.1 Computer and Electronic Data Requirements

The laboratory assures that computers, user-developed computer software, and automated equipment used for the acquisition, processing, recording, reporting, storage, or retrieval of environmental test data are:

- documented in sufficient detail and validated as being adequate for use;
- protected for integrity and confidentiality of data entry or collection, data storage, data transmission and data processing;
- maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of environmental test data; and
- held secure including the prevention of unauthorized access to, and the unauthorized amendment of, computer records. Data archive security is addressed in Section 5 “Control of Records” and building security is addressed in Section 20 “Accommodations and Environmental Conditions”.

Computers and instrumentation are tracked via a database that contains information such as the PC/instrument name, operating system and associated software. Purchased Microsoft Office open licenses are also tracked in the database. The database is stored securely in the IT folder on the Teklab Server.

21.6.2 Data Reduction

The analyst calculates final results from raw data or appropriate computer programs provide the results in a reportable format. The test methods or SOPs provide required concentration units, calculation formulas and any other information required to obtain final analytical results.

The laboratory has manual integration procedures that must be followed when integrating peaks during data reduction. See SOP4026 Manual Integrations.

Data is collected and reported by analysts after completion of a run of analysis in which all Quality control parameters are within the specified limits.

Calculations used to determine concentrations of the analytes for each parameter are included or referenced in each SOP. The calculations involve calibration factors that relate a known concentration to a measured concentration. The units are based on the calibration concentrations that are also defined in each SOP. Raw data and final results are recorded in the analysis logsheet (by the analyst), or the original printed data package from the instrument is retained. The raw results and corresponding quality control results are downloaded or manually entered into the Laboratory Information System (LIMS). The lab supervisor or other data validator reviews the calculated results, ensures that the data is free from transcription and calculation errors and checks the corresponding quality control information (ICB, ICV, CCBs, CCVs, MS/MSDs and RSD/RPD results). If the quality control information is within specified limits and the calculations are correct, the lab supervisor or other data validator validates the records in the LIMS. See the applicable SOP (1020, 1270, 1280 and 1290) for identification of individuals responsible for assessing each QC data type.

Data for pH, temperature, Dissolved Oxygen, Turbidity, ORP and conductivity is read directly from the instrument. All other data must be calculated manually to some degree. It is the responsibility of the analyst to convert raw data into reportable values and the lab supervisor or other data validator to ensure calculations are correct and that quality control checks are within specified limits.

All analysis have their own individual data packet to record analysis, unless computer generated reports are deemed acceptable by the Quality Assurance Officer and/or Technical Manager. See SOP 1291 Record Retention and Access. Data packets and/or computer-generated reports are maintained by the analysts responsible for performing the analysis and kept in the appropriate area of the laboratory. The data packet contains a cover sheet and a data sheet or sheets to record reagent and standard solution lot numbers. The data packets also contain information on any cleanup or separation procedure, sample ID codes, volumes and weights, if applicable. Problems noted during analysis are documented on the cover sheet of the data packet or computer generated report.

All raw data must be either retained in hard copy format and/or scanned to PDF and is maintained as described in Section 5 "Control of Records".

21.6.3 Data Review Procedures

Data review procedures are located in Section 26.4 – "Data Review".

Section 22 - CALIBRATION REQUIREMENTS: Equipment and Instruments

(TNI V1:M2 – Sect 5.5 and Section 1.7 of Technical Modules TNI V1:M4)

22.1 General Equipment Requirements

Any equipment procured in the support of tests must be of adequate quality to sustain confidence in the laboratory's tests, as specified by the SOP for each analytical method. Laboratory supervisors are responsible for informing the quality department of new equipment procurements and creating a maintenance log on the LIMS system. Where no independent assurance of the quality of the equipment is available, the equipment must be shown to produce acceptable results for the test method, within quality control limits of the test, before onset of sample analysis.

See General Equipment Maintenance SOP1210 for details on performance and documentation of equipment maintenance, inspection and cleaning. Manuals provided by the manufacturer of the equipment provide information on use, maintenance, handling and storage of the equipment. Any item of equipment subjected to overloading or mishandling which gives questionable results, or has been shown by verification or otherwise to be defective, shall be taken out of service. That equipment shall be clearly identified with a sign stating "OUT OF SERVICE" and wherever possible, stored in the rear storage area until it has been repaired and shown by calibration, verification or test to perform satisfactorily. The laboratory shall examine the effect of this defect on previous calibrations or tests. If it is shown that previous tests are affected, then procedures for nonconforming work are followed and results are documented (see Section 11 – "Control of Nonconforming Environmental Testing Work" and Section 13 – "Corrective Action"). The laboratory shall maintain documentation of all maintenance, calibration and instrument operation activities. Proper instrument maintenance is essential to the success of any analytical laboratory. Teklab's policy is to include instrument troubleshooting and maintenance as standard training for its analysts. Analysts gain a more thorough understanding of the analytical methodology and produce higher quality analytical results when they are capable of solving problems associated with instrument operation. Teklab employs service agreements and/or onsite/offsite service support to supplement our maintenance program whenever the analytical instrumentation requires expertise beyond our capabilities or safety concerns dictate the use of individuals with specialized training.

All instruments must be clearly labeled with unique identification (e.g. Milestone MPR-600/6S, Microwave 1).

Equipment is operated only by authorized and trained personnel (see Section 18 – "Personnel"*)*.

Test equipment, including hardware and software, are safeguarded from adjustments that would invalidate the test result measurements by limiting access to the equipment and using password protection where possible (see Sections 21.6 – "Control of Data" and 5.2 "Records Management and Storage").

Each item of equipment and software used for testing and significant to the results is uniquely identified. Records of equipment and software are maintained and include the following:

a) identity of the equipment and its software;
b) manufacturer's name, type identification, serial number or other unique identifier;
c) checks that equipment complies with specifications of applicable tests;
d) current location;
e) manufacturer's instructions, if available, or a reference to their location;
f) dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and the due date of next calibration;
g) maintenance carried out to date; documentation on all routine and non-routine maintenance activities and reference material verifications;
h) any damage, malfunction, modification or repair to the equipment;

See Section Appendix F for a current list of Teklab equipment.

The laboratory documents and maintains records, whether hard copy or electronic, of instrument and equipment calibrations, including at a minimum:

- Calibration procedures, calibration frequency, calibration acceptance criteria;
- Procedures to label all calibration curves, including the date, approved test method, analyte, standard concentrations, and instrument response; and
- Procedures to label the axes of the calibration curve.

For electronic data processing systems, which automatically compute the calibration curve, the system records the equation for the curve and correlation coefficient. Laboratory personnel record correlation coefficient when the calibration curve is prepared manually.

See Section 5 of this manual for more information on Control of Records.

22.2 Support Equipment

The laboratory has equipment that is applicable to its accreditation.

Support Equipment includes, but is not limited to: balances, ovens, refrigerators, freezers, incubators, temperature measuring devices, and volumetric dispensing devices.

Before being placed into service, support equipment shall be calibrated or checked to establish that it meets the laboratory's specification requirements and complies with the relevant standard specifications. All support equipment is maintained in proper working order. Records are kept for all repair and maintenance activities, including service calls. Balances are calibrated annually by a member of the Quality Department. Records of calibrations are stored in the Quality Folder on the Teklab server.

All raw data records, where applicable, are retained to document equipment performance. These records include logbooks, data sheets, or equipment computer.

See SOP1210 for more information.

22.2.1 Support Equipment Maintenance

Regular maintenance of support equipment, such as balances is conducted at least annually. Maintenance on other support equipment, such as ovens, refrigerators, and thermometers is conducted on an as needed basis.

Records of maintenance to support equipment are documented in Instrument Maintenance Logs located in the LIMS or hard copy maintenance logbooks.

22.2.2 Support Equipment Calibration

Relevant SOPs:
SOP 1180 - Balance use, maintenance and calibration
SOP 1190 - Auto Pipet and Syringe use, maintenance and calibration
SOP 1200 - Dessicant maintenance
SOP 1210 - General Equipment Maintenance
SOP 1220 - Thermometer use, maintenance and calibration.

SOP 1230 - Refrigerator and freezer use, maintenance and calibration.
SOP 1240 - Oven use, maintenance and calibration.

All support equipment is calibrated or verified at least annually over the entire range of use using NIST traceable references where available. The results the calibration of support equipment is within specifications, otherwise:

- equipment is removed from service until repaired
- records are maintained of correction factors to correct all measurements. If correction factors are used this information is clearly marked on or near the equipment.

Support equipment such as balances, ovens, refrigerators, freezers, and water baths are verified with a NIST traceable reference if available, each day prior to use, to ensure operation is within the expected range for the application for which the equipment is to be used. Acceptance criteria can be found in the applicable calibration SOP.

The laboratory identifies each refrigerator, freezer, thermometer, oven, and incubator in a way that establishes their use and distinguishes them from other similar equipment in the laboratory.

Volumetric dispensing devices (except Class A glassware and Glass microliter syringes) are checked for accuracy on a quarterly basis.

The laboratory checks the calibration of infra-red thermometers at least quarterly against a NIST-traceable thermometer. The comparisons are made at the temperature at which the thermometer will be used.

The laboratory shall monitor and control method specific temperature requirements for incubators, heating blocks and water baths each day of use. The laboratory maintains documentation of the results.

The calibration temperatures of laboratory hot blocks used for digestion are checked at least annually and after repairs. When digital readout is in units other than temperature, correlation of the digital readout to the temperature required for the test is documented. Temperature or digital readout is documented each day of use.

Laboratory personnel calibrate turbidimeters on a daily basis or before each use, whichever is less frequent, pursuant to section 5.2.1 of “Manual for the Certification of Laboratories Analyzing Drinking Water”.

See applicable calibration SOPs for more information. See Sections 4 “Document Control” and 5 “Record Control” for details regarding documentation.

A pH meter having the accuracy of at least +/- 0.05 pH units and a scale readability of at least 0.01 pH units must be used for pH analysis.

A conductivity meter with an error not exceeding 1% or one μmhos/cm, whichever is greater, must be used by the laboratory.

All glassware used for purposes that may subject it to damage from heat or chemicals shall be of borosilicate glass. All volumetric glassware used for standard preparation shall be ASTM class A.

Teklab uses Class S or NVLAP approved certified weights to calibrate balances. The laboratory re-certifies its reference weights at least once every five years. Other laboratory weights are calibrated annually by a member of the Quality Department. Records of the calibrations are stored in the Quality Folder on the Teklab Server.

The laboratory ensures that the NIST traceable thermometer is calibrated at least once every five years.

22.3 Analytical Equipment

22.3.1 Maintenance for Analytical Equipment

All equipment is properly maintained, inspected, and cleaned.

Maintenance of analytical instruments and other equipment may include regularly scheduled preventive maintenance or maintenance on an as-needed basis. Instrument malfunction is documented in the LIMS, which become part of the laboratory's permanent records.

22.4 Instrument Calibration

Initial instrument calibration and continuing instrument calibration verification are an important part of ensuring data of known and documented quality. Calibration requirements are included in laboratory SOPs. Generally, procedures and criteria regarding instrument calibrations are provided or referenced in the individual SOPs.

Section 22.2.2 includes information on calibration of support equipment. The following Section covers calibration of analytical equipment.

22.4.1 Initial Instrument Calibration

Verification of instrument calibration will include a blank (ICB) and either an Initial Calibration Verification (ICV) or QC sample (independent reference sample) at the beginning and end of each run of analysis and at least once every 20th sample in between (CCB/CCV) unless the analytical method does not require it, such as in methods which utilize internal standards. Any ICV off by more than the limits specified for that analysis or any QC sample outside the concentration range provided with the sample will cause the run to be rejected and require corrective action. All new instruments must have method detection limit (MDL) studies and method validation studies performed before the analysis of any samples. See the applicable method SOP for more information on calibration, ICB/ICV/CCB/CCV acceptance criteria and equipment maintenance requirements.

The laboratory performs an initial calibration of all instrumentation and equipment as specified in the approved laboratory SOP. The laboratory uses calibration standards traceable to national standards where available. When traceability is not applicable, the laboratory produces evidence of correlation of results through the analysis of a sample of known concentration which is traceable to national standards (proficiency testing), independent analysis or use of a suitable interlaboratory comparison.

22.4.1.1 Records

Initial instrument calibration records includes calculations, integrations, acceptance criteria, and associated statistics referenced in the applicable test method SOP either in the data packet or in Teklab LIMS.

Sufficient raw data records are collected to allow reconstruction of the initial instrument calibration. These include, at a minimum, calibration date, test method, instrument, analysis date, analyte names, analysts signature or initials, concentration and response, calibration curve or response factor, or unique equation or coefficient used to reduce instrument responses to concentration.

Calibration date and expiration criteria is documented in the applicable SOP for equipment requiring calibration, where practicable (see Section 22.1).

22.4.1.2 Number of Standards and Concentrations:

This section dictates the general calibration procedures and frequency for all instrumentation at Teklab. The number of standards required for calibration is indicated and the minimum correlation factor (R) for the curve is indicated in the applicable SOP.

For instrumentation where single point calibration is recommended by manufacturer's instructions, such as with some ICP and ICP/MS technologies (with a zero and single point calibration), the following apply:

1) Prior to the analysis of samples, the zero point and single point calibration are analyzed and the linear range of the instrument are established by analyzing a series of standards, one of which must be at the lowest quantitation level. Sample results within the established linear range will not require data qualifier flags.
2) Zero blank and single point calibration standards are analyzed with each analytical batch for methods where they are specified.
3) A standard corresponding to the limit of quantitation must be analyzed with each analytical batch and must meet established acceptance criteria when using single point plus zero blank calibrations.
4) The linearity of single point plus zero blank calibrations is verified at a frequency established by the method or the manufacturer.

If the reference or mandated method does not specify the number of calibration standards, the minimum number of points for establishing the initial instrument calibration shall be three (TNI 2009 M1V4 Section 1.7.1.1j). When not specified by the test method, the appropriate number of standards for use in the initial calibration curve is determined using the following procedure:

Determine a percent relative standard deviation (%RSD) of:

- The analysis of a minimum of seven replicate measurements of a standard with a concentration at one to three times the MDL; or
- The response factors (internal standard calibration) or calibration factors that cover the expected calibration range.

Determine the minimum number of calibration standards to be used in the initial calibration curve by correlating the %RSD with the number of required calibration standards:

%RSD	**Number of Calibration Standards**
0 -<2	1**
2 -<10	3
10-<25	5
>25	7

**Assumes linearity through the origin (0,0).
For analytes for which there is no origin (such as pH), at least a two point calibration curve is used.

The number of calibration standards (as determined from the applicable SOP) and a blank shall be used to generate the initial calibration curve of the approved test method.

If the calibration curve is not linear as defined in subsection 22.4.1.3(d) and the approved test method allows for the use of non-linear calibration curves; additional calibration standards shall be used to define the calibration.

If the approved test method specifies the generation and use of a calibration curve, all sample results shall be reported from sample analyses within the range of the calibration curve, except, when the approved test method specifically allows otherwise (for example ICP analysis above the highest calibration standard concentration but within the linear dynamic range as established by the laboratory pursuant to the applicable approved test method). See 22.4.1.2(1-4) for exception procedures.

The lowest calibration standard is the lowest concentration for which quantitative results can be reported without qualification. The lowest calibration standard is at or below the Practical Quantitation Limit (PQL) and is greater than the Method Detection Limit (MDL). Results that are less than the PQL are considered to have increased uncertainty, and are reported with “J” qualifiers as defined in the case narrative of the final report.

The highest calibration standard is the highest concentration for which quantitative results can be reported. Data reported exceeding the highest calibration standard without dilutions is considered to have increased uncertainty and are reported with "E" qualifiers as defined in the case narrative of the final report.

22.4.1.3 Evaluation, Verification and Corrective Action

All initial instrument calibrations are verified with a standard obtained from a second source traceable to a national standard when commercially available. If a second source is not available, a standard prepared from a vendor certified different lot may be used.

a) ICV check standards are prepared at the concentrations specified in the approved test method. If the approved test method does not specify the concentration for the ICV check standard, a concentration at 10% to 50% of the maximum calibration range is used. Exceptions may be made for multi analyte tests in which the ICV is prepared using standard mixes.

b) The laboratory utilizes the ICV check standards' acceptance criteria specified in the approved test method. If the approved test method does not specify the ICV acceptance criteria, the results of the analyses of the ICV check standard shall be within CCV criteria, or within 15% of the true value or within the 95% confidence interval determined from a minimum of 20 analysis of the ICV check standards.

If the analysis of the ICV check standard fails to meet the acceptance criteria specified in subsections 22.4.1.3(b) above, the laboratory shall either:

c) Suspend sample analysis and take corrective action to be followed immediately by a reanalysis of the ICV check standard; or

d) Immediately reanalyze the ICV check standard; and evaluate the subsection 22.4.1.3(c) ICV check standard reanalysis results as follows:

- The laboratory may continue sample analysis for the analytes for which the results of the reanalysis of the ICV check standard meet the acceptance criteria specified in subsection 22.4.1.3 (b).
- The laboratory shall terminate sample analysis or reject sample analysis data for the analytes for which the results of the reanalysis of the ICV check standard fail to meet the acceptance criteria specified in subsection 22.4.1.3 (b).
- The laboratory may proceed with sample analysis for the analytes for which the acceptance criteria were not met only after the establishment and verification of a new initial calibration curve pursuant to this Section.
- In the instance samples were ran after a failing ICV, and re-analysis is impossible, any data reported with a failing ICV shall be reported with data qualifying codes.

Quantitation is always determined from the initial calibration unless the test method or applicable regulations require quantitation from the continuing instrument calibration verification.

All initial calibration curves are subject to a calibration linearity test.

e) The calibration linearity shall be determined by the following as directed in the test method:

- *A linear regression analysis of the calibration curve;*
- *Determining the %RSD of the response factors (internal standard calibration); or*
- *Determining the %RSD of the calibration factors (external standard calibration).*

f) The initial calibration curve is considered linear when:

- *The correlation coefficient from the linear regression analysis is 0.995 or greater (Unless otherwise stated in the method)*
- *The %RSD of the response factor is 15% or less; or*
- *The %RSD of the calibration factors is 30% or less.*

g) If the initial calibration curve is linear as determined pursuant to:

- *The correlation coefficient in 22.4.1.3 (f), the laboratory utilizes the linear regression to determine the analytical results;*
- *The response factor in 22.4.1.3 (f), the laboratory utilizes the average response factor to determine the analytical result; or*
- *The calibration factor in 22.4.1.3(f), the laboratory utilizes the average calibration factor to determine the analytical results.*

Corrective actions are performed when the initial calibration results are outside acceptance criteria. Calibration points are not dropped from the middle of the curve unless the cause is determined and documented. If the cause cannot be determined, the calibration curve is re-prepared. If the low or high calibration point is dropped from the curve, the working curve is adjusted and sample results outside the curve are qualified. See Section 11 – "Control of Nonconforming Environmental Testing".

22.4.2 Continuing Instrument Calibration

22.4.2.1 Records

Sufficient raw data records are retained to allow reconstruction of the continuing instrument calibration verification. Continuing instrument calibration verification records connect the continuing verification date to the initial instrument calibration. The laboratory documents all activities related to calibration and standardization as specified

Where appropriate, the laboratory has manual integration procedures (SOP 4026) that are adhered to when evaluating calibration data.

22.4.2.2 Frequency

The laboratory analyzes a continuing calibration blank when required by the test method. The analysis of the CCV check standard must meet the acceptance criteria specified in 22.4.2.3.1

The laboratory initially analyzes a CCV check standard;

1. At the approved test method specified concentration, or if the approved test method does not specify the concentration for the CCV check standard, the concentration shall be at 25% to 50% of the maximum of the calibration range. Exceptions may be made for multi analyte tests in which the ICV is prepared using standard mixes.

2. The laboratory shall analyze a CCV check standard at the beginning and end of each analytical batch. Further frequency of the CCV shall be determined by the SOP for that particular test. For instruments using internal standards, the laboratory shall analyze a CCV check standard at the beginning of each analytical batch.
3. A CCV must be repeated whenever it is expected that the analytical system may be out of calibration or might not meet the verification acceptance criteria.
4. A CCV must be repeated if the time period for calibration or the most previous calibration verification has expired.

22.4.2.3 Evaluation, Verification and Corrective Actions

To verify the continued acceptability of the initial calibration, the laboratory prepares and performs the analysis of a CCV check standard for all instrumentation and equipment according to the following procedure:

a) The laboratory utilizes a CCV check standard prepared from the initial calibration curve standards or from a second source material.

b) The laboratory prepares a CCV check standard at a concentration within the range of the initial calibration standards.

c) Whenever the laboratory does not prepare an initial calibration curve on the day of analysis, the laboratory verifies the integrity of the initial calibration curve prior to sample analysis, by analyzing continuing calibration verification with each analytical batch.

22.4.2.3.1 Acceptance Criteria

The laboratory utilizes the CCV check standards' acceptance criteria specified in the approved test method SOP. If the approved test method does not specify the CCV acceptance criteria, the CCV check result shall be within 15% of the true value or within the 95% confidence interval determined from a minimum of 20 analysis of the CCV check standard at a single concentration.

22.4.2.3.2 Acceptance Criteria failure

If the analysis of the CCV check standard fails to meet the acceptance criteria specified above the laboratory suspends sample analysis and makes routine corrective action to be noted on the raw data package and followed by an immediate reanalysis of the CCV check standard. Evaluate the check standard reanalysis results as follows:

a) The laboratory continues sample analysis for the analytes for which the results of the second analysis of the CCV check standard meet the acceptance criteria specified in subsection 22.4.2.3.1.
b) The laboratory terminates sample analysis or rejects sample analysis data for the analytes for which the results of the second analysis of the CCV check standard fail to meet the acceptance criteria specified in subsection 22.4.2.3.1.
c) The laboratory may proceed with sample analysis for the analytes for which the acceptance criteria were not met only after the establishment and verification of a new initial calibration curve pursuant to this section.

22.4.3 Unacceptable Continuing Instrument Calibration Verifications

If routine corrective action for continuing instrument calibration verification fails to produce a second consecutive (immediate) calibration verification within acceptance criteria, then a new calibration is performed or acceptable performance is demonstrated after corrective action with two consecutive calibration verifications.

For any samples analyzed on a system with an unacceptable calibration, some results may be useable under the following conditions:

a) If the acceptance criteria are exceeded high (high bias) and the associated samples are below detection, then those sample results that are non-detects may be reported as non-detects.

b) If the acceptance criteria are exceeded low (low bias) and there are samples that exceed the maximum regulatory limit, then those exceeding the regulatory limit may be reported.

Section 23 – Standards and Reagents

(TNI V1:M2 – Section 5.6)

Measurement quality assurance comes in part from traceability of standards to certified materials.

All equipment used affecting the quality of test results are calibrated prior to being put into service and on a continuing basis (see Section 22 "Calibration Requirements"). These calibrations are traceable to national standards of measurement where available.

If traceability of measurements to SI units is not possible or not relevant, evidence for correlation of results through interlaboratory comparisons, proficiency testing, or independent analysis is provided.

23.1 Reference Standards

Reference standards are standards of the highest quality available at a given location, from which measurements are derived (e.g. ASTM Class 1 weights, NIST traceable reference thermometers).

Reference Standards, such as ASTM Class 1 weights, are used for calibration only and for no other purpose. Reference standards, such as ASTM Class 1 weights, are calibrated by an entity that can provide traceability to national or international standards. The following reference standards are sent out to be calibrated to a national standard as indicated in Section 22 – "Calibration Requirements"

23.2 Standards and Reagents

Reference materials, where commercially available, are traceable to national standards of measurement, or to Certified Reference Materials, usually by a Certificate of Analysis.

Upon receipt, all reagents and standards shall be inspected, receipt dated, initialed, the lot number shall be recorded and an expiration date shall be assigned. No reagents or standards shall be used beyond their expiration date without verification of their continued validity.

All reagents and standards shall be of adequate quality to sustain confidence in the laboratory's test, as specified by the SOP for each analytical method. Laboratory supervisors are responsible for scanning and linking all Certificates of Analysis of standards into Teklab LIMS. Where no independent assurance of the quality of reagents or standards is available, the standard or reagent must be shown to produce acceptable results for the test method, within quality control limits of the test, before onset of sample analysis. See SOP1250 "Reagents and Standards" for more information.

23.3 Transport and Storage

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials.

Reference standards and materials are stored according to manufacturer's recommendations, method SOP requirements and separately from samples.

23.4 Labeling

The laboratory has procedures for purchase, receipt and storage of standards, reagents and reference materials. Purchase procedures are described in Section 7 – "Purchasing Services and Supplies".

All containers of prepared standards and reagents are labeled with a unique identification number (using the LIMS identification system) and an expiration date (where applicable). This information is documented in the LIMS and all records retained.

23.4.1 Stock Standards and Reagents

The laboratory retains records supplied by the manufacturer/vendor, which include the manufacturers' Certificate of Analysis or purity for standards, the date of receipt, recommended storage conditions and an *expiration date after which the material shall not be used unless its reliability is verified by the laboratory. These documents are retained for the same length of time as that required for the retention of documentation associated with the analytical results for which the standards or reagents were used.

If reference materials cannot be purchased with a Certificate of Analysis, the laboratory produces evidence of correlation of results through the analysis of a sample of known concentration which is traceable to national standards (proficiency testing), independent analysis or use of a suitable interlaboratory comparison.

Records shall include:

- the manufacturer/vendor name (or traceability to purchased stocks or neat compounds)
- the manufacturer's Certificate of Analysis or purity (if supplied)
- the date of receipt
- recommended storage conditions

This information is logged into the applicable section of the LIMS. Certificates of Analysis for Standards are scanned and linked to the LIMS by the applicable department or a member of the quality department.

In methods where the purity of reagents is not specified, analytical reagent grade is used. If the purity is specified, that is the minimum acceptable grade**.** Purity is verified and documented according to Section 7 – "Purchasing Services and Supplies".

*If the original container does not have an expiration date provided by the manufacturer or vendor, it is not required to be labeled with an expiration date.

23.4.2 Prepared Standards and Reagents

Preparation of standard solutions are documented to include; date of preparation, expiration date (expiration of the standard shall not exceed the preparation date of the parent standard or stock solution), concentration of the parent standard or stock solution, concentration of standard working solution and the initials of the person preparing the solution. All standard solutions are prepared using class A or equivalent glassware and analytical balances. Standard concentrations (or a dilution thereof) are checked using an independent reference standard.

Reagent purity is checked through the use of Laboratory Control Blanks. Any contamination discovered in a reagent will be noted and that lot of reagent shall not be used.

The laboratory documents and maintains records concerning the receipt, use and traceability of analytical reagents and standards, including at a minimum:

- Verification of standards traceable to national standards. If traceability to a national standard is not possible, the lab demonstrates by appropriate means (e.g. analyses of PT samples) that the instrumentation/equipment is properly calibrated;
- Certificate of the origin, purity and traceability of all standards. These records include the date of receipt, storage conditions, and the date of opening.
- Procedures to ensure the traceability of working and intermediate standards to purchased stock standards or neat compounds which include the date of preparation and preparer's initials; and
- Procedures to clearly identify all prepared reagents and standards, including preparation date, concentrations, and preparer's initials;

See Section 5 of this Quality Manual for more information on control of records.

Section 24 - COLLECTION OF SAMPLES

(TNI V1:M2 – Section 5.7)

Regardless of the laboratory's level of control over sampling activities, all the requirements of this section are essential to ensure sample integrity and valid data and shall be followed by the laboratory. Sampling performed by Teklab, Inc. is governed by SOP 1150. Field sampling and any laboratory sub-sampling necessary to obtain sample aliquots for testing are covered in SOP 1150.

24.1 Sampling Containers and Kits

The laboratory offers clean sampling containers and kits for use by clients.
See the following Teklab SOPs for more information:
1081 Sample Kit Preparation
1082 Bottle Certification
1083 5035 Sampling Kit Preparation
1090 Landfill Sample Bottles

24.2 Sampling Plan

The laboratory uses sampling plans provided by clients or prepared in consultation with the client. The plan must include any factors that must be controlled to ensure the validity of the test. Sampling plans and written sampling procedures are used for sampling substances, materials or products for testing. The plan and procedures are made available at the sampling location.

The laboratory's procedures for dealing with non-conformances are used when the client requests any deviations from the sampling plan or sampling procedures. The requests are documented and included in the final test report.

See the following Teklab SOPs for more information:
1150 Sampling Instructions
1151 Groundwater Sampling

Section 25 – Sample Receipt and Storage

(TNI V1:M2 – Section 5.8 and Section 1.7 of Technical Modules TNI V1: M 3-7)

This section applies to samples received by Teklab and will be used to guide clients in sampling requirements specified in the "Federal Register, 40 CFR Part 136, Table II". Teklab does not reuse sample containers at this time except for air. See SOP 6000 SiloniteTM canisters for cleaning procedures for air containers.

25.1 Sample Receipt

When samples are received at the laboratory, the chain-of-custody is reviewed, the condition is documented, samples are given unique identifiers, and they are logged into the sample tracking system.

25.1.1 Chain of Custody

A customer service specialist or their designated representative indicates receipt of samples by signing the accompanying custody form. The supervisor or project manager reviews the signed form. The original signed custody form becomes part of the final data package that is reported to the client. The laboratory scans and files a copy of the signed custody form along with the final report as a permanent record of the sample receipt.

25.1.2 Legal/Evidentiary Chain of Custody

The laboratory has procedures for legal chain of custody services. If samples are noted as being used for legal/evidentiary purposes, special chain of custody procedures are put into place by the laboratory. See Sop1065 "Legal or Evidentiary Custody" for more information.

25.2 Sample Acceptance

Procedures for opening shipping containers and examining samples are provided in SOPs 1110 "Sample Pickup and Delivery" and 1070 "Sample Acceptance".

Teklab has a sample acceptance policy that is made available to sample collection personnel (See SOP 1070 Sample Acceptance). It emphasizes the need for use of water resistant ink, providing proper documentation (to include sample ID, location, date and time of collection, collector's name, preservation type, sample type and any special remarks about the sample), labeling of sample containers to include a unique sample ID, use of appropriate containers, adherence to holding times, and sample volume requirements. In addition the laboratory has nonconformance/corrective action procedures to handle samples that do not meet the requirements above or show signs of damage, contamination or inadequate preservation. Data will be appropriately qualified where samples are reported that do not meet sample acceptance requirements.

On samples receipt the laboratory checks for the conditions above and logs the applicable information into the LIMS Sample Checklist. This checklist becomes part of the final report. Criteria regarding preservation, holding time and sample volume requirements can be found in 1000 series SOP Appendix B

If these conditions are not met, the laboratory follows SOP1070 and the client is contacted prior to any further processing, then

1) the sample is rejected as agreed with the client,
2) the decision to proceed is documented and agreed upon with the client,
3) the condition is noted on the Chain of Custody form and/or lab receipt documents, and;
4) the data are qualified in the case narrative or sample checklist of the final report.

25.2.1 Preservation Checks

See 1000 series SOP Appendix B for information on preservation requirements.

25.3 Sample Identification

The customer service specialists use LIMS to maintain an electronic log book to record, for each sample, the person delivering the sample, the person receiving the sample, the date and time received, source of sample, sample identification and a unique laboratory ID code. The laboratory ID code is used as the link that associates the sample with the field ID code, the date and time of sample collection, the date and time of sample receipt, the requested analysis (including applicable approved test method numbers), any comments resulting from inspection for sample rejection, and other related laboratory activities. The laboratory ID code is transferred to all sub-samples, extracts, and digestates. The custodians document the condition of the sample upon receipt (i.e. unsealed, broken container, etc.). A standardized format is used for the electronic log-in book.

Each sample container is identified by affixing a durable label which specifies the unique LIMS generated laboratory ID code for each container. The LIMS generated laboratory ID code includes the work order number, the lab number and the container identifier.

A work order number is generated by the LIMS system. The first two digits in the work order number indicate the year the sample was received by the laboratory, the third and fourth digit indicate the month received, the remaining four digits indicate the consecutive COC number for the month. Following the work order number, LIMS generates a consecutive lab number for each sample on the COC preceded by a dash. The lab number is followed by a letter to uniquely identify each sample fraction received. When 2 containers or vials are received for the sample fraction, the bottle labels are numbered (i.e. 1 of 2, 2 of 2) so that the analyst can document from which sample container or vial any sub-sample was taken.

All documentation received regarding the sample, such as memos or chain of custody, are scanned and retained with the final report on the Teklab Inc Server.

25.4 Sample Aliquots / Subsampling

In order for analysis results to be representative of the sample collected in the field, the laboratory has subsampling procedures. See SOP1150 for more information.

25.5 Sample Storage

Clean, dry, isolated cabinets and/or refrigerators that can be securely locked from the outside are designated as a "sample storage security areas". In the Teklab Air Laboratory, and the Kansas, Downers Grove and Springfield Service Centers, the entire facility is considered secure. The laboratory limits access to authorized laboratory personnel only. During operating hours, all samples remain in the laboratory secure areas. During non-operating hours, all samples are locked in the storage refrigerators or cabinets in the laboratory secure areas. The laboratory controls and documents access to all samples and sub samples designated as litigation samples by the client. Details can be found in SOP 1065 “Legal or Evidentiary Custody“.

The client must inform the laboratory of any heat-sensitive, light-sensitive, radioactive, or other sample materials having unusual physical characteristics or that require special handling. The custodian shall ensure samples are properly stored and maintained prior to analysis.

The custodian distributes samples to the laboratory supervisor or the appropriate laboratory cooler (or his or her representative) responsible for the lab analysis. Sample transfers within the laboratory are monitored by a sample custodian using the LIMS sample tracking system. Where possible, distribution of samples to the analyst performing the analysis must be made by the custodians.

Laboratory personnel are responsible for the care and custody of the sample once they receive it. They must be prepared to testify that the sample was in their possession and in view or secured in the laboratory at all times from the moment it was received from the custodian, until the completion of the analysis.

Drinking water Bacteria samples are delivered to the Microbiology laboratory immediately upon receipt. They are then logged into the LIMS, prior to analysis. Aqueous and solid samples to be analyzed for Fecal Coliform are stored separately from potable water samples.

The laboratory provides sample storage facilities that prevent cross-contamination of samples and meet the conditions specified by preservation protocols. Samples are stored away from all standards, reagents, food and other potentially contaminating sources. Sample fractions, extracts, leachates and other sample preparation products are stored according to this section, SOP1120 or according to specifications in the approved test method. The laboratory verifies that cross-contamination between samples has not occurred through the examination of storage areas or through the review of analytical data on laboratory blanks that are stored with samples.

Once the sample analyses are completed, the unused portion of the sample, together with all identifying labels, must be returned to the custodian. The returned, tagged sample/s should be retained in the custody room for a period of 30 days for aqueous and drinking water samples and no less than 2 weeks for solids and special wastes. Solids and special wastes are transferred to a storage shed where they are held for an additional 4 weeks when more room is needed in the walk in cooler (unless otherwise requested by the client). Volatile air samples are retained for three days after the final report is issued to the client and then disposed of. Litigation samples are retained until permission is given from the proper authority (See SOP1065 “Legal or Evidentiary Custody” for more information on Litigation Samples).

See SOP1120 “Sample Storage, Retention and Disposal” for more information.

25.6 Sample Disposal

Teklab complies with all applicable federal, state and local laws concerning the handling and disposal of hazardous waste. Teklab also complies with all applicable laws concerning the generation of air pollutants. All laboratory samples are disposed of according to Federal, State and local regulations. Procedures are described in SOP1120 “Sample Storage, Retention and Disposal” and SOP1130 “Waste Disposal” for the disposal of samples, digestates, leachates, and extracts. Records for sample disposal are kept indefinitely

25.7 Sample Transport

Samples that are transported under the responsibility of the laboratory, where necessary, are done so safely and according to storage conditions. This includes moving bottles within the laboratory. Appropriate DOT shipping instructions will be available to clients upon request. Specific safety operations are addressed outside of this document.

Sample shipping procedures are described in SOP 1100 Subcontracting and Shipping.

Section 26 - QUALITY ASSURANCE FOR ENVIRONMENTAL TESTING

(TNI V1:M1, V1:M2 – Section 5.9 and Section 1.7 of Technical Modules TNI V1: M 3-7)

26.1 DEFINITIONS

Quality Control Indicators (QCI); such as Trip Blanks (TB), Duplicates (Dup), Initial Calibration Verification (ICV), Continuing Calibration Verification (CCV), Laboratory Control Blanks (LCB), Laboratory Control Samples (LCS), Standard Reference Materials (QC sample) and Matrix Spikes/Matrix Spike Duplicates (MS/MSD) will be analyzed to assess the quality of the data resulting from the field sampling program and in-house analysis.

Trip blanks (Equipment Blanks):
A trip is used to identify contamination from transport, shipping and site conditions. Trip blanks are analyte-free water taken to the field and returned to the laboratory unopened for analysis, to determine if contamination has occurred. Equipment blanks are used to identify contamination from sampling procedures. Equipment blanks are opened in the field, poured appropriately over or through the sample collection device and brought in for analysis to determine if contamination has occurred.

Field Blanks:
A Field Blank is exposed to the same field conditions as the sample, opened in the field. Its purpose is to assess the potential for field contamination.

Duplicate samples:
Analyzed to check for sampling and analytical reproducibility. Field duplicates are taken during sample collection. Internal duplicates are analyzed in the laboratory by splitting the sample and analyzing each split as an independent sample. See applicable SOP for frequency of matrix spike duplicates by analysis.

LCB (laboratory control blanks) or **MBLK** (method blanks):
A LCB is used to check contamination in the laboratory and is taken through the entire analytical procedure. The method blank consists of a matrix that is similar to the associated samples and is known to be free of the analytes of interest. These samples are used to verify the purity of all chemicals and reagents used in the methodologies and to prove the absence of contamination during the analytical procedure.

LCS samples (Laboratory control samples)**:**
The LCS is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then taken through the entire analysis to determine batch acceptance.

QC samples:

QC samples are purchased from an independent source to verify analytical procedures and calibrations. All QC samples must be NIST traceable reference materials, when available.

If a QC sample is not taken through the entire sample preparation procedure and is used for calibration verification (ex. GFAA), a LCS which has been taken through the entire procedure must also be analyzed.

Matrix spikes:

These provide information about the effect of the sample matrix on the preparation and measurement methodology. All matrix spikes and matrix spike duplicates are hereafter referred to as MS/MSD samples. These samples are always run with another aliquot of the sample that is not spiked. Spiking a sample tells us what effect the sample matrix (i.e. aqueous, solid, non-aqueous liquid) has on the parameter being measured. Sometimes the sample matrix will hide a parameter; a matrix spike will help identify this effect by showing a low recovery. Because matrix spikes give more information about the sample and its matrix, they are preferred to running duplicates. Some analysis (pH and Temp for example) do not lend themselves to matrix spikes very easily, therefore some analysis do not use matrix spikes (inorganic/physical analysis only).

Batch:

Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

Prep Batch:

Composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours

Analytical Batch:

Composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples.

TCLP METALS AND ORGANICS**:** Every unique TCLP sample matrix will be run both with and without matrix spikes, under direction of US EPA SW-846. However, as generally accepted laboratory practice, Teklab will not run TCLP matrix spikes on every sample, unless requested by the client. The frequency of matrix spiking (detailed in the applicable SOP) will be followed unless otherwise requested.

NOTE: Some clients may request specific types of quality control analysis. Those instances will be handled on a case by case basis.

26.2 Essential Quality Control Procedures

Teklab Inc has procedures for monitoring the validity of the testing it performs. The qualities of test results are recorded in such a way that trends are detectable, and where practicable, are statistically evaluated. To evaluate the quality of test results, the laboratory utilizes various evaluation aids such as certified reference materials, proficiency testing samples and control charting.

Quality control data are analyzed and when found to be outside pre-defined criteria, action is taken to correct the problem and to prevent incorrect results from being reported. Data associated with quality control data outside of criteria and still deemed reportable will be qualified so the end user of the data may make a determination of the usability of the data - see Section 27 – "Reporting of Results".

The quality control procedures specified in test methods are followed by laboratory personnel. The most stringent of control procedures is used in cases where multiple controls are offered. If it is not clear which is the most stringent, that mandated by test method or regulation is followed.

Teklab utilizes the quality control procedures set forth in this section if the approved test method does not specify any quality control procedures or the quality control procedures contained in the approved test method are less stringent.

Teklab assesses and evaluates the results of all quality control procedures on an on-going basis.

A) Written procedures to ensure that all results from all quality control procedures are reviewed and the decision made to accept, reject, or qualify sample data before the data is reported.
B) Written criteria for accepting, rejecting, or qualifying sample data based on each quality control procedure.
    i) Teklab uses the acceptance criteria contained in the approved test method for evaluating the results of each of the quality control procedures and for accepting, rejecting, and qualifying sample data.
    ii) If the approved test method does not specify the criteria for evaluating the results of each of the quality control procedures and for accepting, rejecting, and qualifying data, Teklab establishes written criteria.
C) If a quality control procedure results in the laboratory rejecting or qualifying sample data, the laboratory may implement corrective actions. When analyzing reference materials, the laboratory uses the acceptance criteria supplied by the manufacturer.
D) The laboratory completes corrective actions and maintains written records as required in Section 5 of this manual.

Written procedures to monitor routine quality controls including acceptance criteria are located in the test method SOPs, except where noted, and include such procedures as:

- use of laboratory control samples and blanks to serve as positive and negative controls for chemistry methods;
- use of laboratory control samples to monitor test variability of laboratory results;
- use of calibrations, continuing calibrations, certified reference materials and/or PT samples to monitor accuracy of the test method;

- measures to monitor test method capability, such as limit of detection, limit of quantitation, and/or range of test applicability, such as linearity;
- use of regression analysis, internal/external standards, or statistical analysis to reduce raw data to final results;
- use of reagents and standards of appropriate quality and use of second source materials as appropriate;
- procedures to ensure the selectivity of the test method for its intended use;
- measures to assure constant and consistent test conditions, such as temperature, humidity, etc., when required by test method;

26.3 Internal Quality Control Practices

Analytical data generated with QC samples that fall within all prescribed acceptance limits indicate the test method is deemed to be in control.
QC samples that fall outside QC limits indicate the test method are deemed to be out of control (nonconforming) and that corrective action is required and/or that the data are qualified (see Section 11 – "Control of Nonconforming Environmental Testing Work" and Section 13 - "Corrective Actions").

Detailed QC procedures and QC limits are included or referenced in test method standard operating procedures (SOPs), or where unspecified in the SOPs, are detailed in the method.

See applicable SOP for Duplicate and Matrix Spike concentrations and frequency.

26.3.1 General Controls

Teklab follows the quality control procedures and quality control indicators (QCI) specified below:

Laboratory Control Blank (LCB)
A minimum of 1 laboratory control blank (LCB) is analyzed with each preparation batch of environmental samples and carried through the entire analytical process. LCBs are not required for approved test methods, including but not limited to: pH, temperature and conductivity, for which method blanks are not appropriate. For analysis in which no separate preparation method is used, LCBs are prepared at the beginning each batch and once every 20 samples in between.

A) A batch of drinking water sample data meets the requirements of this section only when the method blank does not contain an analyte of interest at a concentration greater than the MDL.

B) A batch of environmental sample data, except for drinking water sample data, meets the requirements of this section when the method blank does not contain an analyte of interest at a concentration greater than the highest of the following:

i) The MDL or PQL whichever the client requires for the reporting limit
ii) 10% of the regulatory limit for that analyte, or
iii) 10% of the measured concentration for that analyte in any environmental sample in the batch.

C) The provisions of subsection 26.2.1 Laboratory Control Blank(B) do not apply in those instances where the method blank criteria have not been met and there are non-detect results for the corresponding analyte in the environmental samples associated with the method blank. In such instances, the non-detect results may be reported with a comment in the sample narrative.

D) The following corrective actions are to be taken when (26.2.1 Laboratory Control Blank)(A), (B), or (C) above are not met:
  i) The run of analysis is terminated (and no sample results are reported);
  ii) The source of the contamination is identified, eliminated and documented;
  iii) The samples are reanalyzed and results are reported only after the conditions of (26.2.1 Laboratory Control Blank)(A), (B) or (C) above are met.
  iv) If corrective actions cannot be taken (i.e. insufficient sample), the results may be reported with the appropriate qualifiers.

Matrix spikes (MS)

Matrix Spikes are performed at a rate of one per 20 or fewer environmental samples per matrix type, per sample extraction or preparation procedure.

A) The laboratory utilizes the spiking analytes specified in the approved test method, except when the approved test method indicates that all method analytes are to be matrix spiked. In such cases the laboratory shall spike the target analytes for the sample or any client requested analytes.

B) If there are no specified spiking analytes, the laboratory spikes per the following:
  i) For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike or spikes are chosen that represent the chemistries and elution patterns of the components to be reported.
  ii) For those test methods that have extremely long lists of analytes, a representative number are chosen using the following criteria for choosing the number of analytes to be spiked.
    a. For methods that include 1-10 targets, all components are spiked;
    b. For methods that include 11-20 targets, at least 10 or 80%, whichever is greater are spiked;
    c. For methods with more than 20 targets, 16 or more components are spiked.

C) The laboratory selects samples on a rotating basis to receive matrix spike analysis from among various client samples, waste streams, monitoring locations and other applicable locations. Matrix spikes are selected randomly, unless specified by the client.

D) As is required in section 10 of this manual, the procedure used to select the sample for matrix spike analysis must be documented.

E) Matrix spikes are not required for approved test methods in which materials for matrix spiking are not available, including but not limited to: total suspended solids, total dissolved solids, total volatile solids, flash point, reactivity, pH color, odor, temperature, dissolved oxygen and turbidity.

F) Matrix spike recoveries are within the acceptance limits when:
   i) They are within the limits given in the approved method (when available), laboratory established limits, or those given by laboratory generated control charts, or
   ii) The matrix spike concentration is less than 20% of the sample concentration, or
   iii) a diluted sample, which is bench spiked, shows a spike recovery within the acceptance criteria given in (F)(i) above. (Note: the reporting limit must be elevated by the dilution factor.)

G) The following corrective actions are taken when (F)(i), (ii), (iii) above are not met:
   i) The samples are reanalyzed, if necessary, and results are reported only after the conditions of (F)(i), (ii) or (iii) above are met, or
   ii) Sample results are qualified, when reporting to customer, as showing adverse matrix effects.

Matrix spike duplicates (MSD)/sample duplicates

MSDs or Sample duplicates are performed at a rate of one per 20 or fewer environmental samples per matrix type, per sample extraction or preparation procedure.

A) Matrix spike duplicates are performed on the same environmental sample chosen for matrix spike analyses.

B) Samples are selected on a routine basis to receive sample duplicate analyses from among various client samples, waste streams, monitoring locations and other applicable locations. Matrix spike duplicates and/or matrix duplicate samples are selected randomly, unless specified by the client.

C) The laboratory documents, as required in section 10 of this manual, the procedure used to select the sample for matrix spike duplicates or sample duplicate analysis.

D) Relative Percent Differences (RPD) are within the acceptance limits when they are within the limits given in the approved method or those given by laboratory generated control charts. The matrix duplicate provides a usable measure of precision only when target analytes are found in the sample chosen for duplication.

E) The following corrective actions are to be taken when (D) above is not met:

i) The sample is reanalyzed, if necessary and results are reported only after the conditions of (D) above are met.

ii) Sample results for matrix spike duplicates or sample duplicates RPD, which do not meet the acceptance criteria of (D), are to be qualified when reporting to the customer as showing adverse matrix effects or problems with the samples composition.

Laboratory control samples (LCS)

LCSs are analyzed at a minimum of one per preparation batch, except for analytes for which spiking solutions are not available such as, total volatile solids, pH, color, odor, temperature, dissolved oxygen or turbidity. In those instances for which no separate preparation method is used, the batch is defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples. Air Testing: If a calibration solution must be used for the LCS, the client shall be notified prior to the start of analysis. Also the concentration of the LCS shall be relevant to the intended use of the data and either at a regulatory limit or below it.

A) The laboratory may use the results of these LCS analyses to determine batch acceptance.

B) The LCS is a quality system matrix, known to be free of analytes of interest, spiked with a known and verified concentration of analytes. All analyte concentrations must be within the calibration range of the methods. The components to be spiked shall be as specified by the mandated test method or other regulatory requirement or as requested by the client. In the absence of specified spiking components, the laboratory shall spike per the following:

i) For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike or spikes are chosen that represent the chemistries and elution patterns of the components to be reported.

ii) For those test methods that have extremely long lists of analytes, a representative number are chosen. The analytes selected shall be representative of all analytes reported. The following criteria shall be used for determining the minimum number of analytes to be spiked.

a. For methods that include 1-10 targets, all components are spiked;
b. For methods that include 11-20 targets, at least 10 or 80%, whichever is greater are spiked;
c. For methods with more than 20 targets, 16 or more components are spiked.

C) The laboratory may use the matrix spike samples as specified in subsection 26.2.1 Matrix Spikes (A) as a LCS when the matrix spike acceptance criteria are as stringent as the LCS acceptance criteria. However, if the laboratory prepares a LCS, the laboratory shall analyze the LCS and use the results to determine batch acceptance. The laboratory shall not use the analyses of matrix spike samples as specified in subsection 26.2.1 Matrix Spikes (A) to override, ignore, or replace an LCS analysis that fails to meet the acceptance criteria. (If there is insufficient sample for reanalysis and the client is unable to re-sample, the data must be reported to the client with the appropriate qualifiers indicating the QC deviation. In control matrix spike and surrogate recoveries will help support the batch acceptance).

D) The analytes must be obtained from a second source if the LCS is to be used to verify the instrument calibration.

E) LCS recoveries are within the acceptance limits when they are within the limits given in the approved method (when available), laboratory established limits, those given by laboratory generated control charts, or client specified assessment criteria.

F) The following corrective actions are to be taken when (E) above is not met:
  - i) The run of analysis is terminated (and no sample results are reported);
  - ii) The reason for the unacceptable recovery is identified, eliminated and documented;
  - iii) The sample batch is reanalyzed and results are reported only after the conditions of (E) above are met.
  - iv) If corrective actions cannot be taken (i.e. insufficient sample), the clients involved are contacted and the samples are recollected or the results are reported with the appropriate qualifiers, according to the client's instructions.

G) If a large number of analytes are in the LCS, it becomes statistically likely that a few will be outside control limits. This may not indicate that the system is out of control; therefore, corrective action may not be necessary. Upper and lower marginal exceedance (ME) limits determine when corrective action is needed. A ME is defined as being beyond the LCS control limit (3 standard deviations), but within the ME limits. ME limits are between 3 and 4 standard deviations around the mean. Marginal exceedances must be random. If the same analyte exceeds the LCS control limit consecutively, it is an indication of a systemic problem. Marginal exceedance limits can be determined by using the control charting feature in Teklab LIMS. It is the responsibility of the laboratory supervisor utilizing a ME allowance, to monitor the LIMS data and assure random behavior. The number of allowable marginal exceedances is as follows:

1. >90 analytes in LCS, 5 analytes allowed in ME of the LCS control limit;
2. 71-90 analytes in LCS, 4 analytes allowed in ME of the LCS control limit;
3. 51-70 analytes in LCS, 3 analytes allowed in ME of the LCS control limit;
4. 31-50 analytes in LCS, 2 analytes allowed in ME of the LCS control limit;
5. 11-30 analytes in LCS, 1 analytes allowed in ME of the LCS control limit;
6. <11 analytes in LCS, 0 analytes allowed in ME of the LCS control limit.

Surrogates

Surrogate compounds are added to all samples, standards, and blanks whenever possible, when conducting analysis by approved test methods utilizing organic chromatography.

A) The compounds specified are chosen to represent the various chemistries of the target analytes in the method or the measurement quality objectives. They are often specified by the mandated method and are deliberately chosen for their being unlikely to occur as an environmental contaminant. Often this is accomplished by using deuterated analogs of select compounds.

B) The surrogate recoveries are within the acceptance limits when they are within the limits given in the approved method or, if not specified, the limits given by the laboratory generated control charts.

C) The following corrective actions are to be taken when (B) above is not met:
   - i) If the surrogates are out of control for a method blank or LCS, the associated batch must be evaluated to determine if this affected any of the individual sample results. Any affected samples must be reanalyzed, if possible. If the second run of analysis shows acceptable recoveries, the reason for the initial poor recoveries must be determined, eliminated and documented. The analysis with the acceptable result is to be reported.
   - ii) Sample results with out of control surrogates must be qualified when reporting to the customer as showing adverse matrix effects.

Teklab monitors tabulations and quality control charts of the results from all quality control indicators via the LIMS

A) For each approved test method, or combination of similar test methods; and
B) For each matrix.

Tabulations, quality control charts or any combination of tabulations and quality control charts of results of quality control indicators include or are linked electronically to the following information:

A) Title;
B) Identification of standard operating procedures (SOP) which requires collection of quality control procedure data;
C) Name of quality control procedure being tabulated;
D) Analytical method;
E) Analyte;
F) Analyte units of measure;
G) Matrix;
H) Fortification concentration;
I) Mean;
J) Standard deviation;
K) Upper control limit (UCL);
L) Lower control limit (LCL);
M) Upper warning limit (UWL);
N) Lower warning limit (LWL);
O) Date of analysis;
P) Sample/QC Sample ID;
Q) Analyst's identification;

References for Minimum QC Requirements:
The individual and overall level of QC effort will be, at a minimum, equivalent to the level of QC effort specified under the NELAP certification program. The level of QC effort for samples not

covered by NELAP certification will be, at a minimum, the QC required by the specified test method ("SW-846, Standard Methods for the Examination of Water, Wastewater", or "Methods for Chemical Analysis of Water and Wastewater" EPA 600). The level of QC effort for testing TCLP organic (Volatile, Semi-Volatile and Pesticide/Herbicide and PCB) will conform to Protocols of SW-846.

Accuracy, Precision and Sensitivity of Analysis

The fundamental QA/QC objective with respect to accuracy, precision and sensitivity of laboratory analytical data is to achieve the QC acceptance criteria of the analytical protocols. The accuracy, precision and sensitivity of all parameters are listed or referenced in the individual SOPs

26.4 Proficiency Test Samples or Interlaboratory Comparisons

Laboratory performance is monitored internally through the review of worksheets or batches, examination of analyst techniques, internal blind QC samples and participation in performance evaluation studies. Examples of this are performance studies from approved TNI PT providers, such as WP, WS, AE and RCRA studies and client provided blind Quality Control studies. These studies are intended to evaluate laboratory performance and help identify problems that exist.

26.4.1 Compliance to Accreditation Requirements

The laboratory must successfully analyze at least two TNI-compliant PT samples per calendar year for each accreditation Fields of Proficiency Testing (FoPT) for which the laboratory is accredited. An exception is made for analytes where there is no PT available from any PTPA approved PT provider at least twice per year. In these cases the lab will run the PTs in the minimum time frame the PTs are available and not at all if they are not available.

The successive PTs are analyzed at least five months apart and no more than 7 months apart unless the PT is being used for corrective action to reinstate accreditation or when applying for initial accreditation, in which case the dates of successive PT samples for the same accreditation FoPT is at least fifteen days apart.

To obtain and/or maintain TNI accreditation Teklab must also:

a. Successfully complete two PT studies for each requested PT field of testing within the most recent three rounds attempted.
b. Have the most recent three rounds attempted occurring within 18 months of the laboratory's application date.
c. Continue to complete PT studies for each PT field of testing and maintain a history or at least two acceptable PT studies for each field of testing out the most recent three.
d. Obtain PT samples from an TNI PTOB/PTPA approved PT Provider.
e. Authorize the PT provider to release all accreditation and remediation results and acceptable/not acceptable status directly to their NELAP primary accrediting authority in addition to Teklab.
f. Ensure that all PT samples are handled in the same manner as real environmental samples utilizing the same staff, methods, procedures, equipment, facilities and

frequency of analysis, as normally used for routine analysis of that analyte and matrix type.

g. Ensure that corrective actions are taken for any failed studies, including determining root cause of the failure. Ensure that documentation of the any corrective actions is provided to the primary accrediting authority.
h. Make available to the assessors of the Primary Accrediting Authority, during on-site audits of Teklab, all laboratory records related to the PT samples and their reporting.

26.4.2 PT Sample Handling and Analysis

Proficiency Testing (PT) samples are treated as typical samples in the normal production process where possible, including the same analysts, preparation, calibration, quality control and acceptance criteria, sequence of analytical steps, number of replicates, and sample log-in. PT samples are not analyzed multiple times unless routine environmental samples are analyzed multiple times. Where PT samples present special problems in the analysis process, they will be treated as laboratory samples where clients have special requests.

The type, composition, concentration and frequency of quality control samples analyzed with the PT samples are the same as with typical samples.

Prior to the closing date of a study, Teklab personnel must not:

- Subcontract analysis of a PT sample to another laboratory being run for accreditation purposes.
- Knowingly receive and analyze a PT for another laboratory being run for accreditation purposes.
- Communicate with an individual from another laboratory concerning the analysis of the PT sample.
- Attempt to find out the assigned value of a PT from the PT Provider.

26.4.3 PT Reporting Procedure (TNI 2009 V1M2 Section 5.2)

Teklab shall evaluate and report the analytical result for accreditation Fields of Proficiency Testing (FoPT) as follows:

a) For instrument technology that employs a multi-point calibration, the laboratory shall evaluate the analytical result to the value of the lowest calibration standard established for the test method used to analyze the PT sample. The working range of the calibration under which the PT sample is analyzed shall be the same range as used for routine environmental samples.
   i. A result for any FoPT at a concentration above or equal to the lowest calibration standard shall be reported as the resultant value.
   ii. A result for any FoPT at a concentration less than the lowest calibration standard shall be reported as less than the value of the lowest calibration standard.
b) For instrument technology (such as ICP-AES or ICP-MS) that employ standardization with a zero point and a single point calibration standard, the laboratory shall evaluate the analytical result to PQL established for the test method

used to analyze the PT sample. The PQL for the FoPT shall be the same as used for routine environmental samples.

i. A result for any FoPT at a concentration above or equal to the PQL shall be reported as the resultant value.
ii. A result for any FoPT at a concentration less than the PQL shall be reported as less than the value of the PQL.

The laboratory shall report the analytical results for accreditation and experimental FoPTs to the Proficiency Testing Provider (PTP) on or before the closing date of the study using the reporting format specified by the PTP.

On or before the closing date of the study, the laboratory shall authorize the PTP to release the laboratory's final evaluation report directly to the laboratory's Primary Accreditation Body (AB)

Teklab must ensure that corrective actions are taken for any failed studies, including determining root cause of the failure. It must also ensure that documentation of the any corrective actions is provided to the primary accrediting authority. The laboratory institutes corrective action procedures for failed PT samples following the guidelines in Section 13 – "Corrective Action".

The laboratory must maintain a copy of the online data entry summary when the PT results are submitted online. These data summary documents are stored on the server in the applicable Proficiency Testing folder. Electronic copies of PT data and documentation are stored on the server or storage hardware indefinitely.

When requested, the laboratory shall submit 'analytical data packages' to the accrediting authority for analytes/methods that are not readily available on Performance testing studies.

Teklab must make available to the assessors of the Primary Accrediting Authority, during on-site audits of Teklab, all laboratory records related to the PT samples and their reporting.

26.5 Data Review

The laboratory reviews all data generated in the laboratory for compliance with SOP, laboratory and, where appropriate, client requirements. See SOP1290 for information on data review.

26.6 Water Quality

Three water sources are in use at the Teklab, Inc. Collinsville facility: general deionized water, volatiles lab deionized water, and metals lab deionized water.

a. General laboratory deionized water produced by running tap water through an activated carbon filter (tank 1) followed by a cation exchange resin bed filter (tank 2) followed by an anion exchanged resin bed filter (tank 3) followed by two mixed bed resin filter (tank 4 and

5). Tank 5 serves as a backup tank. Tank 4 and 5 are monitored to ensure the resistivity is greater than 1 megohm-cm. An audible alarm will sound if resistivity is less than 1 megohm-cm.

b Volatiles lab deionized water uses general laboratory deionized water as the feed water then passes it through one more activated carbon filter, to remove all trace amounts of organics, then passes through a 0.45µm filter to trap any carbon residue that may leave the carbon filter. This water has a minimum quality of medium water quality.

c. Metals lab deionized water uses general laboratory water as the feed water then passes through a Thermo brand "high capacity" 2 bed resin filter followed by 2 Thermo brand " Ultrapure DI" filters with mixed resin beds. This water passes through an in-line resistivity meter, where all readings are greater than 15 megohm-cm with typical readings of 18megohm-cm. This water meets high quality water specifications.

Section 27 – Reporting the Results

(TNI V1:M2 – Section 5.10)

The result of each test performed is reported accurately, clearly, unambiguously, and objectively and complies with all specific instructions contained in the test method. Laboratory results are reported in a test report that includes all the information requested by the client and necessary for the interpretation of the test results and all information required by the method used. See SOP#1290 for more information on reporting of results.

The laboratory pays particular care and attention to the arrangement of the report, especially with regard to presentation of the sample results and ease of assimilation by the reader. The format is carefully and specifically designed for each type of approved test method carried out, but the headings are standardized as far as possible.

27.1 Test Reports

The laboratory issues sample data or sample result reports accurately and in a manner that is understandable to the recipient. Each test report generated contains the following information (unless the laboratory has a valid reason for not doing so, such as a written agreement with the client).

- Name, address and phone number of the laboratory;
- Name and address of client and project;
- The TNI logo with the phrase "NELAP accredited Laboratory". The laboratory's accreditation number appears on the case narrative page of each report;
- Unique identification of the report (such as work order number) and of each page and identification of the total number of pages. Each page in each section is identified as a number of the total report pages, for example 3 of 10 or 1 of 20.
- Report title, such as "Laboratory Results";

- Description and identification of samples (including client ID code);
- Date of sample receipt, sample collection and sample analysis (time of sample collection, if provided by client, and time of sample preparation (if requested by the client) and analysis, if the required holding time for either activity is less than or equal to 48 hours);
- Approved test method and preparation method utilized, including revision numbers;
- Clear indication of TNI accredited analysis by listing the letters “NELAP” next to each accredited analyte. Analytes that are not NELAP accredited are designated by an asterisk in the certification column. An explanation of the asterisk is also noted in the Definitions section of the final report;
- Sample results with any failures or deviations from approved test methods or QC criteria identified in the case narrative, sample narrative, and/or with data qualifiers;
- Signature and name or electronic signature and name, and title of the individuals accepting responsibility for the content of the report and date of issue;
- Clear identification, including the lab name or accreditation number of any sample results that were generated by a subcontracted laboratory;
- A description of the calculations or operations performed on the data, a summary and analysis of the data, and a statement of conclusions drawn from the analysis;
- Identification of the reporting units, such as µg/L or mg/kg;
- A statement that the report shall not be reproduced, except in full, without the written approval of the laboratory, where appropriate;
- Where applicable, a statement to the effect that the sample results relate only to the analytes of interest tested or to the sample as received by the laboratory;
- Where applicable, characterization and condition of the sample;
- Where applicable, reference to sampling procedure; and
- Clear, unequivocal identification of analytical results generated by an approved test method, for which the laboratory is accredited in accordance with the laboratory’s accreditation.

27.2 Supplemental Test Report Information

When necessary for interpretation of the results or when requested by the client, test reports include the following additional information:

a) deviations from, additions to, or exclusions from the test method, information on specific test conditions, such as environmental conditions, and any non-standard conditions that may have affected the quality of the results, and any information on the use and definitions of data qualifiers;

b) a statement of compliance/non-compliance when requirements of the management system are not met, including identification of test results that did not meet the laboratory and regulatory sample acceptance requirements, such as holding time, preservation, etc.;

c) where applicable and when requested by the client, a statement on the estimated uncertainty of the measurement is available

d) Teklab does not include opinions and interpretations in laboratory reports

e) additional information which may be required by specific methods or client;

f) qualification of results with values outside the calibration range as appropriate.

27.3 Environmental Testing Obtained from Subcontractors

When Teklab must subcontract analysis due to workload, need for further expertise, temporary incapacity, or on a continuing basis, work is placed with a laboratory accredited under NELAP for the test to be performed or with a laboratory that meets the applicable statutory and regulatory requirements for performing the tests and submitting the results of test performed.

All subcontracted analyses and the name of the subcontracted lab are documented in the case narrative of the final report. Any non-NELAP accredited work is designated by an asterisk in the certification column.

The intent to subcontract analysis is specified in the project quote when Teklab intends to subcontract any part of a project. When possible, Teklab will advise the client in writing of any subcontracted analysis.

Teklab maintains a register of all subcontractors that it uses for environmental tests and a record of the evidence of compliance for each. The subcontractors may report their results in writing or electronically. A copy of the subcontractors report is made available to the client if requested. A record of subcontracted analysis is retained at Teklab and is archived in accordance with this manual. See Section 10 for more information on Subcontracting.

27.4 Electronic Transmission of Results

The laboratory ensures that when clients require transmission of test results by telephone, tele-facsimile or other electronic or electromagnetic means, laboratory personnel follow documented procedures that ensure the requirements of the TNI Standard and associated procedures to protect the confidentiality and proprietary rights of the client are met (see Section 21- “Environmental Methods and Method Validation”). All electronic transmissions are limited to the contracting client and their designated recipients. Any transmission to a third party requires written confirmation by the contracting client.

27.4.1 Electronic Data Deliverables (EDDs)

EDDs are client driven deliverables that can be produced in various file formats; such as text and Excel files. EDDs, when requested by a client, are provided in addition to the final report. EDDs are prepared using Microsoft Access/VBA, which exports the EDD into the file type the client has requested. EDD files are prepared by Project Managers for the client. Teklab's IT Programmer develops the EDD per client request.

Some clients EDDs are developed to use Equis Data Processor (EDP) software to check the EDD file using the client provided format and reference files. The EDP software checks for, amongst other things, formatting errors and valid values. Problematic EDDs are rejected and flagged for specific errors, helping facilitate any corrections before the EDD is sent to the customer. All electronic transmissions follow Section 27.4 above.

27.5 Amendments to Test Reports

Material amendments to a test report after it has been issued are made only in the form of another document or data transfer. All supplemental reports meet all the requirements for the initial report and the requirements of this Quality Manual.

See SOP1290 for more information on revised reports.

27.6 Electronic signatures

Electronic signatures used in LIMS reports are stored securely in the LIMS SQL tables. Electronic signatures used for purposes out with the LIMS (e.g. signing SOPs, Teklab correspondence) should be stored on the users U Drive.

27.7 Report Signatories

Below is a list of parties authorized to release testing results to clients.

(b) (6)

Director of Customer Service
Project Manager
Project Manager
Project Manager
Project Manager

(b) (6)

Section 28 - Safety

Safety is the number one priority of every employee at Teklab, Inc. Teklab trains employees to ensure that no work is performed in an unsafe environment. Where safety practices are included as part of an approved test method, these practices are strictly followed. While more specific safety criteria are not an aspect of this manual, laboratory personnel must always apply appropriate safety practices.

The specifics of the Teklab safety program are detailed in the Teklab Chemical Hygiene Plan and are defined by the Teklab Safety Officer at monthly safety meetings. Teklab complies with and exceeds all applicable OSHA regulations concerning safe laboratory and workplace operations. See SOP 1161 for more information on Safety.

Teklab's Emergency Action Plan (EAP) is reviewed at least annually by the Safety Officer.

Fire/spill drills are conducted annually.

Section 29 - Bibliography

References:

1. The TNI Standard: Modules 1-7 in the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis (EL-V1, M1 through M7, ISO-2009).

2. "Test Method For The Evaluation of Solid Wastes SW846", "Laboratory Manual Physical/Chemical Properties", volumes 1A, 1B, and 1C, 3rd edition, Office of Solid Waste and Emergency Response, Environmental Protection Agency.

3. "Standard Method for the Examination of Water and Wastewater" online

4. EPA No. 600/4-79-020, "Methods of Chemical Analysis of Water and Wastes" (March 1983).

5. "Quality Assurance of Chemical Measurements" 1989, John Keenan Taylor, Lewis Publishers, Inc.

6. 40 CFR Part 136, Appendix B

- Instrument Y - Hewlett-Packard 5890 Series II GC/5972 MS, 30 meter Restek Rxi-624SilMS column with 0.25mmID, using a split/splitless injection port and glass injection port liner. No cryogenic system is used. 1 each
  - Tekmar LSC3000 sample concentrator.
  - Varian Archon autosampler.
- Mitsubishi brand AOX-200 analyzer "TOX-3" – 1 each

Organic Section

- Instrument AA - 6890 Series II GC - 5973N MS with 6890 Series Injector, with computer
- Instrument AB - 6890 Series II GC - 5973N MS with 6890 Series Injector, with computer
- Instrument B - 5890 Series II GC - 5971 MS with 7673 Series Injector, with computer
- Instrument D - 5890 Series II GC - FID with 7673A Series Injector, with computer
- Instrument E - 5890 Series II GC - Dual ECD with 7673A Series Injector, with computer
- Instrument H - 5890 Series II GC - Dual ECD with 7673 Series Injector, with computer
- Instrument I - 5890 Series II GC - FID with 7673 Series Injector, with computer
- Instrument L - 5890 Series II GC - FID with computer
- Instrument M - 5890 Series II GC - 5972 Mass Spec with 7673 Series Injector, with computer
- Instrument P - 5890 Series II GC - 5971A Mass Spec with 7673 Series Injector, with computer
- Instrument Q - 5890 Series II GC - Dual ECD with 7673 Series Injector, with computer
- Instrument S - HP – 6890 GC - 5973 MS with 6890 Series Injector, with computer
- Instrument X - 5890 Series II GC - Dual Electron Capture Detectors, with computer
- Instrument Z - HP 6890 Series II GC - 5973 MS Model 6890/5973, with computer

Organic Prep Lab

- Fisher Scientific, 550 Sonic Dismembrator and VirSonic Cell Disrupter - 6 each
- Zymark, Turbovap LV evaporator – 2 each
- Glas-Col, 3D Floor Shaker – 2 each
- VWR, Refrigerated Recirculator
- Milestone ETHOS EX microwave extraction system
- NESLAB Refrigerated/Recirculator

Metals Section

- Teledyne Leeman Labs CVAA Hydra II AA Automated Hg Analyzer
- Teledyne Leeman Labs Hydra AF Gold Plus Mercury Analyzer (CVAFS), Autosampler and Micro computer
- Varian MPX CCD Simultaneous ICP-OES – 1 each
- Agilent Technologies CCD Simultaneous ICP-OES - 1 each
- Thermo Fisher Scientific iCAP Qc ICP-MS - 2 each

Metals Prep

- Hot Block Digester, 54 Position with ETR-3200 Controller - 4 each

Inorganic Section

- Environmental Express Ammonia/OOH Micro Distillation Unit - 1 each
- Environmental Express Simple Cyanide Distillation Unit – 3 each
- Parr, Oxygen Bomb Calorimeter, with Parr Bomb Ignition Unit (2 Bomb Units) - 1 each
- Thermo Orion 720A – 1 each

- VWR Symphony B10P - 1 each
- Thermo pH Meter, Orion 3 Star
- Hach DR/2000 Direct Reading Spectrophotometer - 1 each
- Hach DR/2400 Direct Reading Spectrophotometer - 1 each
- Hach DR/2800 Direct Reading Spectrophotometer - 1 each
- Hach DRB 200 25 Position Reactor - 1 each
- Hach 25 Position Reactor – 2 each
- Environmental Express; Hexane Extraction Method/Solid Phase Extraction Manifold - 21 each
- Buchi Rotavapor R-114, waterbath B480 - 1 each
- Buchi Rotovapor R-210, waterbath B491 – 1 each
- Hach 2100 P Turbidimeter - 1 each
- YSI Model 59 Dissolved Oxygen Meter, with 5905 Probe - 1 each
- YSI Model 5000 Dissolved Oxygen Meter, with 5905 Probe - 1 each
- Skalar San++ System, with 4 autoanalyzers, 1 DOC IR detector, 4 Spectrophotmetric Detectors, 1 Amperimetric Detector, and 4 Autosamplers.
- Branson 1510 Ultrasonic Cleaner
- A.I. Scientific Digestion AIM 500-C, 50 Position Digestor
- Koehler Instrument CO. Flash Point Tester – 1 each
- Small scale Flash Point Tester
- Thermoline Type 6000 Muffle Furnace -1 each
- Equatherm Environmental Incubator -1 each
- Precision Low Temperature Incubator -1 each
- Precision Low Temperature Incubator 815 – 1 each
- Fisher Scientific Low Temperature Incubator – 1 each
- Fisher Scientific, Digital Conductivity Meter Model Accumet 30 - 1 each
- Analytical Balances capable of reading 0.1mg – 2 each
- Analytical Top Loader Balance capable of reading 0.01g – 3 each

General Lab Use
- Analytical Balances capable of reading 0.1 mg - 2 each
- Analytical Top Loader Balances capable of reading .01 g - 6 each
- Dynac II Centrifuge - 1 each

Field Use
- Orion pH/temperature meter – 1 each
- Oakton pH/ pH/conductivity/temperature meters – 4 each
- Hach Turbidity Meter Pocket Turbidimeter Cat# 52600-00 – 1 each

COMPUTER SYSTEMS & SOFTWARE PACKAGES

Teklab, Inc. software listing:

- Microsoft Server 2012 (R2 Standard)

- Microsoft SQL Server 2014

- Microsoft Exchange Server 2013

- Microsoft Server 2003 R2 Standard SP2
- Microsoft Server 2003 R2 Enterprise SP2
- Evault (backups)
- Desktop Operating Systems: Windows 98, Windows 2000, Windows XP, Windows 7 and Windows 8.1 and 10.
- Webroot Version9
- Khemia Omega VTEN-64 ELIMS(mod) Environmental Laboratory Information Management System with EDD Module
- Microsoft Office 2003 Professional Edition (Access, Excel, Word, PowerPoint & FrontPage, Outlook) and Microsoft Office 2010 Professional Edition (Excel, Word, PowerPoint & Outlook)
- Adobe Acrobat 7.0, 8.0, 9.0, 10 ActivePDF Composer
- PaperPort 9 Deluxe and PaperPort 12
- Agilent_MSDChemStation E.02.00.493
- Entech Instruments ESP Version 2
- Entech Instruments SmartLab II V4.176
- Quick Books Pro 2014 Accounting Software
- Hewlett-Packard G1032C rev. C.01.00 GC\MS EnviroQuant
- Hewlett-Packard G1701AA rev. C.03.02 GC\MS EnviroQuant
- Hewlett-Packard G1701AA rev. A.03.00 GC\MS EnviroQuant
- Hewlett-Packard G1701BA rev. B.01.00 GC\MS EnviroQuant
- Hewlett-Packard G1701AA rev. C.03.02 GC EnviroQuant
- Hewlett-Packard G1701CA V C.00.00 GC Chemstation
- Hewlett-Packard G1701DA D.02.00 SPI GC/MS
- Thermo Fisher Scientific Qtegra iCAP Q ICP-MS Software
- Varian GC/MS Workstation 6.4.1 with EnviroPro.

- Skalar - FlowAccess Software Version 1.04.7
- 7-Zip
- Win2Pdf
- Gladwin PrintScreen Version 4.4
- Redgate SQL Toolbelt
- UltraEdit
- UltraCompare
- Malwarebytes Premium Antivirus
- Kaseya
- TeamViewer
- DHCP Explorer
- CCleaner
- Magical Jelly Bean Keyfinder
- Microsoft Robocopy
- Newt Professional
- Revo Uninstaller
- Recover Keys
- Treesize Free
- Virtual Clone Drive
- Wireshark
- SmartVault
- TDSS Killer
- IsumSoft Password Reset

- Norton Power Eraser
- Constant Care – SQL server application

Appendix E - Data Qualifiers

#	Unknown hydrocarbon
B	Analyte detected in associated Method Blank
E	Value above quantitation range
H	Holding times exceeded
J	Analyte detected below quantitation limits
M	Manual Integration used to determine area response
N	Parameter not NELAC certified
ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits
S	Spike Recovery outside recovery limits
X	Value exceeds Maximum Contaminant Level
DF	Dilution Factor
RL	Reporting Limit
Surr	Surrogate Standard added by lab
TNTC	Too numerous to count (>200 CFU)
Q	QC criteria failed or noncompliant CCV
NELAP	IL NELAP and NELAP accredited field of testing
IDPH	Illinois Department of Public Health
C	Client requested RL below PQL
D	Diluted out of sample
E	Value above quantitation range
MI	Matrix interference
DNI	Did not ignite

Appendix D

Laboratory Accreditation/Certification List

Teklab Inc maintains the following certifications and accreditations

State	Dept	Cert #	NELAP	Exp Date	Location
Illinois	IEPA	100226	NELAP	1/31/2020	Collinsville
Kansas	KDHE	E-10374	NELAP	4/30/2020	Collinsville
Louisiana	LDEQ	166493	NELAP	6/30/2020	Collinsville
Louisiana	LDEQ	166578	NELAP	6/30/2020	Collinsville Air
Oklahoma	ODEQ	9978	NELAP	8/31/2020	Collinsville
Illinois	IDPH	17584		5/31/2021	Collinsville
Arkansas	ADEQ	88-0966		3/14/2020	Collinsville
Indiana	ISDH	C-IL-06		5/28/2020	Collinsville
Kentucky	UST	0073		1/31/2020	Collinsville
Kentucky	KDEP	98006		12/31/2019	Collinsville
Louisiana	LDPH	LA170027		12/31/2019	Collinsville
Missouri (Micro)	MDNR	00930		5/31/2021	Collinsville
Missouri	MDNR	00930		1/31/2022	Collinsville
Tennessee	TDEC	04905		1/31/2020	Collinsville

The certificates and parameter lists (which may differ) for each organization can be found on the following pages and on the Teklab Inc website.

If accreditation is terminated or suspended, the laboratory will immediately cease to use the certificate number reference in any way and inform clients impacted by the change.

STATE OF LOUISIANA
DEPARTMENT OF ENVIRONMENTAL QUALITY

Is hereby granting a Louisiana Environmental Laboratory Accreditation to

Teklab Air Laboratory
1355 North Bluff Rd Ste F
Collinsville, Illinois 62234

Agency Interest No. 166578
Activity No. ACC20190001

According to the Louisiana Administrative Code, Title 33, Part I, Subpart 3, LABORATORY ACCREDITATION, the State of Louisiana formally recognizes that this laboratory is technically competent to perform the environmental analyses listed on the scope of accreditation detailed in the attachment.

The laboratory agrees to perform all analyses listed on this scope of accreditation according to the Part I, Subpart 3 requirements and agrees to adapt to any changes in the requirements. It also acknowledges that continued accreditation is dependent on successful ongoing compliance with the applicable requirements of Part I and the 2009 TNI Standard by which the laboratory was assessed. Please contact the Department of Environmental Quality, Louisiana Environmental Laboratory Accreditation Program (LELAP) to verify the laboratory's scope of accreditation and accreditation status.

Accreditation by the State of Louisiana is not an endorsement or a guarantee of validity of the data generated by the laboratory. Accreditation of the environmental laboratory does not imply that a product, process, system, or person is approved by LELAP. To be accredited initially and maintain accreditation, the laboratory agrees to participate in two single-blind, single-concentration PT studies, where available, per year for each field of testing for which it seeks accreditation or maintains accreditation as required in LAC 33:I.4711.

(b) (6)

Cheryl Sonnier Nolan
Administrator
Public Participation and Permit Support Services Division

Issued Date: 17 June 2019

Effective Date: July 1, 2019
Expiration Date: June 30, 2020
Certificate Number: 05003

STATE OF LOUISIANA
DEPARTMENT OF ENVIRONMENTAL QUALITY

Effective Date: July 1, 2019

Teklab Air Laboratory
AI Number: 166578
Activity No.: ACC20190001
Expiration Date: June 30, 2020

1355 North Bluff Rd Ste F, Collinsville, Illinois 62234

Certificate Number: 05003

Air Emissions

Analyte	Method Name	Method Code	Type	AB
5105 - 1,1,1,2-Tetrachloroethane	EPA TO-15	10248803	NELAP	LA
5160 - 1,1,1-Trichloroethane	EPA TO-15	10248803	NELAP	LA
5110 - 1,1,2,2-Tetrachloroethane	EPA TO-15	10248803	NELAP	LA
5195 - 1,1,2-Trichloro-2,2,2-trifluoroethane (Freon 113a)	EPA TO-15	10248803	NELAP	LA
5165 - 1,1,2-Trichloroethane	EPA TO-15	10248803	NELAP	LA
4630 - 1,1-Dichloroethane	EPA TO-15	10248803	NELAP	LA
4640 - 1,1-Dichloroethylene	EPA TO-15	10248803	NELAP	LA
5155 - 1,2,4-Trichlorobenzene	EPA TO-15	10248803	NELAP	LA
5210 - 1,2,4-Trimethylbenzene	EPA TO-15	10248803	NELAP	LA
4585 - 1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA TO-15	10248803	NELAP	LA
4695 - 1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon-114)	EPA TO-15	10248803	NELAP	LA
4610 - 1,2-Dichlorobenzene	EPA TO-15	10248803	NELAP	LA
4635 - 1,2-Dichloroethane (Ethylene dichloride)	EPA TO-15	10248803	NELAP	LA
4655 - 1,2-Dichloropropane	EPA TO-15	10248803	NELAP	LA
5215 - 1,3,5-Trimethylbenzene	EPA TO-15	10248803	NELAP	LA
9318 - 1,3-Butadiene	EPA TO-15	10248803	NELAP	LA
4615 - 1,3-Dichlorobenzene	EPA TO-15	10248803	NELAP	LA
4620 - 1,4-Dichlorobenzene	EPA TO-15	10248803	NELAP	LA
4735 - 1,4-Dioxane (1,4- Diethyleneoxide)	EPA TO-15	10248803	NELAP	LA
4862 - 1-Methyl-2-isopropylbenzene (o-Cymene)	EPA TO-15	10248803	NELAP	LA
5220 - 2,2,4-Trimethylpentane (Isooctane)	EPA TO-15	10248803	NELAP	LA
4410 - 2-Butanone (Methyl ethyl ketone, MEK)	EPA TO-15	10248803	NELAP	LA
4535 - 2-Chlorotoluene	EPA TO-15	10248803	NELAP	LA
4860 - 2-Hexanone	EPA TO-15	10248803	NELAP	LA
4542 - 4-Ethyltoluene	EPA TO-15	10248803	NELAP	LA
4995 - 4-Methyl-2-pentanone (MIBK)	EPA TO-15	10248803	NELAP	LA
4315 - Acetone	EPA TO-15	10248803	NELAP	LA
4320 - Acetonitrile	EPA TO-15	10248803	NELAP	LA
4325 - Acrolein (Propenal)	EPA TO-15	10248803	NELAP	LA
4340 - Acrylonitrile	EPA TO-15	10248803	NELAP	LA
4355 - Allyl chloride (3-Chloropropene)	EPA TO-15	10248803	NELAP	LA
4375 - Benzene	EPA TO-15	10248803	NELAP	LA
5635 - Benzyl chloride	EPA TO-15	10248803	NELAP	LA
4395 - Bromodichloromethane	EPA TO-15	10248803	NELAP	LA
4400 - Bromoform	EPA TO-15	10248803	NELAP	LA
4450 - Carbon disulfide	EPA TO-15	10248803	NELAP	LA
4455 - Carbon tetrachloride	EPA TO-15	10248803	NELAP	LA
4475 - Chlorobenzene	EPA TO-15	10248803	NELAP	LA
4575 - Chlorodibromomethane (dibromochloromethane)	EPA TO-15	10248803	NELAP	LA
4485 - Chloroethane (Ethyl chloride)	EPA TO-15	10248803	NELAP	LA
4505 - Chloroform	EPA TO-15	10248803	NELAP	LA
4525 - Chloroprene (2-Chloro-1,3-	EPA TO-15	10248803	NELAP	LA

Clients and Customers are urged to verify the laboratory's current certification status with the Louisiana Environmental Laboratory Accreditation Program.

Air Emissions

Analyte	Method Name	Method Code	Type	AB
butadiene)				
4555 - Cyclohexane	EPA TO-15	10248803	NELAP	LA
9375 - Di-isopropylether (DIPE) (Isopropyl ether)	EPA TO-15	10248803	NELAP	LA
4625 - Dichlorodifluoromethane (Freon-12)	EPA TO-15	10248803	NELAP	LA
4750 - Ethanol	EPA TO-15	10248803	NELAP	LA
4755 - Ethyl acetate	EPA TO-15	10248803	NELAP	LA
4770 - Ethyl-t-butyl ether (ETBE) (2-Ethoxy-2-methylpropane)	EPA TO-15	10248803	NELAP	LA
4765 - Ethylbenzene	EPA TO-15	10248803	NELAP	LA
4835 - Hexachlorobutadiene	EPA TO-15	10248803	NELAP	LA
4895 - Isopropyl alcohol (2-Propanol, Isopropanol)	EPA TO-15	10248803	NELAP	LA
4900 - Isopropylbenzene (Cumene)	EPA TO-15	10248803	NELAP	LA
4950 - Methyl bromide (Bromomethane)	EPA TO-15	10248803	NELAP	LA
4960 - Methyl chloride (Chloromethane)	EPA TO-15	10248803	NELAP	LA
4990 - Methyl methacrylate	EPA TO-15	10248803	NELAP	LA
5000 - Methyl tert-butyl ether (MTBE)	EPA TO-15	10248803	NELAP	LA
4975 - Methylene chloride (Dichloromethane)	EPA TO-15	10248803	NELAP	LA
5005 - Naphthalene	EPA TO-15	10248803	NELAP	LA
4836 - Propylene	EPA TO-15	10248803	NELAP	LA
5100 - Styrene	EPA TO-15	10248803	NELAP	LA
4370 - T-amylmethylether (TAME)	EPA TO-15	10248803	NELAP	LA
5115 - Tetrachloroethylene (Perchloroethylene)	EPA TO-15	10248803	NELAP	LA
5120 - Tetrahydrofuran (THF)	EPA TO-15	10248803	NELAP	LA
5140 - Toluene	EPA TO-15	10248803	NELAP	LA
5170 - Trichloroethene (Trichloroethylene)	EPA TO-15	10248803	NELAP	LA
5175 - Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	EPA TO-15	10248803	NELAP	LA
5225 - Vinyl acetate	EPA TO-15	10248803	NELAP	LA
5230 - Vinyl bromide (Bromoethane)	EPA TO-15	10248803	NELAP	LA
5235 - Vinyl chloride	EPA TO-15	10248803	NELAP	LA
5260 - Xylene (total)	EPA TO-15	10248803	NELAP	LA
4645 - cis-1,2-Dichloroethylene	EPA TO-15	10248803	NELAP	LA
4680 - cis-1,3-Dichloropropene	EPA TO-15	10248803	NELAP	LA
5240 - m+p-xylene	EPA TO-15	10248803	NELAP	LA
4435 - n-Butylbenzene	EPA TO-15	10248803	NELAP	LA
4825 - n-Heptane	EPA TO-15	10248803	NELAP	LA
4855 - n-Hexane	EPA TO-15	10248803	NELAP	LA
5090 - n-Propylbenzene	EPA TO-15	10248803	NELAP	LA
5250 - o-Xylene	EPA TO-15	10248803	NELAP	LA
4440 - sec-Butylbenzene	EPA TO-15	10248803	NELAP	LA
4420 - tert-Butyl alcohol	EPA TO-15	10248803	NELAP	LA
4445 - tert-Butylbenzene	EPA TO-15	10248803	NELAP	LA
4700 - trans-1,2-Dichloroethylene	EPA TO-15	10248803	NELAP	LA
4685 - trans-1,3-Dichloropropylene	EPA TO-15	10248803	NELAP	LA

Non Potable Water

Analyte	Method Name	Method Code	Type	AB
NONE	NONE	NONE	NONE	NONE

Solid Chemical Materials

Analyte	Method Name	Method Code	Type	AB
NONE	NONE	NONE	NONE	NONE

Biological Tissue

Analyte	Method Name	Method Code	Type	AB
NONE	NONE	NONE	NONE	NONE

STATE OF LOUISIANA
DEPARTMENT OF ENVIRONMENTAL QUALITY

Is hereby granting a Louisiana Environmental Laboratory Accreditation to

Teklab Inc
5445 Horseshoe Lake Rd
Collinsville, Illinois 62234-7425

Agency Interest No. 166493
Activity No. ACC20190001

According to the Louisiana Administrative Code, Title 33, Part I, Subpart 3, LABORATORY ACCREDITATION, the State of Louisiana formally recognizes that this laboratory is technically competent to perform the environmental analyses listed on the scope of accreditation detailed in the attachment.

The laboratory agrees to perform all analyses listed on this scope of accreditation according to the Part I, Subpart 3 requirements and agrees to adapt to any changes in the requirements. It also acknowledges that continued accreditation is dependent on successful ongoing compliance with the applicable requirements of Part I and the 2009 TNI Standard by which the laboratory was assessed. Please contact the Department of Environmental Quality, Louisiana Environmental Laboratory Accreditation Program (LELAP) to verify the laboratory's scope of accreditation and accreditation status.

Accreditation by the State of Louisiana is not an endorsement or a guarantee of validity of the data generated by the laboratory. Accreditation of the environmental laboratory does not imply that a product, process, system, or person is approved by LELAP. To be accredited initially and maintain accreditation, the laboratory agrees to participate in two single-blind, single-concentration PT studies, where available, per year for each field of testing for which it seeks accreditation or maintains accreditation as required in LAC 33:I.4711.

(b) (6)

Cheryl Sonnier Nolan
Administrator
Public Participation and Permit Support Services Division

Issued Date: 17 June 2019

Effective Date: July 1, 2019
Expiration Date: June 30, 2020
Certificate Number: 05002

STATE OF LOUISIANA
DEPARTMENT OF ENVIRONMENTAL QUALITY

Effective Date: July 1, 2019

Teklab Inc
AI Number: 166493
Activity No.: ACC20190001
Expiration Date: June 30, 2020

5445 Horseshoe Lake Rd, Collinsville, Illinois 62234-7425

Certificate Number: 05002

Air Emissions

Analyte	Method Name	Method Code	Type	AB
6380 - 1-Methylnaphthalene	EPA TO-13A	10248405	NELAP	LA
5795 - 2-Chloronaphthalene	EPA TO-13A	10248405	NELAP	LA
6385 - 2-Methylnaphthalene	EPA TO-13A	10248405	NELAP	LA
5500 - Acenaphthene	EPA TO-13A	10248405	NELAP	LA
5505 - Acenaphthylene	EPA TO-13A	10248405	NELAP	LA
5555 - Anthracene	EPA TO-13A	10248405	NELAP	LA
5575 - Benz(a)anthracene	EPA TO-13A	10248405	NELAP	LA
5580 - Benzo(a)pyrene	EPA TO-13A	10248405	NELAP	LA
5585 - Benzo(b)fluoranthene	EPA TO-13A	10248405	NELAP	LA
5605 - Benzo(e)pyrene	EPA TO-13A	10248405	NELAP	LA
5590 - Benzo(g,h,i)perylene	EPA TO-13A	10248405	NELAP	LA
5600 - Benzo(k)fluoranthene	EPA TO-13A	10248405	NELAP	LA
5855 - Chrysene	EPA TO-13A	10248405	NELAP	LA
5856 - Coronene	EPA TO-13A	10248405	NELAP	LA
5895 - Dibenz(a,h)anthracene	EPA TO-13A	10248405	NELAP	LA
6265 - Fluoranthene	EPA TO-13A	10248405	NELAP	LA
6270 - Fluorene	EPA TO-13A	10248405	NELAP	LA
6315 - Indeno(1,2,3-cd)pyrene	EPA TO-13A	10248405	NELAP	LA
5005 - Naphthalene	EPA TO-13A	10248405	NELAP	LA
6608 - Perylene	EPA TO-13A	10248405	NELAP	LA
6615 - Phenanthrene	EPA TO-13A	10248405	NELAP	LA
6665 - Pyrene	EPA TO-13A	10248405	NELAP	LA

Non Potable Water

Analyte	Method Name	Method Code	Type	AB
NONE	NONE	NONE	NONE	NONE

Solid Chemical Materials

Analyte	Method Name	Method Code	Type	AB
NONE	NONE	NONE	NONE	NONE

Biological Tissue

Analyte	Method Name	Method Code	Type	AB
NONE	NONE	NONE	NONE	NONE

Clients and Customers are urged to verify the laboratory's current certification status with the Louisiana Environmental Laboratory Accreditation Program.

Claire T. Bogner

To: Alicia K. Verduin
Subject: RE: Certification question

From: Witmer, Heather [mailto:Heather.Witmer@Illinois.gov]
Sent: Tuesday, June 18, 2019 11:26 AM
To: Alicia K. Verduin
Cc: Hopkins, Steve
Subject: RE: Certification question

Hi Alicia,

You can inform your concerned client that the deviations noted from your audit are not severe and can be corrected with simple corrective actions. If I felt as a water lab certification officer that the overall quality of your work was not satisfactory, I would have told you at the time of the audit to cease testing immediately and would have gone through the proper channels to make sure that you followed through with this order.

The regulatory process allows two months for the LCO report to be completed after the biennial audit (which was conducted in May as required), and then two months for the corrective action to be received and found satisfactory.

I will be working on your report this week and unless other more pressing job duties come up, I will have it completed and sent to you by the end of the week.

Hope this helps.

Thanks,
Heather

Heather Witmer, MT (ASCP)
Laboratory Quality Specialist 2
Laboratory Evaluation Officer (Dairy)
Laboratory Certification Officer (Water Micro and Crypto)
Illinois Dept. of Public Health
Division of Labs
825 N. Rutledge
Springfield,IL 62702
217-557-6420
heather.witmer@illinois.gov

Table A

Analytical Requirements for Soil Samples

Product stored in UST system	Required Analysis	Acceptable Method	Maximum Acceptable Reporting Limit
Gasoline, Kerosene, or Jet Fuel	BTEX	Method SW-846 8240, 8260, 8020, 8021	B: <0.01 ppm T: <0.7 ppm E: <0.9 ppm X: <5 ppm
Diesel or regulated Heating Oil	PAH	Method SW-846 8100, 8270, or 8310	Ch: <15 ppm B(a)A: <0.15 ppm c PAH: <0.3 ppm n PAH: <3 ppm NAP: <1 ppm
Waste Oil	PAH	Method SW-846 8100, 8270, or 8310	Ch: <15 ppm B(a)A: <0.15 ppm c PAH: <0.3 ppm n PAH: <3 ppm NAP: <1 ppm
	Total Lead	SW-846 7420, 7421, or 6010	Total Lead <400 ppm
New Oil	PAH	Method SW-846 8100, 8270, or 8310	Ch: <15 ppm B(a)A: <0.15 ppm c PAH: <0.3 ppm n PAH: <3 ppm NAP: <1 ppm
Other Petroleum or Non-Petroleum	Contact the UST Branch		

BTEX: Benzene, Toluene, Ethylbenzene, and Xylene (total)
PAH: Polynuclear Aromatic Hydrocarbons
Ch: Screening level individually for Chrysene
B(a)A: Screening level individually for Benzo(a)anthracene
c PAH: Maximum Acceptable Reporting Limit Individually for Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenzo(a,h)anthracene, and Indeno(1,2,3-cd)pyrene
n PAH: Maximum Acceptable Reporting Limit Individually for Acenaphthene, Acenaphthylene, Anthracene, Benzo(ghi)perylene, Fluoranthene, Fluorene, Phenanthrene and Pyrene
NAP: Naphthalene
ppm: parts per million (mg/kg)

Table B

Analytical Requirements for Water Samples

Product stored in UST system	Required Analysis	Acceptable Method	Maximum Acceptable Reporting Limit
Gasoline, Kerosene, or Jet Fuel	BTEX **	Method SW-846 8240, 8260, 8020, 8021	B: <0.005 ppm T: <0.94 ppm E: <0.47 ppm X: <5.89 ppm
Diesel or regulated Heating Oil	c PAH n PAH NAP	Method SW-846 8100, 8270, or 8310	c PAH: <0.005 ppm n PAH: <3 ppm NAP: <0.3 ppm
Waste Oil	PAH Dissolved Lead *	Method SW-846 8100, 8270, or 8310 SW-846 7420, 7421, or 6010	c PAH: <0.005 ppm n PAH: <3 ppm NAP: <0.3 ppm Dissolved Lead < 0.015 ppm
New Oil	c PAH n PAH NAP	Method SW-846 8100, 8270, or 8310	c PAH: <0.005 ppm n PAH: <3 ppm NAP: <0.3 ppm
MTBE sampling as required by the cabinet for domestic use water sources only	MTBE	Method 5030 in conjunction with SW-846 8240, 8260, 8020, 8021	MTBE: <0.05 ppm
Other Petroleum or Non-Petroleum	Contact the UST Branch		

BTEX: Benzene, Toluene, Ethylbenzene, and Xylene (total)
PAH: Polynuclear Aromatic Hydrocarbons
c PAH: Maximum Acceptable Reporting Limit Individually for Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenzo(a,h)anthracene, and Indeno(1,2,3-cd)pyrene
n PAH: Maximum Acceptable Reporting Limit Individually for Acenaphthene, Acenaphthylene, Anthracene, Benzo(ghi)perylene, Fluoranthene, Fluorene, Phenanthrene and Pyrene
NAP: Naphthalene
ppm: parts per million (mg/L)
* Samples shall be filtered prior to acid preservation. See Table C.
** Shall include a trip blank analysis

Table C

Appropriate Containers, Sample Sizes, Preservation Techniques and Maximum Holding Times *

Parameter	Container type	Sample Size	Preservation Method	Holding Times (Maximum)
Volatile Organics for Soil (BTEX)	Wide-mouth glass w/ Teflon-lined cap	120 ml or 4 oz.	Cool to 4°C	14 days
Volatile Organics for Water (BTEX; MTBE)	Two (2) clear glass w/ Teflon-lined cap (VOA)	40 ml or 1oz.	Add four drops of HCl to ea., Cool to 4°C	14 days
Polynuclear Aromatic Hydrocarbons for Soil (PAH)	Wide-mouth glass w/ Teflon-lined cap	250 ml or 1oz.	Cool to 4°C	14 days until lab extraction 40 days after lab extraction
Polynuclear Aromatic Hydrocarbons for Water (PAH)	Amber glass w/ Teflon-lined cap	1 liter	Cool to 4°C	7 days until lab extraction 40 days after lab extraction
Total Lead for Soil	Wide-mouth glass w/ Teflon-lined cap	500 ml or 16 oz.	N/A	180 days
Dissolved Lead for Water (shall be filtered prior to acid preservation)	Plastic or glass	500 ml or 16 oz.	Cool to 4°C Add HNO3 after filtering until pH is less than 2	180 days
Volatile Organics for Sludge (TCLP)	Wide-mouth glass w/ Teflon-lined cap	120 ml or 4 oz.	Cool to 4°C	14 days until lab extraction 14 days after lab extraction
Acid/Base/Neutral for Sludge(TCLP)	Wide-mouth glass w/ Teflon-lined cap	120 ml or 4 oz.	Cool to 4°C	14 days (hold) 7 days until lab extraction 40 days after lab extraction
Metals for Sludge(TCLP)	Wide-mouth glass w/ Teflon-lined cap	500 ml or 16 oz.	Cool to 4°C	180 days until lab extraction 180 days after lab extraction
Mercury for Sludge(TCLP)	Wide-mouth glass w/ Teflon-lined cap	500 ml or 16 oz.	Cool to 4°C	28 days until lab extraction 28 days after lab extraction

* FOR FURTHER INFORMATION REFER TO US EPA SW-846 PUBLICATION.

COMMONWEALTH OF KENTUCKY

Energy and Environment Cabinet

2019

Wastewater Laboratory Certification Program

In Accordance with KRS 224.10-670 and 401 KAR Chapter 5:320

THIS CERTIFIES THAT

Teklab Inc.
5445 Horseshoe Lake Rd
Collinsville, IL 62234
Laboratory ID Number: KY98006

The above laboratory has complied with Kentucky Administrative Regulation 401 KAR 5:320, Wastewater Laboratory Certification Program, for the analyses of wastewater samples, as specified in 33 U.S.C. 1342, for the method-analyte pairs specified on the attached certification list.

Effective From: January 1, 2019 To: December 31, 2019

(b) (6)

Certification Program Manager

Teklab Inc.
98006

KY Category	CAS #	Analyte	Status	Reference Method	MDL	MDL Units	MRL	MRL Units	ATP	Method Mod
Field		Specific Conductance	Certified	SM 2510 B-1997		N/A	10	umhos/cm	N/A	N
Field		pH	Certified	SM 4500-H+ B-2000		N/A	1	S.U.	N/A	N
Inorganic/General Chemistry		Acidity, Total (as CaCO3)	Certified	SM 2310 B-1997	1.60	mg/L	5	mg/L	N/A	N
Inorganic/General Chemistry		Alkalinity, Total (as CaCO3)	Certified	SM 2320 B-1997	1.55	mg/L	5	mg/L	N/A	N
Inorganic/General Chemistry	7664-41-7	Ammonia	Certified	EPA 350.1 Rev. 2.0 (1993)	0.04	mg/L	0.10	mg/L	N/A	N
Inorganic/General Chemistry		BOD, 5-day	Certified	SM 5210 B-2001	2	mg/L	5	mg/L	N/A	N
Inorganic/General Chemistry		Carbon, Total Organic	Certified	SM 5310 C-2000	0.5	mg/L	1	mg/L	N/A	N
Inorganic/General Chemistry		Chemical Oxygen Demand (COD)	Certified	EPA 410.4, Rev. 2.0 (1993)	6	mg/L	10	mg/L	N/A	N
Inorganic/General Chemistry		Chemical Oxygen Demand (COD)	Certified	SM 5220 D-1997	20	mg/L	50	mg/L	N/A	N
Inorganic/General Chemistry	16887-00-6	Chloride	Certified	SM 4500-Cl$^-$ E-1997	1	mg/L	5	mg/L	N/A	N
Inorganic/General Chemistry	57-12-5	Cyanide, Total (as Cn)	Certified	EPA 335.4 Rev. 1.0 (1993)	0.004	mg/L	0.007	mg/L	N/A	N
Inorganic/General Chemistry		Nitrate-Nitrite (as N)	Certified	SM 4500-NO3$^-$ F-2000	0.01	mg/L	0.05	mg/L	N/A	N
Inorganic/General Chemistry		Nitrogen, Kjeldahl Total (TKN)	Certified	EPA 351.2 Rev. 2.0 (1993)	0.2	mg/L	0.5	mg/L	N/A	N
Inorganic/General Chemistry	64743-03-9	Phenolics, Total	Certified	EPA 420.4 Rev. 1.0 (1993)	0.0036	mg/L	0.005	mg/L	N/A	N
Inorganic/General Chemistry	7723-14-0	Phosphorus, Total (as P)	Certified	EPA 365.4 (Issued 1974)	0.02	mg/L	0.05	mg/L	N/A	N
Inorganic/General Chemistry		Solids, Settleable	Certified	SM 2540 F-1997		N/A	0.1	mg/L	N/A	N
Inorganic/General Chemistry		Solids, Total Suspended (TSS)	Certified	SM 2540 D-1997		N/A	6	mg/L	N/A	N

KY Category	CAS #	Analyte	Status	Reference Method	MDL	MDL Units	MRL	MRL Units	ATP	Method Mod
Inorganic/General Chemistry	14808-79-8	Sulfate, Total (as SO4)	Certified	EPA 375.2, Rev. 2.0 (1993)	5	mg/L	10	mg/L	N/A	N
Inorganic/Metals	7429-90-5	Aluminum, Total (as Al)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.015	mg/L	0.05	mg/L	N/A	N
Inorganic/Metals	7429-90-5	Aluminum, Total (as Al)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.002	mg/L	0.005	mg/L	N/A	N
Inorganic/Metals	7440-36-0	Antimony, Total (as Sb)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.026	mg/L	0.05	mg/L	N/A	N
Inorganic/Metals	7440-36-0	Antimony, Total (as Sb)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00005	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-38-2	Arsenic, Total (as As)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.009	mg/L	0.025	mg/L	N/A	N
Inorganic/Metals	7440-38-2	Arsenic, Total (as As)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00005	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-39-3	Barium, Total (as Ba)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.002	mg/L	0.005	mg/L	N/A	N
Inorganic/Metals	7440-39-3	Barium, Total (as Ba)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00008	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-41-7	Beryllium, Total	Certified	EPA 200.7, Rev. 4.4 (1994)	0.0003	mg/L	0.001	mg/L	N/A	N
Inorganic/Metals	7440-41-7	Beryllium, Total	Certified	EPA 200.8, Rev. 5.4 (1994)	0.0001	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-42-8	Boron	Certified	EPA 200.7, Rev. 4.4 (1994)	0.006	mg/L	0.02	mg/L	N/A	N
Inorganic/Metals	7440-42-8	Boron	Certified	EPA 200.8, Rev. 5.4 (1994)	0.0025	mg/L	0.005	mg/L	N/A	N
Inorganic/Metals	7440-43-9	Cadmium, Total (as Cd)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.0003	mg/L	0.002	mg/L	N/A	N
Inorganic/Metals	7440-43-9	Cadmium, Total (as Cd)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00005	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-70-2	Calcium, total [as Ca]	Certified	EPA 200.7, Rev. 4.4 (1994)	0.019	mg/L	0.05	mg/L	N/A	N

KY Category	CAS #	Analyte	Status	Reference Method	MDL	MDL Units	MRL	MRL Units	ATP	Method Mod
Inorganic/Metals	7440-70-2	Calcium, total [as Ca]	Certified	EPA 200.8, Rev. 5.4 (1994)	0.02	mg/L	0.025	mg/L	N/A	N
Inorganic/Metals	7440-47-3	Chromium, Total (as Cr)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.004	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7440-47-3	Chromium, Total (as Cr)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00006	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-48-4	Cobalt, Total	Certified	EPA 200.7, Rev. 4.4 (1994)	0.002	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7440-48-4	Cobalt, Total	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00005	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-50-8	Copper, Total	Certified	EPA 200.7, Rev. 4.4 (1994)	0.003	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7440-50-8	Copper, Total	Certified	EPA 200.8, Rev. 5.4 (1994)	0.0001	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7439-89-6	Iron, Total (as Fe)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.007	mg/L	0.02	mg/L	N/A	N
Inorganic/Metals	7439-89-6	Iron, Total (as Fe)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.0015	mg/L	0.005	mg/L	N/A	N
Inorganic/Metals	7439-92-1	Lead, Total (as Pb)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.006	mg/L	0.04	mg/L	N/A	N
Inorganic/Metals	7439-92-1	Lead, Total (as Pb)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00005	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7439-95-4	Magnesium, Total (as Mg)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.005	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7439-95-4	Magnesium, Total (as Mg)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.002	mg/L	0.005	mg/L	N/A	N
Inorganic/Metals	7439-96-5	Manganese, Total (as Mn)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.002	mg/L	0.005	mg/L	N/A	N
Inorganic/Metals	7439-96-5	Manganese, Total (as Mn)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.0001	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7439-97-6	Mercury, Total (as Hg)	Certified	EPA 1631E (2002)	0.2	ng/L	0.5	ng/L	N/A	N
Inorganic/Metals	7439-97-6	Mercury, Total (as Hg)	Certified	EPA 245.1 Rev 3.0	0.000051	mg/L	0.0002	mg/L	N/A	N

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Inorganic/Metals	7439-98-7	Molybdenum, Total (as Mo)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.003	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7439-98-7	Molybdenum, Total (as Mo)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00005	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-02-0	Nickel, Total (as Ni)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.003	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7440-02-0	Nickel, Total (as Ni)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.0001	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7723-14-0	Phosphorus, Total (as P)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.01	mg/L	0.05	mg/L	N/A	N
Inorganic/Metals	7440-09-7	Potassium, Total (as K)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.024	mg/L	0.1	mg/L	N/A	N
Inorganic/Metals	7440-09-7	Potassium, Total (as K)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.013	mg/L	0.025	mg/L	N/A	N
Inorganic/Metals	7782-49-2	Selenium, Total (as Se)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.022	mg/L	0.05	mg/L	N/A	N
Inorganic/Metals	7782-49-2	Selenium, Total (as Se)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00018	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-22-4	Silver, Total (as Ag)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.003	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7440-22-4	Silver, Total (as Ag)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00005	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-23-5	Sodium, Total (as Na)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.024	mg/L	0.05	mg/L	N/A	N
Inorganic/Metals	7440-23-5	Sodium, Total (as Na)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.01	mg/L	0.025	mg/L	N/A	N
Inorganic/Metals	7440-28-0	Thallium, Total	Certified	EPA 200.7, Rev. 4.4 (1994)	0.013	mg/L	0.05	mg/L	N/A	N
Inorganic/Metals	7440-28-0	Thallium, Total	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00010	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-31-5	Tin, Total	Certified	EPA 200.7, Rev. 4.4 (1994)	0.011	mg/L	0.02	mg/L	N/A	N

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KY Category	CAS #	Analyte	Status	Reference Method	MDL	MDL Units	MRL	MRL Units	ATP	Method Mod
Inorganic/Metals	7440-31-5	Tin, Total	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00008	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-32-6	Titanium, Total (as Ti)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.002	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7440-32-6	Titanium, Total (as Ti)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00005	mg/L	0.0002	mg/L	N/A	N
Inorganic/Metals	7440-62-2	Vanadium, Total	Certified	EPA 200.7, Rev. 4.4 (1994)	0.003	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7440-62-2	Vanadium, Total	Certified	EPA 200.8, Rev. 5.4 (1994)	0.00020	mg/L	0.0006	mg/L	N/A	N
Inorganic/Metals	7440-66-6	Zinc, Total (as Zn)	Certified	EPA 200.7, Rev. 4.4 (1994)	0.002	mg/L	0.01	mg/L	N/A	N
Inorganic/Metals	7440-66-6	Zinc, Total (as Zn)	Certified	EPA 200.8, Rev. 5.4 (1994)	0.001	mg/L	0.002	mg/L	N/A	N
ORG/Pest/Herb/PCB	11141-16-5	Aroclor 1232	Certified	EPA 608	0.5	ug/L	1	ug/L	N/A	N
ORG/Pest/Herb/PCB	12674-11-2	Aroclor-1016 (PCB-1016)	Certified	EPA 608	0.5	ug/L	1	ug/L	N/A	N
ORG/Pest/Herb/PCB	11104-28-2	Aroclor-1221 (PCB-1221)	Certified	EPA 608	0.5	ug/L	1	ug/L	N/A	N
ORG/Pest/Herb/PCB	53469-21-9	Aroclor-1242 (PCB-1242)	Certified	EPA 608	0.5	ug/L	1	ug/L	N/A	N
ORG/Pest/Herb/PCB	12672-29-6	Aroclor-1248 (PCB-1248)	Certified	EPA 608	0.5	ug/L	1	ug/L	N/A	N
ORG/Pest/Herb/PCB	11097-69-1	Aroclor-1254 (PCB-1254)	Certified	EPA 608	0.5	ug/L	1	ug/L	N/A	N
ORG/Pest/Herb/PCB	11096-82-5	Aroclor-1260 (PCB-1260)	Certified	EPA 608	0.5	ug/L	1	ug/L	N/A	N
ORG/Semi-Volatiles	120-82-1	1,2,4-Trichlorobenzene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	122-66-7	1,2-Diphenylhydrazine	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	7005-72-3	1-Chloro-4-Phenoxybenzene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	111-44-4	2,2'-Dichlorodiethylether	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	88-06-2	2,4,6-Trichlorophenol	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	120-83-2	2,4-Dichlorophenol	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N

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ORG/Semi-Volatiles	105-67-9	2,4-Dimethylphenol	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	51-28-5	2,4-Dinitrophenol	Certified	EPA 625	0.01	mg/L	0.02	mg/L	N/A	N
ORG/Semi-Volatiles	121-14-2	2,4-Dinitrotoluene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	606-20-2	2,6-Dinitrotoluene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	91-58-7	2-Chloronaphthalene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	95-57-8	2-Chlorophenol	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	88-75-5	2-Nitrophenol	Certified	EPA 625	0.001	mg/L	0.02	mg/L	N/A	N
ORG/Semi-Volatiles	91-94-1	3,3'-Dichlorobenzidine	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	534-52-1	4,6-Dinitro-o-Cresol	Certified	EPA 625	0.004	mg/L	0.02	mg/L	N/A	N
ORG/Semi-Volatiles	101-55-3	4-Bromophenyl Phenyl Ether	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	59-50-7	4-Chloro-3-Methylphenol	Certified	EPA 625	0.002	mg/L	0.02	mg/L	N/A	N
ORG/Semi-Volatiles	100-02-7	4-Nitrophenol	Certified	EPA 625	0.004	mg/L	0.02	mg/L	N/A	N
ORG/Semi-Volatiles	83-32-9	Acenaphthene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	208-96-8	Acenaphthylene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	120-12-7	Anthracene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	92-87-5	Benzidine	Certified	EPA 625	0.014	mg/L	0.04	mg/L	N/A	N
ORG/Semi-Volatiles	56-55-3	Benzo[A]Anthracene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	50-32-8	Benzo[A]Pyrene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	205-99-2	Benzo[B]Fluoranthene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	191-24-2	Benzo[G,H,I]Perylene	Certified	EPA 625	0.003	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	207-08-9	Benzo[K]Fluoranthene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	108-60-1	Bis (2-Chloro-Isopropyl) Ether	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N

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ORG/Semi-Volatiles	111-91-1	Bis(2-Chloroethoxy)methane	Certified	EPA 625	0.0010	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	117-81-7	Bis(2-Ethylhexyl) Phthalate	Certified	EPA 625	0.004	mg/L	0.006	mg/L	N/A	N
ORG/Semi-Volatiles	117-84-0	Bis(N-Octyl) Phthalate	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	85-68-7	Butyl Benzyl Phthalate	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	218-01-9	Chrysene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	53-70-3	Dibenzo(a,h)anthracene	Certified	EPA 625	0.003	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	84-74-2	Dibutyl phthalate	Certified	EPA 625	0.003	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	84-66-2	Diethyl Phthalate	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	131-11-3	Dimethyl Phthalate	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	206-44-0	Fluoranthene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	86-73-7	Fluorene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	87-68-3	Hexachloro-1,3-butadiene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	118-74-1	Hexachlorobenzene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	77-47-4	Hexachlorocyclopentadiene	Certified	EPA 625 - Screening only	0.004	mg/L	0.02	mg/L	N/A	N
ORG/Semi-Volatiles	67-72-1	Hexachloroethane	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	193-39-5	Indeno(1,2,3-cd)pyrene	Certified	EPA 625	0.003	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	78-59-1	Isophorone	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	91-20-3	Naphthalene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	98-95-3	Nitrobenzene	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	87-86-5	Pentachlorophenol	Certified	EPA 625	0.004	mg/L	0.02	mg/L	N/A	N
ORG/Semi-Volatiles	85-01-8	Phenanthrene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	108-95-2	Phenol	Certified	EPA 625	0.003	mg/L	0.005	mg/L	N/A	N
ORG/Semi-Volatiles	129-00-0	Pyrene	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N

KY Category	CAS #	Analyte	Status	Reference Method	MDL	MDL Units	MRL	MRL Units	ATP	Method Mod
ORG/Semi-Volatiles	621-64-7	n-Nitrosodi-n-Propylamine	Certified	EPA 625	0.001	mg/L	0.01	mg/L	N/A	N
ORG/Semi-Volatiles	62-75-9	n-Nitrosodimethylamine	Certified	EPA 625	0.004	mg/L	0.02	mg/L	N/A	N
ORG/Semi-Volatiles	86-30-6	n-Nitrosodiphenylamine	Certified	EPA 625	0.002	mg/L	0.01	mg/L	N/A	N
ORG/Volatiles	71-55-6	1,1,1-Trichloroethane	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	79-34-5	1,1,2,2-Tetrachloroethane	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	79-00-5	1,1,2-Trichloroethane	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	75-34-3	1,1-Dichloroethane	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	75-35-4	1,1-Dichloroethylene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	95-50-1	1,2-Dichlorobenzene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	107-06-2	1,2-Dichloroethane (EDC)	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	78-87-5	1,2-Dichloropropane	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	541-73-1	1,3-Dichlorobenzene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	542-75-6	1,3-Dichloropropene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	106-46-7	1,4-Dichlorobenzene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	110-75-8	2-Chloroethyl Vinyl Ether	Certified	EPA 624	5	ug/L	20	ug/L	N/A	N
ORG/Volatiles	107-02-8	Acrolein	Certified	EPA 624	10	ug/L	100	ug/L	N/A	N
ORG/Volatiles	107-13-1	Acrylonitrile	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	71-43-2	Benzene	Certified	EPA 624	0.5	ug/L	2	ug/L	N/A	N
ORG/Volatiles	75-27-4	Bromodichloromethane	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	74-83-9	Bromomethane (Methyl bromide)	Certified	EPA 624	2	ug/L	10	ug/L	N/A	N
ORG/Volatiles	56-23-5	Carbon Tetrachloride	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	108-90-7	Chlorobenzene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	124-48-1	Chlorodibromomethane	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N

KY Category	CAS #	Analyte	Status	Reference Method	MDL	MDL Units	MRL	MRL Units	ATP	Method Mod
ORG/Volatiles	75-00-3	Chloroethane	Certified	EPA 624	2	ug/L	10	ug/L	N/A	N
ORG/Volatiles	67-66-3	Chloroform	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	75-09-2	Dichloromethane (Methylene chloride)	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	100-41-4	Ethylbenzene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	74-87-3	Methyl chloride	Certified	EPA 624	2	ug/L	10	ug/L	N/A	N
ORG/Volatiles	127-18-4	Tetrachloroethylene (PCE)	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	108-88-3	Toluene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	75-25-2	Tribromomethane	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	79-01-6	Trichloroethylene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	75-69-4	Trichlorofluoromethane	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	75-01-4	Vinyl Chloride	Certified	EPA 624	0.5	ug/L	2	ug/L	N/A	N
ORG/Volatiles	156-60-5	trans-1,2-Dichloroethylene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N
ORG/Volatiles	10061-02-6	trans-1,3-Dichloropropene	Certified	EPA 624	1	ug/L	5	ug/L	N/A	N

John Bel Edwards
GOVERNOR

Rebekah E. Gee MD, MPH
SECRETARY

State of Louisiana
Louisiana Department of Health
Office of Public Health

November 29, 2018

(b) (6)
5445 Horseshoe Lake Road
Collinsville, IL 62234

Dear (b) (6)

The requirements for maintaining your certification status for the State of Louisiana are outlined in the 2009 TNI standards and in the Louisiana Administrative Code (LAC) for the Accreditation of Laboratories Conducting Drinking Water Analyses located in LAC 48:V.Chapter 80, LAC 51:XII.101 and 301.

Your laboratory has chosen the State of Illinois as its primary TNI accreditation body. Based on its accreditation, your laboratory is granted this **2019 Certificate of Laboratory Accreditation** for all the parameters listed. The certificate must be conspicuously displayed in the laboratory in a location visible to the public.

If there are any questions, please contact the Safe Drinking Water Program at (225)219-5247.

Sincerely,

(b) (6)

Grant Aucoin
Laboratory Accreditation Program Manager

Enclosures

Office of Public Health Laboratory • 1209 Leesville Avenue • Baton Rouge, Louisiana 70802
Phone: (225) 219-5200 • Fax: (225) 219-4903 • www.ldh.la.gov/lab
An Equal Opportunity Employer

NELAP RECOGNIZED ACCREDITATION BODY

STATE OF LOUISIANA

DEPARTMENT OF HEALTH
OFFICE OF PUBLIC HEALTH

TEKLAB, INC.

5445 Horseshoe Lake Road

Collinsville, IL 62234

is accredited by the State of Louisiana in accordance with the 2009 TNI Standard and/or Department of Health regulations Louisiana Administrative Code 48:V.Chapter 80 and Louisiana Administrative Code 51:XII.101 and 301

Scope of accreditation is limited to the "TNI Accredited Fields of Testing" which accompany this certificate

Continued accredited status depends on successful ongoing participation in the program

CERTIFICATE NUMBER: LA016
EFFECTIVE DATE: January 1, 2019
EXPIRATION DATE: December 31, 2019

(b) (6)

Daniel Ferguson, MD
Public Health Laboratory Director
1209 Leesville Avenue
Baton Rouge, Louisiana 70802

(b) (6)

Grant Aucoin
Laboratory Accreditation Program Manager

subject to forfeiture or revocation

EPA ID: IL00054

Louisiana Department of Health
Office of Public Health
1209 Leesville Avenue
Baton Rouge, LA 70802
(225) 219-5202

Louisiana Accreditation - 2019

Teklab, Inc. located in Collinsville, IL
meets all of the criteria necessary for ACCREDITATION by the State of Louisiana and The NELAC Institute (TNI) for the analysis of drinking water for the following contaminants:

Drinking Water Parameters

Analyte	Method	Primary AB	Method Revision # or date	Technology Description	TNI Method Code	TNI Analyte Code
Alkalinity as CaCO3	SM 2320 B	IL	18th ed.	TITR	20044808	1505
Aluminum	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1000
Antimony	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1005
Arsenic	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1010
Barium	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1015
Barium	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1015
Beryllium	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1020
Beryllium	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1020
Cadmium	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1030
Cadmium	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1030
Calcium	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1035
Chlorine (total residual)	SM 4500-Cl G	IL	18th ed.	UV-VIS	20020604	1940
Chromium	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1040

Certificate #: LA016
Issue Date: 12/20/2018
Effective Date: 1/1/2019
Expires: 12/31/2019

Drinking Water Parameters

Analyte	Method	Primary AB	Method Revision # or date	Technology Description	TNI Method Code	TNI Analyte Code
Chromium	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1040
Color	SM 2120 B	IL	18th ed.	OTHER	20223603	1605
Conductivity	SM 2510 B	IL	21st ed.	COND	20048402	1610
Copper	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1055
Copper	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1055
Cyanide	EPA 335.4	IL	rev 1.0	AUTO	10061402	1645
Dissolved Organic Carbon (DOC)	SM 5310 C	IL	19th ed.	TOC-FID	20138209	1710
Fluoride	SM 4500-F- C	IL	18th ed.	ISE	20101604	1730
Hardness as CaCO3 (calcium)	SM 2340 B	IL	18th ed.	OTHER	20045801	1550
Iron	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1070
Lead	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1075
Magnesium	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1085
Manganese	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1090
Manganese	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1090
Mercury	EPA 245.1	IL	rev 3.0	CVAAS	10036609	1095
Molybdenum	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1100
Nickel	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1105
Nickel	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1105
Nitrate as N	EPA 353.2	IL	rev 2.0	AUTO	10067604	1810
Nitrate-Nitrite as N	EPA 353.2	IL	rev 2.0	AUTO	10067604	1820
Nitrite as N	EPA 353.2	IL	rev 2.0	AUTO	10067604	1840
Nitrite as N	SM 4500-NO2- B	IL	18th ed.	UV-VIS	20024004	1840

Drinking Water Parameters

Analyte	Method	Primary AB	Method Revision # or date	Technology Description	TNI Method Code	TNI Analyte Code
Orthophosphate as P	SM 4500-P E	IL	18th ed.	UV-VIS	20025803	1870
pH	SM 4500-H+ B	IL	18th ed.	ISE	20022406	1900
Selenium	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1140
Silver	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1150
Silver	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1150
Sodium	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1155
Surfactants-MBAS	SM 5540 C	IL	21st ed.	UV-VIS	20144803	2025
Thallium	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1165
Total Dissolved Solids (TDS)	SM 2540 C	IL	18th ed.	GRAV	20049609	1955
Total Organic Carbon (TOC)	SM 5310 C	IL	19th ed.	TOC-FID	20138209	2040
Turbidity	EPA 180.1	IL	rev 2.0	TURB	10011800	2055
Turbidity	SM 2130 B	IL	20th ed.	TURB	20042404	2055
Turbidity	SM 2130 B	IL	18th ed.	TURB	20042006	2055
Zinc	EPA 200.7	IL	rev 4.4	ICP-AES	10013806	1190
Zinc	EPA 200.8	IL	rev 5.4	ICP-MS	10014605	1190

The State of Illinois is the primary TNI Accreditation Body for Teklab, Inc. The Louisiana Department of Health is a secondary Accreditation Body for this laboratory. For a list of additional parameters, refer to the Illinois Environmental Protection Agency.

OKLAHOMA
DEPARTMENT OF ENVIRONMENTAL QUALITY
...for a clean, attractive, prosperous Oklahoma

Oklahoma Department of Environmental Quality
TNI Laboratory Accreditation

NELAP ACCREDITED LABORATORY

State Laboratory ID: 9978
EPA ID: IL00054

Certificate #: 2019-059

Teklab, Inc.

5445 Horseshoe Lake Road
Collinsville, IL 62234

has been accredited for the analysis of environmental samples for analytes listed on the attached Scope of Accreditation.

Continued accreditation is contingent upon successful on-going compliance with OAC 252:307 which was promulgated and adopted pursuant to the Oklahoma Environmental Quality Code (Code), 27AO.S. § 2-4-101 *et seq.* Specific methods and analytes certified are cited on the laboratory's Scope of Accreditation.

The Scope of Accreditation, inspections reports and accreditation status are on file and may be obtained from:
Oklahoma DEQ, State Environmental Laboratory Services Division,
Laboratory Accreditation Program,
707 N Robinson, P.O. Box 1677, Oklahoma City, Oklahoma 73101-1677,
(405) 702-1000, www.deq.state.ok.us.

ISSUED: 9/1/2019

EXPIRES: 8/31/2020

(b) (6)

Chris Armstrong, State Environmental Laboratory Services Division Director

(b) (6)

David Caldwell, Laboratory Accreditation Program

This certificate is valid proof of certification only when associated with its Scope of Accreditation.

7000-STR2-01-03012015

IDPH
ILLINOIS DEPARTMENT OF PUBLIC HEALTH

Awards this certificate of approval for public health laboratory service to

Teklab, Inc.

5445 Horseshoe Lake Road
Collinsville, Illinois 62234

for the following laboratory examinations:

Heterotrophic Plate Count for Water (SM 9215B)
Total Coliform (MF; SM 9222B)
E. Coli (EC-Mug; SM 9222G.1c(2))
Fecal Coliform (MF SM 9222D)

Brenda Johnson, Alicia VerDuin, Jamie Boyer, and Amber Dilallo are approved for the procedures listed above.

Registry no. 17584
Date September 3, 2019
For the period ending May 31, 2021

AUG. 26TH 1818

(b) (6)

Ngozi Ezike, MD
Director

Missouri Department of dnr.mo.gov
NATURAL RESOURCES
Michael L. Parson, Governor Carol S. Comer, Director

OCT 2 8 2019

Ms. Alicia VerDuin
Microbiology Department Supervisor
Teklab, Incorporated (MO Lab# 930)
5445 Horseshoe Lake Road
Collinsville, IL 62234

Dear Ms. Verduin:

Based upon an evaluation of laboratory data by the Missouri Department of Health and Senior Services Laboratory Certification Officer and the on-site evaluation performed by the Illinois Department of Public Health, it is the recommendation of the Laboratory Certification Officer, that Teklab, Incorporated, be reciprocally certified under the provisions of the Missouri Safe Drinking Water Regulations to perform bacteriological analyses for public water supplies in the State of Missouri for the following parameters:

Total Coliform **Fecal Coliform** ***E. coli*** **Heterotrophic Plate Count**

Enclosed please find a certificate of approval and a certified parameter list for your laboratory. The certified parameter references the parameters, methods of analysis, and personnel that have been approved by the State of Missouri to complete bacteriological testing for public water supplies. Your Missouri certification will expire on May 31, 2021, and is contingent upon no changes of the approved methods, analysts, or equipment.

Should there be any changes to your Illinois certification status, please notify this office within 30 days. Any notifications or inquiries related to the approval may be directed to Ms. Ellen Harrel of my staff, who may be reached at P.O. Box 176, Jefferson City, MO 65102, or by telephone at 573-751-1077.

Sincerely,

WATER PROTECTION PROGRAM
(b) (6)

for
David J. Lamb, Chief
Public Drinking Water Branch

DJL/eh

Enclosures

c: Ms. Ashley Mehmert, Department of Health and Senior Services

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DRINKING WATER LABORATORY
CERTIFIED PARAMETER LIST

This is to certify that the following personnel of the

Teklab, Incorporated

located at

5445 Horseshoe Lake Road, Collinsville, Illinois 62234

have been approved to perform the indicated procedures on drinking water under the Missouri Public Drinking Water Regulations (10 CSR 60-5.020):

PERSONNEL

Alicia VerDuin– Supervisor
Brenda Johnson– Analyst
Jamie Boyer– Analyst
Amber Dilallo– Analyst

PARAMETERS AND METHODS

Total Coliform – SM 9222B Membrane Filtration (Les Endo – LTB – BG)
E. coli – SM 9222G.1c(2) EC Broth with MUG
Fecal Coliform - SM 9222D Membrane Filtration (mFC Agar)
Heterotrophic Plate Count – SM9215B Pour Plate (Plate Count Agar)

Missouri Certificate No.: 930
Expiration Date: May 31, 2021
Illinois Certificate No.: IL 17584
Original Certifying State: Illinois

State of Missouri
Department of Natural Resources

Certificate of Approval
for Microbiological Laboratory Service

This is to certify that

Teklab, Incorporated

is hereby approved to perform the analysis of drinking water as specified on the Certified Parameter List, which must accompany this certificate to be valid.

Certification Number 930

Date Issued October 28, 2019

Expiration Date May 31, 2021

(b) (6) [redacted] for DAVID LAMB

Chief, Public Drinking Water Branch
Water Protection Program
Missouri Department of Natural Resources

(b) (6) [redacted]

Evaluation Officer, State Public Health Laboratory
Missouri Department of Health and Senior Services

IDPH

ILLINOIS DEPARTMENT OF PUBLIC HEALTH

Awards this certificate of approval for public health laboratory service to

Teklab, Inc.

5445 Horseshoe Lake Road
Collinsville, Illinois 62234

for the following laboratory examinations:

Heterotrophic Plate Count for Water (SM 9215B)
Total Coliform (MF; SM 9222B)
E. Coli (EC-Mug; SM 9222G.1c(2))
Fecal Coliform (MF SM 9222D)

Brenda Johnson and Kalyn Foecke are approved for the procedures listed above.

Registry no. 17584
Date May 24, 2017
For the period ending May 31, 2019

AUG. 26th 1818

(b) (6)

Nirav D. Shah, M.D., J.D.,
Director

State of Kansas

Department of Health and Environment

CERTIFICATE

This is to certify that Certification No.: E-10374

Teklab, Inc.

5445 Horseshoe Lake Road
Collinsville, IL 62234-7425

has been accredited in accordance with K.S.A. 65-1,109a under the standards adopted in K.A.R. 28-15-36 for performing environmental analyses for the parameters listed on the most current scope of accreditation. Continuous accreditation depends on successful, ongoing participation in the program. Clients are urged to verify with this agency the laboratory's certification status for particular methods and analytes.

Effective Date: 5/1/2019

Expiration Date: 4/30/2020

(b) (6)

Director
Office of Laboratory Services

(b) (6)

Certification Section Chief
Office of Laboratory Services

Division of Environment
Kansas Health and Environmental Laboratories
Environmental Laboratory Improvement Program
6810 SE Dwight Street
Topeka, KS 66620-0001

Kansas
Department of Health
and Environment

Phone: 785-296-3811
Fax: 785-559-5207
KDHE.ELIPO@KS.GOV
www.kdheks.gov/envlab

Lee A. Norman, M.D., Secretary

Laura Kelly, Governor

The Kansas Department of Health and Environment encourages all clients and data users to verify the most current scope of accreditation for certification number E-10374

The analytes tested and the corresponding matrix and method which a laboratory is authorized to perform at any given time will be those indicated in the most recently issued scope of accreditation. The most recent scope of accreditation supersedes all previously issued scopes of accreditation. It is the certified laboratory's responsibility to review this document for any discrepancies. This scope of accreditation will be recalled in the event that your laboratory's certification is revoked.

Accreditation Start: 5/1/2019 Accreditation End: 4/30/2020

EPA Number: ***IL00054*** **Scope of Accreditation for Certification Number: E-10374**

Teklab, Inc.	**Primary AB**
Program/Matrix: ***CWA (Non Potable Water)***	
Method EPA 120.1	
Conductivity	KS
Method EPA 160.4	
Residue-volatile	KS
Method EPA 1631E	
Mercury	KS
Method EPA 1664A	
Oil & Grease	KS
Method EPA 180.1	
Turbidity	KS
Method EPA 200.7	
Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Boron	KS
Cadmium	KS
Calcium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Iron	KS
Lead	KS
Magnesium	KS
Manganese	KS
Molybdenum	KS

Program/Matrix: ***CWA (Non Potable Water)***

Nickel	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Tin	KS
Titanium	KS
Vanadium	KS
Zinc	KS

Method EPA 200.8

Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Boron	KS
Cadmium	KS
Calcium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Iron	KS
Lead	KS
Magnesium	KS
Manganese	KS
Molybdenum	KS
Nickel	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Thallium	KS
Tin	KS
Titanium	KS
Vanadium	KS
Zinc	KS

Method EPA 245.1

Mercury	KS

Method EPA 335.4

Cyanide	KS

Method EPA 350.1

Ammonia as N	KS

Method EPA 351.2

Total Kjeldahl Nitrogen (TKN)	KS

Method EPA 353.2

Nitrate	KS

Program/Matrix: ***CWA (Non Potable Water)***

	Primary AB
Nitrite	KS
Method EPA 365.4	
Phosphorus	KS
Method EPA 375.2	
Sulfate	KS
Method EPA 410.4	
Chemical oxygen demand	KS
Method EPA 420.1	
Total phenolics	KS
Method EPA 420.4	
Total phenolics	KS
Method EPA 6010B	
Arsenic	KS
Cadmium	KS
Copper	KS
Lead	KS
Molybdenum	KS
Nickel	KS
Selenium	KS
Total chromium	KS
Zinc	KS
Method EPA 608	
4,4'-DDD	KS
4,4'-DDE	KS
4,4'-DDT	KS
Aldrin	KS
alpha-BHC (alpha-Hexachlorocyclohexane)	KS
Aroclor-1016 (PCB-1016)	KS
Aroclor-1221 (PCB-1221)	KS
Aroclor-1232 (PCB-1232)	KS
Aroclor-1242 (PCB-1242)	KS
Aroclor-1248 (PCB-1248)	KS
Aroclor-1254 (PCB-1254)	KS
Aroclor-1260 (PCB-1260)	KS
beta-BHC (beta-Hexachlorocyclohexane)	KS
Chlordane (tech.)(N.O.S.)	KS
delta-BHC	KS
Dieldrin	KS
Endosulfan I	KS
Endosulfan II	KS
Endosulfan sulfate	KS
Endrin	KS
Endrin aldehyde	KS
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	KS
Heptachlor	KS
Heptachlor epoxide	KS

Program/Matrix: ***CWA (Non Potable Water)***

Toxaphene (Chlorinated camphene)	KS

Method **EPA 624**

1,1,1-Trichloroethane	KS
1,1,2,2-Tetrachloroethane	KS
1,1,2-Trichloroethane	KS
1,1-Dichloroethane	KS
1,1-Dichloroethylene	KS
1,2-Dichlorobenzene (o-Dichlorobenzene)	KS
1,2-Dichloroethane (Ethylene dichloride)	KS
1,2-Dichloropropane	KS
1,3-Dichlorobenzene	KS
1,4-Dichlorobenzene	KS
2-Chloroethyl vinyl ether	KS
Acrolein (Propenal)	KS
Acrylonitrile	KS
Benzene	KS
Bromodichloromethane	KS
Bromoform	KS
Carbon tetrachloride	KS
Chlorobenzene	KS
Chlorodibromomethane	KS
Chloroethane (Ethyl chloride)	KS
Chloroform	KS
cis-1,3-Dichloropropene	KS
Ethylbenzene	KS
Methyl bromide (Bromomethane)	KS
Methyl chloride (Chloromethane)	KS
Methylene chloride (Dichloromethane)	KS
Tetrachloroethylene (Perchloroethylene)	KS
Toluene	KS
trans-1,2-Dichloroethylene	KS
trans-1,3-Dichloropropylene	KS
Trichloroethene (Trichloroethylene)	KS
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	KS
Vinyl chloride	KS

Method **EPA 625**

1,2,4-Trichlorobenzene	KS
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	KS
2,4,6-Trichlorophenol	KS
2,4-Dichlorophenol	KS
2,4-Dimethylphenol	KS
2,4-Dinitrophenol	KS
2,4-Dinitrotoluene (2,4-DNT)	KS
2,6-Dinitrotoluene (2,6-DNT)	KS
2-Chloronaphthalene	KS
2-Chlorophenol	KS
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	KS

Program/Matrix: ***CWA (Non Potable Water)***

2-Nitrophenol	KS
3,3'-Dichlorobenzidine	KS
4-Bromophenyl phenyl ether	KS
4-Chloro-3-methylphenol	KS
4-Chlorophenyl phenylether	KS
4-Nitrophenol	KS
Acenaphthene	KS
Acenaphthylene	KS
Anthracene	KS
Benzidine	KS
Benzo(a)anthracene	KS
Benzo(a)pyrene	KS
Benzo(b)fluoranthene	KS
Benzo(g,h,i)perylene	KS
Benzo(k)fluoranthene	KS
bis(2-Chloroethoxy)methane	KS
bis(2-Chloroethyl) ether	KS
Butyl benzyl phthalate	KS
Chrysene	KS
Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)	KS
Dibenz(a,h) anthracene	KS
Diethyl phthalate	KS
Dimethyl phthalate	KS
Di-n-butyl phthalate	KS
Di-n-octyl phthalate	KS
Fluoranthene	KS
Fluorene	KS
Hexachlorobenzene	KS
Hexachlorobutadiene	KS
Hexachlorocyclopentadiene	KS
Hexachloroethane	KS
Indeno(1,2,3-cd) pyrene	KS
Isophorone	KS
Naphthalene	KS
Nitrobenzene	KS
n-Nitrosodimethylamine	KS
n-Nitrosodi-n-propylamine	KS
n-Nitrosodiphenylamine	KS
Pentachlorophenol	KS
Phenanthrene	KS
Phenol	KS
Pyrene	KS

Method SM 2120 B-2011

Color	KS

Method SM 2130 B-2001

Turbidity	KS

Method SM 2310 B-1997

	Primary AB
Program/Matrix: ***CWA (Non Potable Water)***	
Acidity, as CaCO3	KS
Method SM 2320 B-1997	
Alkalinity as CaCO3	KS
Method SM 2340 B-1997	
Hardness	KS
Method SM 2510 B-1997	
Conductivity	KS
Method SM 2540 B-1997	
Residue-total	KS
Method SM 2540 C-1997	
Residue-filterable (TDS)	KS
Method SM 2540 D-1997	
Residue-nonfilterable (TSS)	KS
Method SM 2540 F-1997	
Residue-settleable	KS
Method SM 2550 B-2000	
Temperature, deg. C	KS
Method SM 3120 B-1999	
Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Boron	KS
Cadmium	KS
Calcium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Iron	KS
Lead	KS
Magnesium	KS
Manganese	KS
Molybdenum	KS
Nickel	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Thallium	KS
Vanadium	KS
Zinc	KS
Method SM 3500-Cr B-2009	
Chromium VI	KS
Method SM 4500-Cl G-2000	

Program/Matrix: ***CWA (Non Potable Water)***

	Primary AB
Total residual chlorine	KS
Method SM 4500-Cl$^-$ C-1997	
Chloride	KS
Method SM 4500-Cl$^-$ E-1997	
Chloride	KS
Method SM 4500-CN$^-$ E-1999	
Cyanide	KS
Method SM 4500-CN$^-$ G-1999	
Available Cyanide	KS
Method SM 4500-F$^-$ C-1997	
Fluoride	KS
Method SM 4500-H+ B-2000	
pH	KS
Method SM 4500-NO2$^-$ B-2000	
Nitrite	KS
Method SM 4500-NO3$^-$ F-2000	
Nitrate-nitrite	KS
Method SM 4500-O G-2001	
Oxygen, dissolved	KS
Method SM 4500-P E-1999	
Orthophosphate as P	KS
Method SM 4500-S2$^-$ D-2000	
Sulfide	KS
Method SM 4500-SO3$^-$ B-2000	
Sulfite-SO3	KS
Method SM 5210 B-1997	
Biochemical oxygen demand	KS
Carbonaceous BOD, CBOD	KS
Method SM 5220 D-1997	
Chemical oxygen demand	KS
Method SM 5310 C-2000	
Total organic carbon	KS
Method SM 5540 C-2000	
Surfactants - MBAS	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Method EPA 1010A

Ignitability	KS

Method EPA 1020B

Ignitability	KS

Method EPA 1311

Toxicity Characteristic Leaching Procedure (TCLP)	KS

Method EPA 1312

Synthetic Precipitation Leaching Procedure (SPLP)	KS

Method EPA 6010B

Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Boron	KS
Cadmium	KS
Calcium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Iron	KS
Lead	KS
Lithium	KS
Magnesium	KS
Manganese	KS
Molybdenum	KS
Nickel	KS
Phosphorus	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Strontium	KS
Thallium	KS
Tin	KS
Titanium	KS
Vanadium	KS
Zinc	KS

Method EPA 6020A

Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Cadmium	KS
Calcium	KS

Program/Matrix: ***RCRA (Non Potable Water)***

	Primary AB
Chromium	KS
Cobalt	KS
Copper	KS
Iron	KS
Lead	KS
Magnesium	KS
Manganese	KS
Nickel	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Thallium	KS
Vanadium	KS
Zinc	KS

Method EPA 7196A

Chromium VI	KS

Method EPA 7470A

Mercury	KS

Method EPA 7471B

Mercury	KS

Method EPA 8015B

1,4-Dioxane (1,4- Diethyleneoxide)	KS
Diesel range organics (DRO)	KS
Ethanol	KS
Ethylene glycol	KS
Isobutyl alcohol (2-Methyl-1-propanol)	KS
Isopropyl alcohol (2-Propanol, Isopropanol)	KS
Methanol	KS
n-Butyl alcohol (1-Butanol, n-Butanol)	KS
n-Propanol (1-Propanol)	KS
tert-Butyl alcohol	KS

Method EPA 8081B

4,4'-DDD	KS
4,4'-DDE	KS
4,4'-DDT	KS
Alachlor	KS
Aldrin	KS
alpha-BHC (alpha-Hexachlorocyclohexane)	KS
alpha-Chlordane, cis-Chlordane	KS
beta-BHC (beta-Hexachlorocyclohexane)	KS
Chlordane (tech.)(N.O.S.)	KS
delta-BHC	KS
Dieldrin	KS
Endosulfan I	KS
Endosulfan II	KS

Program/Matrix: *RCRA (Non Potable Water)*

Endosulfan sulfate	KS
Endrin	KS
Endrin aldehyde	KS
Endrin ketone	KS
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	KS
gamma-Chlordane	KS
Heptachlor	KS
Heptachlor epoxide	KS
Methoxychlor	KS
Toxaphene (Chlorinated camphene)	KS

Method EPA 8082

Aroclor-1016 (PCB-1016)	KS
Aroclor-1221 (PCB-1221)	KS
Aroclor-1232 (PCB-1232)	KS
Aroclor-1242 (PCB-1242)	KS
Aroclor-1248 (PCB-1248)	KS
Aroclor-1254 (PCB-1254)	KS
Aroclor-1260 (PCB-1260)	KS

Method EPA 8151A

2,4,5-T	KS
2,4-D	KS
2,4-DB	KS
3,5-Dichlorobenzoic acid	KS
4-Nitrophenol	KS
Acifluorfen	KS
Bentazon	KS
Chloramben	KS
DCPA di acid degradate	KS
Dicamba	KS
Dichloroprop (Dichlorprop)	KS
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	KS
MCPA	KS
MCPP	KS
Pentachlorophenol	KS
Picloram	KS
Silvex (2,4,5-TP)	KS

Method EPA 8260B

1,1,1,2-Tetrachloroethane	KS
1,1,1-Trichloroethane	KS
1,1,2,2-Tetrachloroethane	KS
1,1,2-Trichloroethane	KS
1,1-Dichloroethane	KS
1,1-Dichloroethylene	KS
1,1-Dichloropropene	KS
1,2,3-Trichlorobenzene	KS
1,2,3-Trichloropropane	KS
1,2,4-Trichlorobenzene	KS

Program/Matrix: ***RCRA (Non Potable Water)***

	Primary AB
1,2,4-Trimethylbenzene	KS
1,2-Dibromo-3-chloropropane (DBCP)	KS
1,2-Dibromoethane (EDB, Ethylene dibromide)	KS
1,2-Dichlorobenzene (o-Dichlorobenzene)	KS
1,2-Dichloroethane (Ethylene dichloride)	KS
1,2-Dichloropropane	KS
1,3,5-Trimethylbenzene	KS
1,3-Dichlorobenzene	KS
1,3-Dichloropropane	KS
1,4-Dichlorobenzene	KS
1-Chlorobutane	KS
2,2-Dichloropropane	KS
2-Butanone (Methyl ethyl ketone, MEK)	KS
2-Chloroethyl vinyl ether	KS
2-Chlorotoluene	KS
2-Hexanone	KS
2-Nitropropane	KS
4-Chlorotoluene	KS
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	KS
4-Methyl-2-pentanone (MIBK)	KS
Acetone	KS
Acetonitrile	KS
Acrolein (Propenal)	KS
Acrylonitrile	KS
Allyl chloride (3-Chloropropene)	KS
Benzene	KS
Bromobenzene	KS
Bromochloromethane	KS
Bromodichloromethane	KS
Bromoform	KS
Carbon disulfide	KS
Carbon tetrachloride	KS
Chlorobenzene	KS
Chlorodibromomethane	KS
Chloroethane (Ethyl chloride)	KS
Chloroform	KS
cis-1,2-Dichloroethylene	KS
cis-1,3-Dichloropropene	KS
cis-1,4-Dichloro-2-butene	KS
Dibromomethane (Methylene bromide)	KS
Dichlorodifluoromethane (Freon-12)	KS
Diethyl ether	KS
Ethyl acetate	KS
Ethyl methacrylate	KS
Ethylbenzene	KS
Hexachlorobutadiene	KS
Hexachloroethane	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Iodomethane (Methyl iodide)	KS
Isopropylbenzene	KS
Methacrylonitrile	KS
Methyl bromide (Bromomethane)	KS
Methyl chloride (Chloromethane)	KS
Methyl methacrylate	KS
Methylene chloride (Dichloromethane)	KS
m-Xylene	KS
Naphthalene	KS
n-Butylbenzene	KS
Nitrobenzene	KS
n-Propylbenzene	KS
o-Xylene	KS
Pentachloroethane	KS
Propionitrile (Ethyl cyanide)	KS
p-Xylene	KS
sec-Butylbenzene	KS
Styrene	KS
tert-Butyl alcohol	KS
tert-Butylbenzene	KS
Tetrachloroethylene (Perchloroethylene)	KS
Toluene	KS
trans-1,2-Dichloroethylene	KS
trans-1,3-Dichloropropylene	KS
trans-1,4-Dichloro-2-butene	KS
Trichloroethene (Trichloroethylene)	KS
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	KS
Vinyl acetate	KS
Vinyl chloride	KS

Method EPA 8270C

1,2,4-Trichlorobenzene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Diphenylhydrazine	IL
1,3-Dichlorobenzene	IL
1,4-Dichlorobenzene	IL
1,4-Naphthoquinone	IL
1-Naphthylamine	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,4,5-Trichlorophenol	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL

Program/Matrix: ***RCRA (Non Potable Water)***

2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Methylaniline (o-Toluidine)	IL
2-Methylnaphthalene	IL
2-Naphthylamine	IL
2-Nitroaniline	IL
2-Nitrophenol	IL
3,3'-Dichlorobenzidine	IL
3,3'-Dimethylbenzidine	IL
3-Methylcholanthrene	IL
3-Methylphenol (m-Cresol)	IL
3-Nitroaniline	IL
4-Aminobiphenyl	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chloroaniline	IL
4-Chlorophenyl phenylether	IL
4-Methylphenol (p-Cresol)	IL
4-Nitroaniline	IL
4-Nitrophenol	IL
5-Nitro-o-toluidine	IL
7,12-Dimethylbenz(a) anthracene	IL
Acenaphthene	IL
Acenaphthylene	IL
Acetophenone	IL
Aniline	IL
Anthracene	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
Benzyl alcohol	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
Butyl benzyl phthalate	IL
Chlorobenzilate	IL
Chrysene	IL
Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)	IL
Diallate	IL
Dibenz(a,h) anthracene	IL
Dibenzofuran	IL
Diethyl phthalate	IL
Dimethoate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL

Program/Matrix: ***RCRA (Non Potable Water)***

Diphenylamine	IL
Ethyl methanesulfonate	IL
Famphur	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Hexachloropropene	IL
Indeno(1,2,3-cd) pyrene	IL
Isodrin	IL
Isophorone	IL
Isosafrole	IL
Methyl methanesulfonate	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodiethylamine	IL
n-Nitrosodimethylamine	IL
n-Nitroso-di-n-butylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
n-Nitrosomethylethalamine	IL
n-Nitrosopiperidine	IL
o,o,o-Triethyl phosphorothioate	IL
Pentachlorobenzene	IL
Pentachloronitrobenzene	IL
Pentachlorophenol	IL
Phenanthrene	IL
Phenol	IL
Pronamide (Kerb)	IL
Pyrene	IL
Pyridine	IL
Safrole	IL

Method EPA 9012A

Cyanide	KS

Method EPA 9014

Cyanide	KS

Method EPA 9020B

Total organic halides (TOX)	KS

Method EPA 9023

Extractable organics halides (EOX)	KS

Method EPA 9034

Sulfide	KS

Method EPA 9036

Sulfate	KS

Program/Matrix: ***RCRA (Non Potable Water)***

Method EPA 9040B	
pH	KS
Method EPA 9050A	
Conductivity	KS
Method EPA 9060A	
Total organic carbon	KS
Method EPA 9065	
Total phenolics	KS
Method EPA 9066	
Total phenolics	KS
Method EPA 9095A	
Paint Filter Test	KS
Method EPA 9214	
Fluoride	KS
Method EPA 9251	
Chloride	KS
Method KS LRH GC/MS	
Total Petroleum Hydrocarbons C5 - C8	KS
Method KS MRH/HRH GC-FID	
Total Petroleum Hydrocarbons C19 - C35	KS
Total Petroleum Hydrocarbons C9 - C18	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

Method EPA 1010A

Ignitability	KS

Method EPA 1020B

Ignitability	KS

Method EPA 1311

Toxicity Characteristic Leaching Procedure (TCLP)	KS

Method EPA 1312

Synthetic Precipitation Leaching Procedure (SPLP)	KS

Method EPA 6010B

Aluminum	KS
Antimony	KS
Arsenic	KS
Barium	KS
Beryllium	KS
Boron	KS
Cadmium	KS
Calcium	KS
Chromium	KS
Cobalt	KS
Copper	KS
Iron	KS
Lead	KS
Lithium	KS
Magnesium	KS
Manganese	KS
Molybdenum	KS
Nickel	KS
Phosphorus	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Strontium	KS
Thallium	KS
Tin	KS
Titanium	KS
Vanadium	KS
Zinc	KS

Method EPA 6020A

Aluminum	KS
Antimony	KS
Barium	KS
Beryllium	KS
Cadmium	KS
Chromium	KS
Cobalt	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

Copper	KS
Iron	KS
Lead	KS
Magnesium	KS
Manganese	KS
Nickel	KS
Potassium	KS
Selenium	KS
Silver	KS
Sodium	KS
Thallium	KS
Vanadium	KS
Zinc	KS

Method EPA 7196A

Chromium VI	KS

Method EPA 7471B

Mercury	KS

Method EPA 8015B

1,4-Dioxane (1,4- Diethyleneoxide)	KS
Diesel range organics (DRO)	KS
Ethanol	KS
Ethylene glycol	KS
Isobutyl alcohol (2-Methyl-1-propanol)	KS
Isopropyl alcohol (2-Propanol, Isopropanol)	KS
Methanol	KS
n-Butyl alcohol (1-Butanol, n-Butanol)	KS
n-Propanol (1-Propanol)	KS
tert-Butyl alcohol	KS

Method EPA 8081B

4,4'-DDD	KS
4,4'-DDE	KS
4,4'-DDT	KS
Alachlor	KS
Aldrin	KS
alpha-BHC (alpha-Hexachlorocyclohexane)	KS
alpha-Chlordane, cis-Chlordane	KS
beta-BHC (beta-Hexachlorocyclohexane)	KS
Chlordane (tech.)(N.O.S.)	KS
delta-BHC	KS
Dieldrin	KS
Endosulfan I	KS
Endosulfan II	KS
Endosulfan sulfate	KS
Endrin	KS
Endrin aldehyde	KS
Endrin ketone	KS
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

gamma-Chlordane	KS
Heptachlor	KS
Heptachlor epoxide	KS
Methoxychlor	KS
Toxaphene (Chlorinated camphene)	KS

Method EPA 8082

Aroclor-1016 (PCB-1016)	KS
Aroclor-1221 (PCB-1221)	KS
Aroclor-1232 (PCB-1232)	KS
Aroclor-1242 (PCB-1242)	KS
Aroclor-1248 (PCB-1248)	KS
Aroclor-1254 (PCB-1254)	KS
Aroclor-1260 (PCB-1260)	KS

Method EPA 8151A

3,5-Dichlorobenzoic acid	KS
Acifluorfen	KS
Bentazon	KS
Chloramben	KS
DCPA di acid degradate	KS
Dichloroprop (Dichlorprop)	KS
MCPA	KS
MCPP	KS
Picloram	KS

Method EPA 8260B

1,1,1,2-Tetrachloroethane	KS
1,1,1-Trichloroethane	KS
1,1,2,2-Tetrachloroethane	KS
1,1,2-Trichloroethane	KS
1,1-Dichloroethane	KS
1,1-Dichloroethylene	KS
1,1-Dichloropropene	KS
1,2,3-Trichlorobenzene	KS
1,2,3-Trichloropropane	KS
1,2,4-Trichlorobenzene	KS
1,2,4-Trimethylbenzene	KS
1,2-Dibromo-3-chloropropane (DBCP)	KS
1,2-Dibromoethane (EDB, Ethylene dibromide)	KS
1,2-Dichlorobenzene (o-Dichlorobenzene)	KS
1,2-Dichloroethane (Ethylene dichloride)	KS
1,2-Dichloropropane	KS
1,3,5-Trimethylbenzene	KS
1,3-Dichlorobenzene	KS
1,3-Dichloropropane	KS
1,4-Dichlorobenzene	KS
1-Chlorobutane	KS
2,2-Dichloropropane	KS
2-Butanone (Methyl ethyl ketone, MEK)	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

	Primary AB
2-Chloroethyl vinyl ether	KS
2-Chlorotoluene	KS
2-Hexanone	KS
2-Nitropropane	KS
4-Chlorotoluene	KS
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	KS
4-Methyl-2-pentanone (MIBK)	KS
Acetone	KS
Acetonitrile	KS
Acrolein (Propenal)	KS
Allyl chloride (3-Chloropropene)	KS
Benzene	KS
Bromobenzene	KS
Bromochloromethane	KS
Bromodichloromethane	KS
Bromoform	KS
Carbon disulfide	KS
Carbon tetrachloride	KS
Chlorobenzene	KS
Chlorodibromomethane	KS
Chloroethane (Ethyl chloride)	KS
Chloroform	KS
cis-1,2-Dichloroethylene	KS
cis-1,3-Dichloropropene	KS
cis-1,4-Dichloro-2-butene	KS
Dibromomethane (Methylene bromide)	KS
Dichlorodifluoromethane (Freon-12)	KS
Diethyl ether	KS
Ethyl acetate	KS
Ethyl methacrylate	KS
Ethylbenzene	KS
Hexachlorobutadiene	KS
Hexachloroethane	KS
Iodomethane (Methyl iodide)	KS
Isopropylbenzene	KS
Methacrylonitrile	KS
Methyl bromide (Bromomethane)	KS
Methyl chloride (Chloromethane)	KS
Methyl methacrylate	KS
Methylene chloride (Dichloromethane)	KS
m-Xylene	KS
Naphthalene	KS
n-Butylbenzene	KS
Nitrobenzene	KS
n-Propylbenzene	KS
o-Xylene	KS
Pentachloroethane	KS

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

	Primary AB
Propionitrile (Ethyl cyanide)	KS
p-Xylene	KS
sec-Butylbenzene	KS
Styrene	KS
tert-Butyl alcohol	KS
tert-Butylbenzene	KS
Tetrachloroethylene (Perchloroethylene)	KS
Toluene	KS
trans-1,2-Dichloroethylene	KS
trans-1,3-Dichloropropylene	KS
trans-1,4-Dichloro-2-butene	KS
Trichloroethene (Trichloroethylene)	KS
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	KS
Vinyl acetate	KS
Vinyl chloride	KS

Method EPA 8270C

1,2,4-Trichlorobenzene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Diphenylhydrazine	IL
1,3-Dichlorobenzene	IL
1,4-Dichlorobenzene	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,4,5-Trichlorophenol	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Methylaniline (o-Toluidine)	IL
2-Methylnaphthalene	IL
2-Nitroaniline	IL
2-Nitrophenol	IL
3,3'-Dichlorobenzidine	IL
3-Methylphenol (m-Cresol)	IL
3-Nitroaniline	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chloroaniline	IL
4-Chlorophenyl phenylether	IL
4-Methylphenol (p-Cresol)	IL
4-Nitroaniline	IL
4-Nitrophenol	IL
Acenaphthene	IL

Program/Matrix: ***RCRA (Solid & Hazardous Material)***

Acenaphthylene	IL
Aniline	IL
Anthracene	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
Benzyl alcohol	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
Butyl benzyl phthalate	IL
Chrysene	IL
Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)	IL
Dibenz(a,h) anthracene	IL
Dibenzofuran	IL
Diethyl phthalate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Indeno(1,2,3-cd) pyrene	IL
Isophorone	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodiethylamine	IL
n-Nitrosodimethylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
n-Nitrosomethylethalamine	IL
Pentachlorobenzene	IL
Pentachlorophenol	IL
Phenanthrene	IL
Phenol	IL
Pyrene	IL
Pyridine	IL

Method EPA 9014

Cyanide	KS

Method EPA 9020B

Total organic halides (TOX)	KS

Method EPA 9023

Arkansas Department of Environmental Quality

Laboratory Accreditation Program

TEKLAB

COLLINSVILLE, IL

has earned accreditation by law in accordance with Ark. Code Ann. § 8-2-201 et seq., the State Environmental Laboratory Accreditation Program Act for the following parameters:

Acidity
Alkalinity
Ammonia
BOD
CBOD
Chloride
Chlorine
COD
Conductivity
Cyanide
Fluoride
Hardness
Nitrate
Nitrate+Nitrite
Nitrite
Oil & Grease
Orthophosphate
pH
Phenol
Sulfate
Sulfide
Surfactants
TDS
TKN
TOC
Total Phosphorus
Total Solids
TSS
Turbidity
Aluminum
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Hex. Chromium
Iron
Lead
Magnesium
Manganese
Mercury
Molybdenum
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Tin
Titanium
Vanadium
Zinc
Fecal coliform
DRO
GRO
Ignitability
TOX
TPH
Herbicides
PCBs
Pesticides
Semi-volatiles
Volatile Organics

Laboratory ID: **88-0966**
Certificate Number: **19-022-0**
Issued Date: **14 March 2019**
Expired Date: **14 March 2020**

(b) (6)

Becky W. Keogh
ADEQ Director

State of Missouri
Department of Natural Resources

Certificate of Approval
for Chemical Laboratory Service

This is to certify that

Teklab, Incorporated

is hereby approved to perform the analysis of drinking water as specified on the Certified Parameter List, which must accompany this certificate to be valid.

Certification No. 930

Date Issued January 16, 2019

Expiration Date January 31, 2022

(b) (6)

Chief, Public Drinking Water Branch
Water Protection Program
Department of Natural Resources

(b) (6)

Director, Environmental Services Program
Department of Natural Resources

(b) (6)

Evaluation Officer, Environmental Services Program
Department of Natural Resources

MISSOURI DEPARTMENT OF NATURAL RESOURCES

DRINKING WATER LABORATORY

CERTIFIED PARAMETER LIST

This is to certify that

Teklab, Incorporated

located at

5445 Horseshoe Lake Road, Collinsville, Illinois 62234

has been approved to perform the indicated procedures on drinking water under the Missouri Public Drinking Water Regulations (10 CSR 60-5.020). Specific method numbers or references are included in parenthesis when appropriate.

INORGANIC

SM 3112B, 18Ed.
Mercury

SM 4500F-C, 18Ed.
Fluoride

SM 4500NO2-B, 18Ed.
Nitrite

EPA 200.7 R4.4
Barium; Beryllium; Cadmium; Chromium; Copper; Nickel

EPA 200.8 R5.4
Antimony; Arsenic; Barium; Beryllium; Cadmium; Chromium; Copper; Lead; Nickel; Selenium; Thallium

EPA 245.1 R3.0
Mercury

EPA 335.4 R1.0
Total Cyanide

EPA 353.2 R2.0
Total Nitrate and Nitrite; Nitrate

Expiration Date: January 31, 2022
Missouri Certificate No.: 930
Original Certifying State: Illinois

Kansas
Department of Health
and Environment
Health and Environmental Laboratories

State of Kansas

Department of Health and Environment

CERTIFICATE

This is to certify that Certification No.: E-92716

Teklab, Inc.

8421 Nieman Rd.
Lenexa, KS 66214

has been accredited in accordance with K.S.A. 65-1,109a under the standards adopted in K.A.R. 28-15-36 for performing environmental analyses for the parameters listed on the most current scope of accreditation. Continuous accreditation depends on successful, ongoing participation in the program. Clients are urged to verify with this agency the laboratory's certification status for particular methods and analytes.

Effective Date: 12/11/2018

Expiration Date: 1/31/2022

(b) (6)

Secretary
Department of Health and Environment

(b) (6)

Section Chief
Department of Health and Environment

State of Tennessee

DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES

Certifies That

Teklab, Incorporated – Collinsville, IL

Having Met the Requirements of the Regulations for the Certification of Laboratories Analyzing Drinking Water is hereby Approved as a

State Certified Laboratory in Chemistry

To perform the Analyses as Indicated on the Certified Parameter List For the Public Water Systems of Tennessee

Laboratory ID Number 04905

(b) (6)

Prasad Subbanna
Laboratory Certification Officer
Division of Water Resources

Date Effective: 2/1/19 Date Issued: 5/13/19 Date Expires: 1/31/20

This certification is subject to performance on E.P.A. Proficiency Testing Samples, laboratory inspections, payment of annual fees, is nontransferable, and supersedes previously issued certificates

Certified Parameters - 2018

TENNESSEE

Teklab, Inc. TN04905 EPA # IL00054 5/14/2019

Attn: Claire Bogner
5445 Horseshoe Lake Rd.
Collinsville, IL 62234

Parameter	EPA Parameter #	Approved Method	Study Type	Date Complete	PT Provider / WS #
Disinfectant Residuals					
Free Chlorine Residual	1013	SM - 4500-Cl G	Proficiency Test	11/19/2018	ERA / WS-267
Free Chlorine Residual	1013	SM - 4500-Cl G	Proficiency Test	5/24/2018	ERA / WS-261
Total Chlorine Residual	1012	SM - 4500-Cl G	Proficiency Test	11/19/2018	ERA / WS-267
Total Chlorine Residual	1012	SM - 4500-Cl G	Proficiency Test	5/24/2018	ERA / WS-261
Inorganics					
Alkalinity	1928	SM - 2320 B	Proficiency Test	5/24/2018	ERA / WS-261
Alkalinity	1928	SM - 2320 B	Proficiency Test	11/19/2018	ERA / WS-267
Calcium	1016	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Color	1905	SM - 2120 B	Proficiency Test	5/24/2018	ERA / WS-261
Color	1905	SM - 2120 B	Proficiency Test	11/19/2018	ERA / WS-267
Conductivity	1064	SM - 2510 B	Proficiency Test	5/24/2018	ERA / WS-261
Conductivity	1064	SM - 2510 B	Proficiency Test	11/19/2018	ERA / WS-267
Cyanide	1024	EPA - 335.4	Proficiency Test	11/19/2018	ERA / WS-267
Cyanide	1024	EPA - 335.4	Proficiency Test	5/24/2018	ERA / WS-261
Fluoride	1025	SM - 4500-F-C	Proficiency Test	11/19/2018	ERA / WS-267
Fluoride	1025	SM - 4500-F-C	Proficiency Test	5/24/2018	ERA / WS-261
Iron	1028	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Iron	1028	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
MBAS (Foaming Agent)	1089	SM - 5540 C	Proficiency Test	11/19/2018	ERA / WS-267
MBAS (Foaming Agent)	1089	SM - 5540 C	Proficiency Test	5/24/2018	ERA / WS-261
Nitrate	1040	EPA - 353.2	Proficiency Test	11/19/2018	ERA / WS-267
Nitrate	1040	EPA - 353.2	Proficiency Test	5/24/2018	ERA / WS-261
Nitrate + Nitrite	1038	EPA - 353.2	Proficiency Test	5/24/2018	ERA / WS-261
Nitrate + Nitrite	1038	EPA - 353.2	Proficiency Test	11/19/2018	ERA / WS-267
Nitrite	1041	SM - 4500-NO2-B	Proficiency Test	11/19/2018	ERA / WS-267
Nitrite	1041	SM - 4500-NO2-B	Proficiency Test	5/24/2018	ERA / WS-261
Ortho-phosphate	1044	SM - 4500-P E	Proficiency Test	11/19/2018	ERA / WS-267
Ortho-phosphate	1044	SM - 4500-P E	Proficiency Test	5/24/2018	ERA / WS-261
Silica	1049	SM - 4500-Si-E	Proficiency Test	11/19/2018	ERA / WS-267
Silica	1049	SM - 4500-Si-E	Proficiency Test	5/24/2018	ERA / WS-261
Sodium	1052	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Sodium	1052	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267

Parameter	EPA Parameter #	Approved Method	Study Type	Date Complete	PT Provider / WS #
TDS	1930	SM - 2540 C	Proficiency Test	11/19/2018	ERA / WS-267
TDS	1930	SM - 2540 C	Proficiency Test	5/24/2018	ERA / WS-261
TOC (total organic carbon)	2920	SM - 5310 C	Proficiency Test	11/19/2018	ERA / WS-267
TOC (total organic carbon)	2920	SM - 5310 C	Proficiency Test	5/24/2018	ERA / WS-261
Total Hardness	1916	SM - 2340 B	Proficiency Test	11/19/2018	ERA / WS-267
Total Hardness	1916	SM - 2340 B	Proficiency Test	5/24/2018	ERA / WS-261

Metals

Parameter	EPA Parameter #	Approved Method	Study Type	Date Complete	PT Provider / WS #
Antimony	1074	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Antimony	1074	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Arsenic	1005	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Arsenic	1005	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Barium	1010	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Barium	1010	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Barium	1010	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Barium	1010	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Beryllium	1075	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Beryllium	1075	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Beryllium	1075	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Beryllium	1075	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Cadmium	1015	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Cadmium	1015	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Cadmium	1015	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Cadmium	1015	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Chromium	1020	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Chromium	1020	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Chromium	1020	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Chromium	1020	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Copper	1022	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Copper	1022	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Copper	1022	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Copper	1022	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Lead	5000	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Lead	5000	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Magnesium	1031	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Magnesium	1031	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Manganese	1032	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Manganese	1032	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Manganese	1032	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Manganese	1032	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Mercury	1035	EPA - 245.1	Proficiency Test	5/24/2018	ERA / WS-261
Mercury	1035	SM - 3112 B	Proficiency Test	11/19/2018	ERA / WS-267
Mercury	1035	EPA - 245.1	Proficiency Test	11/19/2018	ERA / WS-267

Parameter	EPA Parameter #	Approved Method	Study Type	Date Complete	PT Provider / WS #
Mercury	1035	SM - 3112 B	Proficiency Test	5/24/2018	ERA / WS-261
Nickel	1036	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Nickel	1036	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Nickel	1036	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Nickel	1036	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Selenium	1045	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Selenium	1045	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Thallium	1085	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Thallium	1085	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Aluminum	1002	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Aluminum	1002	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Aluminum	1002	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Silver	1050	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261
Silver	1050	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Silver	1050	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Silver	1050	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Zinc	1095	EPA - 200.8	Proficiency Test	11/19/2018	ERA / WS-267
Zinc	1095	EPA - 200.7	Proficiency Test	5/24/2018	ERA / WS-261
Zinc	1095	EPA - 200.7	Proficiency Test	11/19/2018	ERA / WS-267
Zinc	1095	EPA - 200.8	Proficiency Test	5/24/2018	ERA / WS-261

MATTHEW G. BEVIN
GOVERNOR

CHARLES G. SNAVELY
SECRETARY

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

ANTHONY R. HATTON
COMMISSIONER

300 SOWER BOULEVARD
FRANKFORT, KENTUCKY 40601

May 6, 2019

Teklab Inc
5445 Horseshoe Lake Rd
Collinsville, KY 62234

Re: Laboratory Certification Renewal Approval
Agency Interest Number (AI #): 120568

Dear Certified Laboratory:

The Underground Storage Tank (UST) Branch has received your current National Environmental Laboratory Accreditation Program (NELAP) or American Association for Laboratory Accreditation (A2LA) submitted on April 30, 2019. In accordance with 401 KAR 42:250, Section 20, your laboratory certification has been approved for renewal. We have updated our database to reflect your laboratory certification expiration dates from March 13, 2019 to January 31, 2020.

This laboratory certification is only intended for the use with the Kentucky UST Branch. The approval is based on accreditation by either A2LA or by an approved state to accredit environmental laboratories in accordance with the NELAP requirements and standards. Approved laboratories must be capable of analyzing each of the parameters listed in Table 7 and Table 8 in the UST Corrective Action Manual, incorporated by reference in 401 KAR 42:060, using at least one (1) of the acceptable methods. For other analysis directed by the UST Branch not listed in Table 7 and Table 8 as referenced above, the laboratory performing the directed analysis must be currently accredited by either A2LA or by an approved state to accredit environmental laboratories in accordance with the NELAP requirements and standards. The UST Branch does not regulate or certify those laboratories providing analysis of waste required by an accepting facility.

All documents may be submitted electronically (preferred) using our website or by mail at the address below. Always refer to the appropriate site AI # when contacting the UST Branch, and include the AI # on all documents submitted.

Division of Waste Management
Underground Storage Tank Branch
300 Sower Boulevard, Second Floor
Frankfort KY 40601
www.eec.ky.gov/Environmental-Protection/Waste/underground-storage-tank

More information including UST regulations, outlines, forms and updates can be found on our website. If you have any questions regarding this letter, please contact me at 502-782-6330 or mhollingsworth@ky.gov.

Sincerely,

(b) (6)

Melinda Hollingsworth,
UST Branch, Claims & Payment Section

Indiana State
Department of Health
An Equal Opportunity Employer

Eric J. Holcomb
Governor

Kristina Box, MD, FACOG
State Health Commissioner

LETTER OF RECIPROCAL CERTIFICATION

May 6, 2019

Clair Bogner
TEKLAB, Inc,
5445 Horseshoe Lake Road
Collinsville, IL 62234

Dear Clair Bogner:

The Chemistry Laboratory, ISDH Laboratories, Indiana State Department of Health, has reviewed your request to become a certified laboratory for chemical analyses of drinking water in the state of Indiana, pursuant to the requirements under the Safe Drinking Water Act (SDWA) 42 U.S.C. 300f et seq., the National Primary Drinking Water Regulations (NPDWR) 40 CFR 141 and 142, and the Indiana Primary Drinking Water Regulations (IPDWR) 327 IAC 8-2. Your submittal package contained certification information for the state of Illinois, citing on-site inspections, and the analysis of water supply (WS) proficiency testing (PT) samples from an Illinois approved proficiency testing program.

Based on Indiana's policy of approving laboratories that are certified for drinking water analyses by states whose programs are approved by USEPA, and based on the results of the WS studies provided, the ISDH issues the following determination, pursuant to IC 4-21.5-3-5:

- The laboratory is hereby full certification for: *antimony, arsenic, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, nickel, selenium, thallium, copper, lead, nitrate and nitrite (*as indicated on the Illinois certification letter or certificate).

- The laboratory has been assigned laboratory number C-IL-06. This identification number is to be used on all reports for compliance monitoring of public water supplies to the Indiana Department of Environmental Management.

The expiration of Indiana certification will be the date that the laboratory's Illinois certification expires (**January 31, 2020**). The status of Indiana certification will be reviewed, and if necessary, downgraded by Indiana, when: [1] an on-site evaluation by Illinois is completed and a report of unsatisfactory performance is submitted by Illinois to the Indiana certification officer; or

[2] the laboratory does not successfully analyze one (1) WS PT sample annually; or [3] the laboratory does not pay yearly Indiana laboratory certification fee.

In addition, the laboratory is required to provide the certification officer with the following documents, as they become available: [1] any change in certification status or expiration date of Illinois certificate, and [2] reports of WS PT sample analysis.

If you wish to seek review or stay of the effectiveness of this determination, pursuant to IC 4-21.5-3-7, you are required to submit, in writing, a petition, on or before June 6, 2019, to:

Office of the Secretary
Indiana State Department of Health
2 North Meridian Street
Indianapolis, IN 46204

The petition for review or stay must include facts demonstrating that:

- The petitioner is a person to whom the determination is specifically directed;
- The petitioner is aggrieved or adversely affected by the agency determination; or,
- The petitioner is entitled to review under any law.

Questions concerning the certification status granted by this letter should be directed to Katie Sullivan, Chemistry Laboratory Certification Officer, 317 921-5505.

Dated at Indianapolis, Indiana, this 6th day of May 2019.

Sincerely,

(b) (6)

Judith C. Lovchik, PhD, D(ABMM)
Assistant Commissioner, Public Health Protection and Laboratory Services
Indiana State Department of Health
550 West 16th Street
Indianapolis, Indiana 46202
317 921-5808

A copy of this letter was sent on the above date, electronically, to:

Casey Davidson
Indiana Department of Environmental Management
Drinking Water Branch
100 North Senate Avenue
Indianapolis, IN

Indiana State Department of Health

SCOPE OF CERTIFICATION
TEKLAB, Inc.
Collinsville, IL
C-IL-06

ANALYTE	METHOD	ANALYTE	METHOD
		PCB	
METALS		as decachlorobiphenyl	Not certified
Antimony	EPA 200.8 rev 5.4		
Arsenic	EPA 200.8 rev 5.4	**HAA5s**	
Barium	EPA 200.7 rev 4.4; EPA 200.8 rev 5.4	Bromoacetic acid	Not certified
Beryllium	EPA 200.7 rev 4.4; EPA 200.8 rev 5.4	Bromochloroacetic acid	Not certified
Cadmium	EPA 200.7 rev 4.4; EPA 200.8 rev 5.4	Chloroacetic acid	Not certified
Chromium	EPA 200.7 rev 4.4; EPA 200.8 rev 5.4	Dibromoacetic acid	Not certified
Copper	EPA 200.7 rev 4.4; EPA 200.8 rev 5.4	Dichloroacetic acid	Not certified
Lead	EPA 200.8 rev 5.4	**DISINFECTION BYPRODUCTS**	
Mercury	EPA 245.1 rev 3.0; SM 3112B 18thed		
Nickel	EPA 200.7 rev 4.4; EPA 200.8 rev 5.4	Bromate	Not certified
Selenium	EPA 200.8 rev 5.4	Chlorite	Not certified
Thallium	EPA 200.8 rev 5.4		
		TTHM	
NONMETALS		Bromodichloromethane	Not certified
Cyanide	EPA 335.4 rev 1.0	Bromoform	Not certified
Fluoride	SM 4500-F C 18th ed	Chlorodibromomethane	Not certified
Nitrate	EPA 353.2 rev 2.0	Chloroform	Not certified
Nitrite	EPA 353.2 rev 2.0; SM 4500-NO_2 B 18th ed		
		CARBAMATES	
PESTICIDES		Carbofuran	Not certified
Alachlor	Not certified	Oxamyl (vydate)	Not certified
Atrazine	Not certified		
Chlordane	Not certified		
Endrin	Not certified		

Revised: May 2, 2019 By: (b) (6)

Indiana State Department of Health

SCOPE OF CERTIFICATION
TEKLAB, Inc.
Collinsville, IL
C-IL-06

ANALYTE	METHOD	ANALYTE	METHOD
PESTICIDES continued		**HERBICIDES**	
Heptachlor	Not certified	2,4-D	Not certified
Heptachlor epoxide	Not certified	2,4,5-TP (silvex)	Not certified
Hexachlorobenzene	Not certified	Dalapon	Not certified
Hexachlorocyclopentadiene	Not certified	Dinoseb	Not certified
Lindane	Not certified	Diquat	Not certified
Methoxychlor	Not certified	Endothall	Not certified
Simazine	Not certified	Glyphosate	Not certified
Toxaphene	Not certified	Pentachlorophenol	Not certified
20 REGULATED VOCs & VINYL CHLORIDE		Picloram	Not certified
Benzene	Not certified	**PAH**	
Carbon tetrachloride	Not certified	Benzo(a)pyrene	Not certified
Chlorobenzene	Not certified		
1,2-dichlorobenzene	Not certified	**EDB & DBCP**	
1,4-dichlorobenzene	Not certified	1,2-Dibromoethane	Not certified
1,2-dichloroethane	Not certified	1,2-Dibromo3Chloropropane	Not certified
1,1-dichloroethylene	Not certified	**ADIPATE & PHTHALATE**	
cis-1,2-dichloroethylene	Not certified		
trans-1,2-dichloroethylene	Not certified	Di(2-ethylhexyl)adipate	Not certified
1.2-dichloropropane	Not certified	Di(2-ethylhexyl)phthalate	Not certified
Ethylbenzene	Not certified	**MISCELLANEOUS ANALYTES**	
Styrene	Not certified		
Tetrachloroethylene	Not certified	2,3,7,8-TCDD (dioxin)	Not certified
Toluene	Not certified	Asbestos	Not certified
1,1,1-trichloroethane	Not certified	Uranium (*by 200.8 only*)	Not certified
Trichloroethylene	Not certified		
Xylenes (total)	Not certified		
Dichloromethane	Not certified		
1,2,4-trichlorobenzene	Not certified		
1,1,2-trichloroethane	Not certified		
Vinyl chloride	Not certified		

Revised: May 2, 2019 By (b) (6)

STATE OF ILLINOIS

ENVIRONMENTAL PROTECTION AGENCY
NELAP - RECOGNIZED

ENVIRONMENTAL LABORATORY ACCREDITATION

is hereby granted to

Teklab, Incorporated
5445 Horseshoe Lake Rd.
Collinsville, IL 62234

NELAP ACCREDITED

Accreditation Number #100226

According to the Illinois Administrative Code, Title 35, Subtitle A, Chapter II, Part 186, ACCREDITATION OF LABORATORIES FOR DRINKING WATER, WASTEWATER AND HAZARDOUS WASTES ANALYSIS, the State of Illinois formally recognizes that this laboratory is technically competent to perform the environmental analyses listed on the scope of accreditation detailed below.

The laboratory agrees to perform all analyses listed on this scope of accreditation according to the Part 186 requirements and acknowledges that continued accreditation is dependent on successful ongoing compliance with the applicable requirements of Part 186. Please contact the Illinois EPA Environmental Laboratory Accreditation Program (IL ELAP) to verify the laboratory's scope of accreditation and accreditation status. Accreditation by the State of Illinois is not an endorsement or a guarantee of validity of the data generated by the laboratory.

Primary Accrediting Authority:Illinois

(b) (6)

Celeste M. Crowley
Supervisor
Environmental Laboratory Accreditation Program

Certificate No: 1002262019-1
Expiration Date: 1/31/2020
Issued On: 5/2/2019

State of Illinois
Environmental Protection Agency

Certificate No.: 1002262019-1

Awards the Certificate of Approval to:

Teklab, Incorporated
5445 Horseshoe Lake Rd.
Collinsville, IL 62234

Accreditation Start: 1/31/2019 Accreditation End: 1/31/2020

The Illinois Environmental Laboratory Accreditation Program encourages all clients and data users to verify the most current scope of accreditation for Teklab, Incorporated.

Field of Testing /Matrix: ***CWA (Non Potable Water)***

	Primary AB
Method EPA 120.1	
Conductivity	IL
Method EPA 160.4	
Residue-volatile	IL
Method EPA 1631E	
Mercury	IL
Method EPA 1664A	
Oil & Grease	IL
Method EPA 180.1	
Turbidity	IL
Method EPA 200.7	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Phosphorus	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL

Field of Testing /Matrix: ***CWA (Non Potable Water)***

Method **EPA 200.8**

Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL

Method **EPA 245.1**

Mercury	IL

Method **EPA 335.4**

Cyanide	IL

Method **EPA 350.1**

Ammonia	IL

Method **EPA 351.2**

Total Kjeldahl Nitrogen (TKN)	IL

Method **EPA 353.2**

Nitrate	IL
Nitrate plus Nitrite as N	IL
Nitrite as N	IL

Method **EPA 365.4**

Phosphorus	IL

Method **EPA 375.2**

Sulfate	IL

Method **EPA 410.4**

Chemical oxygen demand	IL

Method **EPA 420.1**

Total phenolics	IL

Method **EPA 420.4**

Field of Testing /Matrix: ***CWA (Non Potable Water)***

	Primary AB
Total phenolics	IL

Method **EPA 608**

	Primary AB
4,4'-DDD	IL
4,4'-DDE	IL
4,4'-DDT	IL
Aldrin	IL
alpha-BHC (alpha-Hexachlorocyclohexane)	IL
Aroclor-1016 (PCB-1016)	IL
Aroclor-1221 (PCB-1221)	IL
Aroclor-1232 (PCB-1232)	IL
Aroclor-1242 (PCB-1242)	IL
Aroclor-1248 (PCB-1248)	IL
Aroclor-1254 (PCB-1254)	IL
Aroclor-1260 (PCB-1260)	IL
beta-BHC (beta-Hexachlorocyclohexane)	IL
Chlordane (tech.)(N.O.S.)	IL
delta-BHC	IL
Dieldrin	IL
Endosulfan I	IL
Endosulfan II	IL
Endosulfan sulfate	IL
Endrin	IL
Endrin aldehyde	IL
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	IL
Heptachlor	IL
Heptachlor epoxide	IL
Methoxychlor	IL
Toxaphene (Chlorinated camphene)	IL

Method **EPA 615**

	Primary AB
2,4,5-T	IL
2,4-D	IL
Dicamba	IL
Silvex (2,4,5-TP)	IL

Method **EPA 624**

	Primary AB
1,1,1-Trichloroethane	IL
1,1,2,2-Tetrachloroethane	IL
1,1,2-Trichloroethane	IL
1,1-Dichloroethane	IL
1,1-Dichloroethylene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Dichloroethane (Ethylene dichloride)	IL
1,2-Dichloropropane	IL
1,3-Dichlorobenzene	IL
1,4-Dichlorobenzene	IL
2-Chloroethyl vinyl ether	IL
Acetonitrile	IL
Acrolein (Propenal)	IL
Acrylonitrile	IL
Benzene	IL
Bromodichloromethane	IL

	Primary AB
Field of Testing /Matrix: ***CWA (Non Potable Water)***	
Bromoform	IL
Carbon tetrachloride	IL
Chlorobenzene	IL
Chlorodibromomethane	IL
Chloroethane (Ethyl chloride)	IL
Chloroform	IL
cis-1,3-Dichloropropene	IL
Ethylbenzene	IL
Methyl bromide (Bromomethane)	IL
Methyl chloride (Chloromethane)	IL
Methyl tert-butyl ether (MTBE)	IL
Methylene chloride (Dichloromethane)	IL
Tetrachloroethylene (Perchloroethylene)	IL
Toluene	IL
trans-1,2-Dichloroethylene	IL
trans-1,3-Dichloropropylene	IL
Trichloroethene (Trichloroethylene)	IL
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	IL
Vinyl chloride	IL
Xylene (total)	IL
Method EPA 625	
1,2,4-Trichlorobenzene	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Nitrophenol	IL
3,3'-Dichlorobenzidine	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chlorophenyl phenylether	IL
4-Nitrophenol	IL
Acenaphthene	IL
Acenaphthylene	IL
Anthracene	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
bis(2-Ethylhexyl) phthalate (DEHP)	IL
Butyl benzyl phthalate	IL

Field of Testing /Matrix: ***CWA (Non Potable Water)***

	Primary AB
Chrysene	IL
Dibenz(a,h) anthracene	IL
Diethyl phthalate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Indeno(1,2,3-cd) pyrene	IL
Isophorone	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodimethylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
Pentachlorophenol	IL
Phenanthrene	IL
Phenol	IL
Pyrene	IL
Method OIA 1677-09	
Available Cyanide	IL
Method SM 2120 B-2001	
Color	IL
Method SM 2130 B-2001	
Turbidity	IL
Method SM 2310 B-1997	
Acidity, as CaCO3	IL
Method SM 2320 B-1997	
Alkalinity as CaCO3	IL
Method SM 2340 B-1997	
Hardness	IL
Method SM 2510 B-1997	
Conductivity	IL
Method SM 2540 B-1991	
Residue-total	IL
Method SM 2540 C-1997	
Residue-filterable (TDS)	IL
Method SM 2540 D-1997	
Residue-nonfilterable (TSS)	IL
Method SM 2540 E-1997	
Residue-volatile	IL
Method SM 2540 F-1997	
Residue-settleable	IL
Method SM 2550 B-2000	

Field of Testing /Matrix: ***CWA (Non Potable Water)***

	Primary AB
Temperature, deg. C	IL
Method SM 3112 B-2009	
Mercury	IL
Method SM 3120 B-1999	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Phosphorus	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Thallium	IL
Vanadium	IL
Zinc	IL
Method SM 3500-Cr B-2009	
Chromium VI	IL
Method SM 4500-Cl G-2000	
Total residual chlorine	IL
Method SM 4500-Cl^- C-1997	
Chloride	IL
Method SM 4500-Cl^- E-1997	
Chloride	IL
Method SM 4500-CN^- E-1999	
Cyanide	IL
Method SM 4500-CN^- G-1999	
Available Cyanide	IL
Method SM 4500-F^- C-1997	
Fluoride	IL
Method SM 4500-H+ B-2000	
pH	IL
Method SM 4500-NH3 H	
Ammonia	IL
Method SM 4500-$NO2^-$ B-2000	

	Primary AB
Field of Testing /Matrix: ***CWA (Non Potable Water)***	
Nitrite	IL
Method SM 4500-NO3$^-$ F-2000	
Nitrate plus Nitrite as N	IL
Method SM 4500-O G-2001	
Oxygen, dissolved	IL
Method SM 4500-P E-1999	
Orthophosphate as P	IL
Method SM 4500-S2$^-$ D-2000	
Sulfide	IL
Method SM 4500-SO3$^-$ B-2000	
Sulfite-SO3	IL
Method SM 5210 B-2001	
Biochemical oxygen demand	IL
Carbonaceous BOD, CBOD	IL
Method SM 5220 D-1997	
Chemical oxygen demand	IL
Method SM 5310 C-2000	
Total organic carbon	IL
Method SM 5540 C-2000	
Surfactants - MBAS	IL

Field of Testing /Matrix: ***CWA (Solid & Hazardous Material)***

Method **EPA 160.4**

Residue-volatile	IL

Method **EPA 200.7**

Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Phosphorus	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL

Method **EPA 245.1**

Mercury	IL

Method **EPA 351.2**

Total Kjeldahl Nitrogen (TKN)	IL

Method **EPA 353.2**

Nitrate	IL
Nitrate plus Nitrite as N	IL
Nitrite as N	IL

Method **EPA 365.4**

Phosphorus	IL

Method **EPA 420.1**

Total phenolics	IL

Method **EPA 608**

4,4'-DDD	IL
4,4'-DDE	IL
4,4'-DDT	IL
Aldrin	IL
alpha-BHC (alpha-Hexachlorocyclohexane)	IL
Aroclor-1016 (PCB-1016)	IL

Field of Testing /Matrix: ***CWA (Solid & Hazardous Material)***

Aroclor-1221 (PCB-1221)	IL
Aroclor-1232 (PCB-1232)	IL
Aroclor-1242 (PCB-1242)	IL
Aroclor-1248 (PCB-1248)	IL
Aroclor-1254 (PCB-1254)	IL
Aroclor-1260 (PCB-1260)	IL
beta-BHC (beta-Hexachlorocyclohexane)	IL
Chlordane (tech.)(N.O.S.)	IL
delta-BHC	IL
Dieldrin	IL
Endosulfan I	IL
Endosulfan II	IL
Endosulfan sulfate	IL
Endrin	IL
Endrin aldehyde	IL
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	IL
Heptachlor	IL
Heptachlor epoxide	IL
Methoxychlor	IL
Toxaphene (Chlorinated camphene)	IL

Method **EPA 624**

1,1,1-Trichloroethane	IL
1,1,2,2-Tetrachloroethane	IL
1,1,2-Trichloroethane	IL
1,1-Dichloroethane	IL
1,1-Dichloroethylene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Dichloroethane (Ethylene dichloride)	IL
1,2-Dichloropropane	IL
1,3-Dichlorobenzene	IL
1,4-Dichlorobenzene	IL
2-Chloroethyl vinyl ether	IL
Acetonitrile	IL
Acrolein (Propenal)	IL
Acrylonitrile	IL
Benzene	IL
Bromodichloromethane	IL
Bromoform	IL
Carbon tetrachloride	IL
Chlorobenzene	IL
Chlorodibromomethane	IL
Chloroethane (Ethyl chloride)	IL
Chloroform	IL
cis-1,3-Dichloropropene	IL
Ethylbenzene	IL
Methyl bromide (Bromomethane)	IL
Methyl chloride (Chloromethane)	IL
Methyl tert-butyl ether (MTBE)	IL
Methylene chloride (Dichloromethane)	IL
Tetrachloroethylene (Perchloroethylene)	IL
Toluene	IL

Field of Testing /Matrix: ***CWA (Solid & Hazardous Material)***

trans-1,2-Dichloroethylene	IL
trans-1,3-Dichloropropylene	IL
Trichloroethene (Trichloroethylene)	IL
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	IL
Vinyl chloride	IL
Xylene (total)	IL

Method **EPA 625**

1,2,4-Trichlorobenzene	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Nitrophenol	IL
3,3'-Dichlorobenzidine	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chlorophenyl phenylether	IL
4-Nitrophenol	IL
Acenaphthene	IL
Acenaphthylene	IL
Anthracene	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
bis(2-Ethylhexyl) phthalate (DEHP)	IL
Butyl benzyl phthalate	IL
Chrysene	IL
Dibenz(a,h) anthracene	IL
Diethyl phthalate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Indeno(1,2,3-cd) pyrene	IL
Isophorone	IL

Field of Testing /Matrix: ***CWA (Solid & Hazardous Material)***

	Primary AB
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodimethylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
Pentachlorophenol	IL
Phenanthrene	IL
Phenol	IL
Pyrene	IL
Method SM 2130 B-2001	
Turbidity	IL
Method SM 2310 B-1997	
Acidity, as CaCO3	IL
Method SM 2320 B-1997	
Alkalinity as CaCO3	IL
Method SM 2540 F-1997	
Residue-settleable	IL
Method SM 2550 B-2000	
Temperature, deg. C	IL
Method SM 3112 B-2009	
Mercury	IL
Method SM 3120 B-1999	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Phosphorus	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Thallium	IL
Vanadium	IL
Zinc	IL
Method SM 3500-Cr B-2009	
Chromium VI	IL

Field of Testing /Matrix: ***CWA (Solid & Hazardous Material)***

	Primary AB
Method **SM 4500-Cl G-2000**	
Total residual chlorine	IL
Method **SM 4500-Cl^- C-1997**	
Chloride	IL
Method **SM 4500-Cl^- E-1997**	
Chloride	IL
Method **SM 4500-CN^- G-1999**	
Available Cyanide	IL
Method **SM 4500-NH3 H**	
Ammonia	IL
Method **SM 4500-$NO2^-$ B-2000**	
Nitrite	IL
Method **SM 4500-$NO3^-$ F-2000**	
Nitrate plus Nitrite as N	IL
Method **SM 4500-P E-1999**	
Orthophosphate as P	IL
Method **SM 4500-$S2^-$ D-2000**	
Sulfide	IL
Method **SM 4500-$SO3^-$ B-2000**	
Sulfite-SO3	IL

Field of Testing /Matrix: ***RCRA (Non Potable Water)***

	Primary AB
Method EPA 1010A	
Ignitability	IL
Method EPA 1020B	
Ignitability	IL
Method EPA 1311	
Toxicity Characteristic Leaching Procedure (TCLP)	IL
Method EPA 1312	
Synthetic Precipitation Leaching Procedure (SCLP)	IL
Method EPA 6010B	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Lithium	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Phosphorus	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Strontium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL
Method EPA 6020A	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL

Field of Testing /Matrix: ***RCRA (Non Potable Water)***

	Primary AB
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Thallium	IL
Vanadium	IL
Zinc	IL
Method EPA 7196A	
Chromium VI	IL
Method EPA 7470A	
Mercury	IL
Method EPA 7471B	
Mercury	IL
Method EPA 8015B	
1,4-Dioxane (1,4- Diethyleneoxide)	IL
Diesel range organics (DRO)	IL
Ethanol	IL
Ethylene glycol	IL
Isobutyl alcohol (2-Methyl-1-propanol)	IL
Isopropyl alcohol (2-Propanol, Isopropanol)	IL
Methanol	IL
n-Butyl alcohol (1-Butanol, n-Butanol)	IL
n-Propanol (1-Propanol)	IL
tert-Butyl alcohol	IL
Method EPA 8081B	
4,4'-DDD	IL
4,4'-DDE	IL
4,4'-DDT	IL
Alachlor	IL
Aldrin	IL
alpha-BHC (alpha-Hexachlorocyclohexane)	IL
alpha-Chlordane, cis-Chlordane	IL
beta-BHC (beta-Hexachlorocyclohexane)	IL
Chlordane (tech.)(N.O.S.)	IL
delta-BHC	IL
Dieldrin	IL
Endosulfan I	IL
Endosulfan II	IL
Endosulfan sulfate	IL
Endrin	IL
Endrin aldehyde	IL
Endrin ketone	IL
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	IL
gamma-Chlordane	IL

Field of Testing /Matrix: ***RCRA (Non Potable Water)***

Heptachlor	IL
Heptachlor epoxide	IL
Methoxychlor	IL
Toxaphene (Chlorinated camphene)	IL
Method EPA 8082	
Aroclor-1016 (PCB-1016)	IL
Aroclor-1221 (PCB-1221)	IL
Aroclor-1232 (PCB-1232)	IL
Aroclor-1242 (PCB-1242)	IL
Aroclor-1248 (PCB-1248)	IL
Aroclor-1254 (PCB-1254)	IL
Aroclor-1260 (PCB-1260)	IL
Method EPA 8151A	
2,4,5-T	IL
2,4-D	IL
2,4-DB	IL
3,5-Dichlorobenzoic acid	IL
4-Nitrophenol	IL
Acifluorfen	IL
Bentazon	IL
Chloramben	IL
Dalapon	IL
DCPA di acid degradate	IL
Dicamba	IL
Dichloroprop (Dichlorprop)	IL
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	IL
MCPA	IL
MCPP	IL
Pentachlorophenol	IL
Picloram	IL
Silvex (2,4,5-TP)	IL
Method EPA 8260B	
1,1,1,2-Tetrachloroethane	IL
1,1,1-Trichloroethane	IL
1,1,2,2-Tetrachloroethane	IL
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	IL
1,1,2-Trichloroethane	IL
1,1-Dichloroethane	IL
1,1-Dichloroethylene	IL
1,1-Dichloropropene	IL
1,2,3-Trichlorobenzene	IL
1,2,3-Trichloropropane	IL
1,2,4-Trichlorobenzene	IL
1,2,4-Trimethylbenzene	IL
1,2-Dibromo-3-chloropropane (DBCP)	IL
1,2-Dibromoethane (EDB, Ethylene dibromide)	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Dichloroethane (Ethylene dichloride)	IL
1,2-Dichloropropane	IL
1,3,5-Trimethylbenzene	IL

Field of Testing /Matrix: ***RCRA (Non Potable Water)***

	Primary AB
1,3-Dichlorobenzene	IL
1,3-Dichloropropane	IL
1,4-Dichlorobenzene	IL
1-Chlorobutane	IL
2,2-Dichloropropane	IL
2-Butanone (Methyl ethyl ketone, MEK)	IL
2-Chloroethyl vinyl ether	IL
2-Chlorotoluene	IL
2-Hexanone	IL
2-Nitropropane	IL
4-Chlorotoluene	IL
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	IL
4-Methyl-2-pentanone (MIBK)	IL
Acetone	IL
Acetonitrile	IL
Acrolein (Propenal)	IL
Acrylonitrile	IL
Allyl chloride (3-Chloropropene)	IL
Benzene	IL
Bromobenzene	IL
Bromochloromethane	IL
Bromodichloromethane	IL
Bromoform	IL
Carbon disulfide	IL
Carbon tetrachloride	IL
Chlorobenzene	IL
Chlorodibromomethane	IL
Chloroethane (Ethyl chloride)	IL
Chloroform	IL
Chloroprene (2-Chloro-1,3-butadiene)	IL
cis-1,2-Dichloroethylene	IL
cis-1,3-Dichloropropene	IL
cis-1,4-Dichloro-2-butene	IL
Dibromomethane (Methylene bromide)	IL
Dichlorodifluoromethane (Freon-12)	IL
Diethyl ether	IL
Di-isopropylether (DIPE) (Isopropyl Ether)	IL
Ethyl acetate	IL
Ethyl methacrylate	IL
Ethylbenzene	IL
Hexachlorobutadiene	IL
Hexachloroethane	IL
Iodomethane (Methyl iodide)	IL
Isopropylbenzene	IL
Methacrylonitrile	IL
Methyl acrylate	IL
Methyl bromide (Bromomethane)	IL
Methyl chloride (Chloromethane)	IL
Methyl methacrylate	IL
Methyl tert-butyl ether (MTBE)	IL
Methylene chloride (Dichloromethane)	IL

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
m-Xylene	IL
Naphthalene	IL
n-Butylbenzene	IL
Nitrobenzene	IL
n-Propylbenzene	IL
o-Xylene	IL
Pentachloroethane	IL
Propionitrile (Ethyl cyanide)	IL
p-Xylene	IL
sec-Butylbenzene	IL
Styrene	IL
tert-Butyl alcohol	IL
tert-Butylbenzene	IL
Tetrachloroethylene (Perchloroethylene)	IL
Tetrahydrofuran (THF)	IL
Toluene	IL
trans-1,2-Dichloroethylene	IL
trans-1,3-Dichloropropylene	IL
trans-1,4-Dichloro-2-butene	IL
Trichloroethene (Trichloroethylene)	IL
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	IL
Vinyl acetate	IL
Vinyl chloride	IL
Xylene (total)	IL
Method **EPA 8270C**	
1,2,4-Trichlorobenzene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Diphenylhydrazine	IL
1,3-Dichlorobenzene	IL
1,3-Dinitrobenzene (1,3-DNB)	IL
1,4-Dichlorobenzene	IL
1,4-Dioxane (1,4- Diethyleneoxide)	IL
1,4-Naphthoquinone	IL
1-Naphthylamine	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,4,5-Trichlorophenol	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Methylaniline (o-Toluidine)	IL
2-Methylnaphthalene	IL
2-Methylphenol (o-Cresol)	IL
2-Naphthylamine	IL
2-Nitroaniline	IL
2-Nitrophenol	IL

Field of Testing /Matrix: *RCRA (Non Potable Water)*

	Primary AB
3,3'-Dichlorobenzidine	IL
3,3'-Dimethylbenzidine	IL
3-Methylcholanthrene	IL
3-Methylphenol (m-Cresol)	IL
3-Nitroaniline	IL
4-Aminobiphenyl	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chloroaniline	IL
4-Chlorophenyl phenylether	IL
4-Dimethyl aminoazobenzene	IL
4-Methylphenol (p-Cresol)	IL
4-Nitroaniline	IL
4-Nitrophenol	IL
5-Nitro-o-toluidine	IL
7,12-Dimethylbenz(a) anthracene	IL
Acenaphthene	IL
Acenaphthylene	IL
Acetophenone	IL
Aniline	IL
Anthracene	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
Benzoic acid	IL
Benzyl alcohol	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
bis(2-Ethylhexyl) phthalate (DEHP)	IL
Butyl benzyl phthalate	IL
Carbazole	IL
Chlorobenzilate	IL
Chrysene	IL
Diallate	IL
Dibenz(a,h) anthracene	IL
Dibenzofuran	IL
Diethyl phthalate	IL
Dimethoate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL
Diphenylamine	IL
Ethyl methanesulfonate	IL
Famphur	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL

Field of Testing /Matrix: ***RCRA (Non Potable Water)***

Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Hexachloropropene	IL
Indeno(1,2,3-cd) pyrene	IL
Isodrin	IL
Isophorone	IL
Isosafrole	IL
Methyl methanesulfonate	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodiethylamine	IL
n-Nitrosodimethylamine	IL
n-Nitroso-di-n-butylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
n-Nitrosomethylethalamine	IL
n-Nitrosopiperidine	IL
n-Nitrosopyrrolidine	IL
o,o,o-Triethyl phosphorothioate	IL
Parathion	IL
Pentachlorobenzene	IL
Pentachloronitrobenzene	IL
Pentachlorophenol	IL
Phenanthrene	IL
Phenol	IL
Pronamide (Kerb)	IL
Pyrene	IL
Pyridine	IL
Safrole	IL

Method **EPA 8270C Mod LVI**

Acetochlor	IL
Alachlor	IL
Atrazine	IL
Butylate	IL
Cyanazine	IL
EPTC (Eptam, s-ethyl-dipropyl thio carbamate)	IL
Metolachlor	IL
Metribuzin	IL
Pendimethalin (Penoxalin)	IL
Simazine	IL
Trifluralin (Treflan)	IL

Method **EPA 9012A**

Cyanide	IL

Method **EPA 9014**

Cyanide	IL

Method **EPA 9020B**

Total organic halides (TOX)	IL

Method **EPA 9023**

Extractable organics halides (EOX)	IL

Method **EPA 9034**

Field of Testing /Matrix: ***RCRA (Non Potable Water)***

	Primary AB
Sulfide	IL
Method EPA 9036	
Sulfate	IL
Method EPA 9040B	
pH	IL
Method EPA 9050A	
Conductivity	IL
Method EPA 9060A	
Total organic carbon	IL
Method EPA 9065	
Total phenolics	IL
Method EPA 9066	
Total phenolics	IL
Method EPA 9095A	
Paint Filter Test	IL
Method EPA 9214	
Fluoride	IL
Method EPA 9251	
Chloride	IL

Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***

	Primary AB
Method **EPA 1010A**	
Ignitability	IL
Method **EPA 1020B**	
Ignitability	IL
Method **EPA 1311**	
Toxicity Characteristic Leaching Procedure (TCLP)	IL
Method **EPA 1312**	
Synthetic Precipitation Leaching Procedure (SCLP)	IL
Method **EPA 6010B**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Lithium	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Phosphorus	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Strontium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL
Method **EPA 6020A**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL

Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***

Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Thallium	IL
Vanadium	IL
Zinc	IL
Method EPA 7196A	
Chromium VI	IL
Method EPA 7471B	
Mercury	IL
Method EPA 8015B	
1,4-Dioxane (1,4- Diethyleneoxide)	IL
Diesel range organics (DRO)	IL
Ethanol	IL
Ethylene glycol	IL
Isobutyl alcohol (2-Methyl-1-propanol)	IL
Isopropyl alcohol (2-Propanol, Isopropanol)	IL
Methanol	IL
n-Butyl alcohol (1-Butanol, n-Butanol)	IL
n-Propanol (1-Propanol)	IL
tert-Butyl alcohol	IL
Method EPA 8081B	
4,4'-DDD	IL
4,4'-DDE	IL
4,4'-DDT	IL
Alachlor	IL
Aldrin	IL
alpha-BHC (alpha-Hexachlorocyclohexane)	IL
alpha-Chlordane, cis-Chlordane	IL
beta-BHC (beta-Hexachlorocyclohexane)	IL
Chlordane (tech.)(N.O.S.)	IL
delta-BHC	IL
Dieldrin	IL
Endosulfan I	IL
Endosulfan II	IL
Endosulfan sulfate	IL
Endrin	IL
Endrin aldehyde	IL
Endrin ketone	IL
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	IL
gamma-Chlordane	IL
Heptachlor	IL
Heptachlor epoxide	IL
Methoxychlor	IL

Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***

	Primary AB
Toxaphene (Chlorinated camphene)	IL
Method EPA 8082	
Aroclor-1016 (PCB-1016)	IL
Aroclor-1221 (PCB-1221)	IL
Aroclor-1232 (PCB-1232)	IL
Aroclor-1242 (PCB-1242)	IL
Aroclor-1248 (PCB-1248)	IL
Aroclor-1254 (PCB-1254)	IL
Aroclor-1260 (PCB-1260)	IL
Method EPA 8151A	
3,5-Dichlorobenzoic acid	IL
Acifluorfen	IL
Bentazon	IL
Chloramben	IL
Dalapon	IL
DCPA di acid degradate	IL
Dichloroprop (Dichlorprop)	IL
MCPA	IL
MCPP	IL
Picloram	IL
Method EPA 8260B	
1,1,1,2-Tetrachloroethane	IL
1,1,1-Trichloroethane	IL
1,1,2,2-Tetrachloroethane	IL
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	IL
1,1,2-Trichloroethane	IL
1,1-Dichloroethane	IL
1,1-Dichloroethylene	IL
1,1-Dichloropropene	IL
1,2,3-Trichlorobenzene	IL
1,2,3-Trichloropropane	IL
1,2,4-Trichlorobenzene	IL
1,2,4-Trimethylbenzene	IL
1,2-Dibromo-3-chloropropane (DBCP)	IL
1,2-Dibromoethane (EDB, Ethylene dibromide)	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Dichloroethane (Ethylene dichloride)	IL
1,2-Dichloropropane	IL
1,3,5-Trimethylbenzene	IL
1,3-Dichlorobenzene	IL
1,3-Dichloropropane	IL
1,4-Dichlorobenzene	IL
1-Chlorobutane	IL
2,2-Dichloropropane	IL
2-Butanone (Methyl ethyl ketone, MEK)	IL
2-Chloroethyl vinyl ether	IL
2-Chlorotoluene	IL
2-Hexanone	IL
2-Nitropropane	IL
4-Chlorotoluene	IL

Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***

4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	IL
4-Methyl-2-pentanone (MIBK)	IL
Acetone	IL
Acetonitrile	IL
Acrolein (Propenal)	IL
Allyl chloride (3-Chloropropene)	IL
Benzene	IL
Bromobenzene	IL
Bromochloromethane	IL
Bromodichloromethane	IL
Bromoform	IL
Carbon disulfide	IL
Carbon tetrachloride	IL
Chlorobenzene	IL
Chlorodibromomethane	IL
Chloroethane (Ethyl chloride)	IL
Chloroform	IL
Chloroprene (2-Chloro-1,3-butadiene)	IL
cis-1,2-Dichloroethylene	IL
cis-1,3-Dichloropropene	IL
cis-1,4-Dichloro-2-butene	IL
Dibromomethane (Methylene bromide)	IL
Dichlorodifluoromethane (Freon-12)	IL
Diethyl ether	IL
Di-isopropylether (DIPE) (Isopropyl Ether)	IL
Ethyl acetate	IL
Ethyl methacrylate	IL
Ethylbenzene	IL
Hexachlorobutadiene	IL
Hexachloroethane	IL
Iodomethane (Methyl iodide)	IL
Isopropylbenzene	IL
Methacrylonitrile	IL
Methyl acrylate	IL
Methyl bromide (Bromomethane)	IL
Methyl chloride (Chloromethane)	IL
Methyl methacrylate	IL
Methyl tert-butyl ether (MTBE)	IL
Methylene chloride (Dichloromethane)	IL
m-Xylene	IL
Naphthalene	IL
n-Butylbenzene	IL
Nitrobenzene	IL
n-Propylbenzene	IL
o-Xylene	IL
Pentachloroethane	IL
Propionitrile (Ethyl cyanide)	IL
p-Xylene	IL
sec-Butylbenzene	IL
Styrene	IL
tert-Butyl alcohol	IL

Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***

tert-Butylbenzene	IL
Tetrachloroethylene (Perchloroethylene)	IL
Tetrahydrofuran (THF)	IL
Toluene	IL
trans-1,2-Dichloroethylene	IL
trans-1,3-Dichloropropylene	IL
trans-1,4-Dichloro-2-butene	IL
Trichloroethene (Trichloroethylene)	IL
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	IL
Vinyl acetate	IL
Vinyl chloride	IL
Xylene (total)	IL

Method **EPA 8270C**

1,2,4-Trichlorobenzene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Diphenylhydrazine	IL
1,3-Dichlorobenzene	IL
1,4-Dichlorobenzene	IL
1,4-Dioxane (1,4- Diethyleneoxide)	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,4,5-Trichlorophenol	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Methylaniline (o-Toluidine)	IL
2-Methylnaphthalene	IL
2-Methylphenol (o-Cresol)	IL
2-Nitroaniline	IL
2-Nitrophenol	IL
3,3'-Dichlorobenzidine	IL
3-Methylphenol (m-Cresol)	IL
3-Nitroaniline	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chloroaniline	IL
4-Chlorophenyl phenylether	IL
4-Methylphenol (p-Cresol)	IL
4-Nitroaniline	IL
4-Nitrophenol	IL
Acenaphthene	IL
Acenaphthylene	IL
Aniline	IL
Anthracene	IL
Benzidine	IL
Benzo(a)anthracene	IL

Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***

Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
Benzoic acid	IL
Benzyl alcohol	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
bis(2-Ethylhexyl) phthalate (DEHP)	IL
Butyl benzyl phthalate	IL
Carbazole	IL
Chrysene	IL
Dibenz(a,h) anthracene	IL
Dibenzofuran	IL
Diethyl phthalate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Indeno(1,2,3-cd) pyrene	IL
Isophorone	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodiethylamine	IL
n-Nitrosodimethylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
n-Nitrosomethylethalamine	IL
Pentachlorobenzene	IL
Pentachlorophenol	IL
Phenanthrene	IL
Phenol	IL
Pyrene	IL
Pyridine	IL

Method **EPA 8270C Mod LVI**

Acetochlor	IL
Alachlor	IL
Atrazine	IL
Butylate	IL
Cyanazine	IL
EPTC (Eptam, s-ethyl-dipropyl thio carbamate)	IL
Metolachlor	IL
Metribuzin	IL
Pendimethalin (Penoxalin)	IL
Simazine	IL
Trifluralin (Treflan)	IL

Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***

Method **EPA 9014**

Cyanide	IL

Method **EPA 9020B**

Total organic halides (TOX)	IL

Method **EPA 9023**

Extractable organics halides (EOX)	IL

Method **EPA 9034**

Sulfide	IL

Method **EPA 9036**

Sulfate	IL

Method **EPA 9045C**

pH	IL

Method **EPA 9060A**

Total organic carbon	IL

Method **EPA 9065**

Total phenolics	IL

Method **EPA 9214**

Fluoride	IL

Field of Testing /Matrix: ***SDWA (Potable Water)***

Method EPA 180.1	
Turbidity	IL
Method EPA 200.7	
Aluminum	IL
Barium	IL
Beryllium	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Copper	IL
Iron	IL
Magnesium	IL
Manganese	IL
Nickel	IL
Silver	IL
Sodium	IL
Zinc	IL
Method EPA 200.8	
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Cadmium	IL
Chromium	IL
Copper	IL
Lead	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Selenium	IL
Silver	IL
Thallium	IL
Zinc	IL
Method EPA 245.1	
Mercury	IL
Method EPA 335.4	
Cyanide	IL
Method EPA 353.2	
Nitrate	IL
Nitrite	IL
Method SM 2320 B-1991	
Alkalinity as CaCO3	IL
Method SM 2340 B-1990	
Hardness	IL
Method SM 2510 B-1997	
Conductivity	IL
Method SM 2540 C-1991	
Total dissolved solids	IL

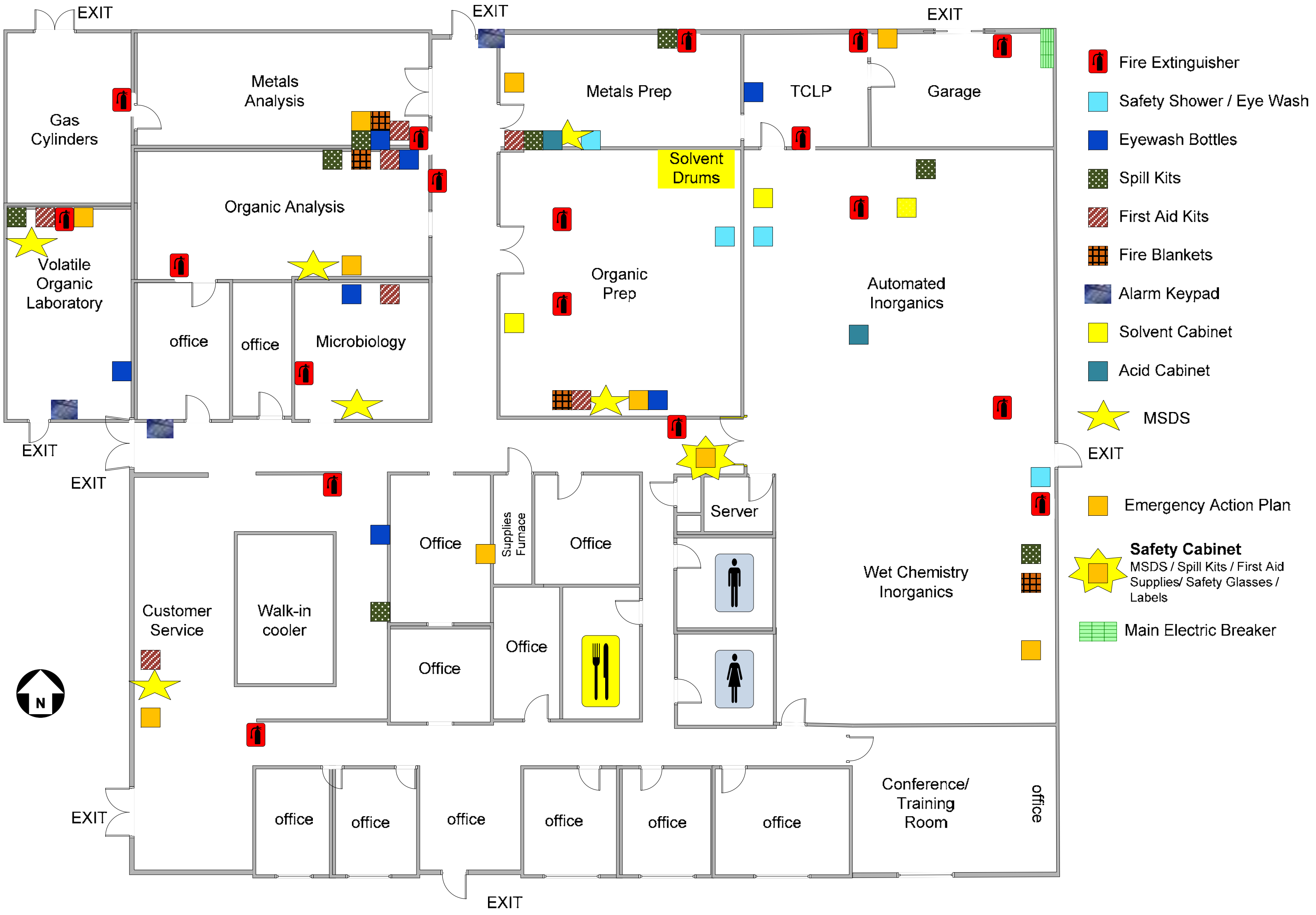
Field of Testing /Matrix: ***SDWA (Potable Water)***

	Primary AB
Method SM 3112 B-1988	
Mercury	IL
Method SM 4500-Cl G-1989	
Total chlorine	IL
Method SM 4500-F$^-$ C-1988	
Fluoride	IL
Method SM 4500-H+ B-1990	
pH	IL
Method SM 4500-NO2$^-$ B-1988	
Nitrite	IL
Method SM 4500-P E-1988	
Orthophosphate as P	IL
Method SM 4500-Si E	
Silica as SiO2	IL
Method SM 5310 C	
Dissolved organic carbon (DOC)	IL
Total organic carbon	IL
Method SM 5540 C-2000	
Foaming agents	IL

End of Scope of Accreditation

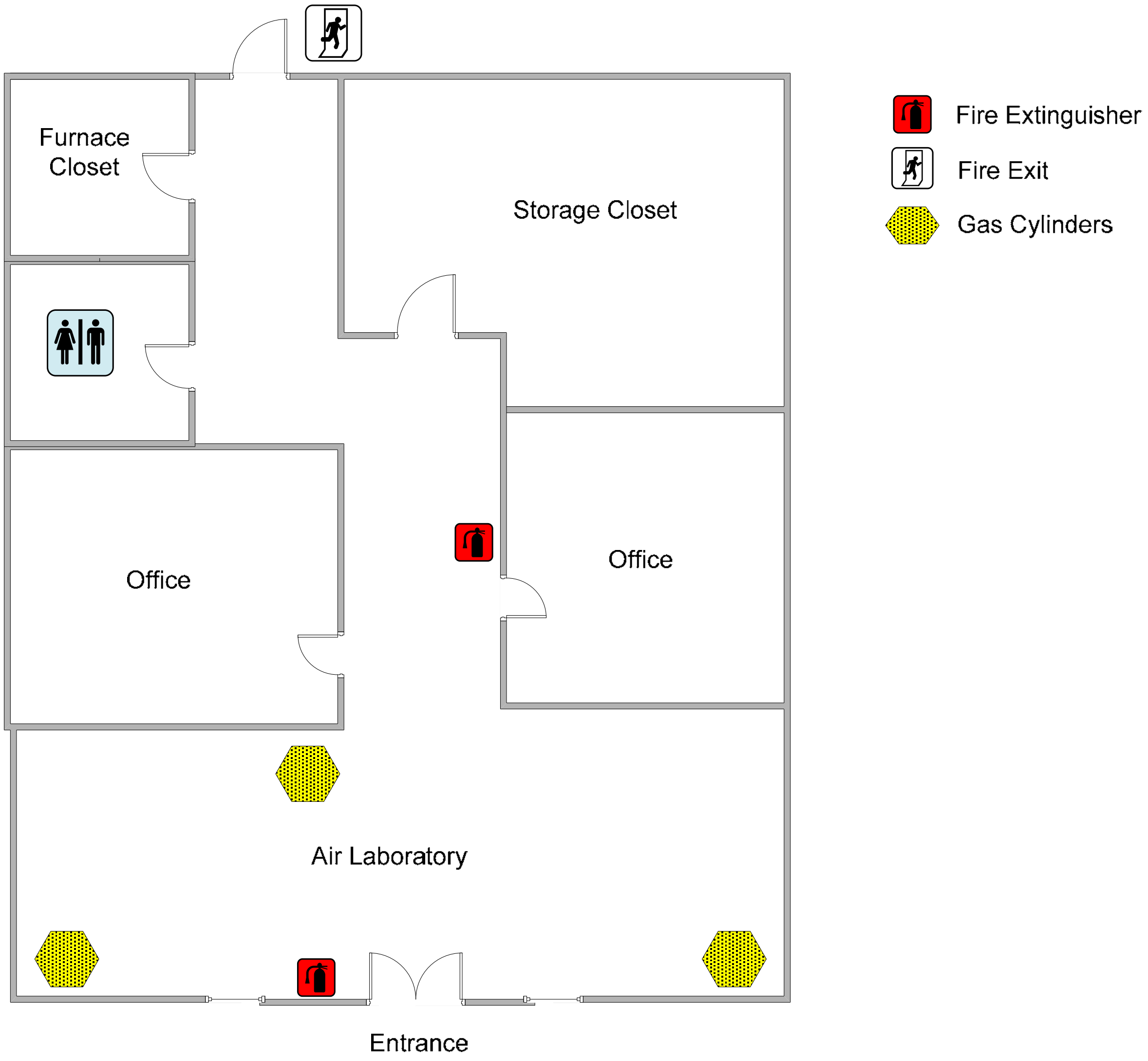
Appendix C - Laboratory Floor Plans

C.1 Collinsville (Corporate)



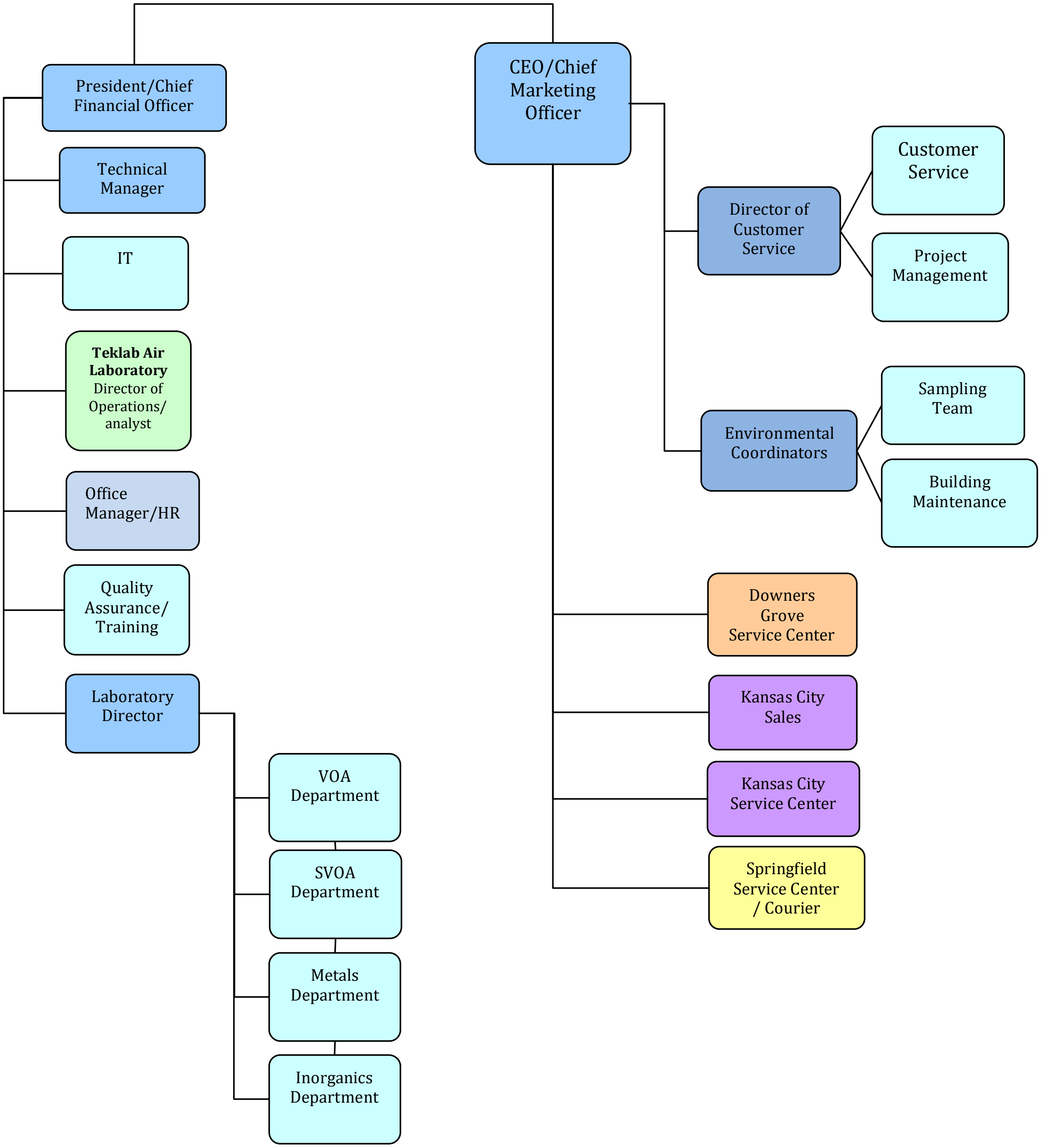
Property of Teklab Inc

C.2 Collinsville Air Laboratory

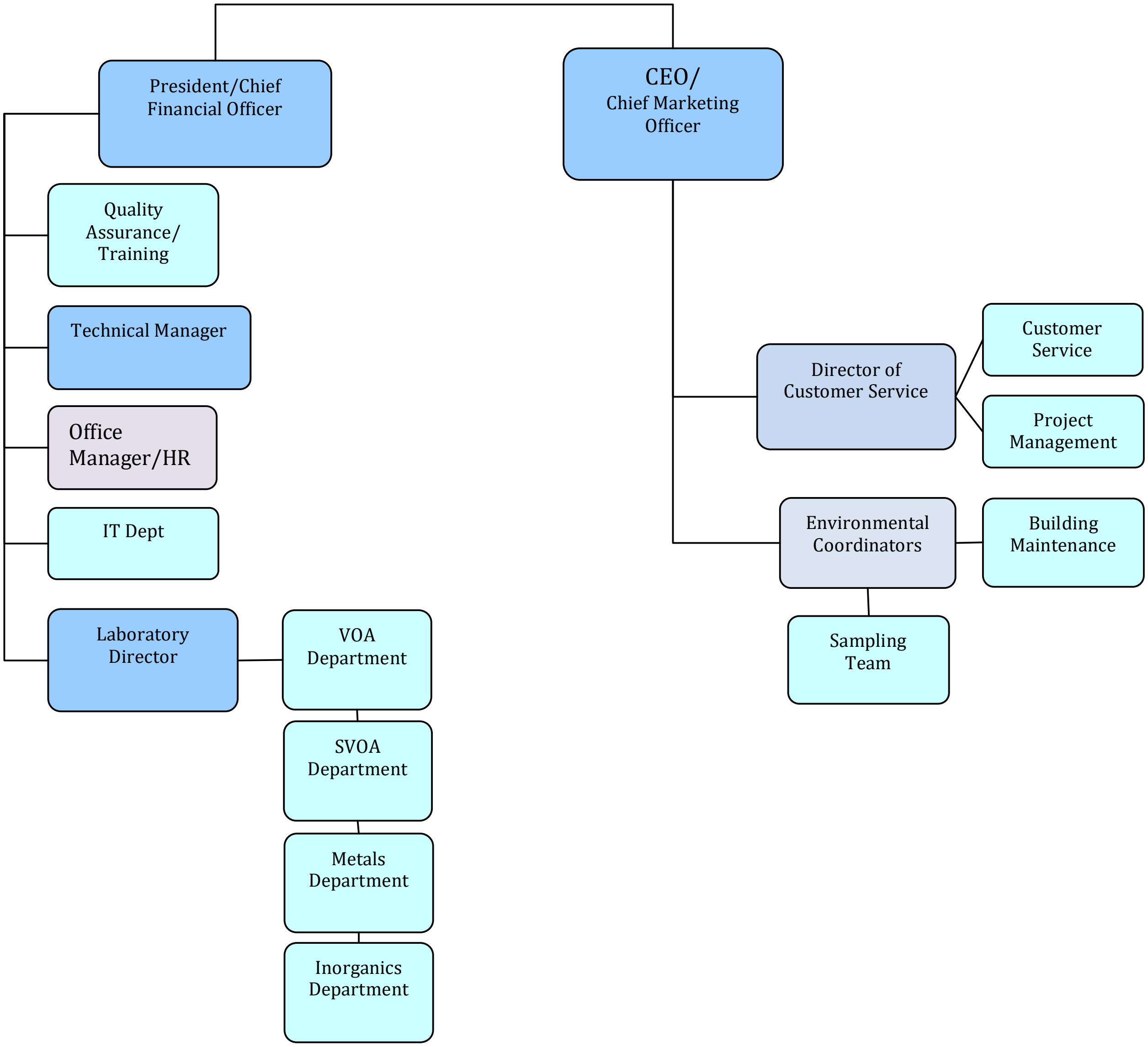


Appendix B
Laboratory Organization Charts

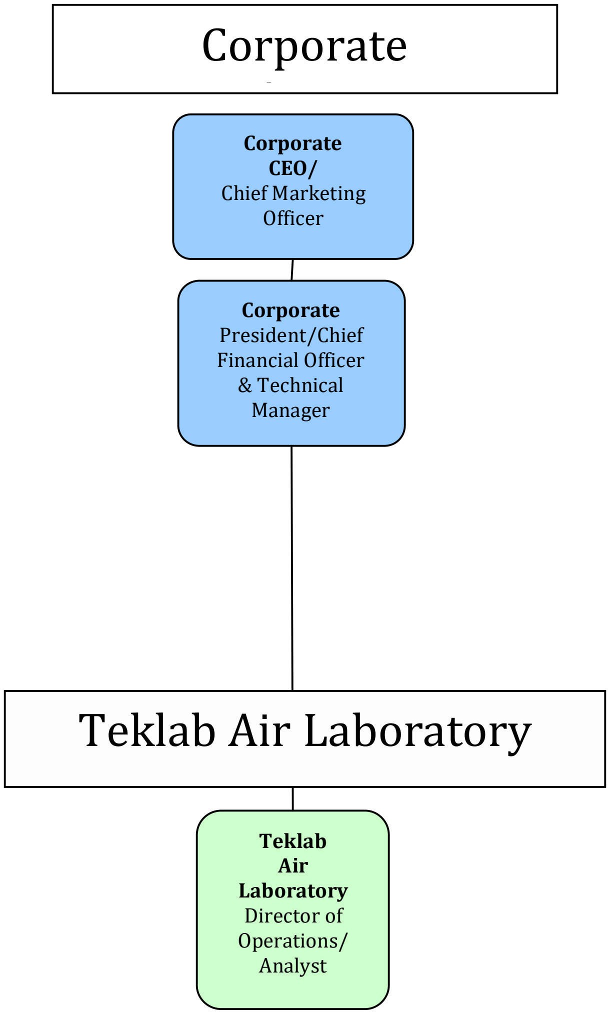
B.1 Teklab Inc



B.2 Teklab Inc – Collinsville (Corporate)



B.3 Teklab Inc – Teklab Air Laboratory



Appendix A

Ethics and Data Integrity Policy

Ethics, Legal Responsibility, & Conflict of Interest (Rev. B)

Effective Date: 11/14/05
Reference: TNI Standard – Quality Systems

To all Teklab, Inc. Employees, Customers and Vendors,

Teklab, Inc. will not tolerate any improper, unethical or illegal actions by its employees, customers or vendors. No customer, employee or vendor shall enter into any agreement (written or implied) and shall not engage in activities which would put any commercial, financial or other pressure on an employee of Teklab, Inc. which might adversely affect the quality of that employees work. Any employee determined to be involved in such behavior will be disciplined, up to and including termination of employment at Teklab, Inc. Any customer or vendor determined to be involved in such behavior will be sanctioned, up to and including termination of any future business with Teklab, Inc.

Teklab, Inc. will use the following procedures to proactively detect any improper, unethical or illegal actions:

1.) Internal data reviews and audits
2.) Daily interactions of the management staff with employees
3.) Daily interactions with customers and vendors
4.) Confidentiality for individuals reporting potential problems (unless the problem develops to the point where Teklab, Inc. no longer has control (i.e. court orders, etc.))
5.) Internal investigations when employees identify potential problems
6.) External investigations by the appropriate authorities, when necessary
7.) Prosecution when appropriate

All Teklab, Inc. personnel must be free from any commercial, financial and any other pressures that might adversely affect the quality of their work. Teklab, Inc. shall use the following procedures to proactively detect any of those pressures:

1) Daily interactions of the management staff with employees
2) Daily interactions with customers and vendors
3) Confidentiality for individuals reporting potential problems (unless the problem develops to the point where Teklab, Inc. no longer has control (i.e. court orders, etc.))
4) Internal investigations when employees identify potential problems
5) External investigations by the appropriate authorities, when necessary
6) Prosecution when appropriate

We at Teklab, Inc. take our reputation and the law seriously. We will not tolerate any improper, unethical or illegal actions. We will turn people in to the proper authorities and/or press charges, when appropriate.

(b) (6)

James S. Riley
President/Chief Financial Officer

APPENDIX B – Sample Collection, Preservation, Shipment and Storage

SAMPLE COLLECTION

Sample collection techniques must be in accordance with methods developed by USEPA, ASTM, Standard Methods or other recognized organizations. Samples must be properly preserved, (e.g. preservative added, iced, etc.) packaged, labeled and documented at the time of collection. All sampling activities should be documented (by the sampler) and performed in such a manner as to ensure that contamination does not occur. Teklab, Inc. will provide applicable copies of recognized sampling techniques to its Clients upon request. However, the implementation of these techniques is the responsibility of the Client submitting the samples to Teklab, Inc. Any deviations from the recognized sampling techniques or any project specific sampling techniques must be noted by the Client on the Chain of Custody form or attached to the Chain of Custody form.

See the Teklab field sampling procedures for information concerning Teklab-performed field sampling. This section applies to samples received by Teklab and will be used to guide clients in sampling requirements specified in the "Federal Register, 40 CFR Part 136, Table II".

The individual analyst, analyst in training, or technician performs internal (i.e. laboratory sub-sampling) sample collection. This is performed by thoroughly mixing or homogenizing the sample prior to removing a sub-sample for analysis. Care must be taken to ensure that the sub-sample and remaining sample represent the same sample. If not, that analysis and any additional analyses on the remaining sample will not be representative. If a problem occurs with a sample and a representative sub-sample can no longer be obtained, the Client must be notified so that another sample may be collected and submitted.

Air analysis is the only department that reuses sample containers at this time. See Air SOP6000 for cleaning procedures.

SAMPLE SHIPMENT

The Client should make the determination as to whether sample shipping is necessary during planning for the project. This need is established by evaluating the analysis to be performed, sample holding times and location of the site and the laboratory. Shipping or transporting samples to a laboratory should be done within a timeframe such that recommended holding times are met and in accordance with all federal, state and local transportation regulations. Samples received out of holding time, without proper preservation or in an unusable manner (e.g. broken or open sample containers, etc.) will be noted on the chain of custody form and the Client will be notified as soon as possible, prior to the initiation of any analysis. See also SOP1100 Subcontracting and Shipping.

SAMPLE STORAGE

Samples must be stored in a manner which maintains their physical and chemical integrity as well as possible. All Teklab, Inc. samples that require thermal preservation must be stored in a refrigerator above freezing-6.0 degrees C, and the storage temperatures must be monitored and recorded each day of use. Samples must be stored in a designated area separate from any food, standards, or reagents. The sample storage area must be such that unauthorized access is not possible and that sample internal chain of custody is maintained. Sample extracts for organic analysis will be maintained in separate refrigerators. The refrigerator temperature will be monitored and recorded each day of use. Sample digestates for metals analysis will be stored in the metals analysis laboratory on the appropriate storage rack. Volatile organic samples will be stored in the VOA laboratory sample refrigerator only.

Storage areas for solvents, reagents, standards and reference materials must be adequate to preserve their identity, concentration, purity and stability prior to use.

Laboratory storage areas are as follows:

LOGIN	Lockable walk-in refrigerator Lockable storage cabinet
INORGANIC LAB	Lockable sample refrigerators Reagent/Standard refrigerator
METALS PREP LAB	Lockable cabinets Digestate storage shelves
METALS ANALYSIS LAB	Digestate storage shelves
SEMI-VOLATILE PREP	Standard refrigerator Lockable sample refrigerator
SEMI-VOLATILE LAB	Standard/extract refrigerators Standard freezer
VOLATILE LAB	Lockable sample refrigerators Standard refrigerator Standard freezer
MICROBIOLOGY	Standard refrigerator Standard freezer

SAMPLE CONTAINERS, PRESERVATION AND HOLDING TIMES

Total and prolonged preservation of samples is practically impossible. Preservation can only slow the changes that continue after the sample is removed from its source. Therefore as a general rule, it is best to analyze the sample as soon as possible after collection. This is especially true when the parameter is expected to be in the low ug/l range. The following tables list recommended preservation and holding times, as well as, volumes needed for analysis. The tables are not inclusive of all analyses performed at, or subcontracted by, Teklab, Inc. See appropriate references for more information.

TABLE 1
SAMPLE VOLUME REQUIREMENTS, PRESERVATION AND MAXIMUM HOLDING TIMES - AQUEOUS (Wastewater, Groundwater, Drinking Water)

PARAMETER	VOL(ML)	CONTAINER (P: plastic; G: glass)	PRESERVATIVE	HOLDING TIME
PHYSICAL PROPERTIES				
Color	50	P,G	Cool, Above freezing to 6^0C	48 Hours
Conductance	100	P,G	Cool, Above freezing to 6^0C	28 Days
Hardness	100	P,G	HNO_3, pH<2	6 Months
Odor	200	G only	Cool, Above freezing to 6^0C	24 Hours
pH	25	P,G	None required	Analyze within 15 minutes
TDS	100	P,G	Cool, Above freezing to 6^0C	7 Days
TSS	100	P,G	Cool, Above freezing to 6^0C	7 Days
TS	100	P,G	Cool, Above freezing to 6^0C	7 Days
TVS	100	P,G	Cool, Above freezing to 6^0C	7 Days
Settleable Matter	1000	P,G	Cool, Above freezing to 6^0C	48 Hours
Temperature	1000	P,G	None required	Analyze Immediately
Turbidity	100	P,G	Cool, Above freezing to 6^0C	48 Hours
METALS				
Dissolved	250	P,G	Filter on site, HNO_3, pH<2	6 Months
Suspended	250	P,G	Filter on site	6 Months
Total	250	P,G	HNO_3, pH<2	6 Months

PARAMETER	VOL(ML)	CONTAINER (P: plastic; G: glass)	PRESERVATIVE	HOLDING TIME
METALS cont.				
Boron & Silicon	250	P only	Cool, Above freezing to 6^0C HNO_3, pH<2	6 Months
Chromium (+6)	250	P,G	Cool, Above freezing to 6^0C	24 Hours
Mercury, Dissolved	250	P,G	Filter on site, HNO_3, pH<2	28 Days
Mercury, Total	250	P,G	HNO_3, pH<2	28 Days
Mercury, Low Level	250	P,G	Bromine Chloride	48 Hours (to preserve)
INORGANIC				
Acidity	100	P,G	Cool, Above freezing to 6^0C	14 Days
Alkalinity	100	P,G	Cool, Above freezing to 6^0C	14 Days
Chloride	50	P,G	None required	28 Days
Chlorine	200	P,G	None required	Analyze within 15 minutes
Cyanide	500	P,G	Cool, Above freezing to 6^0C NaOH, pH>12 (Ascorbic Acid to remove chlorine prior to preservation of DW source)	14 Days
Fluoride	500	P,G	None required	28 Days
Nitrogen, Ammonia	500	P,G	Cool, Above freezing to 6^0C H_2SO_4, pH<2	28 Days
Nitrogen, Total Kjeldahl	500	P,G	Cool, Above freezing to 6^0C H_2SO_4, pH<2	28 Days
Nitrate & Nitrite	250	P,G	Cool, Above freezing to 6^0C H_2SO_4, pH<2	28 Days
Nitrate	250	P,G	Cool, Above freezing to 6^0C	48 Hours
Nitrite	250	P,G	Cool, Above freezing to 6^0C	48 Hours
Dissolved Oxygen	300	G (bottle & top) *Documentation on file from USEPA authorizing use of Environmental Express single-use, coated-PET BOD bottles	None Required	Analyze within 15 mins
Phosphorus, Total	100	P,G	Cool, Above freezing to 6^0C H_2SO_4, pH<2 Sample may be HNO3-preserved for analysis by ICP.	28 Days
Phosphorus, Dissolved	100	P,G	Cool, Above freezing to 6^0C Filter on site, H_2SO_4, pH<2 Sample may be HNO3-preserved for analysis by ICP.	28 Days
OrthoPhosphate, Dissolved	100	P,G	Cool, Above freezing to 6^0C Filter within 15 minutes	48 Hours
OrthoPhosphate, Total	100	P,G	Cool, Above freezing to 6^0C	48 Hours
Silica	100	P only	Cool, Above freezing to 6^0C	28 Days
Sulfate	500	P,G	Cool, Above freezing to 6^0C	28 Days
Sulfide	500	P,G	Cool, Above freezing to 6^0C 2 ml zinc acetate plus NaOH, pH>9	7 Days
Sulfite	100	P,G	None Required	Analyze within 15 minutes
ORGANIC				
BOD/CBOD	500	P,G	Cool, Above freezing to 6^0C	48 Hours
COD	50	P,G	Cool, Above freezing to 6^0C H_2SO_4, pH<2	28 Days

ORGANIC cont.				
PARAMETER	VOL(ML)	CONTAINER (P: Plastic; G: Glass)	PRESERVATIVE	HOLDING TIME
MRH/HRH (Kansas)	1000	1250ml amber glass	Preserved in Acid. 5mL 1:1 HCl per liter to pH 2 or less Cooled to 4 ± 2°C	Extracted within 14 days of collection Analyzed within 40 days of extraction
Oil & Grease	1000	G only	Cool, Above freezing to 6^0C H_2SO_4, pH<2	28 Days
Organic Carbon	250	G only	Cool, Above freezing to 6^0C H_2SO_4, pH<2	28 Days
Phenol	125	G only	Cool, Above freezing to 6^0C H_2SO_4, pH<2	28 Days
MBAS	500	P,G	Cool, Above freezing to 6^0C	48 Hours
TOX	250	G only	Cool, Above freezing to 6^0C H_2SO_4, pH<2	28 Days
VOA	40	G vials	Cool, Above freezing to 6^0C HCl, pH<2 Sodium Thiosulfate if chlorinated (VOA624) TSP, pH>11 (MRBCA Oxygenates)	14 Days 7 days if Unpreserved or Sodium Thiosulfate 72 hours for Acrolein (unpreserved)
Semi-Volatiles	1000	G teflon	Cool, Above freezing to 6^0C	7 Days to extraction 40 Days for extracts
Pesticide/PCB/Herb	1000	G teflon	Cool, Above freezing to 6^0C	7 Days to extraction 40 Days for extracts
AIR				
Air TO-15	fill to ~-5"Hg	Canisters	Room temp	30 days
Air TO-15	fill 70-90%	Sampling bags	Room temp	48 hours to transfer
Air TO-13		PUF cartridges	Cool, 4 C	7 days to extraction 40 days for extracts
SUBCONTRACTING				
Gross Alpha/Beta	1000	G only	HNO3, pH<2	6 months
MICRO				
Total Coliform	120	Sterile P, G	None Required (see note**)	30 hours
Fecal Coliform	120	Sterile P, G	None Required (see note**)	8 hours (delivery within 6 hours of collection; analysis within 2 hours of receipt)
HPC (DW)	120	Sterile P, G	None Required (see note**) If analysis cannot be started within hold time, cool to <4^0C	8 hours
HPC (WW/GW)	120	Sterile P, G	None Required (see note**)	24 hours

** Samples from a chlorinated source must be preserved with Sodium Thiosulfate.

TABLE 2
SAMPLE VOLUME REQUIREMENTS, PRESERVATION AND MAXIMUM HOLDING TIMES – SOILS/SOLIDS/MISCELLANEOUS

PARAMETER	VOL(ML)	CONTAINER (P: Plastic; G: Glass)	PRESERVATIVE	HOLDING TIME
PHYSICAL PROPERTIES				
pH	25	P,G	None Required	Analyze within 15 minutes
TS	100	P,G	Cool, Above freezing to 6^{0}C	7 Days
TVS	100	P,G	Cool, Above freezing to 6^{0}C	7 Days
Temperature	1000	P,G	None Required	Analyze Immediately
METALS				
Total	250	P,G	None Required	6 Months
Chromium (+6)	250	P,G	Cool, Above freezing to 6^{0}C	1 Month to Extraction 4 Days after Extraction
Mercury	250	P,G	Cool, Above freezing to 6^{0}C	28 Days
INORGANIC				
PARAMETER	VOL(ML)	CONTAINER (P: Plastic; G: Glass)	PRESERVATIVE	HOLDING TIME
Alkalinity	50	P,G	Cool, Above freezing to 6^{0}C	14 Days
Chloride	50	P,G	None Required	28 Days
Cyanide	150	P,G	Cool, Above freezing to 6^{0}C	14 Days
Fluoride	100	P,G	None Required	28 Days
Nitrogen, Ammonia	150	P,G	Cool, Above freezing to 6^{0}C	28 Days
Nitrogen, Total Kjeldahl	150	P,G	Cool, Above freezing to 6^{0}C	28 Days
Nitrate & Nitrite	100	P,G	Cool, Above freezing to 6^{0}C	28 Days
Nitrate	100	P,G	Cool, Above freezing to 6^{0}C	7 days to extraction 48 Hours for extracts
Nitrite	100	P,G	Cool, Above freezing to 6^{0}C	7 days to extraction 48 Hours for extracts
Phosphorus	100	P,G	Cool, Above freezing to 6^{0}C	28 Days
Sulfate	100	P,G	Cool, Above freezing to 6^{0}C	28 Days
Sulfide	150	P,G	Cool, Above freezing to 6^{0}C	14 Days
ORGANIC				
Organic Carbon	50	G only	Cool, Above freezing to 6^{0}C	28 Days
Phenol	100	G only	Cool, Above freezing to 6^{0}C	28 Days
EOX	50	G only	Cool, Above freezing to 6^{0}C	28 Days
Semi-Volatiles	250	G Teflon	Cool, Above freezing to 6^{0}C	14 Days to extraction 40 Days for extracts
MRH/HRH (Kansas)	30 grams	250ml clear jar	Cooled to 4 ± 2°C Unpreserved	Extracted within 14 days of collection Analyzed within 40 days of extraction
Pesticide/PCB/Herb	250	G Teflon	Cool, Above freezing to 6^{0}C	14 Days to extraction 40 Days for extracts
VOA	40 (5 grams)	G Vials	Cool, Above freezing to 6^{0}C 5ml of NaHSO4, pH<2 5ml of TSP, pH>11 (MRBCA Oxygenates)	14 Days

See appropriate reference method (SW846, Standard Methods, EPA 600, etc.) for more detailed information on sample preservation and holding times.

(b) (6) [redacted] 12/12/2018

Approving Authority Approval/Effective Date

TEKLAB, INC.
STANDARD OPERATING PROCEDURE
COLORIMETRIC DETERMINATION OF CYANIDE AFTER DISTILLATION

SCOPE

This procedure is applicable to the determination of cyanide concentration in sample distillates from the Total Cyanide distillation SOP 2090. This method may be used for Total, Amenable, or Weak Acid Dissociable Cyanide. Holding time for cyanide samples is 14 days from collection. Sample distillates should be stored from just above freezing to 6°C. See LIMS for current test codes, MDLs, and PQLs.

SUMMARY

The alkaline distillate from preliminary distillation is converted to CNCl by reaction with chloramine-T at $pH < 8$ without hydrolyzing to CNO^{-1} (**CAUTION** - CNCl is a toxic gas; avoid inhalation.) CNCl reacts with a pyridine-barbituric acid reagent forming a red-colored complex measured at 578 nm.

SAFETY

Eye protection and gloves must be worn when running this analysis. Use caution when dealing with acids and compounds with cyanide present. Some chemicals associated with this analysis have the potential to be highly toxic or hazardous. Consult the appropriate SDS for more detailed safety information; especially review the SDS on the following chemicals: Potassium Cyanide, Sulfuric Acid, Hydrochloric Acid, Sodium Hydroxide, and Pyridine.

EQUIPMENT and SUPPLIES

1. Glassware – Class A volumetric flasks and pipettes as required
2. Plastic cups
3. Spectrophotometer for use at 578 nm, providing a light path of 1 cm or longer.
4. Flow-thru cell for use with spectrophotometer

REAGENTS and STANDARDS (Quality Manual Chapter 23)

1. *General laboratory deionized water (DI water):* Refer to section 26.6 of the Quality Assurance Manual for further description.
2. *Chloramine-T solution:* Dissolve 0.5 g chloramine-T in 50 mL DI water. Prepare fresh daily.
3. *Pyridine-barbituric acid reagent:* While stirring in a hood, dissolve 30 g barbituric acid in ~200 mL DI water. Add 150 mL of pyridine. Add 30 mL hydrochloric acid (HCl). Transfer to a 500 mL volumetric flask and dilute to volume with DI water. Mix until barbituric acid is dissolved. Expiration is 6 months; store in an amber bottle under refrigeration. Discard if a precipitate develops.
4. *Buffer:* Dissolve 138 g of sodium phosphate monobasic (NaH_2PO_4) in ~800 mL DI water and dilution to volume in a 1 L volumetric flask.
5. *0.25N NaOH:* Dilute 500 mL 10N NaOH to 20 L in Nalgene carboy.
6. *1000 ppm Stock Free Cyanide solution, for standard curve:* Purchased from vendor.
7. *10 ppm Free Cyanide intermediate solution, for standard curve:* Dilute 1 mL of 1000 ppm Stock Cyanide solution to 100 mL with 0.25 N NaOH. Expiration is 7 days.
8. *1000 ppm Stock Free Cyanide solution, for ICV/CCV/LCS/MS/MSD:* Purchased from vendor.

Must be a separate source from the standard curve solution.

9. *10 ppm Free Cyanide intermediate stock, for ICV/CCV:* Dilute 1 mL of 1000 ppm Stock Cyanide solution to 100 mL with 0.25 N NaOH.

The reagents listed above have an expiration period of 12 months and are stored on the bench unless noted otherwise. Standards and reagents purchased from vendors expire one year from the day they are opened unless the vendor expiration date precedes that date.

CALIBRATION (Quality Manual Chapter 22)

See Total Cyanide Excel spreadsheet for current curve and QC concentrations and spike amounts.

Curves and calibration standards are made by diluting a 10 ppm intermediate solution in 10 mL of 0.25 N NaOH.

Calibration curve is valid for one month.

Calibration Requirement	Acceptance Criteria	Frequency
PQL Curve Standard	80-120 % recovery	1/month
Other Curve Standards	90-110 % recovery	1/month
ICB	≤ MDL*	1/batch
CCB	≤ PQL*	1/10 samples
ICV	90-110 % recovery	1/batch
CCV	90-110 % recovery	1/10 samples

*An ICB must not be more negative than the MDL. A CCB must not be more negative than the PQL.

For more detailed calibration information, see SOP 2000.

QUALITY CONTROL (Quality Manual Chapter 26)

See Total Cyanide Excel spreadsheet for current curve and QC concentrations and spike amounts.

QC Requirement	Acceptance Criteria	Frequency
MBLK	≤ MDL*	1/batch
LCS	85-115 % recovery	1/batch
Duplicate	15 % RPD (aqueous samples) 20 % RPD (solid samples)	1/10 Samples and rechecks
MS/MSD	85-115 % recovery 15 % RPD	By client request

*An MBLK must not be more negative than the MDL.

See SOP 2090 for the MBLK/LCS/MS/MSD prep procedure.
See SOP 2000 for additional Quality Control information.
See SOP 1020 for Control Charting procedures.

CORRECTIVE ACTION (Quality Manual Chapter 13)

Problem	Potential Corrective Action
Low or High LCS recoveries	Ensure analysis was performed using 0.25N NaOH for dilutions and QC, not DI water. Remake 0.25N NaOH. Perform standard checks/observe relationship. Check pipette calibration.
Standard curve calibration coefficient is less than 0.995 and/or standards recover outside acceptable limits	Remake calibration curve. Ensure analysis was performed using 0.25N NaOH for dilutions and QC, not DI water. Remake 0.25N NaOH. Ensure reagents are made correctly and not expired. Perform standard checks/observe relationship. Check pipette calibration.
Drift in absorbance values	Clean or replace Flow-thru cell, replace tubing. Replace spectrophotometer lamp.

INTERFERENCES

Interferences are eliminated or reduced using the distillation procedure outlined in SOP 2090. Refer to SOP 2090 or reference methods for additional details on potential cyanide interferences.

ANALYTICAL PROCEDURE

Prior to analysis, samples are prepped following the procedure outlined in SOP 2090.

1. Turn on spectrophotometer and set wavelength to 578 nm. Allow at least 10 minutes for warm-up prior to sample analysis. Rinse Flow-Thru set-up of spectrophotometer with 0.25N NaOH solution before analysis. Note: Use ONLY 0.25N NaOH solution to rinse during analysis; rinsing with DI water will alter pH of samples, and may cause inaccurate readings.
2. Pipette 10 mL of 0.25N NaOH solution or sample (or dilution thereof) into a plastic cup. Sample dilutions must be made using the 0.25N NaOH solution.
3. Spike calibration samples (QC samples are spiked in prep).
4. Add 3 mL of buffer solution to all cups and swirl to mix.
5. Add 0.4 mL of chloramine-T solution to all cups and swirl to mix.
6. Wait 2 minutes, then add 1.0 mL of pyridine-barbituric acid reagent to all cups and swirl to mix.
7. Wait 8 minutes, and pour each sample through the flow-thru cell of the spectrophotometer. Pour gently to prevent bubbles from entering the cell.
8. Record sample IDs, dilutions, and absorbance of standards and samples in the Total Cyanide Excel spreadsheet. Dilute and re-analyze any samples with an absorbance above the highest calibration standard. Diluted samples that fall below the reporting limit should be re-analyzed with a lesser dilution.

ROUTINE MAINTENANCE

- Keep spectrophotometer and components clean. Rinse sample cup and flow-thru cell well with DI water immediately following analysis.

- Clean up any spills immediately.
- Flow-thru cell and sample cup may be cleaned with a dilute acid and/or base solution, followed by several DI rinses. Replace when broken, damaged, or contaminated to a point affecting the integrity of analysis.
- Replace tubing and spectrophotometer lamp as needed.
- Document maintenance in LIMS.

DATA ANALYSIS and CALCULATIONS

Obtain a standard curve by plotting the absorbance of the standards by the above procedure against cyanide concentration in mg/L, using the curve table in the Total Cyanide Excel spreadsheet. The concentration of cyanide in mg/L in samples is calculated automatically by the Excel spreadsheet by comparing sample absorbance with standard curve. The raw concentration is multiplied by any dilution factors to obtain the final concentration. The Excel file automatically creates a .CSV file to be uploaded directly into LIMS, including all raw results and dilution factors. See SOP 1050 for instructions on plotting a curve and quantifying samples using a calculator.

Since new curves are not prepared for each analysis, the date the curve was prepared and the correlation coefficient of that curve must be saved to the Total Cyanide Excel spreadsheet template. Sample results must be quantified from the most current calibration curve.

CN, mg/L or mg/Kg = X * DF * PF

Where,

X = sample concentration from standard curve
DF = dilution factor (10/volume of sample used in dilution)
PF = prep factor (250/volume or weight of sample used in prep)

Solid samples may be calculated to a dry weight basis by using the Pmoist selection in LIMS. Samples requiring results on a dry weight basis will also request a total solids analysis. The technician assigned to the total solids analysis will enter the Pmoist result in LIMS. Once the Pmoist factor is entered, calculation of a sample in LIMS will convert the final result to a dry weight basis and change the units to mg/Kg-dry.

For more detailed calculation information see SOP 2000.

REFERENCES/METHOD DEVIATIONS

SM 4500-CN E, 1999:

- Stock cyanide solutions are not standardized against silver nitrate to monitor standard strength. Standards are purchased from a vendor and strength is monitored through daily analysis of the same standards on the Cyanide Autoanalyzer (SOP 2097).
- A reduced volume procedure is utilized. Sample and reagent ratios are maintained.
- Sodium phosphate monobasic buffer is used in place of acetate buffer, following the procedure in SW846 9014.

SW846 9014:

- Stock cyanide solutions are not standardized against silver nitrate to monitor standard strength. Standards are purchased from a vendor and strength is monitored through daily analysis of the same standards on the Cyanide Autoanalyzer (SOP 2097).
- Sample distillates are not checked for excess chlorine with KI-starch paper after the addition of chloramine-T.
- The standard curve range has been reduced to accommodate for the MDL and PQL achievable in the lab, and to improve method performance.

METHOD PERFORMANCE

MDL/Method Validation: See Quality Manual Chapter 21
IDMP/ADOC: See Quality Manual Chapter 19

SAMPLE HANDLING

See 1000 Series SOP Appendix B

POLLUTION PREVENTION

See 1000 Series SOP Appendix D

WASTE MANAGEMENT

See 1000 Series SOP Appendix D

Cora L. Fickinger	12/14/2018
Approving Authority	Effective Date

The use of this SOP is governed by the TEKLAB Quality Assurance Manual and associated SOPs including but not limited to 1030, 1031, 1250, 1280, 1290, and 1310. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling refer to SOP 1150.

The track changes are missing from this revision because this SOP is a total revision – the previous contents were deleted and replace with a new format and content.

DEFINITIONS

See SOP 2000

TEKLAB, INC.
STANDARD OPERATING PROCEDURE
Total Phosphorus by Semi-Automated Colorimetry

SCOPE

This method is to be used to determine the concentration of phosphorus in aqueous, non-aqueous, and solid samples. This method is used in the calculation of P_2O_5. Aqueous samples are preserved with H_2SO_4 to PH < 2. Holding time is 28 days. See LIMS for current test codes, MDLs, and PQLs.

SUMMARY

The SAN^{plus} analyzer is a fully closed automatic system that all samples and standards undergo the same treatment. Chemical analysis is accomplished on the SAN^{plus} analyzer using the principle of segmented (continuous) flow analysis. Total Phosphorus in the sample is digested in a block digestor with sulfuric acid, potassium sulfate and cupric sulfate as a catalyst to convert all forms of phosphorus into ortho phosphate. Sample is mixed with a solution made from ammonium molybdate, potassium antimony tartrate, sulfuric acid, and ascorbic acid to form an antimony-phospho-molybdate complex. The ascorbic acid reduces the complex to an intense blue complex measured at 660 nm. The Total Kjeldahl Nitrogen and Total Phosphorus digestion procedures are the same; therefore, they may be analyzed on the SAN^{plus} analyzer simultaneously, from the same digestion tube.

SAFETY

Eye protection and gloves are required for this procedure. Use caution when pouring concentrated acids. Also, use caution when dealing with concentrated acids, elevated temperatures, and heavy metals. Any spills must be cleaned up immediately. The fume hood must be on and sash pulled down to the 100 feet/min mark at minimum at all times during digestion to contain fumes produced by digestion process. See the appropriate SDS for more detailed safety information; especially review the SDS on the following chemicals: Sulfuric Acid and Sodium Hydroxide.

EQUIPMENT AND SUPPLIES

1. SAN^{plus} analyzer – Automated analytical equipment (continuous segmented flow) consists of components shown in Diagram 1.
2. Skalar Flow Access Version 2.0.15 (32 bit)
3. Glassware – Class A volumetric flasks and pipettes, as required.
4. Sample tubes-16x100 (glass)
5. 15 mL graduated dilution tubes

REAGENTS and STANDARDS(Quality Manual Chapter 23)

1. *General laboratory deionized water (DI water):* Refer to section 26.6 of the Quality Assurance Manual for further description.
2. *Digestion Solution:* While stirring in a hood, dissolve 268 g potassium sulfate (K_2SO_4) and 14.6 g $CuSo_4$ in ~1400 mL of DI water. Slowly add 268 mL of concentrated H_2SO_4. Caution: Solution will become very hot! Allow solution to cool and dilute to 2L in a volumetric flask with DI water.
3. *Sodium Chloride Solution*: Dissolve 80 g sodium chloride (NaCl) in 2L of DI water. Solution may be divided into separate 1 L portions, one for TKN analysis and the other for TP analysis. For TP analysis, add ~2 mL FFD6. Expiration is three months from preparation.
4. *Ammonium Molybdate Solution:* Dissolve 0.2 g potassium antimony tartrate and 8.0 g ammonium molybdate in DI water and dilute to 1L, then add ~2 mL FFD6. Expiration is three months from preparation.
5. *Ascorbic Acid Solution*: Dissolve 60 g ascorbic acid and 2 mL of acetone in DI water and dilute to 1L. Expiration is three months from preparation.
6. *Sulfuric Acid Solution (4%)*: Dilute 40 mL of concentrated sulfuric acid to 1L with DI water.
7. *Phosphorus Rinsing Liquid*: Dilute 400 mL of digestion solution to 1L with reagent water.
8. *1000 ppm Phosphorus as P stock standard*: Purchased from vendor.
9. *50 ppm Intermediate phosphorus as P standard, for standard curve*: Dilute 12.5 mL of 1000 ppm phosphorus as P stock solution to 250 mL with DI water. Expiration is three months from preparation.
10. *1000 ppm Phosphate as P stock standard, for ICV/CCV*: Purchased from vendor.

The reagents listed above have an expiration period of 12 months unless noted above. Above reagents stored on bench unless noted above. Standards and reagents purchased from vendors expire one year from the day they are opened unless the vendor expiration date precedes that date.

Concentrations of purchased standards may change; if concentrations do change, adjustments will be made to make the appropriate stock solutions.

CALIBRATION (Quality Manual Chapter 22)

See Autoanalyzer QC spreadsheet located in the Automated Inorganics folder on the F drive of the Teklab Data Server for current curve and QC concentrations and spike amounts. F:\Automated Inorganics\Autoanalyzer QC.xls. This QC page can also be found within the TKN-TP Excel template file for daily analysis, also located on the F drive.

The calibration curve is made by diluting a 50ppm solution in 10 mL of rinsing liquid. Calibration standards are made by diluting a 1000 ppm Phosphate as P standard in 10 mL of rinsing liquid.

A new curve is made fresh every time calibration is required.

For more detailed calibration information see SOP 2000

Calibration Requirement	Acceptance Criteria	Frequency
PQL Curve Standard	80-120 % recovery	1/36 hours
Other Curve Standards	90-110 % recovery	1/36 hours
QCS	90-110 % recovery	1/batch*
ICB	≤MDL**	Immediately after calibration
ICV	90-110 % recovery	Immediately after calibration
CCB	≤PQL**	1/10 Samples
CCV	85-115 % recovery	1/10 Samples

*A QCS is only required when a previously analyzed curve is used for analysis.

QUALITY CONTROL (Quality Manual Chapter 26)

See Autoanalyzer QC spreadsheet for current QC concentrations and spike amounts.

QC Requirement	Acceptance Criteria	Frequency
MBLK	≤MDL**	1/batch
LCS	85-115 % recovery	1/batch
MS/MSD	85-115 % recovery	1/10 Samples
MSD	15% RPD	1/10 Samples
Duplicate	15% RPD	All solid samples and sample recheck

**An ICB/MBLK must not be more negative that the MDL. A CCB must not be more negative than the PQL.

A LCS is prepared by spiking 10 mL of digestion solution with the combination spike solution.

A MS/MSD is prepared by spiking 25 mL (or a dilution there of) of sample with the combination spike solution.

See SOP 2400 for the TKN/TP prep procedure and additional QC sample information.
See SOP 2000 for additional Quality control information.
See SOP 1020 for Control Charting Procedure.

CORRECTIVE ACTION (Quality Manual Chapter 13)

Problem	Potential Corrective Action
Noise in sample peaks/CCB issues	Check that proper rinsing liquid is connected Replace rinsing liquid bottle Remake rinsing liquid Clean instrument
Low or High LCS recoveries	Check for hangar granules Check block temperature Remake combination spike solution Remake digestion solution

	Clean glassware
Method Blank contamination	Check that proper rinsing liquid is connected Clean glassware
Baseline Drift	Invert flowcell to remove any trapped air Reseat flowcell in detector Monitor bubble pattern for issue
Baseline Noise	Change reagents Change pump tubing Check for sensitivity change or baseline shift Monitor bubble pattern for issue Clean instrument
Sensitivity change/Baseline Shift	Change lamp in detector Change wavelength filter Change reagents Monitor bubble pattern for issue

For general QC corrective actions see corrective action flow charts in SOP 2000.
All other corrective actions are performed in accordance with Quality Manual Chapter 13.

INTERFERENCES

High silica concentrations cause positive interference. Arsenate reacts with the molybdate reagent to produce a blue color similar to that formed with phosphate causing a positive interference. Concentrations as low as 0.1 mg As/L interfere with the phosphate determination. Hexavalent chromium and nitrite interfere to give results about 3% low at concentrations of 1 mg/L and 10-15% low at 10 mg/L. Samples for total phosphorus should be filtered only after digestion.

ANALYTICAL PROCEDURE

Prior to analysis, samples are prepped following the procedure outlined in SOP 2400. The digestates from this prep procedure are analyzed on the instrument according to the following procedure.

1. Connect all pump deck tubing as shown in Diagram 1.
2. Prepare, fill and connect reagents.
3. Prepare loading guide.
4. With the instrument computer turned on, turn on the instrument interface, pump deck, and sampler (in order).
5. After the sampler has initialized, open Flow Access program and enter your user name and password.
6. Select active system followed by TP module.
7. Change communication light to green to start reagents pumping.
8. Turn on the reactor (set to 37°C).
9. Use remote in flow access to change sample time to 60 sec and wash time to 90 sec, air time 1 sec.
10. If a new curve will be analyzed, open the TP Method and select the “Calibration” tab. Ensure “Calibrate” is checked and the correct Calibration Type (First Order Forced-Thru) is selected.

11. If a prior curve is to be used for analysis, open the TP Method and select the "Calibration" tab. Uncheck "Calibrate" and select run file to use for calibration.
12. Close method and use the check mark to select the TP module on the main screen.
13. Open the Realtime window to ensure a stable baseline is established.
14. Prepare and load the curve in the appropriate positions according to the Flow Access table.
15. Load all QC and samples (digestates) in the sampler trays, per loading guide. Label all sample tubes with QC ID, sample ID, and dilution.
16. Select the appropriate Flow Access Table (curve vs. no curve). Copy and paste the Excel loading guide into the Flow Access Table, matching tray positions and dilutions exactly. Insert a QC bracket, consisting of an Ignore, CCB, CCV, Drift, and Wash (in that order) at least every 10 samples. Space samples where needed with additional Ignores.
17. Once a stable baseline has been established, close the Realtime window and click the Start icon to begin analysis. Note: Analysis will not begin until the Realtime window is closed.
18. Open Realtime window to monitor analysis. After initial Wash, the Results window may be opened to monitor analysis.
19. Monitor run, checking calibration and QC results. Additional samples or dilutions and QC samples may be added as needed.
20. If run must continue after work hours, select the "Enable Time Program" button to ensure run stops after the last Wash.
21. Once run is complete, continue to Data Analysis and Calculations.

ROUTINE MAINTENANCE

Prior to the first analysis of the day, the instrument must be cleaned with a ~1% Hypochlorite solution for 15-30 minutes, followed immediately by a DI water rinse (15-30 minutes). This is documented on the Data Packet Cover Sheet for every day of analysis. Rinse the instrument between analyses for 15-30 minutes with DI water.

Monthly, or more often as needed, replace all pump deck tubing and sample lines. This and all other maintenance performed on the instrument must be documented in the instrument maintenance section in LIMS.

DATA ANALYSIS and CALCULATIONS:

After run is complete check for proper marking of peaks and QC compliance, and then print the curve, realtime graph, calibration constants, and results. The results pages should include position, type, Sample ID, external dilution, result, height, corrected height, and time. Go through data, highlighting all samples to be reported.

Run data from Flow Access is copied and pasted directly into the TKN/TP Excel file, which generates a .CSV file to be uploaded directly into LIMS, including all dilution factors or prep factors. Samples with dilutions are back-calculated by the Excel file so that the raw, rather than final result is uploaded into LIMS.

Any dilution factor or preparation factors must be documented on data package and when entering data into the LIMS. Report only those values that fall between the lowest and highest calibration standard. Samples exceeding the highest standard concentration must be diluted within range of the standard curve. Samples that are diluted below the PQL must be reanalyzed at a lesser dilution or reported with qualifiers and/or comments. Add all appropriate comments for qualifiers where needed.

After results are entered into the LIMS, a quality review is performed.

Date on raw data is displayed in yy/mm/dd format.

Concentration mg/L = X *PF*DF

Where,

X = sample result
PF = Prep Factor
DF = Dilution Factor

Solid samples may be calculated to a dry weight basis by using the Pmoist selection in LIMS. Samples requiring results on a dry weight basis will also request a total solids analysis. The technician assigned to the total solids analysis will enter the Pmoist result in LIMS. Once the Pmoist factor is entered, calculation of a sample in LIMS will convert the final result to a dry weight basis and change the units to mg/Kg-dry.

For more detailed calculation information see SOP 2000

$P_2O_5 = [TP_{(\text{raw concentration})} * PF * DF] * 2.29136$

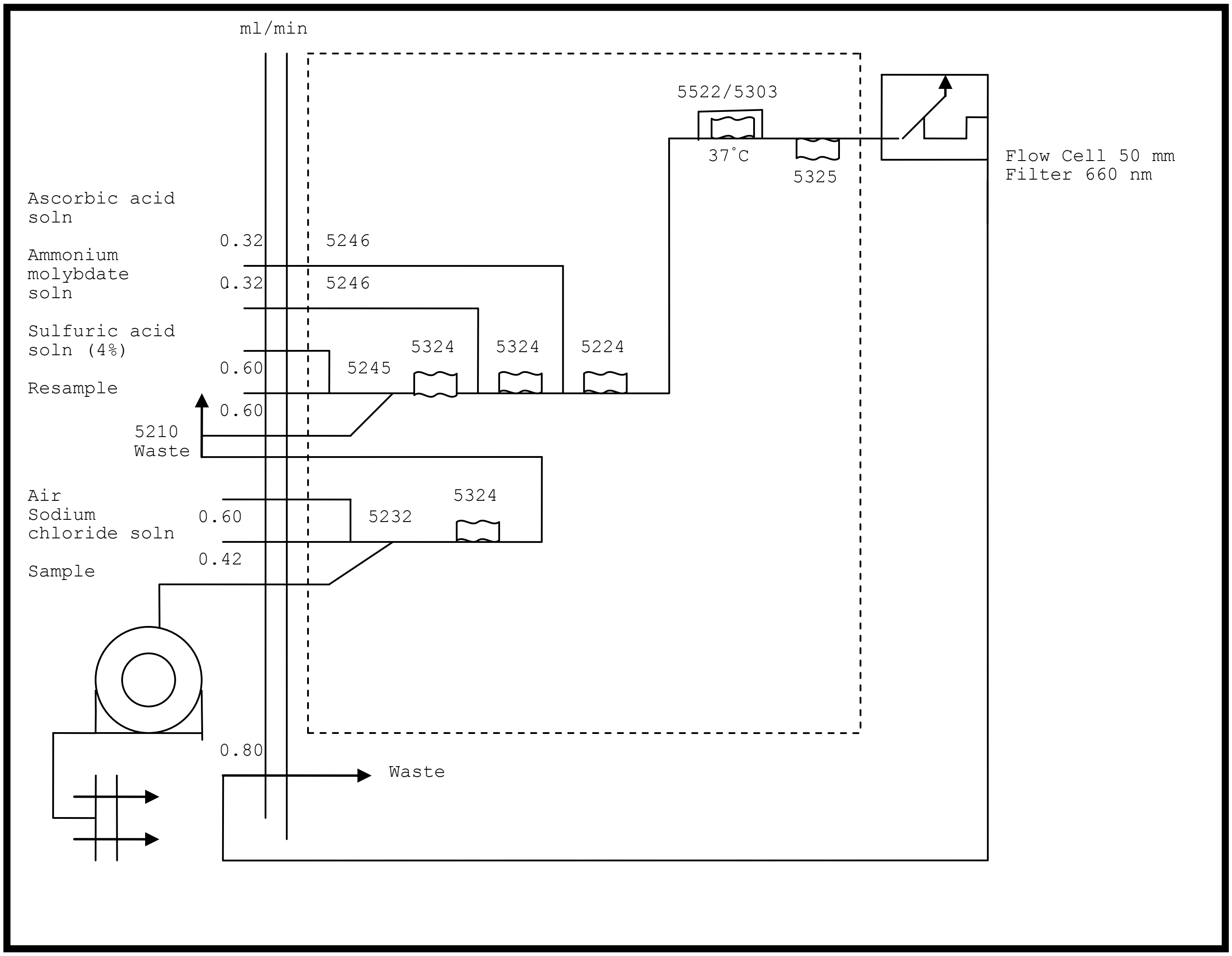
REFERENCES/ METHOD DEVIATIONS

EPA 365.4:

- If Total Phosphorus and Total Kjeldahl Nitrogen are requested on the same sample, they maybe analyzed from the same digestate and analyzed simultaneously on the autoanalyzer.
- Mercury free digestion solution is used as listed in TKN method EPA 351.2 to prevent mercury waste.
- 10 mL digestion solution is used per 25 mL of sample as listed in TKN method EPA 351.2.
- A 4% sulfuric acid solution is used in analysis, per manufacturer’s method, rather than 2% solution.

TABLES & DIAGRAMS

Diagram 1



METHOD PERFORMANCE

MDL/Method Validation: See Quality Manual Chapter 21
IDMP/ADOC: See Quality Manual Chapter 19

SAMPLE HANDLING

See SOP Appendix B

POLLUTION PREVENTION

See SOP Appendix D

WASTE MANAGEMENT

See SOP Appendix D

Cora L. Fickinger 12/14/2018
Approving Authority Effective Date

*The effective date reflects the implementation date. Which is the date the new information was added into the PDF copy of the SOP.

The use of this SOP is governed by the TEKLAB Quality Assurance Manual and associated SOPs including but not limited to 1030, 1031, 1250, 1280, 1290, and 1310. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling refer to SOP 1150

DEFINITIONS

See SOP 2000

TEKLAB, INC.
STANDARD OPERATING PROCEDURE
ICP ANALYSIS

SCOPE

Inductively coupled plasma optical emission spectroscopy (ICP-OES) is used to determine trace metal and some non-metal concentrations in solution. This procedure is applicable to the determination of concentration of elements listed in Table 1 in drinking waters, aqueous samples, TCLP/SPLP/Shake extracts, solids, oils, wipes, air cartridges and non-aqueous liquids. See LIMS for current test codes. Aqueous samples are preserved with HNO_3, pH<2. Holding time for ICP samples is 6 months. All samples except dissolved samples and Drinking Waters with turbidity <1 NTU require digestion prior to analysis. See the most recent versions of metals digestion SOPs (3029, 3032, and 3034) for appropriate methods and procedures. This analysis is capable of analyzing sample concentrations from the Method Detection Limit (MDL) to the upper Linear Dynamic Range (LDR). See LIMS for most up to date MDLs, PQLs and LDRs for each analyte. See Teklab 1000 series SOP Appendix C for MDL calculations and definitions.

SUMMARY

An aliquot of well mixed, homogeneous aqueous or solid sample is accurately weighed or measured (approximately 50 ml of liquid or 0.50 g of a solid) for sample processing. For total recoverable analysis of a solid or an aqueous sample containing undissolved material, analytes are solubilized by gentle refluxing with nitric acid, hydrochloric acid and hydrogen peroxide (solids only). After cooling, the sample is diluted up to volume and filtered as needed. For the determination of dissolved analytes in a filtered aqueous sample aliquot, the sample is made ready for analysis by the appropriate addition of nitric acid and hydrochloric acid, and then diluted to a predetermined volume and mixed before analysis. For the determination of analytes in a non-filtered Drinking Water with turbidity <1 NTU, the sample is prepared per SOP 3034 prior to direct analysis. See the metals preparation SOPs for additional information on preparation techniques.

The analysis described in this method involves multi-elemental determinations by a Varian Vista-MPX CCD Simultaneous ICP-OES Spectrometer (ICP3) and/or Agilent Technologies 720 ICP-OES (ICP4). The instruments measure characteristic atomic and ionic line emission spectra by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element specific emission spectra are produced by radio frequency inductively coupled plasma. The spectra are dispersed by the Echelle spectrometer where light is dispersed along two axes by both a grating and a prism and then focused onto the charged coupled device (CCD) chip. The megapixel detector chip simultaneously measures the complete sample spectrum with over one million active detectors. The CCD chip is a two-dimensional detector where individual resolution elements (pixels) are independently and electronically accessible. The detector is mounted on a two stage peltier device and cooled to -30 degrees Celsius for ICP3 and -35 degrees Celsius for ICP4 for low dark current and improved stability. Photocurrents from the CCD are partially processed by a built in on-board controller in the spectrometer. However, most computations converting intensity to concentration are performed on the host personal computer. The technique used for quantitative determinations is off-peak background and interelement corrections of the measured concentration and adjustment with any dilution factors.

SAFETY

Extreme caution must be exercised, as the concentrated acids and heavy metals used in the department have the potential for adverse health affects. Protection such as safety glasses and gloves must be worn; a lab coat is provided and is strongly recommended. High voltage is required to operate this instrument. Only properly trained service technicians can perform maintenance that requires the cover to be removed from the instrument. High temperature surfaces exist and care must be taken when working around them. Samples, standards, and reagents contain acids and other known or unknown hazards; use caution when handling them. See the appropriate SDS for more detailed safety information: Hydrochloric Acid, Nitric Acid, *Hydrofluoric Acid*, Hydrogen Peroxide and Cesium Chloride.

Hydrofluoric Acid – Only a small amount (<100 mL 48% HF) is purchased and stored in the metals department. Only individuals that are properly trained on how to handle HF are allowed to use HF. A 10 mL aliquot of 1-10% HF solution is used weekly to clean the nebulizer.

EQUIPMENT & SUPPLIES

1. Varian Vista-MPX CCD and Agilent Technologies 720 ICP-OES with autosampler.
2. 99.999% Argon gas supply
3. Computer with instrument specific software and Printer
4. Class A glassware
5. Air displacement pipetters (2 µl-20 µl, 20 µl-200 µl, and 100 µl-1000 µl)
6. 17 x 100mm or 13 x 100mm culture tubes
7. 17 ml centrifuge tubes
8. 10ml syringes with 0.45µm syringe filters

REAGENTS AND STANDARDS (Quality Manual Chapter 23)

1) All reagents must be analytical grade or better and all standards must be traceable to NIST standards.
2) See the most recent version of SOP 3070 for standard preparation, storage, and tracking information.
3) Trace metal grade concentrated Nitric Acid
4) Trace metal grade concentrated Hydrochloric Acid
5) Plasma grade stock solutions. For all custom stock standards, refer to the Analytical category in LIMS under Spike/Standards for analytes and concentrations.
6) Standardization Blank, Initial and Continuing Calibration Blank (ICB/CCB) in a 2% v/v nitric acid and 5% v/v hydrochloric acid matrix. Add 500 ml of trace metal grade concentrated nitric acid and 1250 ml trace metal grade hydrochloric acid to approximately 15L of metals lab deionized water and dilute to 25L mark in Nalgene container. Refer to section 26.5 Quality Assurance Manual for further description of metals lab deionized water.
7) Calibration Standards:
    a. Calibration Standard #1 – From 1000 mg/L single element stock standards, add 0.5ml of Ag, 1.0ml of each As, B, Be, Co, Cr, Cu, Mn, Mo, Sb, Se, Sr, Tl, and V, 2.0ml of each Al, Ba, Cd, Fe, Ni, Pb, Sn, and Zn; and from 10,000 mg/L single element stock standards, add 0.5ml of each Ca and Mg, and 1.0ml of Na to a 1000ml volumetric flask containing approximately 500ml of standardization blank water. Dilute to final volume of 1L with standardization blank water and mix well. If there is a custom standard available; add 10 mL of ICP Cal 1 Solution #1 and ICP Cal 1 Solution #2 to a 1000 mL volumetric flask containing

approximately 500 mL of standardization blank water. Dilute to final volume of 1L with standardization blank water and mix well. See Table 2 for final analyte concentrations.

b. Calibration Standard #2 – Add 100ml of Interference Check Standard #1 (ICM-441) Stock Solution to a 1000ml volumetric flask containing approximately 500ml of standardization blank water. Dilute to final volume of 1L with standardization blank water and mix well. See Table 2 for final analyte concentrations.
c. Calibration Standard #3 – From 1000 mg/L single element stock standards, add 1.0ml of each Li, Si, and Ti and 2.0ml of Zn; and from 10,000 mg/L single element stock standards, add 0.5ml of each P and S and 30ml of Na to a 1000ml volumetric flask containing approximately 500ml of standardization blank water. Dilute to final volume of 1L with standardization blank water and mix well. If a custom standard is available, add 10 mL of ICP Cal 3 Solution and 0.5 mL of Si 1,000 mg/L single standard to a 1000 mL volumetric flask containing approximately 500 mL of standardization blank water. Dilute to final volume of 1L with standardization blank water and mix well. See Table 2 for final analyte concentrations.
d. Calibration Standard #4 –0.1 mg/L K See Table 2 for final analyte concentrations and LIMS for preparation.
e. Calibration Standard #5 –1.0 mg/L K See Table 2 for final analyte concentrations and LIMS for preparation.
f. Calibration Standard #6 –10.0 mg/L K See Table 2 for final analyte concentrations and LIMS for preparation.

8) Initial and Continuing Calibration Verification Standards (ICV/CCV)—The ICV and CCV may be the same source, but that source must be independent or a different lot number than the calibration standards. Add 2.0ml of each custom standard stock solution (ICUS-3281, ICUS-3282, and ICUS-3283); and from 1000 mg/L single element stock standards, add 1.0ml of P and S to a 2000ml volumetric flask containing approximately 1000ml of standardization blank water. Dilute to final volume of 2L with standardization blank water and mix well. See Table 2 for final analyte concentrations.
9) Initial and Continuing Calibration Verification Standards High (ICV High/CCV High)— From 10,000 mg/L single element stock standards, add 0.5ml of each Al, Fe and Zn, 1.0ml of Ca and Mg, and 2.0ml of Na to a 1000ml volumetric flask containing approximately 500ml of standardization blank water. Dilute to final volume of 1L with standardization blank water and mix well. If a custom standard is available, add 2 mL ICP ICV/CCV High Custom Standard to a 2000 mL volumetric flask containing approximately 1000 mL of standardization blank water. Dilute to final volume of 2L with standardization blank and mix well. See Table 2 for final analyte concentrations.
10) PQL Standard – Add 10ml of PQL Custom Standard Stock Solution (ICUS-3923) to a 1000ml volumetric flask containing approximately 500ml of standardization blank water. Dilute to final volume of 1L with standardization blank water and mix well. See LIMS for final analyte concentrations
11) Interference Check Standards:
    a. Interference Check Standard A (ICSA) – Add 100ml of Interference Check Standard #1 (ICM-441) Stock Solution to a 1000ml volumetric flask containing approximately 500ml of standardization blank water. Dilute to final volume of 1L with standardization blank water and mix well. See Table 2 for final analyte concentrations.
    b. Interference Check Standard AB (ICSAB) – Add 100ml of Interference Check Standard #1 (ICM-441) Stock Solution, 10ml of Interference Check Standard #2 (ICM-442) Stock

Solution, 0.50ml of each Sb, As, Se, Sr, Mo, and Tl from 1000 mg/L single element stock standards, and 1.0ml of each B, Li, P, S, Si, Sn, and Ti from 1000mg/L single element stock standards, and 1.0ml of each K and Na from 10,000 mg/L single element stock standards to a 1000ml volumetric flask containing approximately 500ml of standardization blank water. Dilute to final volume of 1L with standardization blank water and mix well. See Table 2 for final analyte concentrations.

12) Quality Control Sample (QCS) – Add 5ml of the ICP Multi-element Laboratory Performance Check Standard, 0.4ml of Na and Ca, and 0.1ml of S and Ti from 1000 mg/L single element standards into a 100ml volumetric flask with approximately 50ml of standardization blank water. Dilute to final volume of 100ml with standardization blank water and mix well. See Table 2 for final analyte concentrations. These standards must be from an independent source or lot number different than the calibration standards. The QCS is analyzed quarterly. QCS must be within +/- 5% of the stated value to be acceptable.
13) LCS and MS/MSD samples are prepared at concentrations indicated in LIMS (for preparation see the most recent version of SOPs 3029, 3032, and 3034). The LCS and MS/MSD may be the same source, but must be from an independent source or lot number different than the calibration standards.
14) Ionization Suppression Agent and Internal Standard Solution – Add 10 grams of Cesium Chloride (CsCl) and 1.0ml of each Yttrium and Scandium from a 10,000 mg/L single element stock standard (or 10.0ml of 1,000 mg/L) to 1000ml of standardization blank water and mix well.

All prepared standards and reagents expire six months from date of preparation, unless otherwise stated in the SOP. All purchased stock standards and reagents expire on the manufacturer's indicated expiration date or one year after open date if expiration date not specified.

CALIBRATION (Quality Manual Chapter 22)

Drinking water requirement in ()

Calibration Requirement	Acceptance Criteria	Frequency
Calibration Curve	>0.995	Daily
ICB	< PQL or CRQL(<MDL)	1/Calibration Curve
CCB	< PQL or CRQL(<MDL)	1/10 Samples
ICV/ICV High(EPA/SM)	95-105% recovery	1/Calibration Curve
ICV/ICV High(SW-846)	90-110% recovery	1/Calibration Curve
CCV/CCV High(SM)	95-105% recovery	1/10 Samples
CCV/CCV High(EPA/SW-846)	90-110% recovery	1/10 Samples
PQLSTD (PQLSTD LL)	50-150% recovery	1/Calibration Curve
ICSA	80-120% recovery; all unspiked analytes < PQL or CRQL	1/Calibration Curve
ICSAB	80-120% recovery	1/Calibration Curve

1. This analysis utilizes a blank and single standard (elements are separated into 3 solutions) for daily calibration (with the exception of Potassium, which utilizes a blank and three standards for calibration due to an ionization interference). A multical software feature is used for specific

elements (Al, Ca, Fe, Mg, Na and Zn) in order to meet the sensitivity required while extending the linear dynamic range. The instrument is set-up to calibrate using two different wavelengths and ranges for these elements. For example, Fe 238.204nm is calibrated with a blank and 2mg/L standard and Fe 261.882nm with a 2mg/L and 200mg/L standard. Fe results that are <2mg/L will be reported from Fe 238.204nm and results >2mg/L will be reported from 261.882nm. The correlation coefficient for Potassium must be at least 0.995 for the curve to be acceptable. Since the other elements operate under a single point calibration, their correlation coefficient is always 1.0. The instrument software automatically calculates the correlation coefficient.

2. An initial calibration blank (ICB) is analyzed immediately after calibration and a continuing calibration blank (CCB) after every tenth sample. The result of this analysis must be less than the PQL for the curve to be valid (must be less than MDL for drinking water analysis). If the measured value is outside the PQL range the curve is not validated. The problem must be identified and corrected prior to the analysis of samples. Samples are acceptable if they are non-detects or ten times the contamination.
3. Immediately after ICB a quality control (ICV & ICV High) sample is analyzed. The ICV High is used to evaluate the less sensitive wavelengths and must meet same criteria as ICV. This sample must be from a source different from the calibration standards. The measured value of this sample must be within 10% of the true value for the curve to be validated for SW-846 6010B and 5% for EPA 200.7 R4.4 and SM 3120B. The %RSD must be 3.0% or below for EPA and standard method and 5.0% or below for SW-846. If the measured value is outside the acceptance criteria, the curve is not validated. The problem must be identified and corrected prior to the analysis of samples.
4. The same quality control (CCV & CCV High) sample is subsequently analyzed after every tenth sample. The CCV High is used to evaluate the less sensitive wavelengths and must meet same criteria as CCV. The measured value of this sample must be within 10% for SW-846 and EPA and 5% for standard methods of the true value for the curve to have continued verification. The %RSD must be 5.0% or below for all methods. If the measured value is outside the acceptance criteria, the problem must be identified and corrected and the previous ten samples must be reanalyzed (with a subsequently acceptable QC) prior to reporting results. High recoveries are acceptable if the samples are non-detects.
5. Directly following the ICV High a reporting limit (PQLSTD/PQLSTD LL) sample is analyzed. A low level reporting limit sample is analyzed if a specific CRQL is required. This sample must be from a source independent from the calibration standards. The measured value of this sample must be within 50% of the true value with a %RSD of approximately 20.0% for the curve to be validated for all methods. If the measure value is outside the acceptance criteria, the problem must be identified and corrected prior to the analysis of samples.
6. Right after the PQLSTD an interference check (ICSA) sample is evaluated. This sample must be from a source independent from the calibration standards. The measured value for this sample for all spike analytes must be within 20% of the true value. All unspiked analytes must be below the reporting limit or CRQL. If these conditions are not met, the problem must be identified and corrected prior to the analysis of samples.
7. Immediately following the ICSA another interference check (ISCAB) sample is analyzed. This sample must be from a source independent from the calibration standards. The measured value for this sample must be within 20% of the true value. If these conditions are not met, the problem must be identified and corrected prior to the analysis of samples.

The following is an outline of a typical ICP run and the acceptable Quality Control Limits:

Blank	
CAL	> 0.995
ICB	< PQL/CRQL (MDL for DW)
ICV	+/- 10% with <5% RSD (+/-5% with <3% RSD for SM 3120B and EPA 200.7)
ICV High	+/- 10% with <5% RSD (+/-5% with <3% RSD for SM 3120B and EPA 200.7)
PQLSTD	+/- 50%
PQLSTD LL	+/- 50%
ICSA	+/- 20% all unspiked analytes should be < PQL/CRQL
ICSAB	+/- 20%
MBLK	< MDL or <10% of lowest sample in the batch
LCS	+/- 15%
1st - 8th Samples	
CCB	< PQL /CRQL
CCV	+/- 10% with <5%RSD (+/- 5% for SM 3120B)
CCV High	+/- 10% with <5%RSD (+/- 5% for SM 3120B)
9th Sample	
10th Sample	
10th Sample MS	+/- 25%
10th Sample MSD	+/- 25% (<20% RPD)
11th – 16th Sample	
CCB	< PQL/CRQL
CCV	+/- 10% with <5%RSD (+/- 5% for SM 3120B)
CCV High	+/- 10% with <5%RSD (+/- 5% for SM 3120B)

Note that MBLK, LCS, MS and MSD samples are counted as samples when determining when the CCB and CCV are required. If client request reporting below the PQL then the CRQL must be used in place of the PQL as the control.

QUALITY CONTROL (Quality Manual Chapter 26)

Drinking water requirement in ()

Calibration Requirement	Acceptance Criteria	Frequency
MBLK	< MDL	1/batch
LCS	85-115 % recovery	1/batch
QC	See LIMS	1/solid batch
MS/MSD	75-125 % recovery	1/10 samples
MSD RPD	20 %	1/10 samples
Sample RSD	20 %	n/a

1. MBLK (Method Blank) – An aliquot of reagent water or other blank matrices that is treated exactly as a sample and taken through the entire analytical procedure. The MBLK is used to determine potential laboratory contamination. This sample is prepared and analyzed at a rate of once per batch or once per twenty samples, whichever is more frequent. The measured value of the MBLK must be less than the MDL for the analyte of interest (must be less than MDL for drinking water analysis). If the measured value is outside the acceptance criteria, sample values

may only be reported with comment in LIMS if the samples measured value is less than the PQL or if the sample value is greater than ten times the level of contamination. Corrective action when the MBLK is outside the acceptance criteria is to find the source of contamination, correct the problem, re-prepare samples and reanalyze.

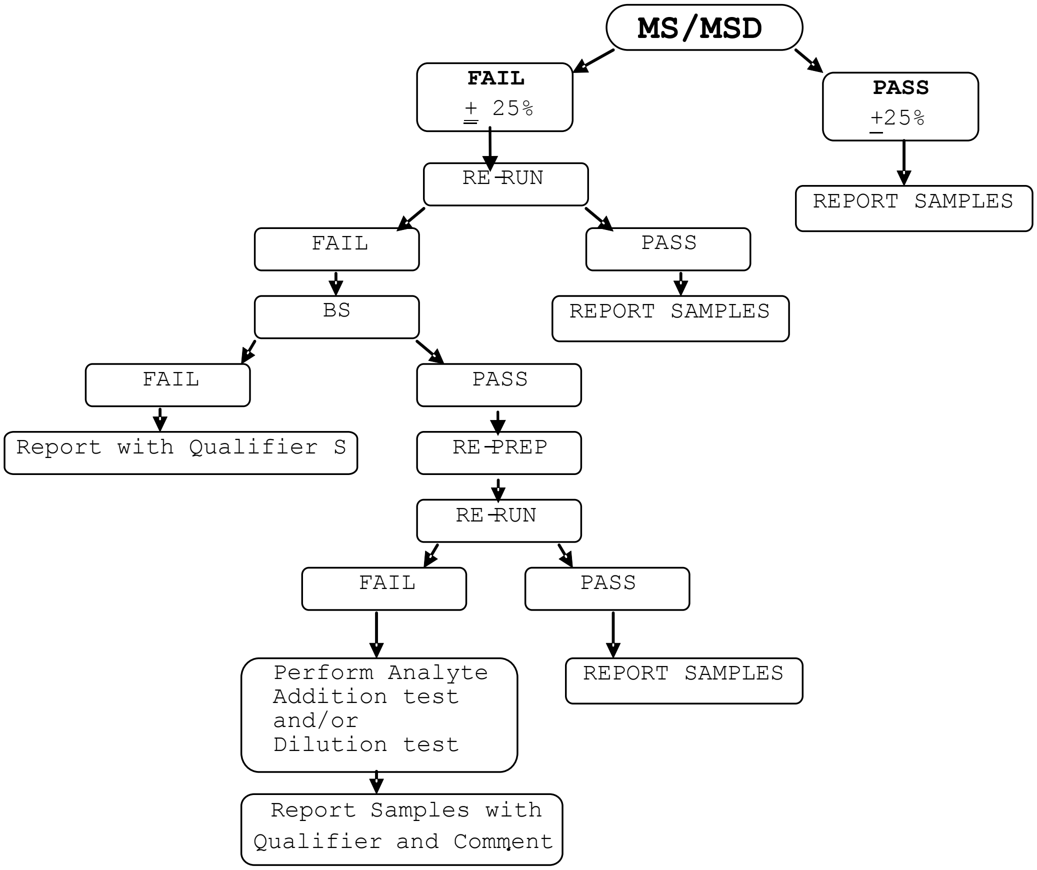
2. LCS (Laboratory Control Sample) – An aliquot of reagent water or other matrices to which known quantities of the method analyte is added. This sample is a source or lot different than the calibration standards. This sample is taken through the entire analytical procedure. The LCS is used to determine whether the method is in control and determine the precision and accuracy of analysis. This sample is prepared and analyzed at a rate of one per batch or once per twenty samples, whichever is more frequent. The measured value of the LCS must be within 15% of the true value. See LIMS for final analyte concentrations. Measured values outside the acceptance criteria may be reanalyzed one time during a single calibration. If the results are still outside the control limits corrective actions (see 1000 series SOP appendix E) to determine the cause of the problem, correction of the problem and reanalysis of the LCS prior to analysis of the samples associated with that LCS is required. If adjustments to the instrument and/or calibration curve and subsequent reanalysis are outside the acceptance criteria, the batch of samples associated with that LCS (for the analyte in question) must be re-prepared and reanalyzed. If LCS recovery is above the upper control limit, any samples that are non-detects may be reported with a sample comment in LIMS. Samples may also be reported with an LCS not within acceptance limits if the LCS meets the marginal exceedance criteria (see Teklab Inc. Quality Manual).
3. MS/MSD (Matrix Spike/Matrix Spike Duplicate) – A randomly selected aliquot of an environmental sample to which known quantities of the method analyte is added in the laboratory. The MS/MSD may be from the same source as the LCS, but must be from a source or lot independent of the calibration standards. The samples are taken through the entire analytical procedure. A separate (unspiked) sample is used to determine the samples background levels of the method analytes. This sample is used to determine whether the sample matrix contributed bias to the analytical results. The duplicate sample (MSD) is used to verify any matrix contributions to bias and to validate the reproducibility of aqueous results. These samples are analyzed at a rate of, at least, once per ten samples per matrix and preparation type (chosen randomly amongst different client's samples). See Quality Manual for matrix Spike selection criteria. See LIMS for final analyte concentrations. The acceptance criteria for the MS and MSD recoveries are +/- 25% of the true value. The acceptance criterion for the reproducibility (RPD) is 20%. Results not meeting the MS or MSD acceptance criteria can be validated by bench spiking. The sample reproduction of the unacceptable results indicates that the recoveries are due to matrix effects. An analyte addition test and/or a dilution test may also be used to confirm matrix interference. Matrix interference is to be noted with a sample comment in LIMS. The reason for poor recoveries or RPD outside the acceptance criteria must be determined, the problem solved and the sample re-prepared prior to reporting results. Samples with a high sample/spike ratio are acceptable and are reported with a sample comment in LIMS. Out of control spike recoveries are flagged with an "S" in the qualifiers column of LIMS and Quality Control reports. Out of control RPD results are flagged with an "R" in the qualifiers column of LIMS and Quality Control reports. See flow chart in following section.
4. QC (Quality Control) – A matrix matched Quality Control sample is added to every soil batch. The Certified Soil Reference Material is purchased through vendor ERA, catalog number 540. See LIMS for specific concentrations and acceptance criteria.

See SOP 1020 for Control Charting Procedure.

CORRECTIVE ACTION (Quality Manual Chapter 13)

Problem	Potential Corrective Action
No or Low Signal for Standards/Samples	Standards/Samples/Internal Standard is not pumping properly Argon gas is not flowing properly Check tubing for excessive fatigue Check tubing for plug
Low signal for Internal Standard (IS)	IS solution empty Difficult sample matrix IS tubing plug IS tubing disconnected
Plasma extinguished unexpectedly	Drain line not draining properly Excessive moisture in transfer tube Excessive moisture in torch Torch and/or cone excessive build-up Nebulizer is not aspirating sample in spray chamber Difficult sample matrix Water not flowing properly in RF coil
RF unattainable	Possible power tube problem
RF failure	Possible RF box problem
Poor Precision	Check tubing or sample probe for plug Check tubing for excessive fatigue Check sample for difficult matrix Check transfer tube fittings Check all gas line fittings Clean nebulizer Clean spray chamber

All other corrective actions are performed Quality Manual Chapter 13.



INTERFERENCES

Spectral, physical, and chemical interferences are the most common interferences in ICP-OES.

Spectral interferences are caused by background emission from continuous or recombination phenomena, stray light from the line emission of high concentration elements, overlap of a spectral line from another element, or unresolved overlap of molecular band spectra. Subtracting the background emission determined by measurement(s) adjacent to the analyte wavelength peak can usually compensate for background emission and stray light. The background location(s) selected must accurately represent background intensities and must be selected to avoid any nearby matrix emission lines. Spectral overlaps can be compensated by inter-element correction (IEC) equations. See the appropriate section of the EPA 200.7 R4.4 or SW 846 6010 B for more details on IEC requirements. Normally, 100 mg/L single element solutions are sufficient. Higher concentrations for Al, Ca, Fe, Mg, Na and S are used due to the fact that these analytes are often found at high concentrations in samples. Interfering elements must be analyzed at the same time as the element of interest. When IECs are applied, their accuracy is verified daily, by analyzing spectral interference check solutions (ICSA and ICSAB). All IEC factors will be updated annually or when changes to the operation conditions warrant.

Physical interferences are effects associated with sample nebulization and transport processes. Physical interferences, especially high dissolved solids, are reduced by the use of a Teflon Burgener nebulizer and an internal standard. Samples high in physical interferences may also need to be diluted prior to analysis. Other solutions to physical interferences and explanations of other interferences can be found in EPA 200.7 R4.4 and SW 846 6010 B. Memory interferences caused by “carry over” effects from a previous sample can be reduced by using 60 second rinse time between samples. Boron, Iron, Molybdenum, and Sulfur are a few of the common elements that may have carry over issues if at significant concentrations. If memory interference is suspected, the sample must be reanalyzed after a long rinse period.

Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects and are highly dependent on matrix type and specific elements. Although ICP-OES is relatively free of chemical interferences due to the high temperature of the plasma, they can be minimized by careful selection of operating conditions (power, nebulizer flow, viewing height, etc) and by buffering the sample and matrix matching. An ionization interference results from a change in ionization equilibria because of an increase in the free electron population of the plasma, due to ionization of constituents of the sample. This occurs when easily ionized elements (Ca, Mg, Na, K, Fe, Al, Li, etc) are present in samples in high concentrations causing a possible suppression or enhancement of certain analytes. An agent such as Cesium can help eliminate the effects from the ionization interference. A 1.0% Cesium Chloride (CsCl) and an internal standard (Yttrium and Scandium) solution is introduced during analysis by utilizing the third channel on the peristaltic pump and a “Y” connector that mixes the sample with the CsCl solution.

PROCEDURE

Follow this daily operations checklist:

1. Verify that there is sufficient argon supply for the day’s operation.
2. Verify that there is sufficient room in the waste collection bottle to accommodate the day’s work.
3. Check that the purge gas system is working.
4. Verify that the cooling water recirculator is on and working. Check refrigerant system compressor fins for dust build up and vacuum if necessary.
5. Insert the autosampler probe into the blank rinse solution.
6. Perform a hard reset periodically of the spectrometer, software, and computer.
7. From the Instrument Setup window, check that the peltier cooling system is operating normally. Verify that the CID temperature is below –30ºC for ICP3 and -35 ºC for ICP4.
8. Lock the peristaltic pump pressure bars to apply pressure to the pump tubings.
9. Perform daily maintenance on the sample introduction system to insure a clean system.
10. Ignite the plasma and allow a 30 minute (ICP4) and 60 minute (ICP3) warm up time.
11. Optimize the peristaltic pump pressure bars until liquid flows smoothly.
12. Calibrate detector while aspirating blank rinse solution and store dark current measurement data by clicking “Store Detector Calibration”.
13. Perform a wavelength calibration while aspirating the wavelength calibration solution (5 ppm Al, As, Ba, Cd, Co, Cr, Cu, Mn, Ni, Pb, Se, Mo, Sr, and Zn and 50 ppm K).
14. Perform a horizontal and vertical torch alignment scan while aspirating a 5 ppm Mn or the wavelength calibration solution.
15. Verify the amount of CsCl/Internal Standard solution is sufficient for analysis.
16. Load autosampler in sequence order according to the ICP Quality Control requirements.
17. Perform a two point calibration using the Calibration Blank and Calibration Standards (Calibration Standard #1, #2, and #3). Potassium is the exception performing a four point calibration using the Calibration Blank and Calibration Standards (Calibration Standard #4, #5, and #6). Flush the

system between standards for 60 seconds.

18. Insure that the instrument is calibrated properly and that all initial QC is within the acceptance limits previously defined prior to analyzing samples. If the calibration or initial QC is unacceptable, the reason must be determined and corrected before analysis of samples begin.
19. Analyze samples. The average value for three replicate integrations is automatically converted into concentrations (mg/l). Each element's average concentration, standard deviation, and %RSD are subsequently printed and kept on file. The file is to be saved based on the date of analysis in the format "yymmdd". Sample results must be quantified from the original instrument calibration.
20. Dilute and reanalyze samples that exceed the linear calibration range. Line switching to less sensitive wavelengths (MultiCal) is automatically set-up for some elements and will extend the linear range. Those elements that do not have automatic line switching or exceed 90% of the LDR of the less sensitive wavelengths must be diluted and reanalyzed manually. No results outside 90% of the LDR are to be reported.
21. Review all QC for the run of analysis. If the run is acceptable, calculate and report the results.
22. When all analyses have been completed, return the spectrometer to Standby Mode as follows:
23. Thoroughly rinse the sample introduction system by aspirating deionized water through it for a few minutes.
24. Extinguish plasma.
25. Release the pressure bars on the pump tubing.
26. All finished samples are to have the completion date written on the sample cup and stored in metals prep for a period of one month.

ROUTINE MAINTENANCE

Document all routine maintenance (except daily) in the LIMS instrument maintenance log. These items are only recommendations and the frequency is variable. Daily maintenance is documented on the Data Coversheet.

Daily	Replace torch Replace cone Clean transfer tube
Weekly	Replace peristaltic pump tubing Clean and/or replace nebulizer Clean torch box and RF coil Clean and/or replace spray chamber
Monthly	Check recirculator water level
Quarterly	Replace sample uptake tubing Tighten and/or replace transfer tube Clean exhaust filter Clean instrument, computer and autosampler Archive instrument data files
Biannual	Clean and replace water in recirulator Replace IS uptake tubing Replace Y connector Replace argon quick release fittings
Yearly	Replace sample probe Replace drain tubing

DATA ANALYSIS & CALCULATIONS

The qualitative aspects of this analysis are derived from characteristic and ionic line emission spectra by optical spectrometry. Element specific emission spectra are produced by radio frequency inductively coupled plasma. The spectra are dispersed by the Echelle spectrometer where light is dispersed along two axes by both a grating and a prism and then focused onto the charge coupled device (CCD) chip. The chip simultaneously measures the complete sample spectrum with over one million active detectors. The CCD chip is a two-dimensional detector where individual resolution elements (pixels) are independently, electronically accessible. Photocurrents from the CCD are partially processed by a built in on-board controller in the spectrometer.

The quantitative aspects of this analysis are derived when the above listed intensity is converted into concentration on the personal computer. Sample results must be quantitated from the initial instrument calibration.

After run is complete, check for proper QC compliance and print autosampler table, curve and results. Go through data and back calculate all dilutions. After everything is calculated, upload all data into LIMS including all dilution factors and prep factors. Report only those values that fall within the calibration range. Samples exceeding the LDR must be diluted. After results are entered into LIMS, a quality review is performed.

Report sample data in units of mg/L for aqueous samples, mg/kg dry weight for solid samples, and µg/L for landfill samples.

The ICPs can automatically correct analyte concentrations by calculating how much each interfering element adds/subtracts to the measured analyte concentration and adjusting the results accordingly. The assumption can generally be made that the relationship between an interfering element’s measured concentration and the amount that it contributes to the apparent analyte concentration is a constant (k). (See the User’s Guide for more detailed information). The calculation is as follows:

$$\text{k1} = \frac{\text{Apparent concentration of analyte}}{\text{Conc. of interfering element determined by the instrument}}$$

The k1 value for each element/wavelength are manually calculated and entered into the operating method.

The average of three replicate sample integrations is electronically converted into concentration (mg/L). Each element’s average concentration, standard deviation and %RSD are subsequently printed and kept on file.

For waters,

The final concentration (mg/L) = Instrument concentration (mg/L) x (A/B) x C

Where, A = final number of liters that the sample was diluted to (usually 0.05 L)
B = initial number of liters of sample prepared (usually 0.05 L)
C = any dilution factor

For soils,

The final concentration (mg/Kg-dry) = Instrument concentration (mg/L) x 1000 x (A/B) x C

Where, A = final number of liters that the sample was diluted to (usually 0.05 L)
B = initial number of grams of dried sample prepared (usually 0.5 g)
C = any dilution factor

The *LCS, MS and MSD recoveries* and the *Relative Percent Difference (RPD)* are calculated as follows:

$$1\text{st } \%MSR = \frac{X_2 - X_1}{\text{Spike conc.}} * 100$$

$$2\text{nd } \%MSR = \frac{X_3 - X_1}{\text{Spike conc.}} * 100$$

$$RPD = \frac{|(X_2 - X_3)|}{(X_2 + X_3)/2} * 100$$

Where,
X_1 = Concentration of unspiked sample, µg/L
X_2 = Concentration of 1st spiked sample, µg/L
X_3 = Concentration of 2nd spiked sample, µg/L

For Potassium Oxide (K_2O),

Potassium, Total (as K_2O), mg/kg-dry = 1.205 x [K, mg/kg-dry]

For Hardness,

Hardness by calculation is determined by computing the results of separate determinations of calcium and magnesium or calcium alone.

Hardness, mg equivalent $CaCO_3$/L = 2.497 x [Ca, mg/L] + 4.118 x [Mg, mg/L]
Calcium Hardness, mg equivalent $CaCO_3$/L = 2.497 x [Ca, mg/L]

For Air Cartridge Prep Factor (ug/total to ug/m^3),

Example: 2.5 L/min for 7 hours

1. Convert Hours into Minutes (7 hours = 420 minutes)
2. Minutes x Flow = a (420 x 2.5 = 1050)
3. Prep Factor / a = b (1/1050 = 0.000952381 ug/m^3)
4. b is new Prep Factor

If no flow value is given, change units from ug/m^3 to ug/total. If sample is B flagging, the blank correction factor may need removed.

REFERENCES/ METHOD DEVIATIONS

Standard Methods 1999-Method 3120B
EPA-600/R-94/111 May 1994-Method 200.7 R 4.4
SW846 Method 6010B R 2 Dec. 1996
Standard Methods 2340B - Hardness

Some modifications have been utilized to accommodate all references. Regulated Drinking Water testing must follow the test method as written without these modifications. Aqueous samples with a silver content greater than 1.0 mg/L (not 0.1 mg/L) as described in method 200.7 R4.4 are re-prepared at a smaller volume because we have found results to be accurate up to this level. A study verifying this statement was done and kept on file. We do not subtract any blank values from results as stated in method 3120B because the instrument automatically subtracts the calibration blank from all results. This is further explained in the interference section of this SOP.

TABLES & DIAGRAMS

See below

METHOD PERFORMANCE

MDL/Method Validation: See Quality Manual Chapter 21
IDMP/ADOC: See Quality Manual Chapter 19

MDLs are performed on all wavelengths except the less sensitive wavelengths because results are not reported below the low standards for these wavelengths. The MDL/PQL in LIMS is reported by element not specific by wavelength. The LOQ for the less sensitive wavelengths, which is the low standard, will be verified every six months. This will also include verification for the upper quantitation limit for the sensitive wavelengths (Al, Ca, Fe, Mg, Na and Zn) where line switching occurs.

SAMPLE HANDLING

See 1000 Series SOP Appendix B

POLLUTION PREVENTION

See 1000 Series SOP Appendix D

WASTE MANAGEMENT

See 1000 Series SOP Appendix D

SIGNATURE

Cora L. Fickinger 12/17/2018
Approving Authority Date (Approval/Effective)

The use of this SOP is governed by the Teklab, Inc. Quality Assurance Manual and associated SOPs including but not limited to 1030, 1031, 1250, 1280, 1290, and 1310. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling refer to SOP 1150. For any necessary sub-sampling refer to SOP 1150.

DEFINITIONS

See 1000 series SOP Appendix A additional definitions

AAT (Analyte Addition Test) – The analyte addition test is performed after the initial MS addition test, which is done per 10% of samples, fails and has been re-prepped and fails a second time. A standard is added to an aliquot of sample and should recover ± 15% of the known value. See EPA 200.7, 4.4, 9.5. If the analyte addition is 20% of the sample analyte concentration, the dilution test may be used to further determine matrix effects.

BS (Bench Spike) - The addition of a known amount of analyte to the digested sample in order to determine the matrix effects of a sample. This technique is used to verify high or low MS/MSD recoveries and is used only when MS/MSD recoveries are outside the acceptable range.

Blank (Calibration Blank) - A volume of distilled or deionized water containing the same reagents, solvents, acids or preservatives contained in the calibration standards. The calibration blank is used to determine the response of the instrument to the zero concentration of an analyte of interest.

CAL (Calibration Standard) - A solution prepared from the dilution of stock standard solutions. This standard has the same acid matrix as the samples and is used to calibrate the instrument. Because this procedure allows for two point calibration (a blank and one standard), the daily test for linearity of the calibration curve is met when the ICV is within limits.

CRQL (Client Requested Quantitation Limit) – A specific PQL requested by client that is usually lower than LIMS PQL but higher that LIMS MDL. It must follow same blank requirements as a PQL.

CCB (Continuing Calibration Blank) - A volume of reagent water with the same acid matrix as in the calibration standard and samples. This blank is used to check the calibration baseline.

CCV (Continuing Calibration Verification) Solution - A solution of method analytes used to periodically evaluate the calibration of the instrument.

DT (Dilution Test) – If the concentration of a sample is a factor of 50 above the IDL in the original solution but <90% of the linear limit, a 1+4 dilution should agree within 10% of the original. If not there is an indication of matrix interference and should be flagged accordingly. The dilution test will follow the analyte addition test if results are substantially high.

ICB (Initial Calibration Blank) - A volume of reagent water with the same acid matrix as in the calibration standard and samples. This blank is used to check the calibration baseline immediately after calibration.

ICV (Initial Calibration Verification) Solution - A solution of method analytes (second source from the calibration standards) used to evaluate the initial calibration of the instrument.

IDL (Instrument Detection Limit) - The concentration equivalent to the analyte signal which is equal to three times the standard deviation of a series of 8 replicate measurements of the calibration blank signal at the same wavelength. The IDL is determined during initial method validation.

IEC (Inter Element Correction) – Per instrument, an IEC is performed in order to determine the true value of a sample concentration based off a determined correction an interfering element that is not the target analyte. The IEC corrects for interferences.

LDR (Linear Dynamic Range) - The concentration range over which the instrument response to an analyte is linear, at a particular wavelength. The LDR is determined during initial method validation, after any major instrumentation change, and verified biannually by analyzing a solution at the LDR concentration with a recovery of +/- 10% of the true value.

MDL (Method Detection Limit) - The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. The MDL is verified annually.

MSA (Method of Standard Additions) - The addition of known amount of analyte to the sample in order to determine the relative response of the detector to an analyte within the sample matrix. The relative responses are then use to assess either an operative matrix effect or the sample analyte concentration.

PQL (Practical Quantitation Limit) – The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.

QCS (Quality Control Sample) - A solution of method analytes of known concentrations which is used to spike an MBLK or sample matrix. This is a source or lot number different than the calibration standards. The QCS is obtained from an external source, different from the calibration standards. It is used to check either laboratory or instrument performance. Unacceptable results for the QCS will stop analysis until the problem is identified, corrected and documented. The mean concentrations from three analyses of the QCS must be within ±5% of the stated values.
The QCS is verified quarterly. See Table for analyte concentrations.

RL (Reporting Limit) – The PQL multiplied by any dilution or preparation factors. The RL appears on the final report. If a CRQL (client requested quantitation limit) exists for the sample and is greater than the final RL, the RL can be replaced with the CRQL at the client's request.

Table 1

ICP REPORTING LIMIT SUMMARY					
Parameter	**Wavelength**	**Less Sensitive Wavelength**	**LDR (ICP3/4) (mg/L)**	**MDL/PQL (mg/L)**	**LCS/MS/MSD (mg/L)**
Aluminum	396.152	394.401	See LIMS	See LIMS	See LIMS
Antimony	206.834	N/A			
Arsenic	188.980	N/A			
Barium	493.408	N/A			
Beryllium	313.107	N/A			
Boron	249.678	N/A			
Cadmium	214.439	N/A			
Calcium	396.847	318.127			
Chromium	267.716	N/A			
Cobalt	228.615	N/A			
Copper	324.754	N/A			
Iron	238.204	261.382			
Lead	220.353	N/A			
Lithium	670.365	N/A			
Magnesium	280.270	279.078			
Manganese	257.610	N/A			
Molybdenum	202.032	N/A			
Nickel	231.605	N/A			
Phosphorus	178.222	N/A			
Potassium	769.897 ICP4 766.491 ICP3	N/A	*		
Selenium	196.026	N/A			
Silicon	251.611	N/A			
Silver	328.068	N/A			
Sodium	589.592	568.821			
Strontium	460.733	N/A			
Sulfur	181.972	N/A			
Thallium	190.794	N/A			
Tin	189.927	N/A			
Titanium	334.941	N/A			
Vanadium	292.401	N/A			
Zinc	206.200	334.502			

*** Since Potassium uses a multipoint calibration, samples that exceed the highest point in the curve are diluted and re-analyzed.**

*****Line switching occurs, for the following elements, at the following concentrations, to the following wavelengths: Aluminum at 2.0 mg/l to 394.401nm, Calcium at 5.00 mg/l to 318.127nm, Magnesium at 5.0 mg/l to 279.078nm, Iron at 2.0 to 261.382nm, Na at 10.00 mg/l to 568.821nm, Zn at 2.00 mg/l to 334.502.**

Table 2

ICP CALIBRATION STANDARDS AND CHECKS SUMMARY						
Parameter	**Calibration Standard 1 (mg/L)**	**Calibration Standard 2 (mg/L)**	**Calibration Standard 3 (mg/L)**	**Calibration Standard 4 (mg/L)**	**Calibration Standard 5 (mg/L)**	**Calibration Standard 6 (mg/L)**
Aluminum	2	500	N/A	N/A	N/A	N/A
Antimony	1	N/A	N/A	N/A	N/A	N/A
Arsenic	1	N/A	N/A	N/A	N/A	N/A
Barium	2	N/A	N/A	N/A	N/A	N/A
Beryllium	1	N/A	N/A	N/A	N/A	N/A
Boron	1	N/A	N/A	N/A	N/A	N/A
Cadmium	2	N/A	N/A	N/A	N/A	N/A
Calcium	5	500	N/A	N/A	N/A	N/A
Chromium	1	N/A	N/A	N/A	N/A	N/A
Cobalt	1	N/A	N/A	N/A	N/A	N/A
Copper	1	N/A	N/A	N/A	N/A	N/A
Iron	2	200	N/A	N/A	N/A	N/A
Lead	2	N/A	N/A	N/A	N/A	N/A
Lithium	N/A	N/A	1	N/A	N/A	N/A
Magnesium	5	500	N/A	N/A	N/A	N/A
Manganese	1	N/A	N/A	N/A	N/A	N/A
Molybdenum	1	N/A	N/A	N/A	N/A	N/A
Nickel	2	N/A	N/A	N/A	N/A	N/A
Phosphorus	N/A	N/A	5	N/A	N/A	N/A
Potassium	N/A	N/A	N/A	0.1	1	10
Selenium	1	N/A	N/A	N/A	N/A	N/A
Silicon	N/A	N/A	1	N/A	N/A	N/A
Silver	0.5	N/A	N/A	N/A	N/A	N/A
Sodium	10	N/A	300	N/A	N/A	N/A
Strontium	1	N/A	N/A	N/A	N/A	N/A
Sulfur	N/A	N/A	5	N/A	N/A	N/A
Thallium	1	N/A	N/A	N/A	N/A	N/A
Tin	2	N/A	N/A	N/A	N/A	N/A
Titanium	N/A	N/A	1	N/A	N/A	N/A
Vanadium	1	N/A	N/A	N/A	N/A	N/A
Zinc	2	N/A	20	N/A	N/A	N/A

Parameter	ICV/CCV (mg/L)	ICV/CCV High (mg/L)	PQLSTD (mg/L)	ICSA (mg/L)	ICSAB (mg/L)	QCS (mg/L)
Aluminum	**1**	**5**	**See LIMS**	**500**	**500**	**1**
Antimony	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Arsenic	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Barium	**1**	**N/A**		**N/A**	**0.5**	**1**
Beryllium	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Boron	**0.5**	**N/A**		**N/A**	**1**	**1**
Cadmium	**1**	**N/A**		**N/A**	**1**	**1**
Calcium	**2.5**	**10**		**500**	**500**	**5**
Chromium	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Cobalt	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Copper	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Iron	**1**	**5**		**200**	**200**	**1**
Lead	**1**	**N/A**		**N/A**	**1**	**1**
Lithium	**0.5**	**N/A**		**N/A**	**1**	**1**
Magnesium	**2.5**	**10**		**500**	**500**	**1**
Manganese	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Molybdenum	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Nickel	**1**	**N/A**		**N/A**	**1**	**1**
Phosphorus	**0.5**	**N/A**		**N/A**	**1**	**5**
Potassium	**5**	**N/A**		**N/A**	**10**	**5**
Selenium	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Silicon	**0.5**	**N/A**		**N/A**	**1**	**5**
Silver	**0.25**	**N/A**		**N/A**	**1**	**0.25**
Sodium	**5**	**20**		**N/A**	**10**	**5**
Strontium	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Sulfur	**0.5**	**N/A**		**N/A**	**1**	**1**
Thallium	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Tin	**1**	**N/A**		**N/A**	**1**	**1**
Titanium	**0.5**	**N/A**		**N/A**	**1**	**1**
Vanadium	**0.5**	**N/A**		**N/A**	**0.5**	**1**
Zinc	**1**	**5**		**N/A**	**1**	**1**

TEKLAB, INC.
STANDARD OPERATING PROCEDURE
MERCURY ANALYSIS

SCOPE

This procedure is applicable to the determination of concentration in drinking waters, aqueous samples, TCLP/SPLP/Shake extracts, solids, oils, wipes and non-aqueous liquids. This procedure may be used for both total and dissolved mercury. Holding time for mercury samples is 28 days. Aqueous samples are preserved with HNO_3, pH<2. Soil samples are stored cool, above freezing to 6°C. See LIMS for current test codes, MDLs and PQLs.

SUMMARY

The digestion oxidizes organic and inorganic mercury into free mercuric ions. A 40 ml portion of sample is used in the hot block digestion SOP 3062 or 0.80g wet weight sample is weighed for solids using SOP 3063. Samples are acidified using the appropriate acids stated in the SOP. Potassium permanganate and potassium persulfate (waters only) are added and the solution is heated at 95ºC to oxidize all possible organic forms of mercury. A solution of sodium chloride and hydroxylamine sulfate is added to reduce the excess oxidizing reagents. The sample is then ready for analysis using the cold vapor atomic absorption technique using a Teledyne Leeman Labs Hydra II AA. The analysis is based on the absorption of radiation at 253.7 nm by mercury vapor. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration.

SAFETY

Extreme caution must be exercised, as the concentrated acids and heavy metals used in the department have the potential for adverse health affects. Protection such as safety glasses and gloves must be worn; a lab coat is provided and is strongly recommended. See the appropriate SDS for additional information on the specific hazards of the reagents and metals standards being used. In particular read SDS for Mercury, Hydrochloric Acid, Nitric Acid, Sulfuric Acid, Sodium Chloride, Hydroxylamine Sulfate, Stannous Chloride, Potassium Permanganate and Potassium Persulfate. A binder is provided with SDS for the chemicals and standards used in the metals prep lab and analysis lab. Electronic SDS copies are located in a database on Teklab data entry computers.

Mercury is extremely toxic and care must be taken to avoid exposure to mercury vapors.

EQUIPMENT & SUPPLIES

1. Teledyne Leeman Labs Hydra II AA and accessories including auto sampler
2. Argon gas supply
3. Computer with instrument specific software and printer
4. Class A glassware
5. Adjustable pipettes
6. Sample tubes – 16x100

REAGENTS AND STANDARDS (Quality Manual Chapter 23)

1. All reagents must be reagent grade or better and all standards must be traceable to NIST standards. See SOP 3070 for preparation, storage and tracking information.
2. *Metals lab deionized water* – refer to section 26.5 of the Quality Assurance Manual for further description.
3. *Hydrochloric Acid* – HCL concentrated low trace metals.
4. *Nitric Acid* - HNO_3 concentrated low trace metals.
5. *Sulfuric Acid* – H_2SO_4 concentrated ACS grade or better
6. *Potassium Permanganate* - ACS grade or better
7. *Potassium Persulfate* - ACS grade or better
8. *Sodium Chloride-Hydroxylamine Sulfate solution* - ACS grade or better
9. *Stannous Chloride* –ACS grade or better
10. *Reductant Stannous Chloride/Hydrochloric Acid Solution*: The solution is 10% wt/volume stannous chloride and 3% vol./vol. hydrochloric acid. Fill a 1 liter nalgene bottle with approximately 800 ml of DI water, add 30 ml of concentrated HCl then add 100 g of Stannous Chloride and dilute to volume with DI water.
11. *Carrier Solution*: The solution is a 3% vol./vol. HCl solution. Fill a 1 liter nalgene bottle with approximately 800 ml of DI water, add 30 ml of concentrated HCl and dilute to volume with DI water.
12. *Stock calibration standard solution* – must be traceable to NIST standards and of a source different than the LCS or MS/MSD and ICV/CCV/QCS quality control standards. The stock standard is purchased at a concentration of 1000 mg/l Hg.
13. *Working calibration standard solution* – Transfer about 80 ml of DI water into a 100 ml class A volumetric flask, add 3.0 ml of HNO_3 and 100 µl of Stock calibration standard solution, and dilute to volume with DI water. Prepare daily.
14. *Calibration standards* – these are prepared by dilution of the working calibration standard solution. A minimum of a blank and five standards are used in calibration of the instrument. See SOP 3062 or 3063 for the calibration concentrations and preparation.
15. *LCS and MS/MSD standards* – these may be the same source, but must be independent of a different lot number than the calibration standards. See SOP 3062 or SOP 3063 for concentrations and preparation.
16. *ICV/CCV/QCS* – this must be a source separate from the calibration standards. See SOP 3062 or 3063 for concentrations and preparation.

CALIBRATION (Quality Manual Chapter 22)

See SOP 3062 or 3063 for more detailed calibration concentrations and preparation.

Calibration Requirement	Acceptance Criteria	Frequency
Calibration Curve	≥0.995	Daily
ICB	< PQL	1/Calibration Curve
CCB	< PQL	1/10 samples
ICV(EPA/SM)	95-105 % recovery	1/Calibration Curve
ICV(SW-846)	90-110 % recovery	1/Calibration Curve
CCV(EPA/SM)	90-110 % recovery	1/10 samples
CCV(SW-846)	80-120 % recovery	1/10 samples

1. A calibration curve must be prepared each day with a minimum of a calibration blank and five standards. The correlation coefficient for all curves must be at least 0.995 for the curve to be acceptable. The instrument software automatically calculates the correlation coefficient. The instrument will not stop analysis with an unacceptable correlation coefficient. The calibration curve must be documented (with the lot number, brand name, date of preparation, and initials of the person preparing the curve) and maintained with the analytical results. One standard must be at or below the regulatory limit if known. Samples must be quantitated from the initial instrument calibration.
2. An initial calibration blank (ICB) is analyzed immediately after calibration and a continuing calibration blank (CCB) after every tenth sample. The result of this analysis must be less than the PQL(MDL for Drinking water analysis) for the curve to be valid. If the measured value is outside the PQL(MDL for Drinking water analysis) range the curve is not validated. The problem must be identified and corrected prior to the analysis of samples.
3. Immediately after ICB a quality control (ICV/QCS) sample is analyzed. This sample must be from a source different from the calibration standards. The value of this standard must be near the middle range of the curve. The measured value of this sample must be within 10% of the true value for the curve to be validated for SW-846 and 5% for EPA and standard methods. If the measured value is outside the acceptance criteria, the curve is not validated. The problem must be identified and corrected prior to the analysis of samples.
4. The same quality control (CCV) sample is subsequently analyzed after every tenth sample. The value of this standard must be near the middle range of the curve. The measured value of this sample must be within 20% for SW-846 and 10% for EPA and standard methods of the true value for the curve to have continued verification. If the measured value is outside the acceptance criteria, the problem must be identified and corrected and the previous ten samples must be analyzed (with a subsequently acceptable QC) prior to reporting results. High recoveries are acceptable if the samples are non-detects.

QUALITY CONTROL (Quality Manual Chapter 26)

See SOP 3062 or 3063 for more detailed quality control preparation and information.

Calibration Requirement	Acceptance Criteria	Frequency
MB	< MDL	1/batch
LCS	85-115 % recovery	1/batch
MS/MSD	75-125 % recovery	1/10 samples
MSD RPD	15 %	1/10 samples
Sample RSD	15 %	n/a
LDR	90-110% recovery	1/calibration

1. MBLK (Method Blank) – For a method blank an aliquot of reagent water or other blank matrices that are treated exactly as a sample and taken through the entire analytical procedure. The MBLK is used to determine potential laboratory contamination. This sample is prepared and analyzed at a rate of once per batch or once per twenty samples, whichever is more frequent. The measured value of the MBLK must be less than MDL. If the measured value is outside the acceptance criteria and not a drinking water sample, sample values may only be reported with a comment if the samples measured value is less

than the PQL or if the sample value is greater than ten times the level of contamination. Corrective action when the MBLK is outside the acceptance criteria is to find the source of contamination, correct the problem, re-prepare samples and reanalyze.

2. LCS (Laboratory Control Sample) – An aliquot of reagent water or other matrices to which known quantities of the method analyte is added. This sample is a source or lot different than the calibration standards. This sample is taken through the entire analytical procedure. The LCS is used to determine whether the method is in control and determine the precision and accuracy of analysis. This sample is prepared and analyzed at a rate of one per batch or once per twenty samples, whichever is more frequent. The measured value of the LCS must be within 15% of the true value. The LCS true value is 5.00 µg/L (0.25 mg/Kg for soils). Measured values outside the acceptance criteria require corrective actions (see appendix E of the 1000 series SOPs.) to determine the cause of the problem, correction of the problem and reanalysis of the LCS prior to analysis of the samples associated with that LCS. If adjustments to the instrument and/or calibration curve and subsequent reanalysis are outside the acceptance criteria, the batch of samples associated with that LCS (for the analyte in question) must be re-prepared and reanalyzed. For LCS recovery above the upper control limit and any samples that are non-detects may be reported with a sample comment in LIMS.
3. MS/MSD (Matrix Spike/Matrix Spike Duplicate) – A randomly selected aliquot of an environmental sample to which known quantities of the method analyte is added in the laboratory. The MS/MSD may be from the same source as the LCS, but must be from a source or lot independent of the calibration standards. The samples are then taken through the entire analytical procedure. A separate (unspiked) sample is used to determine the samples background levels of the method analytes. This sample is used to determine whether the sample matrix contributed bias to the analytical results. The duplicate sample (MSD) is used to verify any matrix contributions to bias and to validate the reproducibility of aqueous results. These samples are analyzed at a rate of, at least, once per ten samples per matrix and preparation type (chosen randomly amongst different client's samples). See Quality Manual for matrix Spike selection criteria. The true value of the MS/MSD is 5.00 µg/L (0.25 mg/Kg). The acceptance criteria for the MS and MSD recoveries are +/- 25% of the true value. The acceptance criteria for the reproducibility (RPD) are 15%. See appendix E of the 1000 series SOPs. for corrective actions. Results not meeting the MS or MSD acceptance criteria can be validated by bench spiking. The sample reproduction of the unacceptable results indicates that the recoveries are due to matrix effects. Matrix interference is to be noted with a sample comment in LIMS. The reason for poor recoveries or RPD outside the acceptance criteria must be determined, the problem solved and the sample re-prepared prior to reporting results. Samples with a high sample/spike ratio are acceptable and are reported with a sample comment in LIMS. Out of control spike recoveries are flagged with an "S" in the qualifiers column of LIMS and Quality Control reports. Out of control RPD results are flagged with an "R" in the qualifiers column of LIMS and Quality Control reports.
4. LDR (Linear Dynamic Range) – The Envoy program uses the absorbency of a given standard to give a calculated concentration. The concentration for the high standard is then verified to be with 10% of the true value. So the LDR is verified with each analytical batch and is documented on the coversheet.

See SOP 1020 for Control Charting Procedure.

CORRECTIVE ACTION (Quality Manual Chapter 13)

Problem	Potential Corrective Action
No or Low Signal for Standards	Hg Lamp is not on Stannous Chloride is not being pumped Stannous Chloride is not potent or fresh Standards are not being pumped Carrier gas is not flowing A leak in the sample vapor path A blockage in the sample vapor path Membrane or dehydrating tube wet Check tubing for excessive fatigue Check cell assembly and tubing for moisture
No or Low Signal for Samples	Digestion is not complete Samples are high in known interferents
Poor Precision for Repeats	Check intensity of lamp Check tubing for plug Check tubing for excessive fatigue Check sample for difficult matrix

All other corrective actions are performed Quality Manual Chapter 13.

INTERFERENCES

Potassium permanganate is added to eliminate possible interference from sulfide. Samples high in chlorides may require additional permanganate (as much as 25 ml) because, during the oxidation step, chlorides are converted to free chlorine, which also absorbs radiation of 253.7 nm. Certain volatile organic materials that absorb at this wavelength may also cause interference.

PROCEDURE

1. See the most recent version of SOP 3062 or SOP3063 for preparation of samples, calibration, and QC samples.
2. Reference the instrument manual for operation and optimization of the instrument. Switch on the instrument and computer and enter Leeman Hydra II AA “Envoy”. Allow the Hg lamp to warm up for at least 30 minutes prior to starting analysis.
3. Open the applicable Hg method.
4. Open a new Chapter, based on the analysis date, in the following format yymmdd.
5. Open a new Sequence based on the analysis date, in the following format yymmdd.
6. Type the instrument QC and batch samples into the auto-sampler file and load the auto-sampler tray. Use care to ensure samples/QC/standards are loaded in the correct numbered auto-sampler position.
7. Make up at least 1 liter of the reductant and carrier solutions.
8. Check to see if the waste bottles are empty (if not empty them).
9. Ensure proper pressure on Argon gauge.

10. Place the tubing into the appropriate reductant or carrier solution. Adjust the peristaltic pump pressure bars and insure that the auto-sampler probe is down. Ensure that all tubing is properly aligned and no leaks are present. Turn on peristaltic pump and adjust flow if needed.
11. Begin the run of analysis, check periodically to make sure that all QC is in range, that the auto-sampler tubing is aligned and flowing and the reductant and carrier solutions do not run dry. If QC is out of range the reason must be determined, corrected and the analysis must be restarted. If the auto-sampler tubing is not aligned properly or the reductant and/or carrier solutions run out; the run must be stopped and restarted from the point of the last valid QC sample. Any samples that are out of calibration range must be diluted until they fall within the calibration curve range. If a sample must be reported that is outside the calibration range, it must be reported with less certainty.
12. When the analysis is complete, remove the tubing from the reductant and carrier bottles and the auto sampler and place it in DI water. Rinse tubing lines with DI water.
13. Remove the tubing from the DI water and allow it to pump dry.
14. Release the pump tubing from the roller.
15. Exit the software and turn off the lamp and/or instrument – periodically restart computer.
16. Empty the waste containers.
17. Record data, dilution factors, etc. in LIMS to be calculated.

ROUTINE MAINTENANCE

These items are only recommendations and the frequency is variable.

1. Daily: Rinse tubing with DI. Daily maintenance is document on the Data Coversheet
2. Monthly: Replace peristaltic pump tubing. Document in the LIMS instrument maintenance log.
3. Quarterly: Replace reductant bottle tubing, clean auto sampler, clean instrument computer, clean instrument and exhaust, and archive instrument data files. Document in the LIMS instrument maintenance log.
4. Biannual: Replace sample probe, replace mixing tubing assembly, and replace sample uptake tubing. Document in the LIMS instrument maintenance log.
5. Yearly: Replace liquid/gas separator, replace dehydrating tube or block, replace rinse bottle tubing, and replace drain tubing. Document in the LIMS instrument maintenance log.

DATA ANALYSIS & CALCULATIONS

After run is complete, check for proper QC compliance and print auto sampler table, curve and results. Go through data and back calculate all dilutions. After everything is calculated, upload all data into LIMS including all dilution factors and prep factors. Report only those values that fall within the calibration range. Samples exceeding the highest standard concentration must be diluted within range of the standard curve. After results are entered into LIMS, a quality review is performed.

Waters/TCLPs - Digested by SOP 3062

$$\text{Conc. Hg } \mu g/L = \frac{\text{Measure Conc. } \mu g/L}{\text{ml sample}} * 40 \text{ ml (basis)} * \text{Dilution factor}$$

Solids - Digested by SOP 3063

$$\text{Conc. Hg mg/Kg} = \frac{\text{Measure Conc. } \mu\text{g/L}/1000 * 0.04 \text{ L (basis)} * \text{Dilution factor}}{\text{kg sample}}$$

Solid samples may be calculated to a dry weight basis by using the P-moist selection in LIMS. Samples requiring results on a dry weight basis will also request a total solids analysis. The technician assigned to the total solids analysis will enter the P-moist result in LIMS. Once the P-moist factor is entered, calculation of a sample in LIMS will convert the final result to a dry weight basis and change the units to mg/Kg-dry

The LCS, MS and MSD recoveries and the Relative Percent Difference (RPD) are calculated as follows:

$$\text{1st \%MSR} = \frac{X_2 - X_1}{\text{Spike conc.}} * 100$$

$$\text{2nd \%MSR} = \frac{X_3 - X_1}{\text{Spike conc.}} * 100$$

$$\text{RPD} = \frac{(X_2 - X_3)}{(X_2 + X_3)/2} * 100$$

Where,

X_1 = Concentration of unspiked sample, µg/L
X_2 = Concentration of 1st spiked sample, µg/L
X_3 = Concentration of 2nd spiked sample, µg/L

REFERENCES/ METHOD DEVIATIONS

SM 3112B
EPA-600 245.1 Revision 3.0
SW-846 7470A waters & 7471B solids

Some minor modifications have been utilized to accommodate all references. No such modifications are made for regulated Drinking Waters.

TABLES & DIAGRAMS

n/a

METHOD PERFORMANCE

MDL/Method Validation: See Quality Manual Chapter 21
IDOC/ADOC: See Quality Manual Chapter 19

SAMPLE HANDLING

See Appendix B of the 1000 series SOPs.

POLLUTION PREVENTION

See Appendix D of the 1000 series SOPs.

WASTE MANAGEMENT

See Appendix D of the 1000 series SOPs.

SIGNATURE

Cora L. Fickinger 12/17/2018
Approving Authority Date (Approval/Effective)

The use of this SOP is governed by the Teklab, Inc. Quality Assurance Manual and associated SOPs including but not limited to 1030, 1031, 1250, 1280, 1290, and 1310. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling refer to SOP 1150. For any necessary sub-sampling refer to SOP 1150.

DEFINITIONS

See Appendix A of the 1000 series SOPs.

TEKLAB, INC.
STANDARD OPERATING PROCEDURE FOR THE ANALYSIS OF PCBs BY CAPILLARY COLUMN GC

SCOPE

The use of this SOP is governed by the TEKLAB Quality Assurance Manual and associated SOPs including but not limited to, 1030, 1031, 1250, 1280, 1290, 1310, and 4026. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling, refer to SOP 1150. Refer to section 5 and 27 of the Quality Manual for record keeping and reporting information.

This SOP describes the procedures for the analyzing of samples for polychlorinated biphenyls (PCBs) as aroclors in extracts from solid, aqueous and non-aqueous matrices in accordance with SW-846 8082 and USEPA 608. Table #2 lists the compounds that are routinely reported by these methods and it gives the Reporting Limits (RL) for each matrix. The RLs given are based on the low-level standard, sample weight extracted, and the final sample volume. Matrix interference may result in higher RLs than those listed.

If a client requests both Pesticide and PCB analysis on the same sample, this may be accomplished from the same extract if all of the calibrations and QC requirements for both methods are met. These two analyses are normally run separately and each follows their own SW-846 method, 8081B (for Pesticides) and 8082 (for PCBs). The calibrations and QC requirements for method 8081B may be found in the TEKLAB SOP 4230.

SUMMARY

This method presents conditions for the analysis of prepared extracts of PCBs. The samples are first extracted using applicable SW-846 method 3510C for aqueous samples, 3550B for solids, and 3580A for non aqueous liquids (the latest revision of Teklab Inc. SOP’s 4114, 4116 and 4110 respectively). The PCBs are injected onto the column, separated and detected by electron capture detection (ECD). Quantitation is by the external standard method. See Table 2 for method detection limits and reporting limits.

SAFETY

Safety glasses and appropriate gloves must be worn while handling samples, standards, solvents or reagents. Aroclors have been classified as a potential carcinogen under OSHA. Standards and samples must be handled with extreme care to avoid excess exposure. Contaminated gloves and clothing must be removed immediately. Read the appropriate SDS for more safety information on the individual solvents and reagents used in this procedure.

- HEXANE
- SULFURIC ACID

EQUIPMENT & SUPPLIES

- Hewlett-Packard 5890 GC with HP 7673A autosampler, single injection onto dual capillary columns and dual electron capture detectors (ECD).
- Chemstation software using Microsoft Windows and HP Enviroquant software.
- Ultra High Purity helium from gas cylinders

- Pre-purified grade 4.8 nitrogen from gas cylinders.
- Class A volumetric flasks with stoppers
- Glass syringes - various sizes
- 2mL autosampler vials with 350uL flat bottom inserts and crimp-top caps

REAGENTS & STANDARDS (Quality Manual Chapter 23)

- Make-up gas: Prepurified 4.8 grade nitrogen
- Carrier Gas: Ultra high purity helium from gas cylinders
- Hexane: reagent grade (AR) or higher
- Stock Standards

  The stock standards are purchased as certified solutions (traceable to national standards where available). Commercially prepared stock standards are purchased from vendors such as, Ultra Scientific or Accustandard, depending on which mix or concentration is required. The stock standards are stored between 0-6°C. All stock standards must be replaced by the manufacturer's expiration date or sooner if comparison with check standards prepared from an independent source indicates a problem.
- Calibration Standards

  The calibration standards are prepared as dilutions of the stock standards with hexane. Calibration standards must be stored between 0-6°C. The standards must be replaced at least every six months or sooner if comparison with check standards indicates a problem. See Table #1 for a list of calibration standard concentrations.
- Quality Control (QC) Standards

  The QC standards (Matrix Spike and LCS standards) are prepared and stored in the same way as the calibration standards. They contain 10ug/mL each of Aroclors 1016 and 1260. The standards must be replaced at least every six months or sooner if comparison with check standards indicates a problem. See Table #2 for final spike concentrations.
- Surrogate Standards

  The surrogate standards are prepared and stored the same as the QC standards. They contain 5ug/mL each of Tetrachloro-m-xylene (TCMX), and Decachlorobiphenyl (DCB). The standards must be replaced at least every six months or sooner if comparison with check standards indicates a problem. See Table #2 for final surrogate concentrations.
- See SOP 4022 Standard Prep and Tracking for additional information on storage conditions and labeling of standards.
- See GC Curve Spreadsheet_RevA for details on preparing the calibration curve standards.

CALIBRATION (Quality Manual Chapter 22)

All samples are quantitated by external calibration. This method assumes a proportional relationship between the calibration standard and the analyte in the sample. An analyte in a sample is quantitated from the initial calibration curve of that analyte with the use of quadratic regression (Eq. #3). The correlation coefficient must be greater than or equal to 0.995. The initial calibration curve for Aroclors 1016 and 1260 is generated by running 8 levels (see Table #1). At least 6 points must be used for a quadratic curve. Multi-level or single point calibration curves may be used to produce calibration curves for additional aroclors. If a single point calibration curve is used for additional aroclors, linear regression (Eq.#2) will be employed. For the Aroclor 1016/1260 initial calibration curve, the lowest level must be at a concentration at or below the reporting limit. The other levels will define the working range of the detector. If a single point calibration is employed for any additional aroclors, the standard used to produce the calibration must be a mid-level standard as compared to the aroclor 1016/1260 calibration curve (ie 1000ng/mL). An initial calibration blank (ICB) must also be analyzed to confirm the absence of system contamination. If the initial calibration does not meet the above criteria it must be rejected and the cause determined. A new initial calibration must then be performed.

An initial calibration verification (ICV) standard is analyzed immediately after each calibration curve. The ICV is a mid level standard containing the aroclors 1016 and 1260 and must be prepared from a second source. The recoveries of each compound in the ICV must be within 15% of the true value. Corrective action must be taken if the ICV fails to meet these criteria. The corrective action would include immediately re-analyzing the ICV if there was an issue with injection, or re-analyzing the calibration curve.

A new calibration curve must be generated after major changes. Major changes include changing the column or cleaning the ECD detectors.

A 12-hour calibration check is a verification of the initial curve performed by the analysis of a continuing calibration verification (CCV) standard. This is a standard containing the surrogates and aroclors 1016 and 1260 near the middle level of the initial calibration curve. A CCV must be analyzed at the beginning and again at the end of every 12-hour sequence. Additionally, a CCV must be analyzed at least once per every twenty samples. A mid level of each of the other aroclors may also be run as part of the 12-hour calibration check. The center of each retention time window is updated with the retention times from each 12-hour calibration check. Any analyte that is reported as anything other than a non-detect must be analyzed after a 12-hour calibration check that has a %drift (%D) (Eq. #5) of +/-15% for that analyte. If the CCV is outside the upper acceptance limits, associated samples that are non-detect may be reported. If the acceptance criteria are exceeded low the samples may be reported if the maximum regulatory limit is exceeded. Otherwise, the samples must be re-analyzed after a calibration check that has met the acceptance criteria has been analyzed. The surrogates in the calibration checks must be within acceptance criteria otherwise the associated samples must be re-analyzed after a calibration check that has met the acceptance criteria has been analyzed.

Equations:

Eq. #1 avg. response factor equation:

$$\text{Response Factor (RF)} = \frac{\text{Area of Peak}}{\text{Mass Injected (ng)}}$$

$$\text{Avg. Response Factor} = \frac{\text{Sum of RFs for each calibration level}}{\text{number of calibration levels}}$$

Eq. #2 linear regression equation:

$$y = ax + b$$

Eq. #3 quadratic equation:

$$y = ax + cx^2 + b$$

Where: y = Instrument response
x = Concentration
a = Slope
b = Intercept
c = Constant

Eq. #4 Percent Relative Standard Deviation:

$$\%RSD = \left(\sqrt{\frac{\sum_{i=1}^{N} \left[\frac{Ci - Pi}{Ci} \right]^{2}}{N - 1}} \right) 100$$

N = number of levels in the curve.
Ci = True concentration in the sample.
Pi = Predicted concentration in the sample.

Eq. #5 % Drift equation:

$$\%D = \frac{\text{Calculated Conc.} - \text{Theoretical Conc.}}{\text{Theoretical Conc.}} * 100$$

QUALITY CONTROL (Quality Manual Section 26)

- Prep Batch
  A prep batch is a set of 20 or fewer environmental samples of the same or similar matrix extracted using the same procedure and reagents within the same 24-hour time period.

- Analytical Batch
  An analytical batch is composed of environmental samples that are analyzed together as a group using the same calibration curve. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

- Method Blank
  The method blank (MBLK) contains deionized water for aqueous samples and sodium sulfate for solid samples. The surrogate is added to the MBLK and it is carried through the same extraction and analytical procedure as the samples. The MBLK should not contain any target analyte at or above the reporting limit. Samples associated with a contaminated method blank may be reported with the appropriate qualifier under the following circumstances:
    1) The target analytes detected in the MBLK are not detected in the sample
    2) The target analytes detected in the MBLK are less than 5% the amount detected in the sample
    3) The target analytes detected in the MBLK are less than 5% of the regulatory limit associated with that analyte.

  If the MBLK is contaminated and these criteria are not met corrective action must occur. The corrective action would be the re-extraction and re-analysis of the affected samples with an acceptable MBLK. If the surrogate recovery in the MBLK is outside of the established control limits, the prep batch is considered out of control and must be re-extracted and re-analyzed if sample amount permits. If there is insufficient sample to re-extract the samples, appropriate qualifiers and/or an explanation in the sample narrative must be reported with the data.

- Laboratory Control Sample
  The laboratory control sample (LCS) is spiked with a mixture of aroclors 1016 and 1260 (see Table #3). The recoveries of these analytes are control charted and can be found in LIMS. If the recovery of either of these analytes is outside of the established control limits, the analysis is out of control. If the LCS recovers outside the upper control limit for either aroclor associated samples may be reported with the appropriate comment only if no target analytes are detected. If the LCS recovers outside the lower control limit or the surrogate recovery is outside the control limits corrective action must occur. The normal corrective action is the re-extraction and re-analysis of the entire prep batch if sample amount permits. If there is insufficient sample to re-extract, appropriate qualifiers and/or a statement is added to the sample narrative.

- Matrix Spike and Matrix Spike Duplicate
  The matrix spike and matrix spike duplicate (MS/MSD) are spiked with a mixture of aroclors 1016 and 1260 (see Table #3). The recoveries of these analytes are control charted and can be found in LIMS. If any of the recovery criteria are not met, the sample must either be re-extracted and re-analyzed or reported with appropriate data qualifiers and/or a statement in the sample narrative. Data qualifier definitions are found in Table 4.

- Surrogates
  The surrogates (TCMX and DCB) are spiked into every sample, MBLK, LCS, and MS/MSD (see Table# 3). The recoveries are control charted and limits can be found in LIMS. If the surrogate recovery in a sample is outside the control limits and can be shown to be the result of matrix interference or sample composition, the data is reported with appropriate qualifiers and a statement in the sample narrative. If the surrogate recovery in a sample is outside of the control limits but it was not caused by matrix interference or sample composition, any affected samples are re-extracted and re-analyzed if sample amount permits. If there is insufficient sample to re-extract, an appropriate statement is added to the case narrative.

  Data qualifier definitions can be found in Table 4.

CORRECTIVE ACTION (Quality Manual Chapter 13)

QC failures may result in re-extraction and re-analysis of samples.
All other corrective actions are performed per Chapter 13 of the Quality Manual.

INTERFERENCES

- Contamination in solvents, reagents, glassware and other sample processing equipment can cause analytical interferences. All of these materials must be proven to be free of contaminants under the conditions of analysis by running laboratory method blanks.
- Matrix interference may be caused by contaminants that are co-extracted from the sample and will vary from sample to sample.
- Phthalate esters, which are common plasticizers, can pose a major problem. Avoiding contact with any plastic materials minimizes interference from phthalates.
- Specific cleanups may be performed on sample extracts, including sulfuric acid cleanup (Method SW-846 3665), and sulfur cleanup (Method SW-846 3660).

PROCEDURE

The general procedure is outlined in SW-846 and/or EPA 600

GC Conditions/Dual-column analysis:

Instrument E:

1. Columns: 1: DB-35MS 30m x 0.32mm ID x 0.25µm film
   2: DB-5XLB 30m x 0.32mm ID x 0.5µm film
   - Carrier gas: helium
     Flow rate: 20 mL/minute total, with approximately 10mL/minute through each column.
   - Initial temperature: 130°C with hold time of 0.5 minutes
   - Program: 24° C/minute to a temperature of 260°C with hold time of 1.5 minutes. Then 30°C/minute with final temperature of 330°C with hold time of 3 minutes.
   - Total run time: 12.75 minutes
2. Injector:
   - Temperature: 250°C
   - Sample injection: on-column injection with 1µL of sample at fast injection rate, which is split onto two columns in the injection port by use of a 2-hole ferrule.
3. Detectors:
   - Temperature: 350°C
   - Make-up gas: nitrogen
     Flow rate: 60 mL/minute

Instrument Q:

Columns: 1: DB-35MS 30m x 0.32mm ID x 0.25µm film
2: DB-XLB 30m x 0.32mm ID x 0.5µm film
   - Carrier gas: helium
     Flow rate: 20 mL/minute total, with approximately 10 mL/minute through each column.
   - Initial temperature: 130°C hold for 0.5minutes
   - Program: 24.0°C/minute to 260°C hold for 1.5 minutes. Then 30.0°C/minute to 330°C hold for 3 minutes.
   - Total run time: 12.75 minutes
1. Injector:
   - Temperature: 250°C
   - Sample injection: on-column injection with 1µL of sample at fast injection rate, which is split onto two columns in the injection port by use of a 2-hole ferrule.
2. Detectors:
   - Temperature: 350°C
   - Make-up gas: nitrogen
     Flow rate: 60mL/minute

- Teklab uses 1µL injection of all standards and sample extracts.
  Add an aliquot from the extract to a 2mL vial using a glass Pasteur pipette. Cap vials with crimp caps. Place the vials in the tray and type in the sequence in Chemstation.

After completion of the sequence analyze the samples, print the raw data to paperport, and import the sample data into LIMS

ROUTINE MAINTENANCE

The following routine maintenance is performed on an as needed basis: Replacing the injection liner, replacing the septum, replacing the inlet seal, cutting the injection port end of the column, replacing the injection syringe.

DATA ANALYSIS AND CALCULATIONS

- Qualitative Identification:
  Tentative identification of a PCB occurs when the three to five major peaks chosen for an aroclor are found in the sample chromatogram falling within the absolute retention time windows and the calculated concentration is above the reported detection limit. The tentative identifications are confirmed using a second GC column of dissimilar stationary phase or, at client request, using a GC/MS. However, the main source of identification for multi-response analytes is the analyst's use of the pattern recognition from the standard as the confirmatory identification. The pattern should be evident on both columns at similar amounts for confirmation. For more information on qualitative identification of PCBs and distinguishing characteristics between aroclors with similar patterns see SOP4220 Appendix 1. See SOP 4026 for instructions on chromatographic peak integration.

- Quantitation:
  The concentration of the analyte in a sample is determined by the external calibration procedure and quantitated from the initial instrument calibration. Samples that are over the calibration range must be diluted. The LIMS makes adjustments for dilutions and alternate final volume. A concentration is calculated for each of the 3 to 5 major peaks used to identify the aroclor and then the average of the concentrations is reported for that aroclor. The following equations are used for aqueous and non-aqueous samples:

For aqueous samples:

$$\text{Concentration } (\mu g/L) = \frac{(A * V_t * D)}{(RF * V_I * V_s)}$$

For non-aqueous samples:

$$\text{Concentration } (\mu g/Kg) = \frac{(A * V_t * D)}{(RF * V_I * W)}$$

Where:

A = Area of the peak for the analyte in the sample.
V_t = Total volume of the concentrated extract (µL)
D = Dilution factor
RF = Mean response factor from the initial calibration (area/ng)
V_I = Volume of extract injected (µL)
V_s = Volume of sample extracted (mL)
W = Weight of sample extracted (g). The wet weight or dry weight may be used depending on the client requests

Solid samples may be calculated to a dry weight basis by using the Pmoist selection in LIMS Samples requiring results on a dry weight basis should also request a total solids analysis. The technician assigned to the total solids analysis will enter the Pmoist result in LIMS. Once the Pmoist factor is entered calculation of a sample in LIMS will convert the final result to a dry weight basis and change the units to µg/Kg-dry.

- Quality Control:

$$\text{Percent Recovery 1st Spike} = \frac{(X_2 - X_1)}{\text{Spike Conc.}} * 100$$

$$\text{Percent Recovery 2nd Spike} = \frac{(X_3 - X_1)}{\text{Spike Conc.}} * 100$$

$$\text{RPD} = \frac{|(X_2 - X_3)|}{(X_2 + X_3)/2} * 100$$

X_1 = Concentration of unspiked sample
X_2 = Concentration of 1st spiked sample
X_3 = Concentration of 2 nd spiked sample.

- The retention time windows for all analytes should be updated from the 12-hour calibration check using the retention of the daily calibration as the center of the window.

- The high and low standards of the initial calibration curve define the acceptable quantitation range for that PCBs analysis. If any sample is determined above this range, the extract must be diluted and reanalyzed.

- The aroclor 1016/1260 mix is used to verify the calibration of the instrument prior to the beginning of analysis and after every 12 hours, as well as at the end of the analytical run. The ending may be re-analyzed immediately after routine maintenance if it fails to pass the first time. A single mid level standard for the other aroclors listed in Table 1 may also be analyzed before each analytical batch.

REFERENCES/METHOD DEVIATIONS

Method 8000B
Method 8082

To best represent any matrix interferences that may be present in the samples analyzed, Teklab reports all surrogate recoveries from the most concentrated analysis.
Method 8082 suggests using a 2µL aliquot of the sample extract to inject on the GC. Teklab injects a 1µL aliquot (11.4.5).
Method 608 suggests diluting the stock calibration standards with isooctane. Teklab dilutes calibration standards with hexane (6.11.1).

TABLES & DIAGRAMS

TABLE #1
PCB CALIBRATION LEVELS, ng/mL

	L1	L2	L3	L4	L5	L6	L7	L8
AROCLOR 1016/1260	20	50	100	200	500	1000	2000	4000
AROCLOR 1221	20	50	100	200	500	1000	2000	4000
AROCLOR 1232	20	50	100	200	500	1000	2000	4000
AROCLOR 1242	20	50	100	200	500	1000	2000	4000
AROCLOR 1248	20	50	100	200	500	1000	2000	4000
AROCLOR 1254	20	50	100	200	500	1000	2000	4000
Amount 4000/200 ng/mL stock added to a final volume of 5mL Hexane	25µL	62.5 µL	125µL	250µ L	625µL	1.25mL	2.5mL	0µL
SURROGATE:								
Tetrachloro-m-xylene	1	2.5	5	10	25	50	100	200
Decachlorobiphenyl	1	2.5	5	10	25	50	100	200

Note: The 4000ng/mL L8 is the high point of the curve and the level used to prepare the other calibration standards.

Note: Aroclors other than 1016/1260 may employ a single point calibration.

TABLE #2
STANDARD ANALYTE LIST AND REPORTING LIMITS (PPB)

Compound	Aqueous MDL	Aqueous PQL	Solids MDL	Solids PQL	Non-aqueous liquids MDL	Non-aqueous liquids PQL
AROCLOR 1016	0.5	1.0	12.5	37.5	500	1500
AROCLOR 1221	0.5	1.0	12.5	37.5	500	1500
AROCLOR 1232	0.5	1.0	12.5	37.5	500	1500
AROCLOR 1242	0.5	1.0	12.5	37.5	500	1500
AROCLOR 1248	0.5	1.0	12.5	37.5	500	1500
AROCLOR 1254	0.5	1.0	12.5	37.5	500	1500
AROCLOR 1260	0.5	1.0	12.5	37.5	500	1500

Note: MDLs are subject to change based on the current year's statistical MDL.

Note: The following concentration factors are assumed in calculating the Reporting Limits:

	Extraction Volume	Final Volume
Aqueous samples	1000 mL	10 mL
Solids	30 g	10 mL
Non-aqueous liquids	1 g	10 mL

TABLE #3
SPIKED COMPOUND CONCENTRATIONS (PPB)

Compound	Aqueous samples	Solids	Non-aqueous liquids
AROCLOR 1016\1260	5.0	166.7	5000
SURROGATES			
Tetrachloro-m-xylene (TXMX)	0.25	8.3	250
Decachlorobiphenyl (DCB)	0.25	8.3	250

Table 4
8082/608 Data Qualifier Definitions

B	Analyte detected in the associated method blank
E	Above the upper quantitation limit
S	Spike recovery outside of quality control limits
R	RPD outside of quality control limits
J	Over MDL but less than PQL
X	Exceeds maximum contaminant level
H	Holding time exceeded

METHOD PERFORMANCE

MDL/Method Validation: See Quality Manual Chapter 21
IDMP/ADOC: See Quality Manual Chapter 19
Analyst must demonstrate proficiency in preparing calibration standards and analyzing calibration curves prior to independent analysis of samples.

SAMPLE HANDLING

See 1000 Series SOP Appendix B

POLLUTION PREVENTION

See 1000 Series SOP Appendix D

WASTE MINIMIZATION

See 1000 Series SOP Appendix D

(b) (6)

11/22/2016

Approving Authority   Approval/Effective Date

DEFINITIONS

Batch:

A Batch is environmental samples of the same matrix that are prepared together with the same process and personnel, using the same lot(s) of reagents. A “Preparation Batch” is composed of one to 20 environmental samples of the same TNI-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first sample and start of processing of the last sample being 24 hours. An “Analytical Batch” is composed of environmental samples (extracts, digestates, or concentrates) which are analyzed together as a group. An analytical batch can exceed 20 samples.

Calibration Curve:

The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.

CCB(Continuing Calibration Blank):

The CCB is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest. This sample is then analyzed to check the state of calibration of an instrument as sample are being analyzed.

CCV(Continuing Calibration Verification)**:**

The CCV is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then analyzed to check the state of calibration of an instrument as sample are being analyzed.

DOC(Demonstration of Capability):

A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

ICB(Initial Calibration Blank):

The ICB is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest. This sample is then analyzed to determine the state of calibration of an instrument before sample analysis is initiated.

ICV(Initial Calibration Verification)**:**

The ICV is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then analyzed to determine the state of calibration of an instrument before sample analysis is initiated.

IDMP(Initial demonstration of Method Performance):

A DOC analyzed to establish competency of an analyst before the analyst is allowed to analyze samples without supervision.

LCS(Laboratory control samples)**:**

The LCS is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then taken through the entire analysis to determine batch acceptance.

Matrix: *These matrix definitions are to be used for purposes of batch and quality control requirements*:

Air and Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device.

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.

Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.

Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.

MBLK(method blanks) or **LCB**(laboratory control blanks):
A LCB is used to check contamination in the laboratory and is taken through the entire analytical procedure. The method blank consists of a matrix that is similar to the associated samples and is known to be free of the analytes of interest. These samples are used to verify the purity of all chemicals and reagents used in the methodologies and to prove the absence of contamination during the analytical procedure.

MDL(Method detection limit):
The MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix type containing the analyte.

MS(Matrix spike):
These provide information about the effect of the sample matrix on the preparation and measurement methodology. All matrix spikes and matrix spike duplicates are hereafter referred to as MS/MSD samples. These samples are always run with another aliquot of the sample that is not spiked. Spiking a sample tells us what effect the sample matrix (i.e. aqueous, solid, non-aqueous liquid) has on the parameter being measured. Sometimes the sample matrix will hide a parameter; a matrix spike will help identify this effect by showing a low recovery. Because matrix spikes give more information about the sample and its matrix, they are preferred to running duplicates. Some analyses (pH and Temp for example) do not lend themselves to matrix spikes very easily, therefore some analyses do not use matrix spikes (inorganic/physical analysis only).

PQL(Practical Quantitation Limit):
The PQL is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.

PQLSTD:
The Standard in the curve at or below the limit of quantitation.

GUIDLINES FOR QUALITATIVE IDENTIFICATION OF AROCLORS

The purpose of this Appendix is to provide guidelines for the qualitative identification of PCB Aroclors. Since different Aroclors can have similar amounts of chlorine by mass and share several congeners, this Appendix is intended to assist in differentiating between the various Aroclors analyzed for by Teklab, Inc. While this appendix will demonstrate some identifying characteristics between similar Aroclors, analyst experience also plays a role in appropriately identifying PCBs in environmental samples.

Each Aroclor will be listed, and identifying characteristics will be noted:

Aroclor 1221

Aroclor 1221 is the earliest eluting Aroclor that Teklab, Inc. analyzes for. Its identification is fairly straightforward as it does not have much interference by overlapping peaks with other Aroclors. The tallest peaks can be seen in on the chromatogram in Figure 1 at 4.83 and 4.63 minutes on column 1 and 5.2 and 5.36 minutes on column 2. It should be noted that due to the early elution, some congeners in Aroclor 1221 elute before surrogate TCMX, which is the tallest peak seen in Figure 1. For the purposes of identification the laboratory only uses 3-5 peaks that elute after surrogate TCMX.

Aroclor 1232

An example chromatogram of Aroclor 1232 can be seen in Figure 2. By comparing Figure 2 to Figure 3 (Aroclor 1242), it can be seen that these two Aroclors share many of the same congeners. The primary difference in pattern recognition to distinguish between these two Aroclors (1232 & 1242) is the first peak integrated by the laboratory for identification. Note in Figure 2 that the peaks integrated at 4.83 min on column 1 and 5.36 min on column 2 are taller than the next integrated peaks at 5.21 min on column 1 and 5.9 min on column two. Also note that in Figure 3 the peaks integrated and 4.83 min on column 1 and 5.37 min on column 2 are shorter than the peaks integrated at 5.21 min on column 1 and 5.74 min on column 2. Typically when those first peaks are taller it indicates the presence of Aroclor 1232 and when they are shorter, Aroclor 1242.

Aroclor 1242

Aroclor 1242 shares many similarities with Aroclors 1016 and 1232. The paragraph on 1232 illustrates the distinguishing differences between Aroclors 1232 and 1242. The primary differences between Aroclors 1242 and 1016 are the peaks near the end of the pattern. Note that in the chromatogram of Aroclor 1242 (Figure 3) the last two peaks integrated for Aroclor 1242 are much taller than the peaks of the same retention time in Aroclor 1016 (Figure 6). Aroclors 1242 and 1016 share the same dominant peak, the peak at 5.63 min on column 1 in Figure 3, therefore this pattern difference at the end of the elution of these Aroclors must be taken into consideration in determining whether Aroclor 1242 or 1016 is present in a sample.

Aroclor 1248

For Aroclor 1248 the tallest peak can be seen in the example chromatogram (Figure 4) eluting at 6.51 min on column 1 and 7.25 min on column 2. This is a distinguishing characteristic of the 1248 pattern because in other Aroclors this will not be the dominant peak. In comparison to the Aroclor 1016 pattern the first three peaks integrated for 1248 can also be taken in to account. In Aroclor 1248 the first three peaks are of similar height. In Aroclor 1016 (Figure 6) the peaks on column 1 at 5.94 min and 6.12 min are considerably shorter than the peak at 5.63 min on the same column. When dealing with weathered Aroclors in a sample these three peak heights can be useful in determining whether Aroclor 1016 or Aroclor 1248 is present in a sample. Besides that, Aroclor 1248 has a fairly unique pattern compared to the other Aroclors.

Aroclor 1254

An example chromatogram of Aroclor 1254 can be seen in Figure 5. Aroclor 1254 also has a fairly unique pattern in comparison to the other Aroclors. The dominant peak can be seen in the example at 7.21 min on column 1 and 8.04 min on column 2. When Aroclor 1254 is the only Aroclor in a sample it is generally easy to determine. When Aroclor 1254 is one of multiple Aroclors in a sample it can take a little more effort to identify as will be discussed in the Presence of Multiple Aroclors and Weathered Aroclors section of this Appendix.

Aroclor 1016

An example chromatogram of Aroclor 1016 can be seen in Figure 6. The pattern for Aroclor 1016 has many similarities with Aroclors 1232 and 1242. The primary differences between 1016 and 1242 are discussed in the Aroclor 1242 section of this appendix. Using the information in the Aroclor 1232 section can also be helpful in differentiating Aroclors 1016 and 1232. Much like Aroclor 1242, the first peak integrated in Aroclor 1016 (4.83 min on column 1 in Figure 6) will typically be much shorter than a peak of similar retention time in the Aroclor 1232 pattern (the peak at 4.83 min on column 1 in Figure 2).

Aroclor 1260

An example chromatogram for Aroclor 1260 can be seen in Figure 6. Note that the chromatogram in Figure 6 illustrates both Aroclors 1016 and 1260. Aroclor 1260 is the latest eluting Aroclor analyzed for by Teklab, Inc. As such, it has a unique pattern and does not get much interference from any of the other Aroclors. Note that the first peak integrated for Aroclor 1260 elutes in the example at 8.52 min on column 1 and 9.2 min on column 2. This late elution and lack of interference from other Aroclors makes Aroclor 1260 fairly straightforward to identify in environmental samples.

Presence of Multiple Aroclors and Weathered Aroclors

The intent of this section is to provide basic guidelines for qualitative identification of multiple Aroclors in the same sample, as well as weathered Aroclors. Analyst experience plays a significant role in making these determinations. Additionally, chromatographic interferences vary from sample to sample and must be taken into consideration as well.

1) When multiple overlapping Aroclors are present it is a good practice to eliminate the primary overlapping peaks if they are biased. For example, looking at Figures 4 and 5 notice that the last two peaks integrated for Aroclor 1248 share a similar retention time with the first two peaks integrated for Aroclor 1254. In the event that both of these Aroclors were present in the same sample and the last two peaks of 1248 were biased high in comparison to the first three, and the first two peaks of 1254 were biased high in comparison with the last three, it could be determined that the bias was occurring due to the presence of both of those Aroclors overlapping and the overlapping peaks could be eliminated for quantitative identification.
2) Any combination of Aroclors 1016, 1232, and 1242 should never be reported from the same environmental sample. Because of the similarities in the patterns of these three Aroclors, the analyst must determine which Aroclor best matches the pattern in the sample and report the other two as non-detect.
3) Weathering can occur in environmental samples and cause Aroclor patterns to be imperfect in comparison with the pattern achieved from running standards. In these cases the analyst should use the guidelines in this Appendix to determine the best match for Aroclors identification. Common effects of weathering are missing peaks or abnormal peak heights as compared to the chromatography of running standards. The analyst must use the available data to determine which Aroclor has the greatest similarities to that of the sample.

Figure 1 Aroclor 1221

```
                              Quantitation Report

  Signal #1 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q052.D\ECD1A.CH Vial: 47
  Signal #2 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q052.D\ECD2B.CH
  Acq On    : 24 Mar 2016  10:58 pm                  Operator: HE
  Sample    : AR 1221-1000 BNA160307ZB               Inst     : Inst Q
  Misc      : ,SV_8082S_W,ICV,1,                     Multiplr: 1.00
  IntFile Signal #1: events.e     IntFile Signal #2: events2.e
  Quant Time: Mar 30 12:47 2016  Quant Results File: Q21-6701.RES

  Quant Method : C:\HPCHEM\1\METHODS\INSTQ~1\Q21-6701.M (Chemstation Integrator)
  Title        : QPCB AR 1221-6701 3/24/2016
  Last Update  : Wed Mar 30 12:44:46 2016
  Response via : Multiple Level Calibration
  DataAcq Meth : QPCBX.M

  Volume Inj.     : 1.0 ul
  Signal #1 Phase : ZB-Multi-Residue- Signal #2 Phase: ZB-Multi-Residue-2
  Signal #1 Info  : 30MX0.32mmX0.5um  Signal #2 Info : 30MX0.32mmX0.25um
```

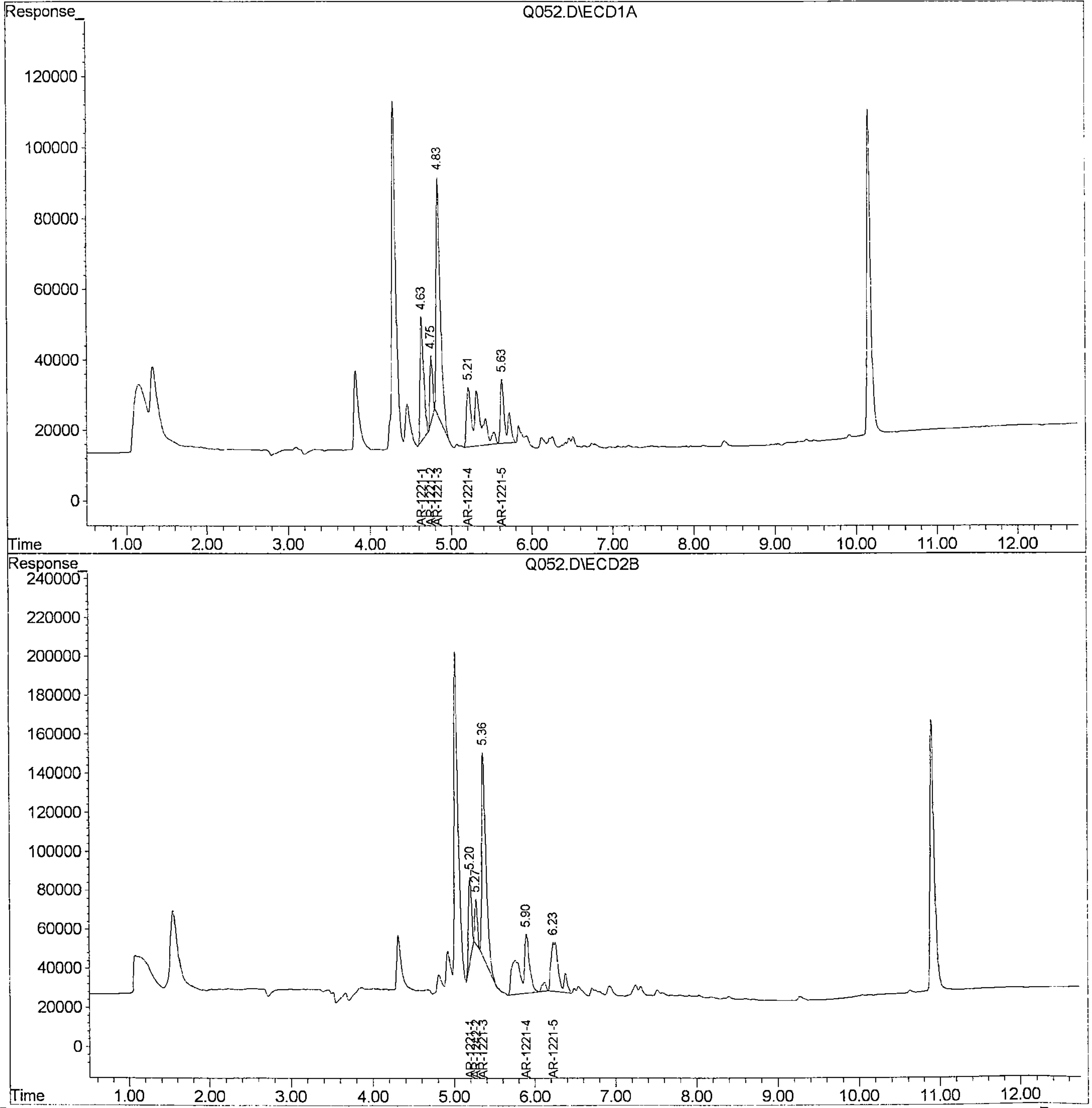


Figure 2 Aroclor 1232

```
                           Quantitation Report

Signal #1 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q060.D\ECD1A.CH Vial: 54
Signal #2 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q060.D\ECD2B.CH
Acq On    : 25 Mar 2016   1:15 am                     Operator: HE
Sample    : AR 1232-1000 BNA160127I                   Inst    : Inst Q
Misc      : ,SV_8082S_W,ICV,1,                        Multiplr: 1.00
IntFile Signal #1: events.e     IntFile Signal #2: events2.e
Quant Time: Mar 30 13:52 2016  Quant Results File: Q32-6702.RES

Quant Method : C:\HPCHEM\1\METHODS\INSTQ~1\Q32-6702.M (Chemstation Integrator)
Title        : QPCB 1232-6702  3/24/2016
Last Update  : Wed Mar 30 13:45:25 2016
Response via : Multiple Level Calibration
DataAcq Meth : QPCBX.M

Volume Inj.     : 1.0 ul
Signal #1 Phase : ZB-Multi-Residue- Signal #2 Phase: ZB-Multi-Residue-2
Signal #1 Info  : 30MX0.32mmX0.5um  Signal #2 Info : 30MX0.32mmX0.25um
```

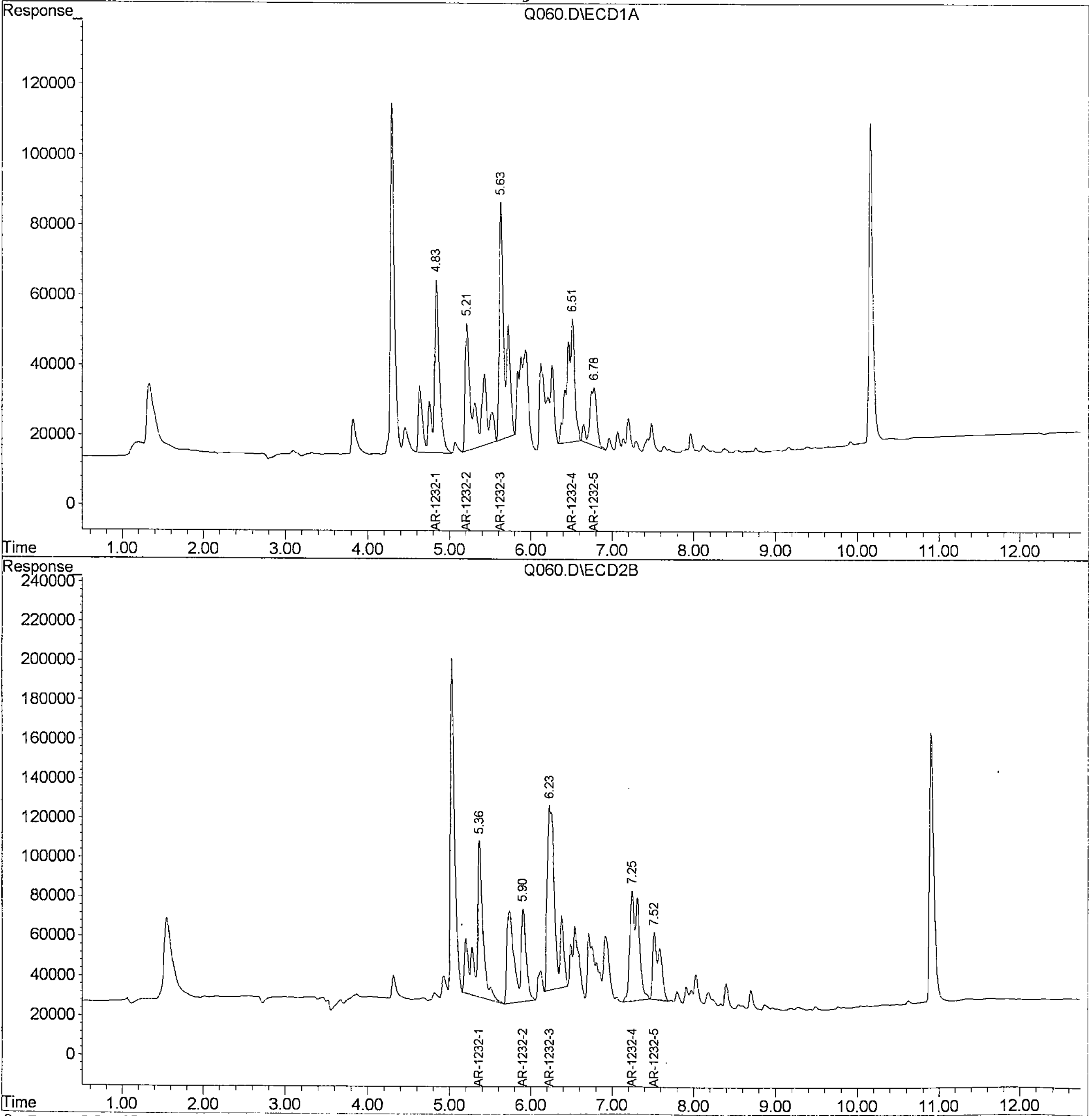


Figure 3 Aroclor 1242

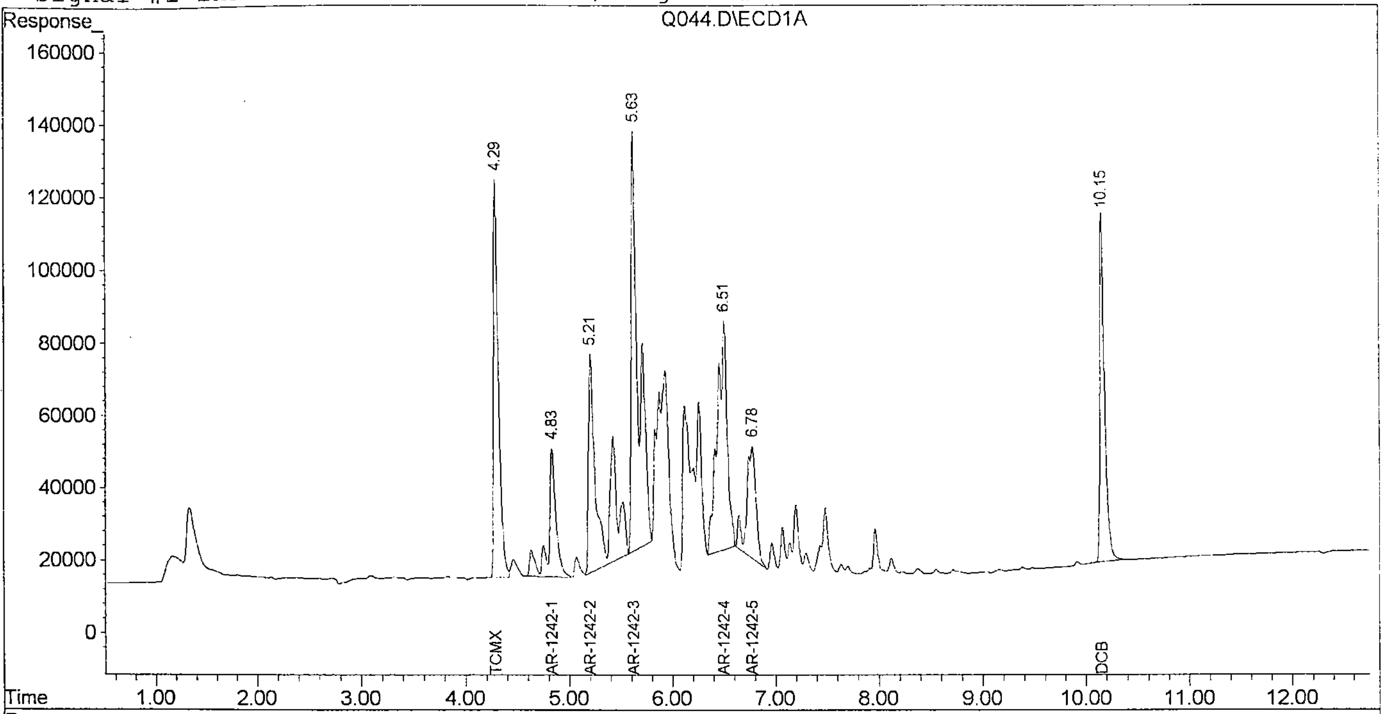
Quantitation Report

```
Signal #1 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q044.D\ECD1A.CH Vial: 39
Signal #2 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q044.D\ECD2B.CH
Acq On     : 24 Mar 2016   8:41 pm                     Operator: HE
Sample     : AR 1242-1000 BNA160309C                   Inst    : Inst Q
Misc       : ,SV_8082S_W,ICV,1,                        Multiplr: 1.00
IntFile Signal #1: rteint.p     IntFile Signal #2: rteint2.p
Quant Time: Mar 29 12:24 2016  Quant Results File: Q42-6695.RES

Quant Method : C:\HPCHEM\1\METHODS\INSTQ~1[redacted]M (RTE Integrator)
Title        : PCB-1242 3/24/2016 (Q42-6695)
Last Update  : Tue Mar 29 12:11:44 2016
Response via : Multiple Level Calibration
DataAcq Meth : QPCBX.M

Volume Inj.       : 1 ul
Signal #1 Phase : ZB-Multi-Residue- Signal #2 Phase: ZB-Multi-Residue-2
Signal #1 Info  : 30mX0.32mmX0.5um) Signal #2 Info : 30MX0.32mmX0.25um
```

Redacted by TekLab



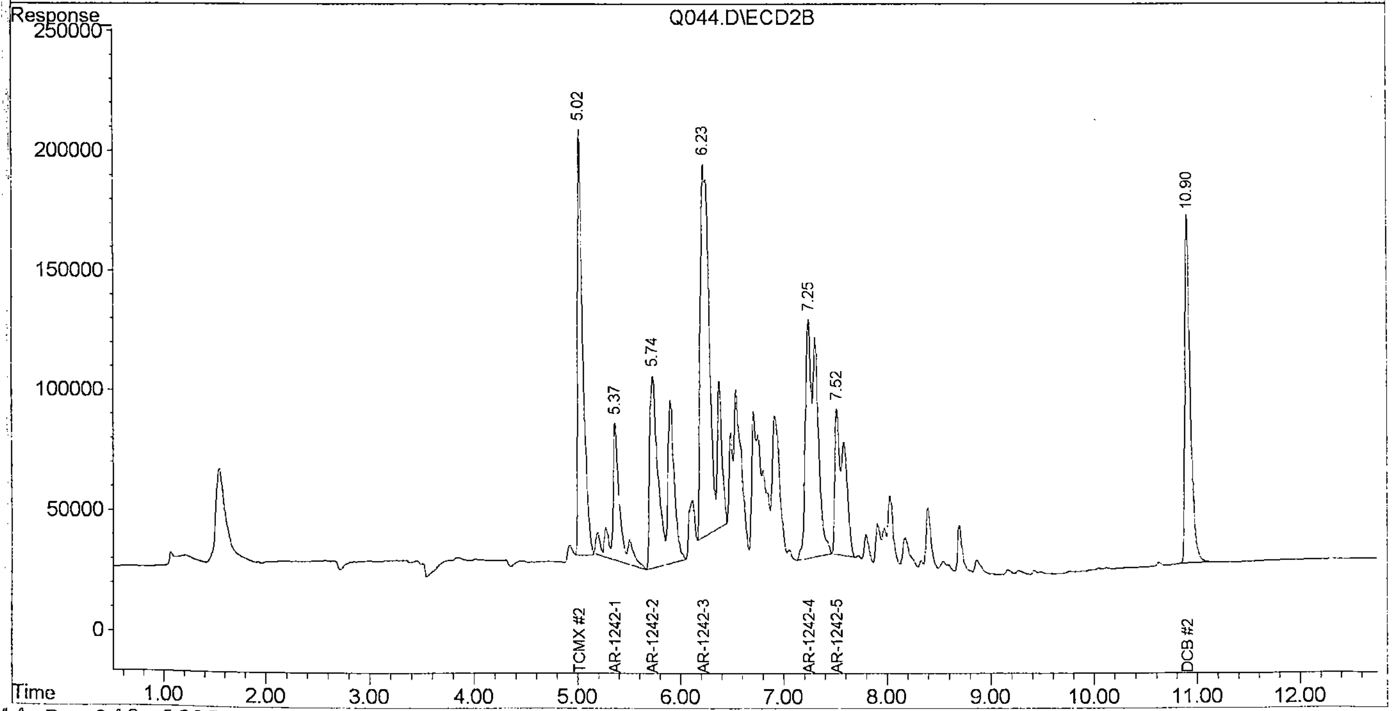


Figure 4 Aroclor 1248

```
Quantitation Report

Signal #1 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q035.D\ECD1A.CH Vial: 30
Signal #2 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q035.D\ECD2B.CH
Acq On    : 24 Mar 2016    6:07 pm                        Operator: HE
Sample    : AR 1248-1000 BNA160309B                       Inst    : Inst Q
Misc      : ,SV_8082S_W,ICV,1,                            Multiplr: 1.00
IntFile Signal #1: rteint.p      IntFile Signal #2:[redacted]2.p
Quant Time: Mar 28 18:56 2016   Quant Results File:[redacted] RES

Quant Method  : C:\HPCHEM\1\METHODS\INSTQ~1\Q48-6694.M (RTE Integrator)
Title         : PCB-1248 3/24/2016 (QPC48-6694)
Last Update   : Mon Mar 28 18:49:35 2016
Response via  : Multiple Level Calibration
DataAcq Meth  : QPCBX.M

Volume Inj.      :
Signal #1 Phase  :                    Signal #2 Phase:
Signal #1 Info   :                    Signal #2 Info :
```

Redacted by TekLab

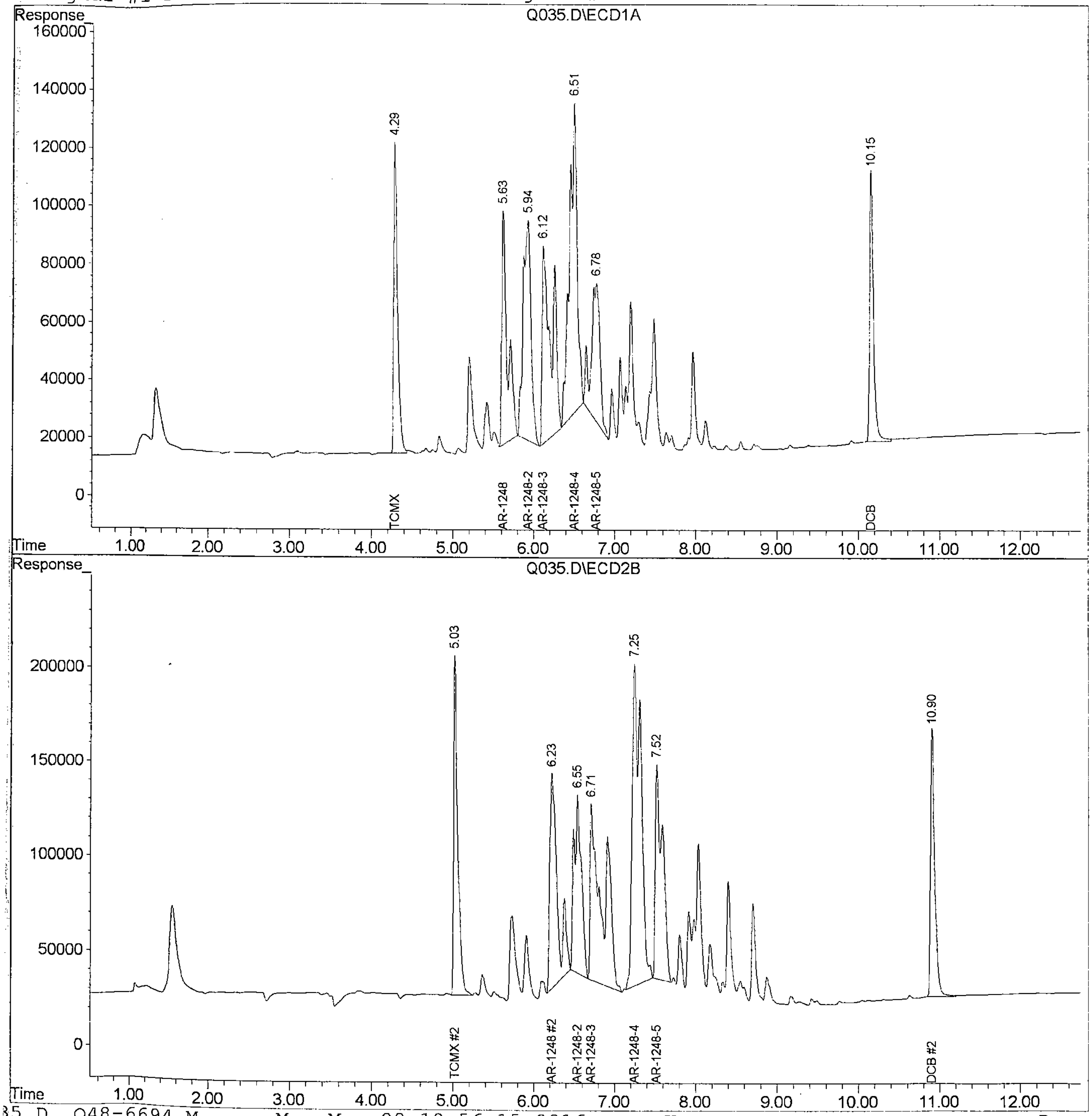


Figure 5 Aroclor 1254

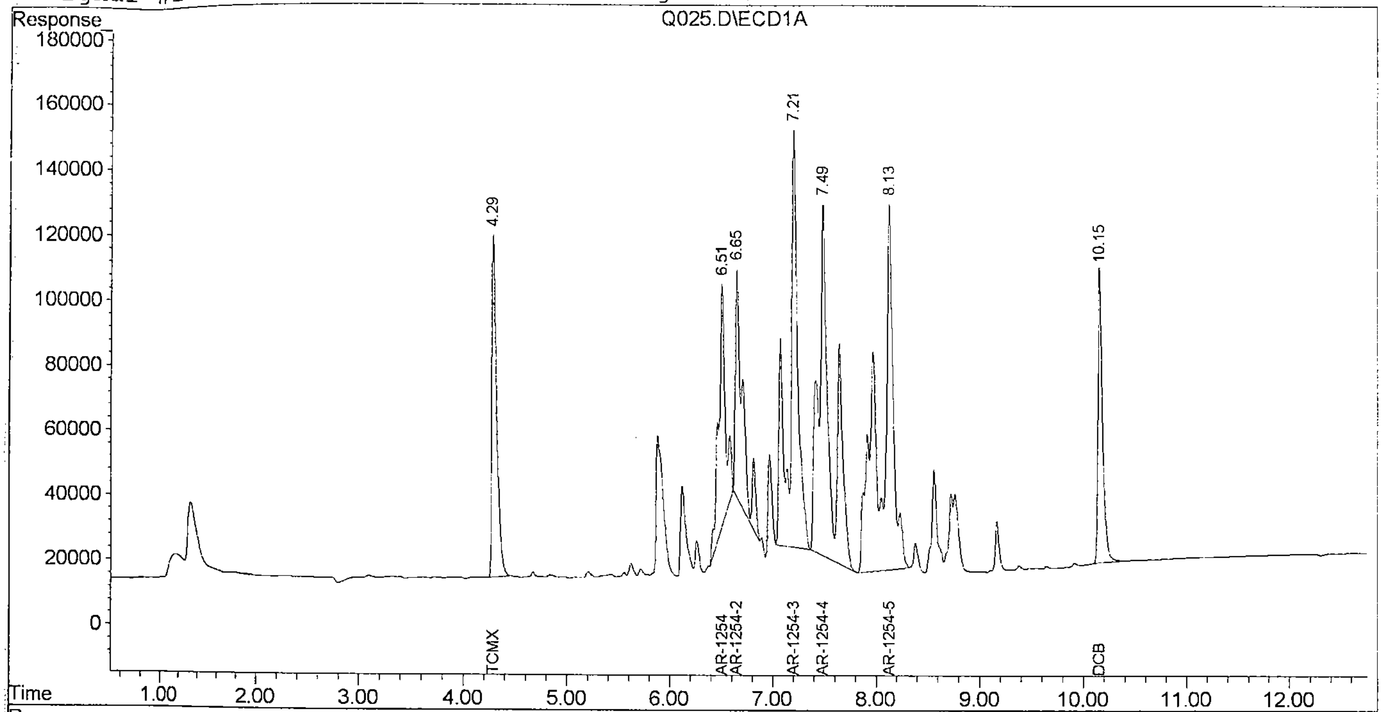
```
                              Quantitation Report

Signal #1 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q025.D\ECD1A.CH Vial: 20
Signal #2 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q025.D\ECD2B.CH
Acq On    : 24 Mar 2016   3:16 pm                  Operator: HE
Sample    : AR 1254-1000 BNA160309A                Inst    : Inst Q
Misc      : ,SV_8082S_W,ICV,1,                     Multiplr: 1.00
IntFile Signal #1: events.e     IntFile Signal #2: events2.e
Quant Time: Mar 28 16:12 2016   Quant Results File: Q54-6693.RES

Quant Method : C:\HPCHEM\1\METHODS\INSTQ~1\[redacted].M (Chemstation Integrator)
Title        : PCB AR-1254-6693 3/24/2016
Last Update  : Mon Mar 28 16:03:16 2016
Response via : Multiple Level Calibration
DataAcq Meth : QPCBX.M

Volume Inj.     :
Signal #1 Phase :                     Signal #2 Phase:
Signal #1 Info  :                     Signal #2 Info :
```

Redacted by TekLab



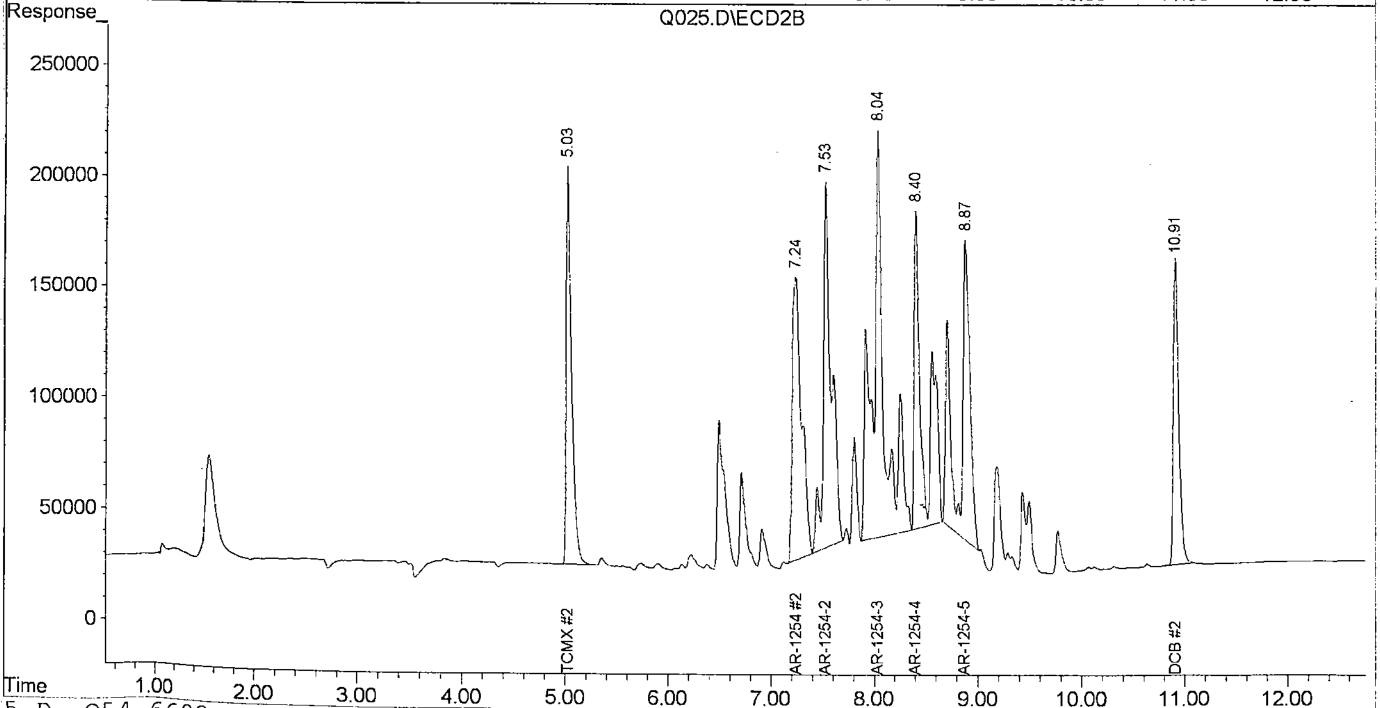


Figure 6 Aroclors 1016 & 1260

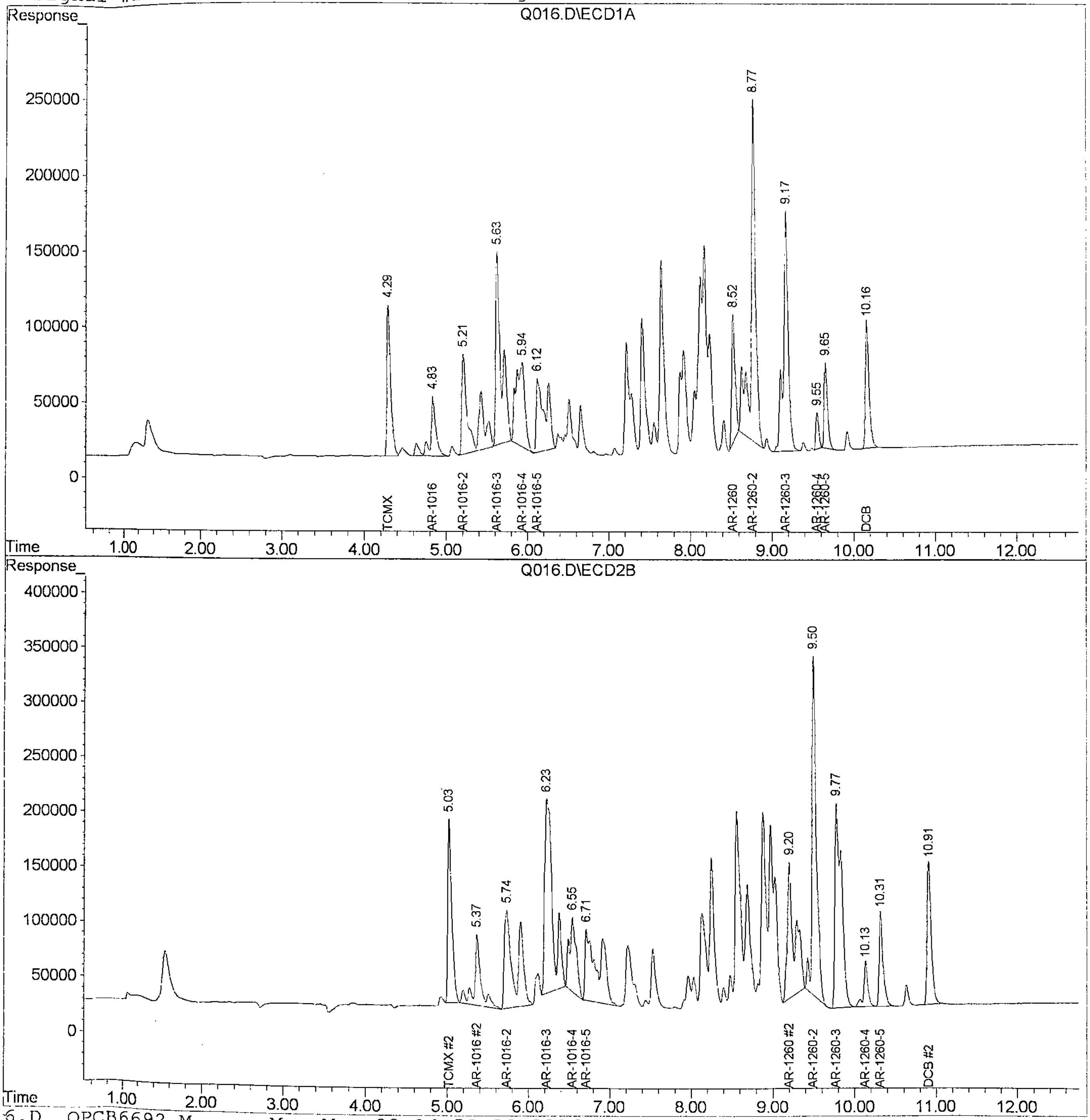
Quantitation Report

```
Signal #1 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q016.D\ECD1A.CH Vial: 11
Signal #2 : C:\HPCHEM\1\DATA\INSTQ~1\PRACTICE\Q160324\Q016.D\ECD2B.CH
Acq On    : 24 Mar 2016   12:42 pm                    Operator: HE
Sample    : AR 1660-1000 BNA160315E                   Inst     : Inst Q
Misc      : ,SV_8082S_W,ICV,1,                        Multiplr: 1.00
IntFile Signal #1: rteint.p      IntFile Signal #2: rteint2.p
Quant Time: Mar 28 14:53 2016   Quant Results File: QPCB6692.RES

Quant Method  : C:\HPCHEM\1\METHODS\INSTQ~1[redacted].M (RTE Integrator)
Title         : AR 1660 3/24/2016 (QPCB6692)
Last Update   : Mon Mar 28 14:32:33 2016
Response via  : Multiple Level Calibration
DataAcq Meth  : QPCBX.M

Volume Inj.      : 1 ul
Signal #1 Phase  : DB-35MS            Signal #2 Phase: DB-XLB
Signal #1 Info   : 30mX0.32mmX0.25um Signal #2 Info : 30mX0.32mmX0.5um
```

Redacted by TekLab



TEKLAB INC
STANDARD OPERATING PROCEDURE
VOLATILE ORGANIC ANALYSIS BY GC/MS

SCOPE

This method is applicable to the analysis of aqueous, solid, non-aqueous liquids, chemical wastes, toxicity characteristic leaching procedure (TCLP) extracts, synthetic precipitation leaching procedure (SPLP) extracts, and shake extracts. This method maybe used for the analysis of volatile organic compounds. Holding time and preservation information can be found in See 1000 series SOP Appendix B. See LIMS for current test codes, analyte list, MDLs and PQLs.

SUMMARY

Volatile compounds are purged from samples using helium and are collected onto a sorbent trap. The trap is rapidly heated and backflushed with helium, which releases the trapped compounds and sweeps them onto a narrow-bore capillary column. The column is temperature programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced with the gas chromatograph (GC). This method is used to quantitate volatile organic compounds that have boiling points of approximately 200ºC or lower.

The working range for aqueous samples with a 5mL purge and solids with 5g of dry weight sample is 5ppb to 200ppb for most compounds. Higher working ranges will apply for compounds that exhibit poor chromatographic behavior, poor purging due to high water solubility, or poor response at low concentrations. Conversely, some compounds will have lower working ranges due to increased purging efficiency and lower reporting limit requirements. Quantitation limits will be proportionately higher for sample extracts and samples that require dilution or reduced sample size to avoid saturation of the analytical detector.

SAFETY

Many of the analytes in the standards are carcinogens, suspected carcinogens, or toxins and must be handled with care. Standards, solvents, reagents, and samples should be handled in such a manner as to avoid excess exposure. Protective gloves must be worn when handling these materials; safety glasses and laboratory coats are recommended. Refer to the appropriate Safety Data Sheets for more specific information on the solvents and compounds used in this method. Samples may contain hazards of unknown origin and should be handled accordingly. All standards and containers must be disposed of in an environmentally safe manner.

EQUIPMENT & SUPPLIES

- Chemstation using HP Enviroquant software.
- Top loading balance, capable of weighing +/- 0.01grams.
- Glass syringes: 10µL, 25µL, 50µL, 100µL, 250µL, 1000µL, 5mL, and 25mL gas tight.
- 40mL VOA vials.
- 5mL frittless sparge vessels for EST Encon Evolution.

- Class A volumetric flasks with glass stoppers: 5mL, 10mL, 50mL, 100mL, 200mL, 250mL, 500mL, 1L, and 2L.
- Glass Pasteur pipets and pipet bulbs.
- 2mL amber vials with Teflon lined screw caps.
- Glass injection port liners.
- Low bleed septa.
- Teflon magnetic stir bars.
- Vortex mixer.
- Centrifuge.
- VOCARB 3000 sorbent traps.

- Instrument A
  - Hewlett-Packard 5890 Series II GC / 5971 Mass Spectrometer (upgraded to 5972) with a metal quad upgrade, 30 meter Restek Rtx-624 column with 0.25mm ID, using a split/splitless injection port and glass injection port liner. No cryogenic system is used.
  - EST Encon Evolution concentrator.
  - EST Centurion autosampler.

- Instrument AF
  - Agilent 7890A GC / 5975 Mass Spectrometer with a 630 meter Restek Rtx-624 column with 0.25mm ID, using a split/splitless injection port and glass injection port liner. No cryogenic system is used.
  - EST Encon Evolution concentrator.
  - EST Centurion autosampler.

- Instrument Y
  - Hewlett-Packard 5890 Series II GC / 5972 Mass Spectrometer, 30 meter Restek Rtx-624 column with 0.25mm ID, using a split/splitless injection port and glass injection port liner. No cryogenic system is used.
  - EST Encon Evolution concentrator.
  - EST Centurion autosampler.

- Instrument N
  - Hewlett-Packard 5890 Series II Plus GC / 5972 Mass Spectrometer with a metal quad upgrade, 30 meter Restek Rxi-624SilMS column with 0.25mmID, using a split/splitless injection port and glass injection port liner. No cryogenic system is used.
  - EST Encon Evolution concentrator.
  - EST Centurion autosampler.

- Instrument AE
  - Agilent 7890A GC / 5975 Mass Spectrometer, 30 meter Restek Rxi-624SilMS column with 0.25mm ID, using a split/splitless injection port and glass injection port liner. No cryogenic system is used.
  - EST Encon Evolution concentrator
  - EST Centurion autosampler.

- Instrument T
  - Hewlett-Packard 6890 Series GC / 5973 Mass Spectrometer, 30 meter Restek Rxi-624SilMS column with 0.25mm ID, using a split/splitless injection port and glass injection port liner. No cryogenic system is used.
  - EST Encon Evolution concentrator
  - EST Centurion autosampler.

Instruments A, AF, and Y are set up to purge samples directly from the Centurion autosampler. This can be done with either aqueous or solid samples. Instruments N, AE, and T are for aqueous samples only. The centurion autosamplers for these instruments transfer 5mL of sample to a sparge vessel on the Encon Evolution where the purging is performed. Primarily, solid matrix samples are run on instruments A, AF, and Y, which will herein be referred to as the "solid instruments." Conversely, instruments N, AE, and T will be referred to as the "aqueous instruments."

REAGENTS & STANDARDS (Quality Manual Chapter 23)

- Methanol, purge and trap grade.
- Deionized water that has passed through a carbon filter.
- Certified Quality Control Standards, purchased from an outside vendor.
  Stock Standards, purchased from an outside vendor. The stock standards are purchased as certified solutions, which are prepared by the manufacturer and are traceable to NIST standards. They are purchased in various mixes and concentrations. All standards that are received in methanol are stored in the freezer and those received in water are stored in the refrigerator or freezer. All stock standards must be replaced by or before the manufacturer's expiration date.
- Internal Standards (IS) and Surrogate Standards (SS), purchased from an outside vendor. The IS/SS stock solution contains a mix of fluorobenzene(IS), chlorobenzene-d5(IS),1,4-dichlorobenzene-d4(IS), dibromofluoromethane(SS), 1,2-dichloroethane-d4(SS), toluene-d8(SS), and 4-bromofluorobenzene(SS). The internal and surrogate standards are purchased as a combined stock solution at 250µg/mL and 50ug/mL for each compound.
- Matrix Spike / Matrix Spike Duplicate Standards (MS/MSD), purchased from an outside vendor. The matrix spike solution is a mixture of 1,1-dichloroethene, benzene, chlorobenzene, ethylbenzene, p-xylenes, o-xylenes, toluene, and trichloroethene at a concentration of 250µg/L for each compound.
- TPH-GRO Standard, purchased from an outside vendor. This standard is a mixture of gasoline and diesel fuel at a concentration of 5000µg/mL.

See VOA Standard preparation controlled document in the Quality Documents folder on the F drive for preparation instructions of the following:

- Working standards
- Intermediate standards
- Calibration standards

- 4-Bromofluorobenzene (BFB)
- Calibration Verification Standards (CCV)
- Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD)
- Quality Check Standard (QCS)
- TCLP MS/MSD
- Retention time marker (RT)

The reagents and prepared standards listed above have an expiration period of 12 months from the date open or prepared unless noted above. The above listed reagents and standards are stored on the bench unless noted above. Standards and reagents purchased from vendors expire one year from the day they are opened unless the vendor expiration date precedes that date.

See SOP 4022 for labeling and additional information on storing of standards.

CALIBRATION (Quality Manual Chapter 22)

The general procedure for calibration is outlined in SW-846.

A new calibration curve must be generated after the MS has been retuned, after major modifications to the system, or after any maintenance or other change that would result in the failure of the daily quality control samples (e.g., BFB, CCV, LCS). See VOA Standard preparation controlled document in the Quality Documents folder on the F drive for calibration curve preparation instructions.

Prior to recalibration, the system must be set up and tuned. It must also be capable of producing spectra for a 50ng injection of BFB that meets the evaluation criteria detailed in Table 2. The BFB peak is evaluated by averaging the scan at the apex with one scan to the right and one scan to the left of the apex. If this three scan average does not produce a successful tune, a different combination of scans may be analyzed. If this is the case, a background subtraction must be performed with any scan that is not part of the BFB peak itself. Initial calibration may only be started after a passing tune is obtained. The injection of the BFB starts the beginning of the 12 hour clock and all samples should be injected within 12 hours in order to be valid. Method 624.1 is different in the fact that the 12 hour clock begins with the injection of the last quality control sample (MBLK) rather than the BFB and all samples, including matrix spikes, must be injected within this 12 period in order to be valid.

An initial calibration must be performed for all compounds that will be quantitated with this method. Calibration curves must be made of at least 5 levels (6 if a quadratic curve fit is utilized), with the lowest level being at or below the reporting limit. All other levels will define the working range of the detector for each compound. Not all levels of the calibration curve must be used for each compound. Acceptable working ranges are based on a unique combination of instrument and analyte performance and may change with each initial calibration. Linearity verification and reporting limit needs are taken into consideration when determining working ranges for specific analytes. When looking at a curve for method 624.1 it is important to note that no interior points of the curve may be dropped. If the high or low end of the curve must be dropped that is acceptable.

After the calibration curve is analyzed on the instrument, the data analysis portion of the Chemstation software is used to review the data file for each level. Individual compounds and surrogates shall be quantitated by extracting and integrating the target ion (m/z) for that compound. The target ion is usually the most abundant of the m/z ions in the spectra, but this is not always the case. When two or more chromatographic peaks overlap and have one or more common ions, an ion that is unique to only one of the overlapping compounds shall be used as the target or qualifier ion. In the case of meta- and para-xylenes, which are completely unresolved in the chromatogram and have virtually identical spectra, it is necessary to quantitate the peak and report the result as a pair (m,p-xylenes). Refer to Tables 1 for information about the employed target and qualifier ions for all compounds.

The calibration described herein is performed using an internal standard type calibration. This involves the comparison of instrument responses of the target analytes to the responses of the internal standards that have been added to each sample prior to purging. Ideally, analytes are calibrated using the nearest eluting internal standard. The ratio of the peak area of the target compound to the peak area of the internal standard is termed the response factor (RF). After each calibration level is reviewed and all compounds and surrogates are integrated properly, the RF for each compound is calculated using the formula:

$$RF = \frac{A_s \text{ x } C_{is}}{A_{is} \text{ x } C_s}$$

Where:
A_s = the peak area of the analyte or surrogate
A_{is} = the peak area of the internal standard
C_s = the concentration of the analyte or surrogate
C_{is} = the concentration of the internal standard

The mean RF ($\overline{RF}$) for each target analyte and surrogate is then calculated.

Calculate the standard deviation (SD) and the relative standard deviation (RSD) for the response factors for all target analytes from the initial calibration, as follows:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(RF_i-\overline{RF})^2}{n-1}} \qquad RSD = \frac{SD}{\overline{RF}} \text{ x } 100$$

Where:

RF_i = RF for each of the calibration standards
$\overline{RF}$ = mean RF for each compound from the initial calibration
n = number of calibration standards

The calibration standards for the TPH-GRO ranges are quantitated by integrating the total ion chromatogram within the respective retention time windows. The windows are determined by analyzing a retention time marker and are defined as the range between -0.1 to +0.1 minutes of the appropriate hydrocarbon peaks. For example, the TPH-GRO OA-1 range is the marked by the 0.1 minutes prior to the elution of MtBE through 0.1 minutes after the elution of naphthalene. Individual quantitation ions are not appropriate for GRO calibration and analysis. A total ion chromatogram (TIC) must be used to calculate the area under the peaks over the entire retention time window. The system will not properly establish a proper baseline over the selected windows. The analyst, therefore, must manually adjust the computer generated baseline for all standards, samples, and blanks. Contrary to individual peak analysis, the blank TIC must be subtracted from all standards and samples to compensate for the addition of the internal and surrogate standards.

Linearity Criteria
The linearity of the target analytes must be checked. If the RSD of any target analyte is 15% or less, then the response factor is assumed to be constant over the calibration range and the average response factor may be used for quantitation. If any analyte has a RSD greater than 15% or if calibration history or other QC indicates it to be necessary an alternative curve fit shall be employed. Linear calibration using a least squares regression is one available alternative. If this type is used, the regression equation must not be forced through zero. A correlation coefficient equal to or greater than 0.99 validates a least squares linear calibration. If this is not appropriate, a non-linear quadratic curve fit can be used. This type of fit also requires use of a minimum of six calibration standards. If the correlation coefficient is greater than or equal to 0.99, the quadratic fit may be used.

The linearity requirement for TPH-GRO calibration is an RSD of or less than 20%.

In method 624.1 if the RSD is less than 35%, the RF can be assumed to be invariant and the average RF can be used for calculations. If any analyte has a RSD greater than 35% or if calibration history or other QC indicates it to be necessary an alternative curve fit shall be employed. If used, the regression must be weighted inversely proportional to concentration (1/C) and the coefficient of determination of the weighted regression must be greater than 0.920.

Initial Calibration Verification (ICV)
An ICV (See LIMS for concentration) from a source other than the calibration source is analyzed and must meet control charted limits. If either of the alternative fits is used for any analyte, the initial calibration verification of that analyte must be within ±15% of the true value. If the initial ICV fails a second ICV may be analyzed to verify the failing analytes after documented corrective action. If the second ICV fails the curve for that analyte is not considered valid. For method 624.1 the ICV must be evaluated using the limits listed in the method.(See LIMS for concentrations.)

Continuing Calibration Verification (CCV/QCS)
In order for a CCV/QCS to pass the following criteria must be met:

a) Five System Performance Check Compounds (SPCCs) must meet minimum average response factor requirements. This is used to check compound instability and to check for degradation caused by contaminated lines or active sites in the system. The five compounds and the minimum mean response factor for each are:

Chloromethane	0.10
1,1-Dichloroethane	0.10
Bromoform	0.10
Chlorobenzene	0.30
1,1,2,2-Tetrachloroethane	0.30

b) Six Calibration Check Compounds (CCCs) are used to evaluate the integrity of the system during calibration. High variability for these compounds may be indicative of system leaks or reactive sites on the column. The six CCCs are:

1,1- Dichloroethene
Chloroform
1,2-Dichloropropane
Toluene
Ethylbenzene
Vinyl Chloride

The RSD for these compounds must be 15% or less. If none of the six CCCs are included in the list of analytes for the method, then all compounds in the method become CCCs.

c) The relative retention time of each target compound in each calibration standard must agree within 0.06 relative retention time units.

d) For method 624.1 all analyte concentrations must meet the recovery limits listed in the method for any compound that will be reported.(See LIMS for concentrations.)

Internal Standards

Internal standard (see above for internal standards list) responses must be within 50-200% of the initial calibration internal response for all samples and QC. Any data that requires reporting with failing internal standards must be qualified using an "I" flag and an appropriate sample narrative must be added.

QUALITY CONTROL (Quality Manual Chapter 26)

LCS/LCSD

A LCS/LCSD(See LIMS for concentrations) is analyzed and must meet the recovery limits found in LIMS. These limits are control charted. The relative percent difference (RPD) between the LCS and LCSD should be 40% or less.

If a large number of analytes are present in the LCS, it is statistically likely that a few will fall outside of the established control limits without indicating a systematic problem. The allowable deviations are termed marginal exceedance (ME) and are allowed if the recovery of the compound falls between the LCS limit (which is three standard deviations) and four standard deviations of the control charted mean. The number of allowable MEs is based on the number of analytes in the LCS, with no allowances for compound lists with less than 11 constituents and up to 5 allowed for lists with 90 or more compounds. See Teklab Quality Manual Section 26.3.1 for a complete list of allowable MEs. Marginal exceedance does not apply for repeated inaccuracy of the same compound. If an analyte falls within ME in the LCS and LCSD, it is not allowed to be used as a ME compound if it exceeds the control limit in the successive LCS. Care must be taken by the analyst to monitor use of marginal exceedances to prevent mishandling of data. All samples analyzed with QC in which MEs are employed shall be appropriately documented in the sample narratives.

If a LCS analyte exceeds the upper control limit, samples that are non-detects may be reported with qualification. Such samples must also be appropriately documented in the sample narrative.

QCS

The QCS is an LCS which has been evaluated using the criteria listed in method 624.1. A QCS (See LIMS for concentrations) is analyzed in any batch that contains samples reported under EPA Method 624.1 Recovery limits for the QCS can be found in LIMS. These limits are control charted.

MBLK

A Method Blank (MBLK) of reagent water must be analyzed and must not contain any target analyte at or above the MDL. If any compound is in the blank at a reportable value, all samples in the associated batch must be reanalyzed or qualified if allowed by one of the following. If a MBLK contains a target analyte above the MDL a comment must be made in the sample narrative. If a MBLK contains a target analyte above the MDL the data shall be qualified with a "B" flag and only data that is non detect or more than 10X MBLK contamination shall be reported. A comment shall be made in the sample narrative.

For 624.1 specifically:

If any analyte of interest is found in the MBLK: 1.) at a concentration greater than the MDL for the analyte, 2.) at a concentration greater than one-third the regulatory compliance limit, or 3.) at a concentration greater than one-tenth the concentration in a sample analyzed during the 12-hour shift, whichever is greater; analysis of samples must be halted and samples affected by the MBLK must be re-analyzed. If, however, continued retesting results in repeated MBLK contamination, the laboratory must document and report the failures (e.g. as qualifiers on results), unless the failures are not required to be reported as determined by the regulatory/control authority. Results associated with MBLK contamination for an analyte regulated in a discharge cannot be used to demonstrate regulatory compliance, QC failures do not relieve a discharger or permittee of reporting timely results.

Surrogate Standard (SS)

Surrogate standards(SS) are added to all samples and QC. Surrogate recovery limits can be found in LIMS. Surrogate recovery limits are control charted. If SS fail in any batch QC the batch is considered out of control and the samples shall be reanalyzed. If multiple SS fail in a sample, the sample shall be reanalyzed, if possible, to verify matrix interference. All SS outliers shall be qualified and commented in the sample narrative appropriately.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Samples are chosen randomly by the operator for matrix spiking. At least 5% of all received samples, with at least one MS/MSD per matrix per 12-hour analytical batch are spiked (if sample volume permits). The recovery limits for both solid and aqueous samples can be found in LIMS. The MS/MSD recovery limits are control charted. The recovery and RPD are calculated for each MS/MSD. If any analytes are outside of the control limits or the RPD is not 20% or less, the data shall be reported with a qualifier and appropriate comment in the sample narrative. Matrix spikes are spiked using the MS/MSD stock standard at 1µL/5mL of sample.

For method 624.1 samples must be spiked with all analytes of interest. Samples must meet the method requirements for percent recovery and percent RPD listed in method 624.1. If this criteria is not met, the sample must be diluted and reanalyzed until criteria has been met. Each new waste stream must be matrix spiked to verify that there is no matrix interference present.

TPH- GRO QC (CCVG/LCSG/LCSGD)

All samples requiring TPH-GRO analysis must be accompanied by a CCVG and a LCSG/LCSGD. The recovery limits are 80-120% for the CCVG and 70-130% for the LCSG/LCSGD. As previously stated, the MBLK TIC for each range is subtracted from the standards prior to this QC recovery determination. Samples requiring TPH-GRO analysis are matrix spiked for individual compounds only and are not spiked for the GRO ranges.

TCLP Matrix Spike

All TCLP extracts are manually matrix spiked, as previously described. Only one MS is necessary for TCLPs of the same matrix. If there is more than one TCLP extract analyzed in any analytical batch, only one extract is spiked with a MSD. Recovery limits can be found in LIMS. If a MSD is also analyzed, the RPD must be at or less than 20%. TCLP MS/MSD are spiked using the TCLP MS/MSD working standard at 12.5µL/50mL.

Volatile Storage Blank (VSB)

Sample contamination that might occur during sample storage is evaluated weekly through the analysis of a holding blank (VSB, Volatile Storage Blank). Fresh VSBs are prepared with deionized water in a 40mL vial with minimal headspace and are stored in each sample refrigerator. After two weeks of storage, the VSB is analyzed and must be free of all target compounds at or above the reporting limit. If a compound is found in the blank, all samples stored in the refrigerator during the specified time shall be reported with the appropriate comment.

See VOA Standard preparation controlled document in the Quality Documents folder on the F drive for preparation instructions of QC.

See VOA folder on the F drive for most current control charts.

See Table 3 for QC frequency.

CORRECTIVE ACTION (Quality Manual Chapter 13)

If a CCV fails the standards are verified to have been prepared correctly and still intermediate standards still viable. A new CCV is analyzed and if it again fails again or the standards are not seen as the problem, on the soil instruments, the needle is cleaned and/or replaced. If QC is still failing the maintenance log located in LIMS is checked to see the most recent source maintenance and/or trap replacement. Source cleaning and/or trap replacement is usually the next step and once this is done a new curve is analyzed. Corrective actions could include further maintenance and or recalibration if necessary.

If bromomethane and/or iodomethane response has dropped significantly, changing and/or conditioning the trap is typically required.

If abnormal peak tailing is noticed the column may be clipped and/or changed to help alleviate the problem.

All other corrective actions are performed Quality Manual Chapter 13

INTERFERENCES

All reagents, standards, and reagent water must be kept free of contamination from any impurities that could cause interference during calibration or sample analysis. Such impurities could compromise the integrity of the standards as well as produce false positives in blanks and samples. Exposure to solvents in other areas of the lab can cause these false positives and should be avoided as much as possible, especially prior to setting up a 12-hour analytical batch. Problematic compounds include, but are not limited to, methylene chloride, acetone, acetonitrile, hexane, chloroform, and 1,1,2-trichloro-1,2,2-trifluoroethane (Freon). Clothing and lab coats that are exposed to these compounds in other areas of the lab can contribute to contamination of the volatile organic laboratory (VOA). Under no circumstances shall a sample received for volatile organic analysis be opened in any other department other than the VOA lab prior to analysis.

Water used as blanks and for dilutions must also be free of common water impurities. City water is deionized by passing through carbon and resin tanks before distribution throughout the building. VOA reagent water is further purified at the point of use with a carbon filter. This filter should be changed annually.

Samples with high levels of analytes can cause contamination of the purge and trap system which can lead to carryover contamination of sequential samples. If carryover is suspected, reanalysis of the potentially contaminated sample is necessary after all contamination has been cleared from the system.

Samples that contain organic materials or carbon can cause issues with internal and surrogate responses. Samples known to foam need to performed at a dilution to prevent sample filling the sparge tube and entering the purge and trap system on the water instruments or entering the needle on the soil instruments. Samples can contain unknown compounds that cause active sites throughout the instrument this may be indicated by issues with tetrachloroethene and pentachloroethene or other target analytes. Samples known to cause active sites should be diluted.

Upon client request, trip blanks can be sent with samples during collection and transport to the lab. These samples are used to monitor contamination due to diffusion of compounds (especially methylene chloride) through the vial septum.

PROCEDURE

Instrument parameters:

Encon Evoloutions on Instruments N, AE, T, A, AF and Y:

- Transfer lines and valves: 160ºC
- Initial trap temperature: less than or equal to 40ºC
- Preheat to purge temperature for 1 minute
- Purge at 45ºC for 9 minutes at 50mL/min
- Dry purge for 0.5 minutes
- Desorb at 250ºC for 0.5 minutes
- Bake at 270ºC for 10 minutes

Instrument N, AE, T, A, AF, & Y:

- Injection port temperature: 220ºC
- Column flow: 1mL/min
- Split ratio: 50:1
- Oven temperature program:
    - 40ºC, hold for 5 minutes
    - Ramp at 11ºC to 60ºC, no hold
    - Ramp at 20ºC to 220ºC, hold 3.18 minutes
    - Total runtime: 18 minutes
- MS analyzer temperature: 280ºC
- MS scan range: 35-260 amu at 3.25 scans/sec

Total runtime may be extended by lengthening the final hold time. This is particularly helpful during analysis of samples that contain excessive amounts of high molecular weight compounds.

Ideally, the autosamplers add 3.0µL of 50µg/mL IS/SS to each standard, blank, and sample.

Analysis Sequence:

A tune check must be analyzed (and all criteria must be met) before running any QC or samples for reporting.

A CCV must be analyzed (and criteria must be met) before running any samples for reporting. If the first CCV fails, a second can be analyzed but this must be done before any samples in order for the samples to be valid. If the second CCV fails, analysis should be halted and the cause for the failure should be identified and corrected.

Sample Prep:
All samples and standards should be allowed to warm to room temperature prior to analysis.

For aqueous samples, a run is set up in the V_PREP_W Excel prep sheet on the F drive and the 40mL vial in placed into the autosampler. The autosampler transfers 5mL of sample to the sparge tube, where the purge and trap portion of the analysis is started. The autosampler is also responsible for adding IS/SS.. If a sample contains high levels of target or non-target analytes and requires dilution, these dilutions are prepared by transferring the needed sample amount with a glass syringe into an appropriately sized Class A volumetric flask. Once brought to volume, the flask should only be inverted two or three times to minimize loss of volatile compounds. The dilution is transferred to a 40mL vial with minimal headspace. All dilutions are recorded in the Excel prep sheet. Any samples that are of oil or product matrix are immediately diluted into methanol at a 20X dilution prior to further dilution. This pre-dilution is recorded in the Excel prep sheet and entered into LIMS as a prep factor. Once a sample has either been analyzed without dilution or an amount of sample has been removed for dilution preparation, the vial shall not be used for further analysis. All TCLP extracts are diluted prior to analysis and a duplicate of this dilution is also matrix spiked by the analyst. SPLP extracts are generally analyzed with no dilution unless any compound is outside of the working calibration range.

Solid samples are prescreened for dilutions using a separate jar if provided by the client. For solid samples that will be analyzed from a sodium bisulfate or TSP preserved vial, the 40mL vial is weighed and recorded in the V_PREP_S excel prep sheet on the F drive and then vortexed and placed directly into the autosampler. For samples that do not come in preserved vials, approximately 5g is weighed into a 40mL VOA vial and the weight is recorded in the Excel prep sheet. Five mL of water and a Teflon stir bar is then added to the vial and the vial is placed on the autosampler. If the sample requires a dilution, approximately 5g of samples is weighed into a 40mL VOA vial, 10mL of methanol is added and the dilution is prepared as listed below. This is all recorded in an excel prep sheet. The purge and trap part of the analysis occurs directly in the 40mL vials, so no sample transfer by the autosampler is necessary. Solids with high analyte concentrations that require dilution have approximately 5g of sample added to a known amount of methanol in a 40mL vial. For these samples, 40mL vial is weighed and the weight is recorded, as well as, the amount of methanol in the V_PREP_S excel prep sheet. The mixture is then vortexed and allowed to either gravity settle or placed in a centrifuge to separate the methanol extract from the sample solids. Dilutions are made directly in 40mL vials containing 5mL of water, a Teflon stir bar, and an appropriately measured volume of the methanol extract. No more than 0.4mL of methanol should be used in any dilution, a minimum of a 12.5X dilutions is performed. Any more than 0.4mL of methanol “washes” surrogate recoveries down and adversely effects chromatography. The vials containing the diluted samples are then placed into the autosampler for analysis. The autosampler is responsible for the addition of IS/SS and 5mL of deionized water to each sample. If sample volume permits, MS/MSD solution is added by the analyst prior to placement in the autosampler.

Sampling kits for EPA 624.1 analysis will include two HCl-preserved vials, one sodium thiosulfate-preserved vial, and one unpreserved vial. Upon arrival at the laboratory, the unpreserved vial will be checked for chlorine. If chlorine is present, analysis will proceed from the sodium thiosulfate-preserved vial. If chlorine is not present, analysis will proceed from the HCl-preserved vial(s). This check will be completed using DPD Total Chlorine Reagent Pillows, and results (along with the date and time) of the check will be included in the sample receiving checklist."

Sample Review
See qualitative and quantitative analysis in data analysis and calculations for compound identification.

After samples are analyzed using the parameters above, data is calculated and reviewed in the Chemstation software. Each analyte detected is reviewed by the analyst for accuracy. During review the analyst looks for appropriate integration, proper identification, appropriate dilution, sample specific QC acceptance and potential carryover for example. All samples requiring manual integration must follow the most up to date version of SOP 4026. After sample review is complete an electronic data file for each sample is compiled and data is entered in LIMS with all appropriate qualifiers and sample narratives. The data is then sent to a data validator for data review.

Samples that exceed the working range of any analyte must be diluted and reanalyzed. If limited sample volume does not permit reanalysis, the data is reported as an estimated concentration for any compound that exceeds the calibration range.

If samples have been analyzed multiple times and consistent results cannot be obtained the highest result is reported with appropriate sample narrative and or qualifiers.

All surrogate recoveries are reported from the most concentrated analysis of each sample.

ROUTINE MAINTENANCE

The sparge tube on the water instruments is cleaned on an as needed basis. This is recorded on the cover sheet.

The source is cleaned approximately every 6 months or as needed. When the source is cleaned the filaments are typically replaced. The column, trap, transfer lines and any other maintenance parts are replaced as needed. Maintenance that is performed as needed is recorded in the LIMS maintenance log.

DATA ANALYSIS & CALCULATIONS

After standards or samples are analyzed as described above, all generated data files must be reviewed by the analyst before reporting to the client. This is broken down into two types of review: Qualitative Analysis and Quantitative Analysis.

Qualitative Analysis:

The qualitative determination of each compound is based on both retention time and comparison of the sample mass spectrum to a known spectrum. This reference spectrum is generated for each compound of interest by analyzing a known standard and saving a copy of the resulting spectrum in a database (termed a library) that is searchable through the Chemstation software. The reference mass spectrum will detail the characteristic ions for each compound, which are defined as the three ions of greatest relative intensity or any ions over 30% relative intensity if less than three such ions occur in the spectrum. These are the primary and qualifier ions for each analyte.

Compounds are qualitatively identified using the following guidelines:

- The intensities of the characteristic ions of a particular compound will maximize within a single or two consecutive scans. The Chemstation software will search for the primary and qualifier ions within a retention time window of ±1 minute of the known retention time and display the ions in an over-lay configuration.

- The relative retention time of the potential analyte's peak must be within ±0.06 RRT units of the known standard.

- Structural isomers that produce similar mass spectra should be identified as individual isomers if they elute at sufficiently different retention times. Adequate resolution is achieved if the height of the valley between the two isomer peaks is less than 25% of the sum of the two peak heights. If this is not attained, the isomers shall be identified as isomeric pairs. This is the case for m,p-xylenes.

- Structural isomers are combined in some cases to give a total calculation for a compound. In these cases, if one of the structural isomers has an analyte concentration which is above the curve, both isomers will then be diluted and reported on the same analytical sequence. The total is then calculated in LIMS using the reported values for the structural isomers which are located in the same analytical sequence. (For example: m,p-xylenes and o-xylenes are structural isomers and are reported as total xylenes by adding the reported concentrations of each isomer together. This is done in LIMS. If m,p-xylenes has a concentration over the calibration curve but o-xylenes does not, the analyst must still dilute the sample and reanalyze for both isomers. The reported results for m,p-xylenes, o-xylenes and total xylenes will all be reported from the same dilution in order for the total xylenes to be correctly calculated.)

- Identification can be hampered when compounds co-elute, which causes mass spectra containing ions from more than one analyte. In this case, appropriate selection of analyte and background spectra by the analyst is very important and is dependent on an analyst's experience and judgment.

- Examination of extracted ion current profiles can aid in the selection of the spectra and the resulting qualitative identification of compounds.

For samples containing compounds not in the calibration standard, a library search can aid in tentative identification of the compounds. A search of the unknown spectra against the NIST library may be performed. The following recommendations can be used to aid in identification of compounds not in the standard:

- Relative intensities of major ions (those greater than 10% of the most abundant ion) in the reference spectrum should be present in the sample spectrum.

- The relative intensities of the major ions should agree within ±20%.

- Molecular ions present in the reference spectrum should be present in the sample spectrum.

- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or the presence of coeluting compounds.

- Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting peaks.

Quantitative Analysis:

Once a compound has been qualitatively identified, the quantitation of that compound will be based on the integrated abundance from the EICP of the primary target ion. Calculation of analyte concentration is performed by the Chemstation software and is based on the type of curve fit designated by the analyst during the initial calibration.

If the RSD of the compound's response factors is 15% or less in the calibration curve, then the response factor is assumed to be constant over the calibration range and the average response factor is used for quantitation. This is performed using the equation:

$$C_s = \frac{A_s \text{ x } C_{is}}{A_{is} \text{ x } \overline{RF}}$$

Where:
C_s = the concentration of the analyte in the sample tube
A_s = the EICP area of the analyte in the sample
C_{is} = the concentration of the internal standard
A_{is} = the EICP area of the internal standard
$\overline{RF}$ = the average response factor for the compound from the calibration curve

When applicable, the concentration of non-target analytes that have been qualitatively identified can be roughly estimated by using the above calculation, using A_s and A_{is} from the total ion chromatograms and assuming a response factor of 1.

Samples quantitated for the TPH-GRO ranges are reviewed as described in the Calibration section, by integrating a TIC for the specified range. The ranges start 0.1 minutes before the RT of the appropriate beginning marker and end 0.1 minutes after the RT of the appropriate ending marker and are: MtBE through naphthalene for Gasoline Range Organics (OA-1), heptane through dodecane for Gasoline Range Organics (C5-C12), hexane through dodecane for TPH (C6-C12) and hexane through decane for TPH-GRO (C6-C10). All standards and samples must have the MBLK TIC subtracted to account for the addition of the IS/SS. TPH-GRO samples are quantitated using chlorobenzene-d5 as its designated internal standard.

If the RSD of the compound's response factors is not 15% or less or calibration history or other QC indicates an alternative curve fit is necessary then one is used, the concentration is calculated by transforming the fit equations. These are:

Linear calibration using least squares regression: $y = mx + d$

Non-linear calibration using a quadratic fit: $y = ax^3 + bx^2 + cx + d$

Where: y = instrument response, A_s/A_{is}
x = concentration, C_s/C_{is}
m = slope of the line
d = intercept
a, b, and c = regression coefficients

Calculations:
Once the concentration in the sample vial is calculated (see above), the concentration of the sample is calculated as:

$$\text{Aqueous Sample Concentration } (\mu g/L) = C_s \times DF \times PFw$$

$$\text{Solid Sample Concentration } (\mu g/kg) = (Cs \times DF \times PFs)$$

Where: C_s = the concentration of the sample in the sample tube
DF = any dilution factors
PFw = Final volume methanol(mL)/Initial sample volume(mL)
PFs = Final volume water/methanol(mL)/sample weight(g)

Solid samples may be calculated to a dry weight basis for a client's final report. This is done through the LIMS system after Pmoist analysis is performed in another part of the laboratory. The resulting concentration is reported as µg/kg-dry.

Refer to Section 21 and 26 of the Quality Manual for information on other quality control calculations such as percent recovery and RPD determination.

REFERENCES/ METHOD DEVIATIONS

SW-846 8260B & EPA 624.1:

USEPA Contract Laboratory Program SOM01.1 (5/2005) criteria for BFB tune evaluation is used to verify the instrument tune.

SW846 5030:

Samples are purged at 40°C instead of at ambient temperature to help purge some of the more water-soluble analytes and achieve lower detection limits.

SW846 5035:

Varying amounts of methanol are used in high concentration samples. Some clients find it beneficial to use only 5mL of methanol for the extraction to lower the total dilution factor by a factor of 2 and allow lower analyte detection limits.

Compounds that are not listed in SW-846 Method 8260B or USEPA Method 624.1 may be analyzed per client request. Before any such analysis, a certified standard is purchased and a MDL study is completed.

TABLES & DIAGRAMS

Table 1: Analytes with Target and Qualifier Ions

Analyte	CAS	Target Ion	Qualifier Ion(s)
1,1,1,2-Tetrachloroethane	630-20-6	131	95, 133
1,1,1-Trichloroethane	71-55-6	97	61
1,1,2,2-Tetrachloroethane	79-34-5	83	85, 131, 168
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	101	151
1,1,2-Trichloroethane	79-00-5	97	99
1,1-Dichloro-2-propanone	513-88-2	63	-
1,1-Dichloroethane	75-34-3	63	65
1,1-Dichloroethene	75-35-4	61	96, 98
1,1-Dichloropropene	563-58-6	75	39
1,2,3-Trichlorobenzene	87-61-6	180	145, 74
1,2,3-Trichloropropane	96-18-4	110	97
1,2,3-Trimethylbenzene	526-73-8	105	120
1,2,4-Trichlorobenzene	120-82-1	180	145, 74
1,2,4-Trimethylbenzene	95-63-6	105	120
1,2-Dibromo-3-chloropropane	96-12-8	157	75, 39
1,2-Dibromoethane *	106-93-4	107	109
1,2-Dichlorobenzene	95-50-1	146	111
1,2-Dichloroethane	107-06-2	62	49
1,2-Dichloropropane	78-87-5	63	65
1,3,5-Trimethylbenzene	108-67-8	105	120
1,3-Butadiene	106-99-0	54	39, 53, 50
1,3-Dichlorobenzene	541-73-1	146	111

1,3-Dichloropropane	142-28-9	76	41
1,4-Dichlorobenzene	106-46-7	146	111
1-Chlorobutane	109-69-3	56	41
2,2-Dichloropropane	594-20-7	77	41
2,2,4-Trimethylpentane	540-84-2	57	41, 56
2-Butanone *	78-93-3	72	43
2-Chloroethyl vinyl ether	110-75-8	63	106
2-Chlorotoluene	95-49-8	91	126
2-Hexanone	591-78-6	58	43
2-Methyl-2-propanol	75-65-0	59	41, 40
2-Methyl pentane	107-83-5	43	42, 71, 57
2-Nitropropane	79-46-9	41	43
4-Chlorotoluene	106-43-4	91	126
4-Methyl-2-pentanone *	108-10-1	58	85, 100, 43
Acetone *	67-64-1	43	58
Acetonitrile *	75-05-8	41	40, 39
Acrolein *	107-02-8	56	55
Acrylonitrile *	107-13-1	53	52, 51
Allyl chloride	107-05-1	39	76, 41
Amyl acetate *	628-63-7	43	70, 61, 55
Benzene	71-43-2	78	-
Bromobenzene	108-86-1	77	156
Bromochloromethane	74-97-5	49	130
Bromodichloromethane	75-27-4	83	47, 129
Bromoform	75-25-2	173	175, 171
Bromomethane	74-83-9	94	96
Butyl acetate *	123-86-4	61	73
Carbon disulfide *	75-15-0	76	-
Carbon tetrachloride	56-23-5	117	119
Chlorobenzene	108-90-7	112	114
Chloroethane	75-00-3	64	66
Chloroform	67-66-3	83	85, 47
Chloromethane	74-87-3	50	52
Chloroprene	126-99-8	53	88
cis-1,2-Dichloroethene *	156-59-2	96	61
cis-1,3-Dichloropropene	10061-01-5	75	77
cis-1,4-Dichloro-2-butene	1476-11-5	75	53, 88, 39
Cyclohexanone	108-94-1	55	42, 69
Dibromochloromethane	124-48-1	129	127
Dibromomethane	74-95-3	93	174
Dichlorodifluoromethane *	75-71-8	85	87
Diisopropyl ether *	108-20-3	45	43, 41, 87
Ethyl acetate *	141-78-6	43	-
Ethyl ether	60-29-7	59	74, 45
Ethyl methacrylate	97-63-2	69	41
Ethylbenzene	100-41-4	106	91
Heptane *	142-82-5	43	57, 71

Hexachlorobutadiene	87-68-3	225	190, 118
Hexachloroethane	67-72-1	117	201, 166
Iodomethane	74-88-4	142	127
Isopropyl acetate *	108-21-4	43	61, 55, 87
Isopropylbenzene	98-82-8	105	120
m,p-Xylenes *	179601-23-1	106	91
Methacrylonitrile	126-98-7	67	41
Methyl acetate *	79-20-9	43	74, 59
Methyl Methacrylate	80-62-6	69	100
Methyl tert-butyl ether *	1634-04-4	73	57
Methylacrylate	96-33-3	55	-
Methylene chloride	75-09-2	84	49, 86
n-Butylbenzene	104-51-8	134	91
n-Hexane *	110-54-3	57	41, 43
n-Nonane	111-84-2	43	57, 85, 71
n-Pentane	109-66-0	43	42, 41, 57
n-Propylbenzene	103-65-1	91	120
Naphthalene *	91-20-3	128	51
Nitrobenzene	98-95-3	77	123, 51
o-Xylene *	95-47-6	91	106
p-Isopropyltoluene	99-87-6	119	134
Pentachloroethane	76-01-7	167	117, 165
Propionitrile	107-12-0	54	-
sec-Butylbenzene	135-98-8	105	134
Styrene *	100-42-5	104	78
tert-Amyl methyl ether	994-05-8	73	43, 55, 87
tert-Butyl Ethyl Ether	637-92-3	59	87, 57, 41
tert-Butylbenzene	98-06-6	91	134
Tetrachloroethene	127-18-4	164	166
Tetrahydrofuran *	109-99-9	72	71, 41, 42
Toluene	108-88-3	91	92
trans-1,2-Dichloroethene	156-60-5	61	96
trans-1,3-Dichloropropene	10061-02-6	75	77
trans-1,4-Dichloro-2-butene	110-57-6	53	89
Trichloroethene	79-01-6	130	132, 95
Trichlorofluoromethane	75-69-4	101	103, 66
Vinyl acetate	108-05-4	43	86
Vinyl chloride	75-01-4	62	64
1,2-Dichloroethene, Total	540-59-0	-	-
1,3-Dichloropropene, Total	542-75-6	-	-
1,4-Dichloro-2-butene, Total	764-41-0	-	-
Xylenes, Total	1330-20-7	-	-
Gasoline Range Organics (C5-C12)	-	-	-
Gasoline Range Organics (OA-1)	-	-	-
Kansas Low Range Hydrocarbon (C5-C8)	-	-	-
TPH (C6-C12)	-	-	-
TPH - GRO (C6 - C10)	-	-	-

1,2-Dichloroethane-d4 [Surrogate]	17060-07-0	65	51, 102
4-Bromofluorobenzene [Surrogate]	460-00-4	174	176, 95
Dibromofluoromethane [Surrogate]	1868-53-7	111	113
Toluene-d8 [Surrogate]	2037-26-5	98	100
Fluorobenzene [Internal Standard]	462-06-6	96	-
Chlorobenzene-d5 [Internal Standard]	3114-55-4	117	82
1,4-Dichlorobenzene-d4 [Internal Standard]	3855-82-1	152	115

Table 2:
BFB Mass Intensity Criteria

BFB Target ION	Low Limit	High Limit
Mass 50 relative to 95	15	40
Mass 75 relative to 95	30	80
Mass 95 relative to 95	100	100
Mass 96 relative to 95	5	9
Mass 174 relative to 95	>50	120
Mass 173 relative to 174	0	<2
Mass 175 relative to 174	5	9
Mass 176 relative to 174	>95	101
Mass 177 relative to 176	5	9

Table 3:
QC Frequency

QC Type	Frequency	Notes
BFB Tune Verification	1/12 hour clock	Analyzed first
CCV/CCVG	1/12 hour clock	CCVG only analyzed if needed
LCS/LCSD/LCSG/LCSGD	1/12 hour clock	LCSG/LCSGD only analyzed if needed
MBLK	1/12 hour clock	
QCS	1/12 hour clock	Only analyzed if needed
MS/MSD	1/20 samples	Analyzed when sample is available
TCLP MS/MSD	1/20 samples per matrix type	

METHOD PERFORMANCE

MDL/Method Validation: See Quality Manual Chapter 21
IDOC/ADOC: See Quality Manual Chapter 19

Prior to unsupervised sample analysis, an analyst must complete all IDOC requirements and have prepared, analyzed and reviewed a calibration curve.

SAMPLE HANDLING

Samples are stored between above freezing and 6.0ºC in a refrigerator that is dedicated to the storage of volatile organic samples. Samples requiring TCLP or SPLP extraction shall be stored in the VOA lab refrigerators until ZHE extraction is performed to prevent contamination. Once extracted (per Teklab SOP 4130 or 4131), the extract is filtered into either a Tedlar bag (for multiphase samples) or 40mL vials and stored in the VOA refrigerators.

See the most current revision of SOP 1083 and See 1000 series SOP Appendix B for sample preservation and collection requirements.

POLLUTION PREVENTION

See 1000 series SOP Appendix D

WASTE MANAGEMENT

See 1000 series SOP Appendix D

SIGNATURE

Cora L. Fickinger	**3/4/2019**
Approving Authority	Date (Approval/Effective)

The use of this SOP is governed by the TEKLAB Quality Assurance Manual and associated SOPs including but not limited to 1030, 1031, 1250, 1280, 1290, and 1310. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling refer to SOP 1150.

DEFINITIONS

Gas chromatograph / mass spectrometer (GC/MS):

A gas chromatograph / mass spectrometer (GC/MS) is an instrument used to separate, identify, and quantitate organic compounds.

Purge and trap:

A purge and trap is a device used to purge volatile organic compounds from a sample and concentrate them onto a sorbent trap. The trapped compounds are subsequently desorbed onto the column of the GC.

Total ion chromatogram (TIC):

A total ion chromatogram (TIC) is a plot of total ion signal recorded as a function of retention time.

Extracted ion current profile (EICP):

An extracted ion current profile (EICP) is a chromatographic plot of the intensity of a single ion recorded as a function of time or scan number.

Batch:

A Batch is environmental samples of the same matrix that are prepared together with the same process and personnel, using the same lot(s) of reagents. A "Preparation Batch" is composed of one to 20 environmental samples of the same TNI-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first sample and start of processing of the last sample being 24 hours. An "Analytical Batch" is composed of environmental samples (extracts, digestates, or concentrates) which are analyzed together as a group. An analytical batch can exceed 20 samples.

Calibration Curve:

The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.

CCB (Continuing Calibration Blank):

The CCB is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest. This sample is then analyzed to check the state of calibration of an instrument as sample are being analyzed.

CCV/CCVK (Continuing Calibration Verification)**:**

The CCV/CCVK is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then analyzed to check the state of calibration of an instrument as sample are being analyzed.

DOC (Demonstration of Capability):

A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

DUP (Duplicate samples):

Analyzed to check for sampling and analytical reproducibility. Field duplicates are taken during sample collection. Internal duplicates are analyzed in the laboratory by splitting the sample and analyzing each split as an independent sample. See applicable SOP for frequency of matrix spike duplicates by analysis.

ICB (Initial Calibration Blank):
The ICB is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest. This sample is then analyzed to determine the state of calibration of an instrument before sample analysis is initiated.

ICV/ICVK (Initial Calibration Verification)**:**
The ICV/ICVK is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then analyzed to determine the state of calibration of an instrument before sample analysis is initiated.

IDOC (Initial Demonstration of Capability):
An IDOC is analyzed to establish competency of an analyst before the analyst is allowed to analyze samples without supervision.

LCS/LCSK (Laboratory control samples)**:**
The LCS or LCSK is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then taken through the entire analysis to determine batch acceptance.

Matrix: *These matrix definitions are to be used for purposes of batch and quality control requirements*:

Air and Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device.

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.

Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.

Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.

MBLK/MBLKK (method blanks) or **LCB** (laboratory control blanks):
A LCB is used to check contamination in the laboratory and is taken through the entire analytical procedure. The method blank consists of a matrix that is similar to the associated samples and is known to be free of the analytes of interest. These samples are used to verify the purity of all chemicals and reagents used in the methodologies and to prove the absence of contamination during the analytical procedure.

MDL (Method detection limit):
The MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix type containing the analyte.

MS/MSK (Matrix spike):
These provide information about the effect of the sample matrix on the preparation and measurement methodology. All matrix spikes and matrix spike duplicates are hereafter referred to as MS/MSD or MSK/MSDK samples. These samples are always run with another aliquot of the sample that is not spiked. Spiking a sample tells us what effect the sample matrix (i.e. aqueous, solid, non-aqueous liquid) has on the parameter being measured. Sometimes the sample matrix will hide a parameter; a matrix spike will help identify this effect by showing a low recovery. Because matrix spikes give more information about the sample and its matrix, they are preferred to running duplicates. Some analyses (pH and Temp for example) do not lend themselves to matrix spikes very easily, therefore some analyses do not use matrix spikes (inorganic/physical analysis only).

PQL (Practical Quantitation Limit):
The PQL is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.

PQLSTD:
The Standard in the curve at or below the limit of quantitation.

QC sample:
QC samples are purchased from an independent source to verify analytical procedures and calibrations. All QC samples must be NIST traceable reference materials, when available.

If a QC sample is not taken through the entire sample preparation procedure and is used for calibration verification (ex. GFAA), a LCS which has been taken through the entire procedure must also be analyzed.

QCS:
Quality check sample to verify the initial and continuing calibration for method 624.1

TEKLAB, INC.
STANDARD OPERATING PROCEDURE
FOR SEMI-VOLATILE ORGANIC ANALYSIS BY GC/MS

SCOPE

The use of this SOP is governed by the TEKLAB Quality Assurance Manual and associated SOPs including but not limited to, 1030, 1031, 1250, 1280, 1290, 1310, and 4026. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling refer to SOP 1150. Refer to sections 5 and 27 of the quality Manual for record keeping and reporting information.

The purpose of this SOP is to define how semi-volatile organic compounds including diesel and oil range organics are analyzed, in accordance with SW-846 method 8270C, EPA 625 and the Missouri Risk-Based Corrective Action Process for petroleum storage tanks (MRBCA), from extracts of samples prepared by solvent extraction and concentration. This method is limited to the analysis of aqueous, solid, non-aqueous liquids, and toxicity characteristic leaching procedure (TCLP) extracts.

At the direction of the Missouri Department of Natural Resources, in addition to the retention time fraction determination, additional whole fraction standards must be analyzed with either GC/MS or GC analyses to allow for both qualitative and quantitative identification of the specific type of petroleum present. Additional standards may include gasoline, #1-#5 diesel, mineral spirits, kerosene, JP4, jet fuel, motor oil, hydraulic fluid, as well as any other fuel type that is considered appropriate.

SUMMARY

Samples are extracted prior to GC/MS analysis according to SW-846 methods 3510, 3550, and 3580 by Teklab Inc. SOPs 4115, 4116, and 4110 for aqueous, solid, and non-aqueous liquid samples respectively and concentrated to a volume of 1 milliliter. 1µL of the extract is injected into a gas chromatograph. The column is temperature programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced to the gas chromatograph (GC).

The compounds that are currently being analyzed for by this SOP are listed in table 1. The working range for sample extracts is 1.0 to 160µg/mL, which equates to 0.001 to 0.160 mg/L for aqueous samples using 1 liter of sample, 0.0333 to 5.333mg/kg for solids using 30 grams of samples, and 10 to 1600 mg/kg for non-aqueous liquids. According to SW-846 Method 8270C, Section 7.5.5, SIM (Selected Ion Monitoring) is acceptable for applications requiring detection limits below the normal range of electron impact mass spectrometry. The working range for SIM sample extracts is 0.10 to 50.0µg/mL, which equates to 0.0001 to 0.050 mg/L for aqueous SIM samples using 1 liter of sample and 0.003 to 1.667mg/kg for SIM solids using 30g of sample. The working range for AGSIM and PSIM sample extracts is 0.0250 to 100.0µg/mL, which equates to 0.000025 to 0.1 mg/L for aqueous SIM samples using 1 liter of sample and 0.007 to 0.1667mg/kg for SIM solids using 30g of sample. These working ranges may change at the analyst's discretion. Some compounds will have working ranges that are higher due to poor chromatographic behavior, poor extraction efficiency or poor response at lower concentrations. The current method detection limits (MDLs) for all analytes and matrices as well as reporting limits can be found in LIMS. This method can be used to quantitate most neutral, acidic, and basic compounds that are soluble in methylene chloride and elute as sharp peaks off of the GC column.

Some compounds require special treatment when being analyzed by this method:

- Benzidine is subject to oxidative losses during solvent concentration and exhibits poor chromatographic behavior. Since Benzidine is such a problematic compound, a separate calibration curve is typically used for Benzidine and 3,3-Dichlorobenzidine.
- Hexachlorocyclopentadiene is subject to thermal decomposition in the GC inlet.
- N-nitrosodiphenylamine is subject to thermal decomposition in the GC inlet and cannot be separated from diphenylamine.
- Pentachlorophenol, 2,4-dinitrophenol, 4-nitrophenol, benzoic acid, 4,6-dinitro-2-methylphenol, 4-chloro-3-methylphenol, 2-nitroaniline, 3-nitroanaline, 4-chloroanaline, and benzyl alcohol are subject to erratic chromatographic behavior, especially if the GC column is contaminated by high boiling solids.
- 1,2-diphenylhydrazine decomposes to azobenzene.

METHOD DEVIATIONS

- Compounds which are not listed in SW-846 Method 8270C may be analyzed at client request. Before any such compound is analyzed, a certified standard is purchased and a MDL study must be completed as well as a bias determination and MDL and PQL validation study.
- To best represent any matrix interferences that may be present in the samples analyzed, Teklab reports all surrogate recoveries from the most concentrated analysis. In the case that the internal and/or surrogate does not work at the more concentrated level, but does work at a dilution the surrogate will be reported from the dilution.
- Deviations from EPA method 625 are that Teklab does not prepare calibration standards by diluting standards with acetone, but with methylene chloride and Teklab uses 1µL injections, not 2-5µL injections. Another deviation from EPA method 625 is that the acid fraction and the base/neutral fraction are analyzed together, not separate. 80 ng of Benzidine is used to evaluate the tailing factor.
- Teklab, Inc. uses 15% RSD for ALL target analytes in a curve. Other %RPD criteria may be used if allowed by a specific method. (i.e. 625)
- Calibration standards are prepared when they are consumed, they have recoveries that are nearing or outside of the control limits, or they are beyond their expiration date or beyond the expiration date of the working stock standard used during preparation. 8270C recommends preparing Calibration standards every week.

DEFINITIONS

See Appendix A

INTERFERENCES

- Contamination in solvents, reagents, glassware and other sample processing equipment can cause analytical interference. All of these materials must be proven to be free of contaminants under the conditions of analysis by running laboratory method blanks.
- The most common interference found in this analysis is contamination of the sample extracts and blanks by phthalate compounds. These compounds are very commonly found in most types of plastics, as they are used as plasticizers. Great care must be taken when collecting and handling samples to avoid contact with any plastics.
- Samples with high levels of any compound may cause contamination of the autosampler syringe or GC system. If this is suspected, the potentially contaminated sample must be re-analyzed. The autosampler syringe and GC system may need to be cleaned prior to any new analysis.

SAFETY

Gloves must be worn while handling samples, standards, solvents or reagents. Standards and samples must be handled with extreme care to avoid excess exposure. Many of the analytes in the standards are carcinogens, suspected carcinogens or toxins and must be handled with extreme care. Contaminated gloves and clothing must be removed immediately. Read the appropriate MSDS for more safety information on the individual solvents and reagents used in this procedure. All standards and containers must be disposed of in an environmentally safe manner.

EQUIPMENT AND SUPPLIES

1. Instrument M
   Hewlett-Packard 5890 Series II GC / 5972 Mass Spectrometer with a 30 meter J&W DB-5ms column, 0.25mm ID and 0.50µm film thickness, and a Hewlett-Packard 7673 autosampler.

2. Instrument B
   Hewlett-Packard 5890 Series II GC/ 5971 Mass Spectrometer with a 30 meter J&W DB-5ms column, 0.25mm ID and 0.50µm film thickness, and a Hewlett-Packard7673 Series autosampler.

3. Instrument K
   Hewlett-Packard 5890 Series II GC / 5971A Mass Spectrometer (upgraded to 5972) with a 30 meter J&W DB-5ms column, 0.25mm ID and 0.50µm film thickness, and a Hewlett-Packard 7673 autosampler

4. Instrument P
   Hewlett-Packard 5890 Series II GC/ 5971A Mass Spectrometer (upgraded to 5972) with a 30 meter J&W DB-5ms column, 0.25mm ID and 0.50µm film thickness, and a Hewlett-Packard 7673 Series autosampler.

5. Instrument S
   Agilent 6890 GC/5973 Mass Spectrometer with a 30 meter J&W DB-5ms column, 0.25mm ID and 0.50µm film thickness and a Cobra L/SSeries autosampler.

6. Instrument G
   Hewlett-Packard 5890 Series II GC / 5972A Mass Spectrometer with a 30 meter J&W DB-5ms column, 0.25mm ID and 0.50μm film thickness, and a Hewlett-Packard 7673 autosampler

7. Chemstation with HP Enviroquant software.
8. Glass syringes: 5μL, 10μL, 25μL, 50μL, 100μL, 250μL, and 1000μL.
9. Volumetric flasks with glass stoppers, class A.
10. Glass Pasteur pipets.
11. 2mL amber vials with Teflon lined screw caps.
12. 2mL clear vials with inserts and snap-on lids or crimp top caps.
13. Glass injection port liners with ferrules (injection port liners can be cleaned and reused).
14. Low bleed septa.

REAGENTS AND STANDARDS

- Methylene chloride, Pesticide Grade.
- Stock Standards
  The stock standards are purchased as certified solutions (traceable to national standards where available). Commercially prepared stock standards are purchased from vendors, such as Accustandard or Absolute, depending on which mix or concentration is required. The stock standards are stored at just above freezing to 6 °C or according to the Manufacturer's instructions. All stock standards must be replaced by the expiration date or sooner if comparison with check standards prepared from an independent source indicates a problem.
- Calibration Standards
  The calibration standards are prepared as dilutions of the stock standards with methylene chloride. The levels and concentration of the calibration standards are listed in Table 2. Calibration standards are stored at <0°C. The standards must be replaced at least every six months or sooner if comparison with check standards indicates a problem. Some Calibration standards require special handling. (i.e. sonication, cold, freeze, ambient)
- Quality Control (QC) Standards

The QC standards (matrix spiking and LCS standards) are prepared in the same way as the calibration standards or purchased as certified solutions (traceable to national standards where available). They are stored at just above freezing to 6 degrees C.

Commercially prepared solutions are purchased from vendors, such as Accustandard or NSI.

- Surrogate Standards (SS)
  Spiking each sample, standard, and method blank with a surrogate monitors the performance of the extraction and the analytical system. The surrogate standards used for 8270 and 625 analysis are 2-Fluorophenol, Phenol-d5, Nitrobenzene-d5, 2-Fluorobiphenyl, 2,4,6-Tribromophenol, and p-Terphenyl-d14. A tinted stock solution containing all six compounds is purchased as a mix with the three acid compounds at

200 µg/mL and the three base/neutral compounds at 100µg/mL. 250µL (50 µL for SIMS analyses) of this solution is added to all samples, blanks and control samples prior to extraction. For AGSIMS analytes, the surrogate standards used are Tributyl phosphate and Triphenyl phosphate. A stock solution is prepared by the analyst to a concentration of 10µg/mL. All samples, blanks, and control samples are spiked with 100µL of this solution prior to extraction.

Internal Standards (IS)

The performance of the analytical system is monitored by spiking each sample, standard, and method blank with internal standards. The internal standards used are 1,4-Dichlorobenzene-d4, Naphthalene-d8, Acenaphthene-d10, Phenanthrene-d10, Chrysene-d12, and Perylene-d12. The stock solution is purchased as a mix with all compounds at 2000 or 4000 µg/mL. No dilution is necessary unless the 4000µg/mL concentration is utilized, in this case a 2X dilution is necessary prior to use. Before making the dilution, the internal standard needs to be warmed and vortexed to allow all of the precipitate to go into solution. Internal standards are stored outside of the refrigerator to help keep the analytes in solution.

- Decafluorotriphenylphosphine (DFTPP)

  This compound is used to verify the tune of the mass spectrometer before every 12-hour shift. It is purchased at a concentration of 250µg/mL. It must be diluted by a factor of 5 by diluting 1.0mL of stock to 5.0mL in methylene chloride. It is placed in amber 2ml vials and properly labeled. 1µL (50ng) of this solution is directly injected onto the column at the beginning of each 12-hour analytical batch.
- Retention Time Marker Standard

  The retention time marker standard is a solution of decane (C10), heneicosane (C21), and pentatriacontane (C35) used to mark the beginning and ending of the retention time ranges for gasoline, diesel and oil range organics. An additional retention time marker standard is also available if needed per clients needs which includes even numbered hydrocarbons octane (C8) through n-Tetracontane (C40).

- See SOP 4022 Standard Prep and Tracking for storage conditions and labeling of standards.

- See section 5 of the quality manual for record keeping information.

SAMPLE COLLECTION, PRESERVATION AND HOLDING TIMES

See Appendix B

QUALITY CONTROL (QUALITY MANUAL SECTION 26)

- Analytical Batch

  An analytical batch is composed of environmental samples that are analyzed together as a group using the same calibration curve or factor. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples, but may not exceed a 12-hour analytical clock from the verification of the tune.

- Method Blank
  The method blank (MBLK) contains reagent water for aqueous samples and sodium sulfate for solid samples. Surrogate is added to the MB and it is carried through the same extraction and analytical procedure as the samples. The results of the MBLK should be: A) Less than the laboratory's MDL for the ana1yte or less than the level of acceptance blank contamination specified in the approved quality assurance project plan. B) Less than 5% of the regulatory limit associated with an analyte. C) Or less than 5% of the sample results for the analyte, whichever is greater. Samples with non-detectable results associated with a contaminated MBLK may be reported with the appropriate qualifier.. Corrective action must occur if the above criteria can not be met. The corrective action would be the re-extraction and re-analysis of the affected samples with an acceptable MBLK. If the surrogate recovery in the MBLK is outside of the established control limits, the prep batch is considered out of control and must be re-extracted and re-analyzed if sample amount permits. If there is insufficient sample to re-extract, appropriate qualifiers and/or an explanation in the case narrative or sample narrative must be reported with the data.

- Laboratory Control Sample
  . The LCS standards are prepared according to SOP4022. The recoveries of these analytes are control charted and can be found in LIMS. . If the recovery of any of these analytes are outside of the established control limits, or marginal exceedence limits where applicable (see the Teklab Quality Assurance Manual Rev. 20 section 26 on page 86-87 for applicability) the analysis is out of control. If after re-analysis the LCS is still out of control, corrective action must occur. The normal corrective action is the re-extraction and re-analysis of the entire prep batch, however if there is insufficient sample to re-extract the samples the data may be reported with appropriate qualifiers. Data qualifier definitions are found in Table 4.

- Matrix Spike and Spike Duplicate
  Prep lab personnel choose samples for matrix spiking. The frequency must be at least 5% of all samples to monitor and evaluate laboratory quality data. A matrix spike and matrix spike duplicate must be prepared for each batch of samples and for each different matrix within the batch, if sample amount permits. . The MS/MSD standard is prepared according to SOP4022. The recovery and the relative percent difference (RPD) of these analytes are control charted and can be found in LIMS. . If any of these analytes are outside of the established control limits the data must be reported with appropriate qualifiers. Data qualifier definitions are found in Table 11.

- Surrogates
  The surrogates are spiked into every sample, MBLK, LCS, and MS/MSD. . The recoveries are determined and control charted and can be found in LIMS. . If the surrogate recovery in the MBLK is outside of the established control limits, the prep batch is considered out of control and must be re-extracted and re-analyzed. If the surrogate recovery in a sample is outside the control limits and can be shown that it is the result of matrix interference, a statement is added to the sample narrative of the final report. If surrogate recovery in a sample is outside the control limits but was not caused by matrix interference, any affected

samples are re-extracted and re-analyzed. If there is insufficient sample to re-extract, an appropriate statement is added to the case narrative.

- Internal Standards
  Spiking each sample, standard, and MB with internal standard of a final concentration of 40µg/mL (20µL per 1mL of sample or standard) and 20µg/mL (10µL per 1mL of sample or standard) for SIMS analysis, monitors the performance of the analytical system. The internal standard retention times and responses in all samples, spikes, blanks, and standards are monitored to check for drifting, poor injection, and matrix interference. The internal responses in the continuing calibration verification (CCV) must not differ from the initial calibration by more than -50% to 200% to be usable. If the internal standard criteria are not met the mass spectrometer must be inspected for malfunction and corrections must be made. A new curve may need to be analyzed or a portion of the column removed. If the internal response in a sample differs from the initial calibration by more than -50% to 200% the associated target analytes can not be reported if requested. The sample will then be re-analyzed for the internal standard and associated target analytes, if the internal standard response differs by more than -50% to 200% again, the associated analytes may be reported with appropriate qualifiers and an appropriate statement in the sample narrative.

- Decafluorotriphenylphosphine (DFTPP)
  This compound is used to verify the tune of the mass spectrometer before every 12-hour shift. If the tune does not pass the criteria in Table 3, the mass spectrometer must be inspected for malfunction and corrections must be made.

CALIBRATION and STANDARDIZATION

The general procedure is outlined in SW-846.

An analyst must have sufficient knowledge of the operation of the GC and MS systems prior to attempting the procedure unless under the direct supervision of someone very knowledgeable about the system. Training on the software that operates the system is also needed. This training must be from an experienced analyst, but can also include training from the instrument vendor where possible.

A new calibration curve must be generated after the mass spec has been re-tuned or major changes to the system that results in the 12-hour continuing calibration verification (CCV) not passing its criteria. Major changes may include changing the column or sufficient contamination to change the column or detector performance.

In order to calibrate the instrument the following steps must be completed

Instrument Conditions

The following instrument configurations must be met:

Instrument M: (8270SIM)

Mass Spec operating conditions: 8270SIM
SIM mode

GC Operating Conditions
Injection port Temp: 250°C
Column Flow rate:
Detector Temp: 315°C
Oven Temperature Program:
Initial Temp: 50°C Hold Time: 2.0 min
Ramp Rate: 22.0°C/min Oven Temp: 260°C Hold Time: 0.0min
Ramp Rate: 6.0°C/min Oven Temp:320°C Hold Time:0.0min
Ramp Rate: 20.0°C/min Oven Temp: 325°C Hold Time: 2.63 min
The final hold time may be shortened as column life goes on.
Total Run Time:22.50 min Inlet Pressure Program:
Constant flow: Off
Initial Pressure: 20psi Initial Time: 0.50min
Rate change: 49.96 Pressure: 9.5psi Time: 4.18min
Rate change: 98.00 Pressure: 16.1psi Time: 5.00min
Rate change: 10.0 Pressure: 20.0psi Time: 21.00min

Instrument B: (8270, 625SIM, PESTSIM, AGSIM)
Mass Spec operating conditions: 8270
Scan from 35 to 500amu
1.3 Scans/sec
GC Operating Conditions
Injection port Temp: 250°C
Column Flow rate:
Detector Temp: 315°C
Oven Temperature Program:
Initial Temp: 50°C Hold Time: 0.5min
Ramp Rate: 17°C/min Oven Temp: 75°C Hold Time: 0. min 0
Ramp Rate: 22°C/min Oven Temp: 220°C Hold Time: 0.0 min
Ramp Rate: 10°C/min Oven Temp: 325°C Hold Time: 5.5 min
The final hold time may be shortened as column life goes on.
Total Run Time: 26.25
Inlet Pressure Program:
Constant flow: off
Initial Pressure: 20psi Initial Time: 0.50min
Rate change: 50 Pressure: 9.5psi Time: 4.18min
Rate change: 99 Pressure: 16.1psi Time: 5.0min
Rate change: 10 Pressure: 20psi Time: 21min

Mass Spec operating conditions: 625 SIM
SIM mode

GC Operating Conditions
Injection port Temp: 250°C

Column Flow rate:
Detector Temp: 325°C
Oven Temperature Program:
Initial Temp: 60°C   Hold Time: 1.0min
Ramp Rate: 22°C/min   Oven Temp: 260°C   Hold Time: 0.0min°
Ramp Rate: 6°C/min   Oven Temp: 320°C   Hold Time: 1.0min
Ramp Rate: 20°C/min   Oven Temp: 325°C   Hold Time: 3.5min
The final hold time may be shortened as column life goes on.
Total Run Time: 26.25min
Inlet Pressure Program:
Constant flow: off
Initial Pressure: 20psi   Initial Time: 0.50
Rate change: 50   Pressure: 9.5 psi   Time: 4.18min
Rate change: 99   Pressure: 16.1 psi   Time: 5.0min
Rate change: 10   Pressure: 20 psi   Time: 21min

Mass Spec operating conditions: PESTSIM
SIM mode

GC Operating Conditions
Injection port Temp: 250°C
Column Flow rate:
Detector Temp: 325°C
Oven Temperature Program:
Initial Temp: 55°C   Hold Time: 2.0min
Ramp Rate: 22°C/min   Oven Temp: 260°C   Hold Time: 0.0min
Ramp Rate: 6°C/min   Oven Temp: 325°C   Hold Time: 0.0min
Ramp Rate: 20°C/min   Oven Temp: 325°C   Hold Time: 0.0min
The final hold time may be shortened as column life goes on.
Total Run Time: 22.15min
Inlet Pressure Program:
Constant flow: off
Initial Pressure: 20psi   Initial Time: 0.50min
Rate change: 50   Pressure: 9.5psi   Time: 4.18min
Rate change: 99   Pressure: 16.1psi   Time: 5.0min
Rate change: 10   Pressure: 20psi   Time: 21.0min

Mass Spec operating conditions: AGSIM
SIM mode
.
GC Operating Conditions
Injection port Temp: 250°C
Column Flow rate:
Detector Temp: 325°C
Oven Temperature Program:

Initial Temp: 40°C	Hold Time: 2.0min	
Ramp Rate: 22°C/min	Oven Temp: 260°C	Hold Time: 0.0min
Ramp Rate: 6°C/min	Oven Temp: 300°C	Hold Time: 0.0min

The final hold time may be shortened as column life goes on.
Total Run Time: 18.67min

Inlet Pressure Program:
Constant flow: off

Initial Pressure: 20[si	Initial Time: 0.50min	
Rate change: 50	Pressure: 9.5psi	Time: 4.18min
Rate change: 99	Pressure: 16.1psi	Time: 5.0min
Rate change: 10	Pressure: 20.0psi	Time: 21.0min

Instrument K: (DRO/ORO, 8270SIM)

Mass Spec operating conditions: DRO/ORO
Scan from 35 to 550amu
1.3 Scans/sec

GC Operating Conditions
Injection port Temp:250°C
Column Flow rate:
Detector Temp:325°C

Oven Temperature Program:

Initial Temp:60°C	Hold Time:2.0 min	
Ramp Rate:30°C/min	Oven Temp: 280°C	Hold Time:0.0min
Ramp Rate:6°C/min	Oven Temp: 325°C	Hold Time:5.17min

Total Run Time: 22.00 minutes

Inlet Pressure Program:
Constant flow: (On)
Constant flow pressure:12.4psi @ 60°C

Mass Spec operating conditions: 8270SIM
SIM mode

GC Operating Conditions
Injection port Temp: 250°C
Column Flow rate:
Detector Temp: 315°C

Oven Temperature Program:

Initial Temp: 40°C	Hold Time: 2.0 min	
Ramp Rate: 22°C/min	Oven Temp: 260°C	Hold Time: 0.0min
Ramp Rate: 6.0°C/min	Oven Temp: 320°C	Hold Time: 1.0min
Ramp Rate: 20°C/min	Oven Temp: 325°C	Hold Time: 3.5min

The final hold time may be shortened as column life goes on.
Total Run Time: 26.25min

Inlet Pressure Program:
Constant flow: Off
Initial Pressure: 20.0psi Initial Time: 0.5min

Rate change: 49.96 Pressure: 9.5psi Time: 4.18min
Rate change: 98.00 Pressure: 16.1psi Time: 5.0min
Rate change: 10 Pressure: 20.0psi Time: 21min

Instrument P: (DRO/ORO)

Mass Spec operating conditions: DRO/ORO
Scan from 35 to 550amu
1.3 Scans/sec
GC Operating Conditions
Injection port Temp:250°C
Column Flow rate:
Detector Temp:325°C
Oven Temperature Program:
Initial Temp: 60°C Hold Time:2.0min
Ramp Rate:30°C/min Oven Temp:280 C Hold Time:0.0min
Ramp Rate:6°C/min Oven Temp:325 C Hold Time:5.17min
Total Run Time: 22.00 minutes
Inlet Pressure Program:
Constant flow: (On)
Constant flow pressure:12.4psi @ 60°C

Instrument S: (8270)

Mass Spec operating conditions: 8270
Scan from 35 to 550amu
2.84 Scans/sec
Quad Temp: 150°C
Source Temp: 230°C
GC Operating Conditions
1µL injection
Injection port Temp:250°C
AUX Temp: 325°C
Oven Temperature Program:
Initial Temp: 50°C Hold Time: 0.5min
Ramp Rate:17°C/min Oven Temp:75°C Hold Time:0.0min
Ramp Rate:22°C/minOven Temp:220°C Hold 0.0min

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Ramp Rate: 10°C/min Oven Temp: 325 Hold Time:7
The final hold time may be shortened as column life goes on.
Total Run Time 26.06min

Inlet Pressure Program:
Mode: Ramped pressure:
Pressure: 20.0 psi
Rate: 50 Final Pressure: 9.50 Final Time: 4.18i
Rate 2: 99 Final Pressure: 16.10 Final Time: 15.0

Gas saver: off

Instrument G: (8270,AIR)

Mass Spec operating conditions: 8270
  Scan from 35 to 550amu
  2.84 Scans/sec
  Quad Temp: 150°C
  Source Temp: 230°C
GC Operating Conditions
  1µL injection
  Injection port Temp:250°C
  AUX Temp: 325°C
Oven Temperature Program:

Initial Temp: 70°C	Hold Time: 1.0min	
Ramp Rate:17°C/min	Oven Temp:320°C	Hold Time:0.0min
Ramp Rate:99°C/min	Oven Temp:330°C	Hold Time:2.90min
Ramp Rate:	Oven Temp:	Hold Time:

The final hold time may be shortened as column life goes on.
Total Run Time 18.71min

Inlet Pressure Program:
  Mode: Pulsed Splitless:
  Pressure: 21.16 psi
  Pulse pressure: 45.0 psi
  Pulse time: 0.50 min
  Purge flow: 20.0/mL/min
  Purge time0.10 min
  Total flow: 24.7 mL/min
  Gas saver: off

Instruments operated in the selective ion monitoring (SIM) mode use the appropriate windows to include the quantitation and confirmation masses listed in Tables 4-7.

Tune Verification

The system must be set up and tuned according to the manufacturer and be capable of producing spectra for a 50 ng injection of decafluorotriphenylphosphine (DFTPP) that meet the evaluation criteria in table 3 Other documented tuning criteria may be used if method performance is not adversely affected. When a successful tune is completed a calibration curve can be analyzed. The DFTPP peak may be evaluated by averaging the scan at the apex, one scan to the left and one to the right. If the three scan average does not produce a successful tune, a different combination of scans may be analyzed. A background scan taken at least 10 scan prior to the beginning of the DFTPP peak or 10 scans after the termination of the DFTPP peak is subtracted from the average and this spectra, evaluated and compared to table 3.

Initial Calibration Blank (ICB)

An initial calibration blank must be analyzed with every initial calibration to prove the instrument is not showing any sign of contamination and/or calibration skew. If the ICB is contaminated the instrument must be evaluated and the source of the contamination remedied prior to calibration.

Initial Calibration

An initial calibration must be performed for all compounds that will be quantitated by this method. Calibration curves must be made of at least 5 levels (3 levels for 625). Note: Alternative calibration criteria from SW-846 8000B requires more calibration levels. The lowest level must be at or below the reporting limit. The other levels will define the working range of the detector. Table 2 indicates the standard levels for each curve and volumes needed for each level. These also list all the concentration of each compound in each level.

Using the data analysis portion of the software, review the data file for each level. The DRO and ORO ranges are quantitated by integrating the total ion chromatogram within the respective retention time windows. Retention time windows are defined for TPH-DRO and TPH-ORO by analyzing a retention time marker standard containing C10, C21, and C35. The retention time window for the TPH-DRO is defined as beginning 0.1 minutes after C10 to 0.1 minutes after C21. The window for TPH-ORO is defined as beginning 0.1 minutes after C21 to 0.1 minutes after C35.

Because the retention time window is several minutes wide for both TPH-DRO and ORO, the system will not accurately or appropriately establish the proper baseline for calibration or quantitation. The analyst must visually examine the computer-generated baseline for every analytical run, and manually adjust the baseline when needed. A properly drawn baseline must extend over the entire retention time window and include the area under the entire TPH-DRO and ORO series of peaks. It is not appropriate to draw the baseline “peak to peak.” Individual quantitation ions are not appropriate for TPH-DRO and ORO calibration or quantitation. The total ion chromatogram (TIC) must be used to calculate the area under the peaks for calibration and quantitation determinations over the entire retention time window. The calibration standards for the TPH-DRO and ORO ranges have little presence in the C21 – C35 range for ORO. Therefore, the response factor calculated for the C10 - C21 window is also used for the C21 – C35 range.

Individual compounds and surrogates shall be quantitated by extracting and integrating the target ion (m/z) for that compound. The target ion is usually the most abundant of the m/z ions in the spectra. In some cases the most abundant ion may not be used. This is true when two or more chromatographic peaks overlap and have one or more common ions. An ion unique to only one of the overlapping compounds shall be used as a target or qualifier ion. In the case of isomers such as meta- and para-cresols, which are completely unresolved and have virtually identical spectra, it is necessary to quantitate the peak and report the result as a pair. A list of compounds and the target and qualifier ions used for this method are found in Table 1.

When identifying and quantitating an analyte the analyst must pay extra attention to specific analytes that have the same primary, secondary ion and in some cases the same RT. In cases like this the analyst must rely on the spectra and the ratio of the specific ions to verify the authenticity of the analyte(s) along with the accuracy of the retention time.

A custom report will be generated after each calibration curve This report will help the verification of incorrect retention times. The report will look at all retention times and flag those that have duplicates . Duplicate retention times are only acceptable if they have a different Quant ion. This custom report is titled 8270RT and is to be used in conjuction with the Excel file titled Single column rt blk.

An additional cutom report titled 625sim, is to be used to verify that the compound Bis(2-ethylhexyl)phthalate is quantitated from the correct peak.

After each level is integrated, the response factor for the area of each compound’s target ion relative to the area of the target ion for the internal standard associated with that compound is calculated using the formula:

$$RF=\frac{A_s \text{ x } C_{is}}{A_{is} \text{ x } C_s}$$

Where:
A_s = the peak area of the analyte or surrogate
A_{is} = the peak area of the internal standard
C_s = the concentration of the analyte or surrogate
C_{is} = the concentration of the internal standard

The mean RF for each target analyte and surrogate is calculated.

Calculate the standard deviation (SD) and relative standard deviation (RSD) of the response factors for all target analytes from the initial calibration, as follows:

$$SD = \sum_{i-1}^{N} \frac{(RF_I - RF)^2}{n-1} \qquad RSD= \frac{SD}{RF} \text{ x } 100$$

where:
RF_I = RF for each of the calibration standards
RF = mean RF for each compound from the initial calibration
n = number of calibration standards, e.g., 5

Calibration (CURVE)

In order for the above calibration curve to be valid The following conditions must initially be met:

1. The four compounds (SPCCs) are checked for a minimum average response factor. (8270 SIM does not have a minimum response factor.) The minimum average response factors for each SPCCs must be 0.050 or greater. These compounds are used to check compound instability and to check for degradation caused by contamination or active sites in the system. The system performance check compounds are N-nitroso-di-n-propylamine, hexachlorocyclopentadiene, 2,4-dinitrophenol, and 4-nitrophenol. These compounds typically have low response factors (0.1-0.2).

2. The **linearity** of the target analytes must be checked. If any analyte has an RSD greater than 15%, then an alternative curve fit needs to be used.

Following SW-846 8000B, section 7.5.2 Linear calibration using a least squares regression, a linear (first order) curve fit will be employed for that analyte.
. If the correlation coefficient (r) is greater
than or equal to 0.99, then that calibration curve will be considered valid and will be used for that analyte.

If the linear calibration is not appropriate, then following 8000B, section 7.5.3 Non-linear calibration, a quadratic (second order) curve fit will be employed.

It should be noted that this will require a minimum of six standards. If the correlation coefficient is greater than or equal to 0.99, then the calibration curve will be considered valid and will be used for that analyte.

If either of these curve fits is employed for calibration of any analyte, then the initial calibration for that analyte will be verified using percent drift of the concentration. If the calculated value of the analyte is not within +/- 15% of the true value, the curve for that analyte is not considered valid and a new calibration is needed. If that analyte is not included within the scope of the data users project-specific needs, then the calibration for the remaining analytes having passing calibration criteria and verification may be used.

3. The RSD of all target analytes for EPA 625 analysis must be less than 35%.
4. An Initial Calibration Verification (ICV) standard must be successfully analyzed. The ICV is a mid-level standard that must pass all of the following criteria in order to be acceptable (ICVs are not required by 625)
   a. The ICV must be a standard that is a second source and is not one of the calibration standards.
   b. The SPCC compounds must have a RF of 0.05 or above.
   c. The CCC analytes must have a %D less than 15%
   d. The Internal Standard response must not differ from the calibration by more than -50 to 200%

In order for the above calibration to be valid for TPH-DRO and TPH-ORO, the following conditions must initially be met:

1. The %RSD for the calibration curve for TPH-DRO must be less than or equal to 20%, so that linearity through the origin can be assumed and an average calibration factor may be used for calculation.

2. The RSD of all target PNA analytes for TPH-DRO and ORO analysis by MRBCA must be 15% or less. If 15% RSD is not achieved, additional calibration options specified in SW-846 8000B must be employed

In order for the above calibration curve to be valid for AgSIM and PestSIM the following conditions must initially be met:

1. The RSD of all target analytes must be less than or equal to 15%. If any analyte has an RSD greater than 15%, then an alternative curve fit needs to be used. See #3 above.

<u>Equations:</u>

Eq. #1 avg. response factor equation:

$$\text{Response Factor (RF)} = \frac{\text{Area of Peak x Concentration of internal standard}}{\text{Mass Injected (ng) x Area of internal standard}}$$

$$\text{Avg. Response Factor} = \frac{\text{Sum of RFs for each calibration level}}{\text{number of calibration levels}}$$

Eq. #2 linear regression equation:

$$y = ax + b$$

Eq. #3 quadratic equation:

$$y = ax + cx^2 + b$$

Where: y = Instrument response
x = Concentration
a = Slope
b = Intercept
c = Constant

Eq. #4 Percent Relative Standard Deviation:

$$\%RSD = \left(\sqrt{\frac{\sum_{i=1}^{N} \left[\frac{Ci - Pi}{Ci} \right]^2}{N - 1}} \right) 100$$

Ci = True concentration in the sample.
Pi = Predicted concentration in the sample.
N = Number of levels in the curve

Eq. #5 % Difference equation:

$$\%D = \frac{\text{Calculated Conc.} - \text{Theoretical Conc.}}{\text{Theoretical Conc.}} * 100$$

PROCEDURE

1. The instrument configurations must be the same as the initial calibration.

2. The mass spec system's tune must be verified. When properly in tune, the system must be capable of producing spectra for a 50 ng injection of decafluorotriphenylphosphine (DFTPP) that meet the evaluation criteria in tables 3. The DFTPP peak may be evaluated by averaging the scan at the apex, one scan to the left and one to the right. If the three scan average does not produce a successful tune, a different combination of scans may be analyzed. A background scan taken at least10 scans prior to the beginning of the DFTPP peak or 10 scans after the termination of the DFTPP peak is subtracted from the average and this spectra evaluated and compared to table 3. If the DFTPP criteria are not met, corrective actions must be taken. Corrective actions include but are not limited to making a fresh DFTPP, re-tuning the mass spectrometer, checking for leaks, changing the septa, cleaning the injection port or cutting the column.

3. For every analyte that is to be quantitated and reported, a mid-level standard must be analyzed. (once per 20 samples or every 12 hours) Quality Manual 22.4.2.2 The following criteria must be satisfied in order for analyses to continue past the CCV:
   a) The SPCC compounds must have a RF of 0.05 or greater.
   b) The %D for all CCC compounds must be 20% or less. NOTE: If ALL CCC's are removed from the target list then all analytes become "C" compounds.
   c) The %D for all analytes for 625, AgSIM, PestSIM, 8270 SIM and 625SIM must be 20% or less. If the recovery of an analyte fails this criterion high it may be used to report as long as the associated environmental samples are non-detects. If the recovery of an analyte fails this low, it may be used only to report as long as the associated samples have detectable concentrations above regulatory limits. If an analyte fails this, either high or low, and is not being requested in particular samples, those samples may be analyzed.
   d) The Internal Standard response must be within -50 to 200% of the initial calibration. If they are not, the system must be evaluated before any analysis can take place. Corrective actions include but are not limited to making a fresh standard, analyzing a new initial calibration curve, checking for leaks, changing the septa, cleaning the injection port or cutting the column.
   e) The retention times of all internal standards must be within +/- 0.50 minutes of the initial calibration if the column length has not been altered since the calibration. If they are not, the system must be evaluated before any analysis can take place.

Corrective actions include but are not limited to making a fresh standard, analyzing a new initial calibration curve, checking for leaks, changing the septa, cleaning the injection port or cutting the column. If the column length has been altered and the retention times have moved, the retention times must be updated.

4. For 625 samples, evaluate the tailing factor for Benzidine and Pentachlorophenol using Chemstation. The tailing factor for Benzidine must be less than 3.0. The tailing factor for Pentachlorophenol must be less than 5.0.

5. An instrument blank or MBLK must be analyzed to verify that the total system is free of contaminants. If the concentration of any analyte is above the reporting limit for that compound, the system and all reagents shall be checked for contamination. Corrective actions include but are not limited to making a fresh blank, changing the septa, cleaning the injection port or cutting the column.

6. The retention time marker standard containing C10, C21, and C35 must be analyzed every 12 hours prior to samples, if samples are to be analyzed and quantitated for TPH-DRO and/or TPH-ORO.

A mid-level standard containing TPH-DRO and TPH-ORO must be analyzed every 12 hours if samples are to be analyzed and quantitated for TPH-DRO and/or ORO. This CCV must meet the following conditions:

a)The %D must be less than or equal to 20% for the TPH-DRO range.
b)The %D for the CCV that contains the PAH's must be less than or equal to 20%.

Failure of any of the above checks makes it necessary to stop the analysis and evaluate the system for problems. Analysis can only resume when all the above criteria are met.

Analysis of Samples

250µL of sample extract is placed in a 2mL vial lined with a vial insert. 5.0µL(2.5µL for SIMS analyses) of the internal standard is added to the sample. Other amounts of sample extract may be used as long as the ratio of internal standard to extract is maintained. Sample vials are placed in the autosampler tray for injection into the GC. The LCS, MS and MSD samples are analyzed in the same fashion as the environmental samples.

DATA ANALYSIS AND CALCULATIONS

Qualitative Analysis

The qualitative determination of each compound is based on retention time and on comparison of the sample mass spectrum. A reference spectrum for all compounds of interest is generated by analyzing a known standard and saving a copy of the reference spectrum in a library database that can be searched through the data system. The characteristic ions are the three of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum. The following criteria are used to identify compounds.

The analyst will review the data in Chemstation and determine if the peak(s) found are the correct ones. Occasionally, the Chemstation software may not integrate the target peak correctly. In this case, manual integration is needed. Before integrating the correct peak, print the chromatogram. After integrating the correct peak, utilizing Qedit annotate function, type the reason why the integration was needed and then print that chromatogram. The following are examples of comments to define why manual integrations were performed.

RTS - Retention Time Shift

BLR - Baseline Resolution

CEP - Co-eluting Peak

COC - Compound Over Calibration

IPI - Incorrect Peak Identification
. For more information on manual integrating see SOP 4026

- The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. The data system will look for the target ion and any qualifier ions within a retention time window of +/- 1-minute and display a trace of the ions in an over-lay configuration. It will also calculate the deviations in retention times of the target and qualifier ions.
- The relative retention times of the sample component must be within +/- 0.06 units of the standard component. This will also be indicated by the data system.
- Structural isomers that produce very similar mass spectra shall be identified as individual isomers if they are sufficiently resolved by the GC column. Sufficient resolution is achieved if the height of the valley between two isomer peaks is less than 25% of the sum of the two peak heights. Otherwise the structural isomers are identified as isomeric pairs. This is the case with m, p-cresols.
- When sample components overlap and produce mass spectra containing ions contributed by more than one analyte, it is important to choose the proper analyte spectra for each component. Selection of background spectra is also very critical. Much of this becomes a matter of analyst experience and judgment.
- Examination of extracted ion current profiles of appropriate ions can aid in the selection of spectra, and in the qualitative identification of compounds.
- For samples containing components not in the calibration standard, a library search of these components may be done. A search of the unknown spectra against the NIST library can be performed, comparing the closest matches to the unknown to determine if it is a potential match. Using the data system, it is possible to estimate the concentration of the unknown, but this is only a rough estimate, as many factors can affect the result.
- The following are recommendations for making tentative identifications of compounds not in the standard:

- Relative intensities of major ions in the reference spectrum (ions greater than 10% of most abundant ion) should be present in the sample spectrum.
- The relative intensities of the major ions should agree within +/- 20%.
- Molecular ions present in the reference spectrum should be present in the sample spectrum.
- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or the presence of co-eluting compounds.
- Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting peaks.

Quantitative Analysis

Once a compound has been identified as a target compound, the quantitation of that compound will be based on the integrated abundance of the extracted ion current profile (EICP) of the primary target ion. The internal standard used will be the one with the retention time nearest the given analyte. Sample results are quantitated from the initial instrument calibration curve.

If the RSD of the compound's response factors (from curve) is less than 15%, then the concentration in the extract may be determined by using the average response factor (RF) from the initial calibration data. The LIMS make adjustments for dilutions and alternate final volume. The following formula is used to calculate the concentration in the sample:

$$C_s = \frac{A_s \times C_{is}}{A_{is} \times RF}$$

Where:

C_s = the concentration of the analyte in the sample extract.
A_s = the EICP area of the sample.
C_{is} = the concentration of the internal standard.
A_{is} = the EICP area of the internal standard.
RF = the average response factor for the compound from the initial calibration curve.

To calculate the concentration in the sample, use the following formulas:

Aqueous samples:	(C_s x DF)/ml of sample extracted
Solid samples:	(C_s x DF)/grams of sample extracted

Where:

C_s = the concentration of analyte in sample extract.
DF = any dilution factors.

Any sample extract containing a compound that exceeds the calibration range of the instrument must be diluted and re-analyzed.

Where applicable, the concentration of non-target analytes identified in the sample shall be estimated. The same formulas as above shall be used with the following modifications: the areas A_s and A_{is} shall be from the total ion chromatograms, and the RF for the compound assumed to be 1. The resulting concentration shall be flagged as an estimate and the internal standard used to quantitate noted.

Solid samples may be calculated to a dry weight basis by using the Pmoist selection in LIMS. Samples requiring results on a dry weight basis must also request a total solids analysis. The technician assigned to the total solids analysis will enter the Pmoist result in LIMS. Once the Pmoist factor is entered calculation of a sample in LIMS will convert the final result to a dry weight basis and change the units to µg/Kg-dry.

- Quality Control:

$$\text{Percent Recovery 1}^{st}\text{ Spike} = \frac{(X_2 - X_1)}{\text{Spike Conc.}} * 100$$

$$\text{Percent Recovery 2}^{nd}\text{ Spike} = \frac{(X_3 - X_1)}{\text{Spike Conc.}} * 100$$

$$\text{RPD} = \frac{\left| (X_2 - X_3) \right|}{(X_2 + X_3)/2} * 100$$

Where:
X_1 = Concentration of unspiked sample
X_2 = Concentration of 1st spiked sample
X_3 = Concentration of 2nd spiked sample.

METHOD PERFORMANCE

See Appendix C

POLLUTION PREVENTION

See Appendix D

WASTE MINIMIZATION

See Appendix D

REFERENCES

SW-846 8000B Rev. 2, 1996
SW-846 8270C Rev. 3, 1996
40CFR Part 136 “APPENDIX A TO PART 136 METHODS FOR ORGANIC CHEMICAL ANALYSIS OF MUNICIPAL AND INDUSTRIAL WASTEWATER”
See Appendix D

(b) (6) [redacted]

6/24/14

Approving Authority | Effective Date

TABLES & CHARTS

Table 1 Compounds Reported by this SOP

Compound	CAS No.	Compound Type	Method	Target Ion	Qualifier Ions
1,2,4-Trichlorobenzene	000120-82-1	TM	8270/625	180	182,145
1,2-Dichlorobenzene	000095-50-1	T	8270/625	146	111,75
1,3-Dichlorobenzene	000541-73-1	T	8270/625	146	111,75
1,4-Dichlorobenzene	000106-46-7	TMC	8270/625	146	111,75
1,4-Dichlorobenzene-d4	003855-82-1	I	8270/625	152	115
1,4-Dioxane	00123-91-1	T	8270	88	58
1-Methylphenanthrene	832-69-9	T	8270/625	192	
2,4,5-Trichlorophenol	000095-95-4	TM	8270	196	97,132,99
2,4,6-Tribromophenol	000118-79-6	S	8270/625	330	332,62,141
2,4,6-Trichlorophenol	000088-06-2	TCM	8270/625	196	198,200
2,4-Dichlorophenol	000120-83-2	TC	8270/625	162	164,98
2,4-Dimethylphenol	000105-67-9	TM	8270/625	122	107,121
2,4-Dinitrophenol	000051-28-5	TPM	8270/625	184	63,154
2,4-Dinitrotoluene	000121-14-2	TM	8270/625	165	63,89
2,6-Dinitrotoluene	000606-20-2	TM	8270/625	165	63,89
2-Chloronapthalene	000091-58-7	T	8270/625	162	127,164
2-Chlorophenol	000095-57-8	TM	8270/625	128	64,130
2-Fluorobiphenyl	000321-60-8	S	8270/625	172	171,170
2-Fluorophenol	000367-12-4	S	8270/625	112	64
2-Methoxy-4-Methylphenol	000093-51-6	T	8270	123	138
2-Methylnaphthalene	000091-57-6	T	8270	142	141
2-Nitroaniline	000088-74-4	T	8270	65	92,138
2-Nitrophenol	000088-75-5	TC	8270/625	139	109,65
3,3'-Dichlorobenzidine	000091-94-1	T	8270/625	252	254,126
3-Nitroaniline	000099-09-2	T	8270	138	108,92
4,6-Dinitro-2-methylphenol	000534-52-1	T	8270/625	198	51,105
4-Bromophenyl phenyl ether	000101-55-3	T	8270/625	248	250,141
4-Chloro-3-methylphenol	000059-50-7	TMC	8270/625	107	144,142,51
4-Chloroaniline	000106-47-8	T	8270	127	65
4-Chlorophenyl phenyl ether	007005-72-3	T	8270	204	206,141
4-Nitroaniline	000100-01-6	T	8270	138	65,108,92
4-Nitrophenol	000100-02-7	TMP	8270/625	109	139,65
Acenaphthene	000083-32-9	TMC	8270/625	153	154,152,76
Acenaphthene-d10	015067-26-2	I	8270/625	164	
Acenaphthylene	000208-96-8	TM	8270/625	152	151,150
Acetochlor	34256-82-1	TC	8270AGSIM	146	162

	15972-60-8	TC	8270AGSIM	160	188
Aldicarb	116-06-3	T	8270	68	100,41,115
Aniline	000062-53-3	T	8270	93	66
Anthracene	000120-12-7	TM	8270	178	76,89
Atrazine	1912-24-9	T	8270	215	200
Atrazine	1912-24-9	TC	8270AGSIM	215	200
Azobenzene	000103-33-3	T	8270/625	77	182,51,105
Benzidine	000092-87-5	T	8270/625	184	92,185
Benzo(a)anthracene	000056-55-3	TM	8270/625	228	114,101
Benzo(a)pyrene	000050-32-8	TCM	8270/625	252	126,125,113
Benzo(b)fluoranthene	000205-99-2	TM	8270/625	252	126,125,113
Benzo(g,h,i)perylene	000191-24-2	TM	8270/625	276	138
Benzo(k)fluoranthene	000207-08-9	TM	8270/625	252	126,125,113
Benzoic Acid	000065-85-0	T	8270	105	122,77,51
Benzyl Alcohol	000100-51-6	T	8270	108	79,51
1-1’-Biphenyl*	000111-44-4	T	8270SIM	154	153,152,76
Bis-(2-Chloroethoxy)methane	000111-91-1	T	8270/625	93	95,123
Bis-(2-Chloroethyl) ether	000111-44-4	TM	8270/625	93	63,95
Bis-(2-Chloroisopropyl)ether	000108-60-1	T	8270/625	45	77,121
Bis-(2-ethylhexyl) phthalate	000117-81-7	TM	8270/625	149	167,57
Bis-(Chloromethyl)ether*	000542-88-1	T	8270	79	49
Butyl benzyl phthalate	000085-68-7	T	8270/625	149	91,206
Butylate**	2008-41-5	TC	8270AGSIM	146	156
Carbofuran	1563-66-2	T	8270	149	164,39
Carbazole	000086-74-8	T	8270	167	139
Chrysene	000218-01-9	TM	8270/625	228	226,229
Chrysene-d12	001717-03-5	I	8270/625	240	120,236
Cyanazine	21725-46-2	TC	8270AGSIM	172	225
Di n-butyl phthalate	000084-74-2	TM	8270/625	149	150,104
	2303-16-4	T	8270	86	43,234
Dibenzo(a,h)anthracene	000053-70-3	TM	8270/625	278	139
Dibenzofuran	000132-64-9	T	8270	168	139
Diethyl phthalate	000084-66-2	TM	8270/625	149	177,150
	000060-51-5	T	8270	87	93,125
Dimethyl phthalate	000131-11-3	TM	8270/625	163	194,164
Di-n-octyl phthalate	000117-84-0	TC	8270/625	149	167,43
EPTC	759-94-4	TC	8270AGSIM	128	132
Ethyl methanesulfate	000062-50-0	T	8270	79	109
Fluoranthene	000206-44-0	TCM	8270/625	202	101,200
Fluorene	000086-73-7	TM	8270/625	166	165,82
Hexachlorobenzene	000118-74-1	TM	8270/625	284	142,249
Hexachlorobutadiene	000087-68-3	TMC	8270/625	225	190,118,83

Hexachlorocyclopentadiene	000077-47-4	TP	8270/625	237	235,272
Hexachloroethane	000067-72-1	TM	8270/625	117	201,199
Indeno(1,2,3-cd)pyrene	000193-39-5	TM	8270/625	276	138
Isophorone	000078-59-1	T	8270/625	82	95,138
m,p-Cresol	000106-44-5	TM	8270	107	77,51,39
Methyl methanesulfate	000066-27-3	T	8270	80	65
Metolachlor	51218-45-2	TC	8270AGSIM	162	238
Metribuzin	21087-64-9	TC	8270AGSIM	198	199
Naphthalene	000091-20-3	TM	8270/625	128	129,127
Naphthalene-d8	001146-65-2	I	8270/625	136	
Nitrobenzene	000098-95-3	TM	8270/625	77	123,65
Nitrobenzene-d5	004165-60-0	S	8270/625	82	128,54
n-Decane*	124-18-5	T	8270/625	57	71, 85
n-Octadecane*	593-45-3	T	8270/625	57	71, 85
	000055-18-5	T	8270	102	44,56
N-Nitrosodimethylamine	000062-75-9	T	8270/625	74	42
	000924-16-3	T	8270	84	57,41
N-Nitroso-di-n-propylamine	000621-65-7	TMP	8270/625	70	43,130
N-Nitrosodiphenylamine	000086-30-6	TC	8270/625	169	84,51
	010595-95-6	T	8270	88	42,56
o-Cresol	000095-48-7	TM	8270	108	77,51,39
Parathion	000056-38-2	T	8270	97	109,291
Pendimethalin	40487-42-1	TC	8270AGSIM	252	281
Pentachlorophenol	000087-86-5	TMC	8270/625	266	264,268
Perylene-d12	001520-96-3	I	8270/625	264	
Phenanthrene	000085-01-8	TM	8270/625	178	76
Phenanthrene-d10	001517-22-2	I	8270/625	188	
Phenol	000108-95-2	TMC	8270/625	94	65,66
Phenol-d5	004165-62-2	S	8270/625	99	71
Pyrene	000129-00-0	TM	8270/625	202	200,203
Quinoline	000091-22-5	TM	8270	129	102,51
Safrole**	0000 94-59-7	T	8270	162	104,77,51
Simazine	122-34-9	T	8270	186	44
Simazine	122-34-9	TC	8270AGSIM	186	201
Thionazin**		T	8270	107	97,96,106
Tributyl phosphate	126-73-8	S	8270AGSIM	99	

* Analyzed only at client request, currently have MDL studies.

**Could be ananlyzed for, no MDL studies have been performed.

I – Internal Standard
S – Surrogate Standard
P – System Performance Check Compound
C – Continuing Calibration Compound
M – Matrix Spike Compound
T – Target Compound

Table 2.

For the 8270/625, client requested and Appendix IX calibration curve use:

Calibration Level ID	Amount of 200µg/mL working standard	Amount of methylene chloride
Level-001	5µL	995µL
Level-005	25µL	975µL
Level-010	50µL	950µL
Level-020	100µL	900µL
Level-035	175µL	825µL
Level-050	250µL	750µL
Level-080	400µL	600µL
Level-100	500µL	500µL
Level-120	600µL	400µL
Level-160	800µL	200µL

The lowest level may not be used for every compound due to low response.

20.0µL of Internal standard is added to 1.0mL volume at all levels.

For the 8270SIM calibration curve use:

Calibration Level ID	Amount of 200µg/mL working standard	Amount of methylene chloride
Level-0.1	2.5 µL	***5ml****
Level-0.5	2.5 µL	997.5 µL
Level-1	5 µL	995 µL
Level-5	25ul µL	975 µL
Level-10	50 µL	950 µL
Level-25	125 µL	875 µL
Level-50	250 µL	750 µL

10.0µL of Internal standard is added per 1.0mL volume at all levels.

*****1ml is taken out then 10** µL of Internal standard is added

For the 8270C Pesticide calibration curve use:

Calibration Level ID	Amount of 100µg/mL working standard	Amount of methylene chloride
Level-002	20µL	980µL
Level-005	50µL	950µL
Level-010	100µL	900µL
Level-020	200µL	800µL
Level-030	300µL	700µL
Level-040	400µL	600µL
Level-050	500µL	500µL

20.0µL of Internal standard is added to 1.0mL volume at all levels.

For the 8270/625 SIMS calibration curve use:

Calibration Level ID	Amount of 200µg/mL working standard	Amount of methylene chloride
Level-0.10	2.5µL	4997.5µL
Level-0.50	2.5µL	997.5µL
Level-01.0	5µL	995µL
Level-05.0	25µL	975µL
Level-10.0	50.0µL	950µL
Level-25.0	125µL	875µL
Level-50.0	250µL	750µL

10.0µL of Internal standard is added per 1.0mL volume at all levels.

For the PSIMS calibration curve use:

Calibration Level ID	Amount of 100/1000/1000µg/mL working standard	Amount of methylene chloride
Level-0.05/2.0	2.5/10/10µL	4977.5µL
Level-0.10/4.0	5/20/20µL	4955µL
Level-0.25/10.0	2.5/10/10µL	977.5µL
Level-0.50/15.0	5/15/15µL	965µL
Level-1.0/20.0	10/20/20µL	950µL
Level-2.5/25.0	25/25/25µL	925µL
Level-25.0/30.0	250/30/30µL	690µL

10.0µL of Internal standard is added per 1.0mL volume at all levels.

For the 8270AGSIMS calibration curve use:

Calibration Level ID	Amount of 10µg/mL working standard	Amount of methylene chloride
Level-0.20	20µL	980µL
Level-0.40	40µL	960µL
Level-0.60	60µL	940µL
Level-0.80	80µL	920µL
Level-01.0	100µL	900µL
Level-02.0	200µL	800µL
Level-03.0	300µL	700µL
Level-04.0	400µL	600µL
Level-05.0	500µL	500µL

10.0µL of Internal standard is added per 1.0mL volume at all levels.

For the SV_TPH_DRO_PAH calibration curve use:

Calibration Level ID	Amount of 200µg/mL working standard	Amount of methylene chloride
Level-160	800µL	200µL
Level-120	600µL	400µL
Level-100	500µL	500µL
Level-50	250µL	750µL
Level-20	100µL	900µL
Level-10	50µL	950µL
Level-1.0	5µL	995µL

20.0µL of Internal standard is added per 1.0mL volume at all levels.

For the DRO/acid/base calibration curve use:

Calibration Level ID	Amount of 20000/2000/1000µg/mL working standard	Amount of methylene chloride
Level-5000	250/80/160µL	510µL
Level-2000	100/60/120µL	720µL
Level-1500	75/50/100µL	775µL
Level-1000	50/40/80µL	830µL
Level-750	37.5/25/50µL	887.5µL
Level-500	25/10/20µL	945µL
Level-250	12.5/2.5/5µL	980µL

20.0µL of Internal standard is added per 1.0mL volume at all levels.

Table 3.

DFTPP Acceptance Criteria When Using Chemstation Autofind and Manually Verifying Tune

m/z	Required Intensity
51	**10 to 80% of the base peak**
68	**Less than 2% of m/z 69**
70	**Less than 2% of m/z 69**
127	**10 to 80% of the base peak**
197	**Less than 2% of m/z 198**
198	**Base Peak or > 50% of 442**
199	**5 to 9% of m/z 198**
275	**10 to 60% of the base peak**
365	**Greater than 1% of the base peak**
441	**Present but less than m/z 443**
442	**Base Peak or > 50% of 198**
443	**15 to 24% of m/z 442**

Table 4. 8270C/625 Data Qualifier Definitions

S	Spike recovery outside of quality control limits
R	RPD outside of quality control limits
J	Over MDL but less then PQL
X	Above the client max contamination limit
E	Over calibration range

Table 5. 8270SIM MS Acquisition Parameters

Group	Name	Start Time (Subject to change with column length)	Mass/Dwell
1	2-Fluorophenol	3.70	112.0, 64.0, 88.0, 58.0/ 100
2	Phenol-d5	6.42	99.0, 71.0, 94.0, 66.0/ 100
3	1,4-Dichlorobenzene	6.89	152.0, 108.0, 107.0, 82.0, 54.0/ 40
4	2,4-Dimethylphenol	7.87	107.0, 122.0/ 100
5	Naphthalene-d8	8.34	136.0, 137.0, 102.0, 128.0, 142.0, 141.0/ 60
6	2-Fluorobiphenyl	9.63	172.0, 85.0, 154.0, 153.0/100
7	Dimethyl Phthalate	10.09	164.0, 163.0, 153.0, 154.0, 152.0, 77.0/ 40

8	Dibenozfuran	10.70	166.0, 165.0, 149.0, 177.0, 168.0, 139.0, 138.0, 65.0/ 60
9	Phenanthrene-d10	12.16	188.0, 178.0, 152.0/ 100
10	Carbozole	12.42	149.0, 150.0, 167.0, 139.0/ 100
11	Fluoranthene	13.40	202.0, 101.0, 244.0,122.0/ 90
12	Benzo(a)anthracene	16.30	228.0,113.0, 240.0, 149.0, 167.0/ 50
13	Benzo(b)fluoranthene	19.00	252.0, 126.0/ 100
14	Benzo(a)pyrene	20.20	252.0, 264.0, 113.0/ 100
15	Indeno(1,2,3-cd)anthracene	23.00	276.0, 138.0, 278.0, 139.0/ 90

Table 6. AGSIM MS Acquisition Parameters

Group	Name	Start Time (Subject to change with column length)	Mass/Dwell
1	1	3.00	136.0/ 100
2	2	3.90	128.0,132.0,146.0,156.0/ 100
3	3	4.15	146.0, 156.0, 160.0, 162.0, 188.0, 198.0, 199.0/ 70
4	4	4.45	164.0/ 100
5	5	4.80	99.0, 264.0, 306.0/ 100
6	6	5.20	186.0, 200.0, 201.0, 215.0/ 100
7	7	5.50	146.0, 160.0, 162.0, 188.0, 198.0, 225.0, 238.0/ 80
8	8	5.90	162.0, 172.0, 225.0, 238.0 / 80
9	9	6.10	252.0, 281.0, 326.0 / 100
10	10	7.80	74.1, 240.0 / 100

Table 7. SIM625 MS Acquisition Parameters

Group	Name	Start Time (Subject to change with column length)	Mass/Dwell
1	2-Fluorophenol	3.00	112.0, 64.0 / 100
2	Phenol-d5	6.38	99.0, 71.0 / 100
3	1,3-Dichlorobenzene	6.82	152.0, 146.0, 148.0/ 100
4	Hexachloroethane	7.45	117.0, 82.0, 77.0, 123.0 / 100
5	2-Nitrophenol	7.85	139.0, 65.0, 180.0, 182.0, 128.0, 127.0, 136.0, 225.0, 227.0, 139.0 / 30
6	2-Fluorobiphenyl	9.70	172.0, 163.0, 77.0 / 100
7	Acenaphthene-d10	10.30	164.0, 109.0, 65.0, 153.0, 154.0 / 50
8	Diethylphthalate	10.90	166.0, 165.0, 198.0, 51.0, 149.0, 177.0 / 100
9	Hexaclorobenzene	11.70	284.0, 286.0 / 100
10	Phenanthrene-d10	12.00	188.0, 178.0, 152.0 / 100
11	Di-n-butylphthalate	12.73	149.0, 150.0 / 100
12	Fluoranthene	13.82	202.0, 101.0, 244.0 / 100
13	Bis(2-ethylhexly)ph	16.70	149.0, 167.0, 240.0 / 100

Table 8. PESTSIM MS Acquisition Parameters

Group	Name	Start Time (Subject to change with column length)	Mass/Dwell
1	2-Fluorophenol	4.00	112.0, 64.0, 100.0, 115.0 / 100
2	Phenol-d5	5.80	99.0, 71.0, 42.0 / 100
3	1,4-Dichlor-d4	6.15	150.0, 152.0, 115.0 / 100
4	Nitrobenezene-d5	6.80	82.0, 128.0, 54.0 / 100
5	Naphthalene	7.50	136.0, 237.0, 235.0, 172.0 / 100
6	Acenaphthene	8.85	164.0, 162.0, 80.0, 172.0, 171.0 / 100
7	Carbofuran	11.00	164.0, 149.0, 201.0, 200.0, 215.0, 186.0 / 100
8	Phenanthrene-d10	11.50	188.0, 160.0, 80.0 / 100
9	Parathion	12.40	97.0, 109.0, 139.0, 291.0 / 100
10	p-Terphenyl-d14	13.80	244.0, 245.0, 122.0 / 100
11	Chyrsene-d12	16.10	240.0, 236.0, 120.0, 106.0, 149.0, 167.0 / 100
12	Beno(a)pyrene	20.10	252.0, 250.0 / 100

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Example 2: PCB-169

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Example 3: PCB-185 obscured by larger congeners in the same level of Chlorination

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Example 4: PCB-126 obscured by interference at a higher level of chlorination

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APPENDIX D

Project Planning Session Summaries

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APPENDIX D

RISK ASSESSMENT WORK PLAN

FINAL RISK ASSESSMENT WORK PLAN

GOODFELLOW FEDERAL COMPLEX
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MISSOURI (MO0602AF)
CONTRACT NUMBER: GS-06P-15-GZ-D-7000
WORK ORDER NUMBER 29

Prepared for:

MR. ERIC GORMAN
GENERAL SERVICES ADMINISTRATION
PUBLIC BUILDINGS SERVICE
2300 MAIN STREET, 7TH FLOOR
KANSAS CITY, MISSOURI

Prepared by:

ETEGRA, INC.
1121 OLIVETTE EXECUTIVE PARKWAY, SUITE 100
ST. LOUIS, MISSOURI

With:

JUNIPER ENVIRONMENTAL, LLC
1 ALBY STREET
ALTON, ILLINOIS

And:

GEOTECHNOLOGY, INC.
11816 LACKLAND ROAD, SUITE 150
ST. LOUIS, MISSOURI

Date:

FEBRUARY 9, 2021

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ATTACHMENTS

Acronyms and Abbreviations

°F	degrees Fahrenheit
%	percent
>	greater than
<	less than
ABS	absorption factor
AC	average concentration
ACH	air changes per hour
ADI	average daily intake
ALM	adult lead methodology
AT	average time
AF	adherence factor
atm-m^3/mole	atmospheres cubic meters per mole
AST	above ground storage tank
bgs	below ground surface
BW	body weight
CDC	Centers for Disease Control
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	conversion factor
COPC	chemicals of potential concern
COOP	Continuity of Operations Program
CSF	cancer slope factor
CSM	conceptual site model
DoD	United States Department of Defense
DISA	Defense Information Systems Agency
DTSC	California Department of Toxic Substances Control
EPC	exposure point concentration
ED	exposure duration
EF	exposure frequency
ET	exposure time
ft	feet
FA	fraction absorbed
FSA	Farm Service Agency
g/m^2-s	grams per square meter-second
GFC	Goodfellow Federal Complex
GOCO	Government-owned/contractor operated
GSA	U.S. General Services Administration
GSD	geometric standard deviation

H	Henry's Law constant
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IEUBK	Integrated Exposure Uptake Biokinetic Model
ITRC	Interstate Technology and Regulatory Council
IUR	inhalation unit risk
K	Overall mass transfer coefficient
kg/m^3	kilogram per cubic meter
K_g	Gas-phase mass transfer coefficient
K_L	Liquid-phase mass transfer coefficient
LAC	lifetime average concentration
LADI	lifetime average daily intake
LOAEL	lowest observed adverse effect level
MC	munitions constituents
MD	munitions debris
MDAS	material documented as safe
MDEH	material documented as an explosive hazard
mg	milligram
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
mg/ m^2	milligrams per meters squared
mm	millimeter
µg/dL	microgram per deciliter
µg/m^3	microgram per cubic meter
MatPb	Mother's Blood Lead Concentration at Childbirth
MW	molecular weight
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NOAEL	no observed adverse effect level
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEF	particulate emission factor
PID	photoionization detector
PPRTV	Provisional Peer-Reviewed Toxicity Values
QA	quality assurance
QC	quality control

RAGS	risk assessment guidance for Superfund
RfC	inhalation reference concentration
RfDd	dermally absorbed reference dose
RfDo	ingestion based oral dose
RI	remedial investigation
RIF	route-specific intake factor
RME	reasonable maximum exposure
RSL	USEPA regional screening level
SA	Skin Surface Area
SAP	sampling and analysis plan
SF	slope factor
SI	site inspection
SLOP	Saint Louis Ordnance Plant
SSL	soil screening level
STC	short term concentration
SVOC	semivolatile organic compound
TPH	total petroleum hydrocarbons
VDEQ	Virginia Department of Environmental Quality
VF	volatilization factor
VISL	vapor intrusion screening level
VOC	volatile organic carbon
UCL	upper confidence limit
UFs	uncertainty factors
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
UST	underground storage tank

1.0 INTRODUCTION

This human health risk assessment work plan provides a detailed description of how the baseline human health risk assessment (HHRA) will be completed to support the Remedial Investigation (RI) for the Goodfellow Federal Complex (GFC - Site) in St. Louis, Missouri.

1.1 Background

The GFC is at 4300 Goodfellow Boulevard in St. Louis, Missouri and occupies a portion of the former St. Louis Ordnance Plant (SLOP) near the western boundary of the City of St. Louis, Missouri (Figure 1). The GFC encompasses approximately 64 acres, and is bordered northeast by the former SLOP, southeast by Planned Industrial Drive, southwest by Edelle Avenue and the SLOP, and northwest by Goodfellow Boulevard. GFC Building 208 B is beyond the security perimeter of the central GFC, within a fenced area on Planned Industrial Drive, approximately 170 yards northeast of GFC Building 105 A/B/C/D. The GFC is developed with buildings, utility tunnels, and a combined stormwater and sanitary sewer collection system.

1.2 Site Physical Setting

The GFC is on the northern flank of the Ozark Plateau in the Dissected Till Plains Physiographic Province, which is characterized by gently rolling hills (Miller et al. 1974). From Goodfellow Boulevard, the Site generally slopes eastward toward the Mississippi River; the northernmost portion of the Site slopes more northeasterly, and the southernmost portion of the Site slopes more southeasterly.

The Mississippi River is approximately 2.5 miles east of the Site. Although drainage from the Site generally follows the topographic gradient toward the Mississippi River, surface water that leaves the Site is directed through the combined storm/sanitary sewers and a wastewater treatment facility before discharging into the Mississippi River (SCS Engineers [SCS] 2008). Based on the general topographic gradient, groundwater beneath the Site flows easterly toward the Mississippi River.

Ground surface at the Site is covered by fill, streets, parking lots, buildings, and other structures. Site surface soils are identified as Urban Land-Upland with 0- to 5-percent slopes (U.S. Department of Agriculture [USDA] 1979). The Urban Land designation applies to areas where structures, asphalt, concrete, and other impervious materials cover over 85 percent of the Site. Subsurface investigations at the Site have identified soils below the fill as predominantly silty clay or silty clay loam (Geotechnology, Inc. 2006; SCS 2008).

The climate in St. Louis County is characterized by cold winters, hot summers, and heavy rains in the spring and early summer (USDA 1979). Prevailing wind is from the south. Average annual temperature in St. Louis, Missouri, is 56°F, with monthly average temperatures ranging from 30°F in January to 79°F in July. Average annual precipitation is 37.1 inches, and average annual snowfall is approximately 19.8 inches (Weatherbase 2012).

2.0 FACILITY DESCRIPTION

2.1 Background

The GFC occupies a portion of a former ordnance plant (i.e., SLOP) over approximately 64 acres (Figure 2). The SLOP was constructed in the early 1940s and fabricated .30 caliber and .50 caliber ammunition. Possible contaminants related to previous Site activities potentially included metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), petroleum hydrocarbons, explosives, other inorganics (e.g., phosphorus), and polychlorinated biphenyls (PCBs). Based on a detailed evaluation of the existing data, the chemicals of potential concern (COPCs) were refined (see Section 3.1.2 of this Risk Assessment Work Plan).

2.2 Operational History

Construction of the SLOP began in January 1941 and was completed in May 1942. The St. Louis Ordnance Plant was the largest small-arms ammunition installation in the world and embodied three operating divisions. The GFC was known as Plant No. 1 and is located on the east side of Goodfellow Boulevard. The facility, a Government-Owned/Contractor Operated (GOCO) plant, produced small arms ammunition (.30 caliber and .50 caliber) and components for the 105-mm shells. Figure 2 shows the layout of the various buildings in Plant No. 1. Buildings 102 and 103 housed the production of .30 caliber ammunition, while Buildings 104 and 105 housed the production of .50 caliber ammunition.

The small arms ammunition production within Buildings 102, 103, 104, and 105 consisted of brass cartridge annealing and shaping, powder and primer packing, lead core insertion, and sorting, packaging, and shipping. Powder canning and storage buildings (Buildings 102 F, 102 H, 103 F, 103 H, 104 G, 104 J, 105 G, and 105 J) sat inside blast proof concrete bunkers (102G, 103 G, 104 H and 105 H) located south of the main production buildings. Powder was moved from the bunkers and brought into Buildings 102 D, 103 D, 104 E, and 105 E for packing. Primer was brought into Buildings 102 E, 103 E, 140 F, and 105 F for packing. Cartridge annealing[1] and shaping took place in all production buildings, as did sorting, packaging, and shipping of the completed cartridges.

Small buildings (102 J, 102 K, 103 J, 103 K, 104 M, 104 N, 105 M, and 105 N) adjacent to production buildings were used for storage of oils and lacquer. Oils and lacquer were transferred from storage areas through a series of mechanical piping into the main production buildings. Based on historical documentation and original construction drawings, the oil is believed to have been utilized during shaping and trimming operations and lacquer was utilized as a waterproofing agent applied to completed cartridges.

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[1] Annealing is a heat treatment process which alters the microstructure of a material to change its mechanical or electrical properties. Typically, in steels, annealing is used to reduce hardness, increase ductility and help eliminate internal stresses.

Current Building 103 F (previously designated as Building 112) was originally constructed to shape and form lead cores for munitions. Numerous slug forming machines, five lead presses, and a remelt room operated on the first floor of the building. Documentation indicates lead was melted in this building through at least February 1957. The building was used for storage following decommissioning and was most recently utilized as a kitchen and cafeteria.

Steam was generated for heating purposes in the Boiler House (Building 111) and was delivered to buildings across the Site through a series of underground utility tunnels. Natural gas is believed to have been the only fuel source used to fire the boiler system. The boiler house was decommissioned and removed from the Site in approximately 1970. Currently, the complex is heated with smaller roof-mounted boiler units operated with natural gas.

Electrical power enters the Site (b) (7)(F) where it is distributed to various transformer vaults in the main buildings. Documentation indicates that the primary transformers have been replaced and that the fluid in all secondary transformers has been replaced with non-PCB containing oil.

Cartridge manufacturing ended at Plant No. 1 at the close of World War II. The U.S. Department of Defense (DOD) converted the Site in the 1960's and 1970's to a Federal Office Complex under the management of the U.S. General Services Administration (GSA). The four primary munitions manufacturing buildings (102, 103, 104, and 105) were decommissioned and converted into office and warehouse space. The grounds surrounding the buildings were graded and converted into parking and greenspace. The powder bunkers were removed during a redevelopment project in 1980. Paved parking and access roads exist in the areas where the bunkers were located. The Site has been utilized for over 20 years as a federal office complex whose primary tenants have included GSA, (b) (7)(F)

A facility map with historical information for the Site prepared by Tetra Tech is included in Attachment A.

2.3 Current and Historical Site Use

Known historical uses of the GFC property include a residence and farmstead (dairy farm) between 1912 and 1925, a community garden between 1936 and 1940, Hickey Park from 1940 to 1941, and Plant 1 of the SLOP from 1941 through the close of World War II. The SLOP reportedly was the largest small-arms ammunition installation in the world, producing small arms ammunition (.30 and .50 caliber) and components for 105-millimeter (mm) artillery shells. In the 1960s and 1970s, the DOD converted Plant 1 to a federal office complex under management of

GSA (SCS 2008). Table 1 lists the individual buildings at the GFC, their historical use and current use. Other considerations include:

- During the late 1970s, the propellant storage buildings were removed during a major renovation of the property where parking lots and streets were constructed (Geotechnology, Inc. 2006).

- During the manufacturing of ammunition, metal shavings suspected of being contaminated with lubricating oils and possible PCB-containing oils were transported by railway across the Site (Geotechnology, Inc. 2006).

- Oil-filed transformers containing PCBs were formerly used at the Site. The PCB transformers were removed from the Site and replaced with dry transformers. Concrete core samples were collected from the concrete foundations in 2013 (Geotechnology, Inc. 2006).

- Miscellaneous commercial operations have occurred in the area such as Able Lift Truck located adjacent to and south of Building 101 and west (upgradient) of Building 110. A farm sale business and fork-truck business previously operated in the area. Many of these commercial businesses use, store and dispose of solvents and petroleum hydrocarbons.

The Site area is currently zoned Industrial District. The current potential exposure scenarios include commercial/industrial workers, trench workers and construction workers The Site is fenced with 24-hour controlled site access. Approximately 80% of the Site is covered by pavement or buildings. Contractors working in designated areas are required to develop Health and Safety Plans. Designated areas include Penthouses, Mechanical spaces, above drop ceilings; basements/basement tunnels/crawl spaces, exterior grounds, substations, and electrical vaults. The City of St. Louis Ordinance 66777 prohibits the use of groundwater as drinking water and also prohibits the drilling or installation of wells for potable water supply within the City of St. Louis.

3.0 Human Health Risk Assessment

In support of the RI and to aid in the decision-making process, a baseline human health risk assessment (HHRA) will be conducted to characterize current and potential threats to the environment from COPCs in the soil and groundwater at the GFC. The baseline HHRA will be conducted in accordance with CERCLA requirements and applicable USEPA guidance. The baseline HHRA will be performed in a manner consistent with and in consideration of *U.S. EPA Risk Assessment Guidance for Superfund Volume I – Parts A through F* (USEPA, 1989, 1991a, 1991b, 1992, 2001a, 2001b, 2004, 2009). The HHRA will be presented in the format described in U.S. EPA's 2001b *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part D Standardized Planning, Reporting, and Review of Superfund Risk Assessment)* or equivalent data presentation. In accordance with USEPA guidance, the baseline HHRA will include the following four steps:

- Data Evaluation

- Exposure Assessment
- Toxicity Assessment
- Risk Characterization

3.1 Data Evaluation and Selection of Chemicals of Potential Concern

The data evaluation step includes compiling the available soil and groundwater data collected during the RI and previous data that is of sufficient quality. Compiled analytical results and statistical summaries will be included in the baseline HHRA.

3.1.1 Previous Investigations

As part of previous investigations, detected concentrations have been compared to risk-based screening values, but there has not been a comprehensive baseline risk assessment completed.

3.1.1.1 Remedial Investigation Reports

2016 – Remedial Investigation Report (Tetra Tech, September 2016)

The focus of this report was investigation of on-site legacy contamination associated with the former ordnance plant operations and characterization of occupational risk. Surface soil (0-1 ft bgs) and a boring to 4 ft bgs was sampled outside of six buildings (107, 136 F, 102 E, J &K, 102 A/B/C, 104 A/B/C/D and 108 A & 111). Groundwater was co-located with a soil boring location between buildings 108 A and 111. Hard clayey soils or other unknown subsurface interference prevented the direct push from reaching groundwater. COPCs were VOCs, SVOCs, and PCBs.

2013 – Occupational Exposure Evaluation Report. Rev 00. (Tetra Tech, June 2013)[2].

To evaluate occupational exposures, destructive core of samples of interior concrete were analyzed for PCBs, bulk surface dust samples were analyzed for lead and/or mercury, and surface soil samples from the interior crawlspace and basements were analyzed for asbestos, lead, mercury and/or SVOCs, depending on the building. Exterior soil samples were collected and analyzed for VOCs, SVOCs, total petroleum hydrocarbons (TPH), pesticides, herbicides, metals and asbestos. The soil sample depth was dependent on the highest photoionization detector (PID) reading from a 4-foot core. Groundwater was sampled from 104 A/B/C/D, 108 A and 111, 108 B, 115 and underground storage tanks (USTs), 122 B, 136 B, 136 E and 136 F. Other locations were met with refusal or insufficient groundwater volume for sampling.

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[2] The focus of the GFC Occupational Exposure Evaluation was on contaminants of concern associated with former ordnance plant operations and not construction or maintenance materials such as lead-based point, asbestos containing building materials, PCB-based caulking or appropriately applied pesticides or herbicides.

3.1.1.2 Preliminary Assessment/Site Investigations

Numerous preliminary assessments and site investigations have been completed for various buildings across the GFC and are listed below.

2008. Combined Preliminary Assessment/Site Inspection Report - (SCS Engineers, August 2008)

Documents various media sampled (wipe, paint chip, soil, groundwater, sump water, tunnel water, and air). Soil from basements and crawl spaces was also sampled along with outdoor subsurface soil borings. This document identifies likely sources of COPCs at each building. This document summarizes previously completed and relevant investigations:

- 2006. Phase I Environmental Site Assessment. Federal Records Center (Geotechnology, November 21, 2006).
- 2006. Environmental Site Investigation Report Buildings 101 and 110 (SCS Engineers, 2006)
- 2006. Environmental Site Investigation Building Series 104 Interim Report (SCS Engineers, 2006)
- 2006. Environmental Site Investigation Building Series 105 Interim Report (SCS Engineers, 2006)
- 2004. Site Investigation, St. Louis Federal Center, Building 103, 103D, 103E (SCS Engineers, 2004.)
- 2004. Environmental Site Investigation Buildings 108A and 108B (SCS Engineers, 2004).
- 2004. Environmental Site Investigation Buildings 104K and 104L (SCS Engineers, 2004).
- 2003. Environmental Site Investigation Report for Buildings 102, 103, 104, and 12 (SCS Engineers, 2003).
- 2002. Phase I Environmental Site Assessment - includes documentation on the history of the Site and interviews (Marc Enviro Services January 24, 2002).

3.1.1.3 Demolition and Remediation Reports

2003 Small Arms Firing Range. Remediation Report Building 105 (SCS Engineers March 18, 2003).

Reported on the demolition, remediation and confirmation wipe sampling of the small arms firing range located in the basement level of Building 105.

3.1.1.4 PCB Reports

Numerous memoranda, notes, manifests, and removal documentation date from 1985-1997 regarding PCBs at GFC.

3.1.2 Basis of COPCs

COPCs were selected based on detailed evaluation of previous sampling data collected at the GFC. Summary information including maps showing the proposed sampling for the media of concern and database summary tables are provided in Appendix A-1 through A-5 of the RIWP.

3.1.2.1 Metals

Metals associated with munitions will be COPCs and include antimony, arsenic, copper, lead and zinc (USACE, 2018).

Lead was detected in soils from the basements from Buildings 103 A/B/C (738 mg/kg, 1,010 mg/kg), Building 103 E (681 mg/kg), Building 104 E (1,930 mg/kg), and Building 104 F (1,080 mg/kg) (Tetra Tech, 2013). Other metals were identified in the Combined PA/SI (SCS, 2008):

- Antimony from the basement of Building 103 F (960-21,000 mg/kg)
- Arsenic in the basements and crawl spaces in Buildings 102, 102 D, 103 F, 104 E, 105, 105 E and the utility tunnel complex (concentrations ranging from 7.3-570 mg/kg).
- Copper was detected in two sediment samples collected from beneath Building 102 (230,000 mg/kg and 170,000 mg/kg).

3.1.2.2 PAHs

PAHs will be evaluated in the HHRA.

Polycyclic aromatic hydrocarbons (PAHs) were detected in surface and subsurface soil samples from outside of Buildings 102 A/B/C, 102 J,102 K (Tetra Tech, 2016).

Interior soils samples collected from the basements from Buildings 103 A/B/C, 104 E resulted in detections of PAHs with the highest concentration of 8.0 mg/kg of benzo(b)fluoranthene (Tetra Tech, 2013).

The PAHs benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenzo(a,h)anthracene were detected at elevated concentrations in shallow soil and sediment samples collected in Buildings 102, 103 F, 105 and from one subsurface soil sample collected from SB105-3 (SCS, 2008).

3.1.2.3 VOCs

To address the potential for exposure of chlorinated solvents or petroleum products, VOCs are COPCs, primarily for groundwater.

Few VOCs have been detected at the Site during the previous investigations. Acetone was detected in soil samples collected from soils outside of Buildings 136 F, 102 A/B/C (Tetra Tech, 2016). Low levels of total xylene were reported in the southeast quadrant soils (0.0027 mg/kg) and for trichloroethene (TCE) in the northeast quadrant soils.

3.1.2.4 PCBs

PCBs are COPCs for the HHRA.

PCBs were detected at elevated concentrations in wipe, subsurface soil and groundwater samples collected in Building 102 and near Buildings 108 A and 108 B. Elevated concentrations of PCBs were in the form of Aroclor 1260 (SCS, 2008).

Due to weathering and environmental transformations, Aroclor mixtures may not maintain their original composition once they are released into the environment. Because of the different solubilities, volatilities, rates of uptake, degradation, and metabolism of the individual congeners that make up the mixtures, differences may exist between the source materials and the PCBs observed in the environment (Van den Berg et al., 1998). To address this uncertainty, several samples will be collected for both Aroclor and PCB congener analysis.

Selected soil samples shall be analyzed for PCBs using USEPA Method 8082 for Aroclors with the USEPA-recommended Soxhlet extraction method (USEPA-SW 846 Method 3540C). Samples shall be analyzed for the 12 dioxin-like PCB congeners using USEPA Method 1668, as follows:

- Non-ortho substituted PCBs: 77, 81, 126, and 169
- Mono-ortho substituted PCBs: 105, 114, 118, 123, 156, 157, 167, and 189.

3.1.2.5 Explosives

COPCs associated with explosives (e.g., nitroaromatics, nitramines, and nitrate esters) will be considered in the risk assessment. Explosives are considered COPCs because of the past use of these chemicals.

3.1.3 Background Data

As discussed by USEPA (2018), “background” refers to constituents or locations that are not influenced by the releases from a site, and is usually described as naturally occurring or anthropogenic (USEPA, 1989; USEPA, 1995):

1) Anthropogenic – natural and human-made substances present in the environment as a result of human activities (not specifically related to the CERCLA release in question); and

2) Naturally occurring – substances present in the environment in forms that have not been influenced by human activity.

The definition of anthropogenic background is not restricted to a specific type of anthropogenic source. USEPA RAGS A (1989) explicitly describes examples of both localized and ubiquitous in terms of anthropogenic background: "Localized anthropogenic background is often caused by a point source such as a nearby factory. Ubiquitous anthropogenic background is often from nonpoint sources such as automobiles" (USEPA, 1989). Similarly, the definition of anthropogenic background USEPA presents in *Role of Background Guidance* includes all contaminants present in the environment due to human activities but not attributable to a CERCLA release, which would include both diffuse and point sources (USEPA, 2002b).

Background data was compiled from two sources:

- Background soil samples were collected at St. Vincent Park (approximately two miles west of the Site); the 89th Army Reserve Center (immediately west of Goodfellow Boulevard); Schnucks Plaza (approximately one mile southeast of the Site); and from a vacant lot near the intersection of Clara Avenue and Hebert Street (approximately half a mile south of the Site) (SCS Engineers, 2008).
- A Site-Specific Environmental Baseline Survey for St. Louis Army Ammunition Plant in St. Louis, Missouri (URS, 2004) was prepared for a nearby site and the resulting background levels are considered representative for the GFC.

Table 2 summarizes the inorganic metals background data and Table 3 summarizes the PAH background data. Both tables include a 95th percentile upper confidence limit of the arithmetic mean concentration (95% UCL) developed using these data that can be used as an exposure point concentration in the risk assessment and in the risk characterization. Attachment B shows the ProUCL output for the calculation of the 95 % UCL for the background data (metals and PAHs).

3.1.4 Risk-Based Screening – Determining COPCs

Prior to any exposure calculations, all the detected concentrations in soil and groundwater will be compared to the latest version of the USEPA Regional Screening Levels (RSLs) for the residential scenario. If the maximum detected concentration from an exposure area is greater than the residential RSL, the constituent will be considered a COPC and retained for the next phase of assessment.

Risk-based screening values for lead will be used in the HHRA. The USEPA soil RSLs are 400 mg/kg for residents and 800 mg/kg for commercial/industrial workers. The tapwater RSL is 0.15 µg/L (USEPA, 2019). If the detected lead concentrations from an exposure area are below the screening values, then lead will not be considered a COPC for that exposure area. If one detection exceeds, then the mean will be calculated, and lead will be included as a COPC.

If VOCs are detected in groundwater, the USEPA Vapor Intrusion Screening Level Calculator (VISL) will be used to screen the COPCs (https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-level-calculator). If there are exceedances assuming a risk level of 10^{-6} and hazard level of 0.1, then inhalation of indoor air will be considered a potentially complete pathway (current and future) and incorporated into the cumulative risk and hazard estimates.

3.2 EXPOSURE ASSESSMENT

The objectives of exposure assessment are to characterize the intensity, frequency, magnitude, and duration of potential human exposures for the subject COPCs and receptor scenarios. The end product of the exposure assessment is an estimate of chemical intake (i.e., a calculated dose) that integrates exposure parameters for the receptors (e.g., contact rates, exposure frequency, and duration) with exposure concentrations for the media of concern.

3.2.1 Exposure Scenarios

The resulting chemical intakes are used in conjunction with chemical-specific toxicity values to evaluate potential health risks for the receptors. Table 4 shows the selection of the exposure pathways. Table 5 shows the exposure parameters. The human exposure scenarios include:

- Current and future commercial/industrial worker – a commercial/industrial worker could be mowing the grass or maintaining the landscape of the area as well as building maintenance. This scenario will consider exposure to surface (0-2 ft bgs) soils (particulate inhalation, incidental ingestion and dermal contact). If VOCs are found in the environmental media, inhalation of vapors will also be evaluated outdoors or within a building (vapor intrusion). The commercial/industrial worker could also work in the crawl spaces or basements of the buildings to access utilities into a building. Groundwater is not available as surface water on the Site and potable water is supplied by the City of St. Louis. Direct exposure to groundwater is not considered a complete pathway for the commercial/industrial worker.

- Construction worker – a construction worker would be working on utilities or in building construction. This is a short-term receptor exposed during the work day working around heavy vehicles suspending dust in the air. The activities for this receptor (e.g., dozing, grading, tilling, dumping, and excavating) typically involve on-site exposure to soils. The construction worker is expected to have an elevated soil ingestion rate (330 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with contaminants in soil, inhalation of volatiles and fugitive dust. This land use is limited to an exposure duration of 1 year. Exposure to groundwater is not considered a complete pathway for the construction worker.

- Trench worker – a trench worker would be working in a temporary construction trench while working on utilities or in building construction. This scenario will consider exposure to groundwater if the trench is in contact with the groundwater bearing unit. Trench workers could be exposed to contaminants in groundwater from dermal contact or inhalation. Incidental ingestion of groundwater is not considered a complete pathway for the trench worker. The 2016 RI report states that groundwater could not be reached because of hard clayey soils and/or other unknown sub-surface interference (Tetra Tech, 2016). It is assumed that the trench is 5 ft wide, 10 ft deep and 10 ft long. It is also assumed that the trench activities would be short term with a 6-week exposure duration. The dimensions of the trench can be altered based on site-specific parameters. More than one trench dimension scenario should be considered.

- Future hypothetical resident – the use of the hypothetical resident provides an upper end of exposure in the HHRA. This exposure scenario is unlikely because of the commercial/industrial nature of the area. This scenario will consider exposure to surface and subsurface soils (particulate inhalation, incidental ingestion, dermal contact). Vapor intrusion is considered a potential future pathway. For this hypothetical scenario, it is assumed that groundwater would be used for potable uses. To better protect human health, exposure to carcinogenic compounds is often assumed to occur during the first 26 years of life. Thus, exposure is assumed to occur during childhood when the intake is greater and the child is more susceptible to the effects of carcinogenic compounds. These 26 years are divided into 6 years of child exposure and 20 years of adult exposure. The risk associated with each of these exposures is combined to obtain an age-adjusted risk that is often more conservative than an evaluation of either the child or adult alone. For residential receptors, this risk assessment will present the non-carcinogenic risk to a child, and the carcinogenic risk to an integrated child/adult resident. Table 5 reflects the age adjusted soil ingestion and dermal contact factor.

3.2.2 Exposure Point Concentrations

The exposure point concentration (EPC) is the concentration of the agent at the exposure point (location of physical contact) to which a receptor potentially could be exposed. The EPC values used in evaluating potential human health risks should be representative of the exposure area being evaluated and consider the degree to which COPCs could migrate from source media (e.g., soil) to the actual points of human exposure (e.g., nose, mouth, skin, etc.). Exposure is defined as the contact of an organism with a chemical or physical agent, that is, a co-occurrence in space and time of the receptor and the COPC.

For each exposure area, summary statistics will be tabulated including minimum and maximum detected concentrations, averages, standard deviations, and the 95% UCL values. Initially, the soil exposure areas will be outdoor soils over the GFC; however, depending on the data, smaller data groupings may be considered[3] Groundwater will be considered one

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exposure area. Exposure areas for the HHRA will be refined following evaluation of the data. Three key data statistics include:

Mean – The simple mean will be used as the EPC for assessment of lead. The mean will be calculated using the latest USEPA's ProUCL software.

95% Upper Confidence Limit – The 95% UCL will be calculated using the latest version of USEPA's ProUCL software.

Maximum Detected Values – The maximum detected values will be tabulated for each COPCs in each exposure area. The maximum serves as a conservative estimate of the source term when the 95% UCL does not apply, such as for limited sample size.

3.2.2.1 Source Term Concentrations

Source term concentration (STC) values are used to evaluate both direct contact and cross-media COPC exposures. For direct contact exposure routes, the exposure point occurs directly at the source (e.g., soil). For the incidental ingestion and dermal absorption exposure routes, the soil is considered a (secondary) source medium that may provide opportunity for direct contact unless engineering controls or existing barriers, like pavement or landscape cover, prevent such access. To quantitatively evaluate potential COPC exposures for each receptor, representative COPC STCs will be the lower of the maximum detected concentration or the 95% UCL.

3.2.2.2 COPC Fate and Transport

For exposure pathways where chemicals may migrate between environmental media (i.e., for inhalation exposure), mathematical "fate and transport" modeling tools will be used to estimate the EPCs, that is, the COPC concentrations at the point of human exposure for each pathway.

Outdoor Particulate Emission Modeling

Potential emissions of COPCs adhered to dust released from soil to outdoor air will be estimated using the model described in *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002). The particulate emission factor (PEF) represents an annual average particulate emission rate based on wind erosion and/or ground disruption during construction/excavation activities. For long-term exposures to residential and commercial/industrial receptors, the emissions part of the PEF equation is based on the "unlimited reservoir" model developed to estimate particulate emissions due to wind erosion (Cowherd 1985). Site-specific water filled soil porosity, total soil porosity, air-filled porosity, soil bulk density and fraction organic carbon will be incorporated into the PEF calculations if these data are available. Default PEFs are available from the California Department of Toxic Substance Control (DTSC) in their 2019 Human Health Risk Assessment Note #1: *Recommended DTSC Default Exposure Factors for use in Risk Assessment at California Hazardous Waste Sites and Permitted*

Facilities: 1.36 x 10^{+9} m^3/kg for residents and commercial/industrial workers and 1.0 x 10^{+6} m^3/kg for the construction worker. The outdoor air particulate emission equations and calculation worksheets will be presented in the HHRA.

Outdoor Vapor Emission Modeling from Soil

Emissions of VOCs from soil to outdoor air for the commercial/industrial worker and resident will be estimated using the model described in Appendix B of *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002). For each soil VOC COPC, an intermedia transfer factor called the volatilization factor (VF) will be calculated using the Q/C term described below and certain soil physical properties. The calculated soil-to-outdoor air VFs will be used to estimate outdoor EPCs for each receptor type. Long-term vapor emission calculations were based on continuous exposure for 8 hours daily exposure, 250 days per year, for 25 years for commercial/industrial receptors. The Q/C term, which represents air mixing and dispersion of emissions, is provided by USEPA (2002). These Q/C parameter values were generated using the Industrial Source Complex model. USEPA presents these values in an algorithm, with calculation options available for various source area sizes, U.S. cities, and climatic zones. For this HHRA, a default Q/C value of 68.18 g/m^2-s per kg/m^3 will be used to model air mixing for the commercial/industrial land use and residential scenario. The VF derivations will be provided in the HHRA.

Trench/Enclosed Space Vapor Modeling from Groundwater (Trench Worker)

The potential for subsurface COPCs to migrate from groundwater into partially enclosed spaces during construction or utility line related activities will be evaluated based on an approach published by the Virginia Department of Environmental Quality (VDEQ, 2018). There are no well-established models available for estimating migration of volatiles from groundwater into a construction or utility trench. The Virginia DEQ model is based on 1) a simple fate and transport equation of a vadose zone model to estimate volatilization of gases (emission flux of VOCs) from contaminated groundwater into the air of the trench and 2) a box model to estimate dispersion of the contaminants from the air inside the trench into the above-ground atmosphere. Table 6 shows the trench model inputs. The worker would be exposed to VOCs in the air inside the trench that results from volatilization from the groundwater pooling at the bottom of the trench. A Volatilization Factor (VF) is used to estimate the concentration of the VOCs in the trench air. The inputs to estimate the VF are shown on Table 6. The VDEQ model assumes that the trench would only intercept the groundwater for a few inches since a groundwater pool of more than a few inches would likely require dewatering. The trench is assumed to be 5 ft wide, 10 ft deep and 10 ft long, although different trench dimension scenarios should be considered based on site-specific observations.

Dermal Absorption through Groundwater Contact (Trench Worker)

In order to evaluate the potential exposures to COPCs in groundwater through dermal contact, dermal absorption will be modeled using the methodology in *Supplemental*

Guidance of Dermal Risk Assessment (USEPA, 2004). The skin is assumed to be composed of two main layers, the stratum corneum and the viable epidermis, with the stratum corneum as the main barrier. A two-compartment distributed model was developed to describe the absorption of chemicals from water through the skin as a function of both the thickness of the stratum corneum (l_{sc}) and the event duration (t_{event}). The exact solution of this model is approximated by two algebraic equations: (1) to describe the absorption process when the chemical is only in the stratum corneum, i.e., non-steady state, where absorption is a function of t_{event}, and (2) to describe the absorption process as a function of t_{event}, once steady state is reached. One fundamental assumption of this model is that absorption continues long after the exposure has ended, i.e., the final absorbed dose (DA_{event}) is estimated to be the total dose dissolved in the skin at the end of the exposure. For highly lipophilic chemicals or for chemicals that are not highly lipophilic but exhibit a long lag time (τ_{event}), some of the chemical dissolved into skin may be lost due to desquamation during the absorption period. A fraction absorbed term (FA) is included in the evaluation of DA_{event} to account for this loss of chemical due to desquamation (USEPA, 2004). It is assumed that the worker would be in contact with the groundwater 4 hours per event.

Dermal Absorption through Groundwater Contact (Resident)

In order to evaluate residents' potential long term maximum exposures to COPCs in groundwater through dermal contact for the resident, dermal absorption will be modeled using the methodology provided in Chapter 3 of *Supplemental Guidance of Dermal Risk Assessment* (USEPA, 2004). The exposure assumptions used for evaluating this pathway are presented in Table 5.

Inhalation of Vapor Emissions from Potable Water

Volatile emissions of COPCs from groundwater to air while using potable water for the resident, and the resulting EPC, will be estimated using the methodology described in Chapter 3 of USEPA's *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)* (USEPA, 1991). USEPA, 1991 cites Andelman (1990) for defining the relationship between the concentration of a contaminant in household water and the average concentration of the volatilized contaminant in air. In the derivation of the default volatilization factor of 0.5 L/m^3, all of the household water uses were considered (e.g., showering, laundering, dish washing). A significant assumption is that half of the concentration of the COPC in water will be transferred into air by all water uses. The volatile emission EPC will be used in the estimation of the inhalation exposure of COPCs from tap water.

Indoor Air Vapor Intrusion Modeling from Soil Gas, Indoor Air or Groundwater

The potential for VOCs to migrate from subsurface soil gas to indoor air will be elevated using USEPA's (June 2015*) OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor air* and its supporting

VISL calculator. The In addition to calculating screening levels, the on-line VISL calculator allows the user to input site data (soil gas or groundwater data).

3.2.3 Exposure Estimates

For potential chemical releases into secondary exposure media, receptors' EPC values will be estimated using chemical transport-fate models as described above. EPC values will be summarized in the risk assessment. The exposure parameters the for current/future commercial/industrial workers, current/future construction trench workers and hypothetical future resident scenarios are shown on Table 5.

3.2.3.1 Intake and Dose Estimation for Direct Contact

Two types of intake dose values were calculated for direct contact exposures (i.e., ingestion and dermal contact). For non-carcinogenic health effects, the applicable measure of intake for chronic toxicants is referred to as the average daily intake (ADI) and for most receptors is a less-than-lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the lifetime average daily intake [(L)ADI]. A generalized form of the equation that is used to calculate the (L)ADI for each COPC is given below:

$$(L)ADI = EPC \cdot \frac{RIF \cdot EF \cdot ED}{BW \cdot AT}$$

where:

(L)ADI = (Lifetime) Average daily intake (mg/kg-day)
EPC = Exposure point concentration (units vary by media)
RIF = Route-specific intake factor (mg/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

For ingestion, the RIF equals the soil ingestion rate (IR-S). For dermal contact, RIF = SA * AF * ABS where SA = skin surface area, AF = adherence factor, and ABS = absorption factor (chemical specific).

3.2.3.2 Exposure Assessment for Inhalation Pathways

The average concentrations (AC) for non-carcinogens or lifetime average concentrations (LAC) for carcinogens will be derived using the following equation for the inhalation pathway:

$$(L)AC = EPC \cdot \frac{EF \cdot ED \cdot ET}{AT \cdot CF}$$

where:

(L)AC = (Lifetime) Average concentration (ug/m^3)
EPC = Exposure point concentration (mg/m^3)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
ET = Exposure time (hours/day)
AT = Averaging time (days)
CF = Conversion factor (24 hours/day)

3.3 Toxicity Assessment

The toxicity assessment step in a health risk evaluation characterizes the relationship between the magnitude of exposure to a COPC and the nature and magnitude of adverse health effects that may result from such exposure (i.e., dose-response relationships). Toxicity values will be taken from the latest version of USEPA's RSL tables. If COPCs that are identified that lack toxicity values, chemical surrogates will be selected and used. Any surrogates used will be identified in the baseline HHRA section.

For PCBs, Aroclor 1016 is considered the "lowest risk" and assigned the lowest risk toxicity criteria; however, all other Aroclors will be assigned the high risk toxicity values (USEPA, 2019).

3.3.1 Carcinogenic Toxicity Assessment

For carcinogenesis, USEPA assumes a mechanism of action in which a single molecular event can cause changes in cells and lead to cancer. This hypothesized mechanism is referred to as non-threshold, and it assumes that there is no level of exposure that does not pose some finite probability of developing cancer.

Based on the evidence that a chemical is a known or probable human carcinogen, a toxicity value, the slope factor (SF), is developed to quantitatively express the dose response relationship. SFs are route-specific and are commonly upper-bound estimates of the probability of a carcinogenic response per unit intake of a chemical over a lifetime. The SFs are generally calculated from the 95% UCL on the slope of the dose–response curve. Slope factors for oral exposures are expressed in units of risk per ingestion exposure $(mg/kg\text{-}d)^{-1}$, while slope factors for inhalation exposures are mathematically re-arranged to express the carcinogenic risk as a function of air concentration, that is, as an "inhalation unit risk" (IUR) expressed in units of $(\mu g/m^3)^{-1}$ (which assumes continuous exposure to COPC-laden air).

3.3.2 Noncancer Toxicity Assessment

The toxicity information most often used to evaluate noncarcinogenic, or threshold, effects in risk assessment is the reference dose or concentration. Reference doses are route-specific and can be an ingestion-based oral dose (RfDo) or a dermally-absorbed reference dose (RfDd), expressed as milligrams of chemical per unit of body weight per day (mg/kg-day). An inhalation reference concentration (RfC), expressed as milligram (mg) of COPC per cubic meter of air, is an air concentration and is assumed to be for continuous exposure. USEPA (1989) defines a chronic reference dose or reference concentration as an estimate of a daily exposure level for humans (including sensitive individuals), with uncertainty spanning perhaps an order of magnitude or greater, that is likely to be without an appreciable risk of deleterious effects during a lifetime.

The use of RfDs and RfCs is based on the concept that a range of exposures exist up to a finite value, or threshold, that can be tolerated without producing a toxic effect. RfDs and RfCs are derived with mathematical uncertainty factors (UFs) that generally consist of multiples of 10 to represent areas of uncertainty inherent in the extrapolation from the available data. These UFs account for the following extrapolations: extrapolation of animal data to humans, sensitive individuals in the exposed population, use of a no observed adverse effect level (NOAEL) from subchronic rather than chronic studies, and the use of a lowest observed adverse effect level (LOAEL) rather than a NOAEL to derive the RfD when a NOAEL has not been determined. The decision on inclusion of appropriate UFs is an intrinsic part of the agency-developed processes for publication of toxicity values, i.e., it is not a decision that is part of a site-specific HHRA.

3.3.3 Lead

USEPA's risk assessment for lead is unique because an RfD value for lead is not available Health effects from exposure to lead, particularly for children, may occur at such low blood lead levels that the use of threshold-based toxicity criteria to evaluate potential risks from exposure to lead is not preferred. Instead, exposure to lead is evaluated using a biomarker (blood lead levels); blood lead modeling, which accounts for multiple sources of exposure to lead, is used to predict blood lead levels. For this reason, the risks from exposure to lead will be characterized separately and will not be included in cumulative risk calculations.

The toxicokinetics (absorption, distribution, metabolism and excretion) of lead are well understood and therefore lead is regulated based on blood lead concentrations. USEPA and the Centers for Disease Control and Prevention (CDC) uses 5 micrograms per deciliter (µg/dL) to identify children with blood lead levels that are much higher than most children's levels. This level is based on the U.S. population of children ages 1-5 years who are in the highest 2.5% of children when tested for lead in their blood (www.cdc.gov/nceh/lead/prevention/blood-lead-levels.htm). USEPA's risk reduction goal for contaminated sites is to limit the probability of a child's blood lead concentration exceeding 10 µg/dL to 5 percent or less after cleanup (https://www.epa.gov/superfund/lead-superfund-sites-risk-assessment); however this lead evaluation will use the more conservative CDC value of 5 µg/dL as the target blood lead level. The Adult Lead Methodology (ALM) will be used to assess lead risks from the soil for the commercial/industrial scenario scenarios. The Integrated Exposure Uptake Biokinetic Model (IEUBK) will be used to assess lead risks from soil at residential scenarios. The baseline blood lead concentration input parameter of the ALM represents the geometric mean blood lead concentration in women of child-bearing age and geometric standard deviation (GSD) input parameter is a measure of in the inter-individual variability in these concentrations. The

Mother's Blood Lead Concentration at Childbirth (MatPb) allows the user to consider the impact of lead transferred from the mother to the fetus *in utero* (USEPA, 2017). The mean lead concentration will be used as the EPC.

The baseline lead concentrations and GSD will be taken from USEPA (2017) Memorandum: Transmittal of Update to the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters.

3.4 Risk Characterization

The risk characterization process integrates the quantitative and qualitative results of the data evaluation, exposure, and toxicity assessments. The purpose of risk characterization is to estimate the likelihood, incidence, and magnitude of the potential human health effects from exposure to the COPCs under study and make judgments about the nature of the health threat to the defined receptor populations. The methods used to characterize potential health risks are specific to carcinogenic and noncancer toxicity. The risk characterization methods will be applied for each type of chemical toxicity are described below.

3.4.1 Cancer Risk

Cancer risks are expressed as the upper-bound, increased likelihood of an individual developing cancer because of exposure to a particular chemical. For example, a cancer risk of 1×10^{-4} refers to an upper-bound increased chance of one in ten thousand individuals exposed, of developing cancer over a lifetime (0.01 percent risk). The following equation is used to estimate the excess cancer risk (a unitless probability):

$$\text{Excess Cancer Risk} = \text{LADI}\times\text{CSF or LAC}\times\text{IUR}$$

where:

LADI = *Lifetime average daily intake (mg/kg-day)*
CSF = *Cancer Slope Factor (mg/kg-day)-1*
LAC = *Lifetime average concentration (µg/m3)*
IUR = *Inhalation Unit Risk (µg/m3)-1*

Cancer risk estimates for individual chemicals are summed to generate an estimate of cumulative risk (i.e., multiple carcinogenic chemicals, potentially via multiple routes of exposure), and it is this cumulative risk estimate that forms the basis for remedial decision-making. In the NCP USEPA states that: "[f]or known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper-bound lifetime cancer risk to an individual between 10^{-6} and 10^{-4}." Cancer risks less than 1×10^{-6} are generally considered *de minimis*.

3.4.2 Noncancer Hazard

The potential for noncancer effects resulting from exposure to a particular chemical are expressed as a hazard quotient (*HQ*). An HQ is the ratio of the estimated intake (*ADI*) or average concentration (*AC*) of a chemical to the corresponding chemical-specific *RfD* or *RfC*:

$$Hazard\ Quotient\ = \frac{ADI}{RfD}\ or\ \frac{AC}{RfC}$$

Chemical- and pathway-specific HQs may be combined to form a hazard index (HI), which is then compared to a typically accepted benchmark level of 1.0. If the HI exceeds 1.0, then combined site-specific exposures exceed the RfDs and/or RfCs, meaning that there is potential for noncancer adverse effects to result from exposure to Site COPCs under the evaluated receptor scenario(s).

3.4.3 Risks and Hazards from Background Concentrations

Baseline human health risks will be calculated using the background data set described in Section 3.1.3. USEPA (2018) states “COPCs that have both release-related and background-related sources should be included in the risk assessment (USEPA, 2002b).” USEPA (1989) notes that “[if] background risk might be a concern, it should be calculated separately from site-related risk,” and notes that the risk characterization section should discuss COPC concentrations on Site relative to background concentrations.

Background risks and hazards will be calculated and discussed in the risk characterization section of the HHRA as compared to the Site related risks and hazards. Background risk will not be “subtracted” from the Site risk, nor will COPCs be removed from the HHRA based on numeric background comparisons, for example comparison of the maximum detected USEPC to the background representative statistic such as an upper tolerance limit.

3.5 Uncertainty Assessment

This HHRA will be prepared in a manner consistent with that generally used in professional practice and in accordance with State and Federal guidance. The assessment will be based on site-specific data, laboratory analytical results, area-specific environmental data, and assumed values and conditions. Although careful professional judgment will be used in the selection of exposure assumptions, some argument could likely be made about the validity of each assumption. The purpose of this section will be to provide information concerning the validity of each assumption, including the effect of each assumption on the overall risk, the major data gaps, and the effect of these data gaps on the accuracy or reasonableness of the risk assessment.

4.0 REFERENCES

Andelman, J.B. 1990. *Total Exposure to Volatile Organic Chemicals in Potable Water*. N.M. Ram, R.F. Christman, K.P. Cantor (eds.) Lewis Publishers.

Cowherd, C., G. Muleski, P. Engelhart, and D. Gillete (1985). *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination*, Prepared for EPA Office of Health and Environmental Assessment.

Geotechnology, Inc. 2006. Final Report. Phase I Environmental Site Assessment. Federal Records Center. 4300 Goodfellow Boulevard. St. Louis, Missouri.

Miller, D.E., et al. 1974. Missouri Geological Survey and Water Resources. Water Resources of the St. Louis Area, Missouri. WR 30.

SCS Engineers (SCS). 2008. Combined Preliminary Assessment / Site Inspection Report. Saint Louis Federal Center, 4300 Goodfellow Boulevard, St. Louis, Missouri. August 2008.

Tetra Tech, 2013. Occupational Exposure Evaluation Report, Rev. 00. General Services Administration. Goodfellow Federal Complex. St. Louis, Missouri. June 2013.

Tetra Tech, 2016. *Remedial Investigation Report Final*. General Services Administration. Goodfellow Federal Complex. St. Louis, Missouri. September 2016.

United States Department of Agriculture (USDA). 1979. *Soil Survey of St. Louis County and St. Louis City, Missouri,* Soil Conservation Service.

United States Army Corps of Engineers. 2018. *Technical Guidance for Military Munitions Response Action*. Manual No. 200-1-15. October 30.

United States Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Interim Final*. EPA/540/1- 89/002. Office of Emergency and Remedial Response. December.

———. 1991a. Risk Assessment guidance for Superfund: Volume I – Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives). Interim. Office of Emergency and Remedial Response. U.S. Environmental Protection Agency, Washington, D.C., OSWER Directive 9285.7-01C, September.

———. 1991b. Risk Assessment guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim. Office of Emergency and Remedial Response. U.S. Environmental Protection Agency, Washington, D.C., EPA/540/R-92/003, December.

———. 1992. *Guidance for Data Usability in Risk Assessment (Parts A and B)*. Office of Emergency and Remedial Response. Publication 9285.7-09A. Washington, D.C. April.

———. 1995. Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites. EPA/540/S-96/500.

———. 2001a. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim, Review Draft-For Public Comment, EPA/540/R/99/005, OSWER 9285.7-02EP, September.

———. 2001b. *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part D), Final.* Office of Emergency and Remedial Response. EPA-540/1-89/002 (interim final); Washington, D.C. December.

———. 2002a. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. EPA 540/R-96/018. EPA Office of Emergency and Remedial Response. Washington, D.C. December.

———. 2002b. Role of Background in the CERCLA Cleanup Program. OSWER 9285.6-07P

———. 2004. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment, Interim). Office of Emergency and Remedial Response. EPA/540/R/99/005. Washington, D.C.

———. 2009. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) Final. Office of Superfund Remediation and Technology Innovation. Washington, D.C, January.

———. 2014. OSWER Directive 9200.1-120. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. Attachment 1. Recommended Default Exposure Factors.

———. 2017. Memorandum: Transmittal of Update to the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters. OLEM Directive 9285.6-56.

———. 2018. Frequently Asked Questions About the Development and Use of Background Concentrations at Superfund Sites: Part One, General Concepts. Office of Superfund Remediation and Technology Innovation. OLEM Directive 9200.2-141A. March, 2018.

———. 2019. Regional Screening Levels (RSLs) – User's Guide. May.

URS, 2004, *Site-Specific Environmental Baseline Survey, St. Louis Army Ammunition Plant St. Louis, Missouri. May.*

Van den Berg et al., 1998. Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. *Environmental Health Perspectives*, 106 (12), 775–792.

VDEQ (Virginia Department of Environmental Quality). 2018. Virginia Unified Risk Assessment Model – VURAM 2.0.

Weatherbase. 2012. Historical Weather for Saint Louis, Missouri, United States of America. http://www.weatherbase.com/weather

FIGURES

Source: USGS Clayton, MO 7.5 Minute Topo Quad, 1993;
USGS Granite City, IL 7.5 Minute Topo Quad, 1998

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Goodfellow Federal Complex
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

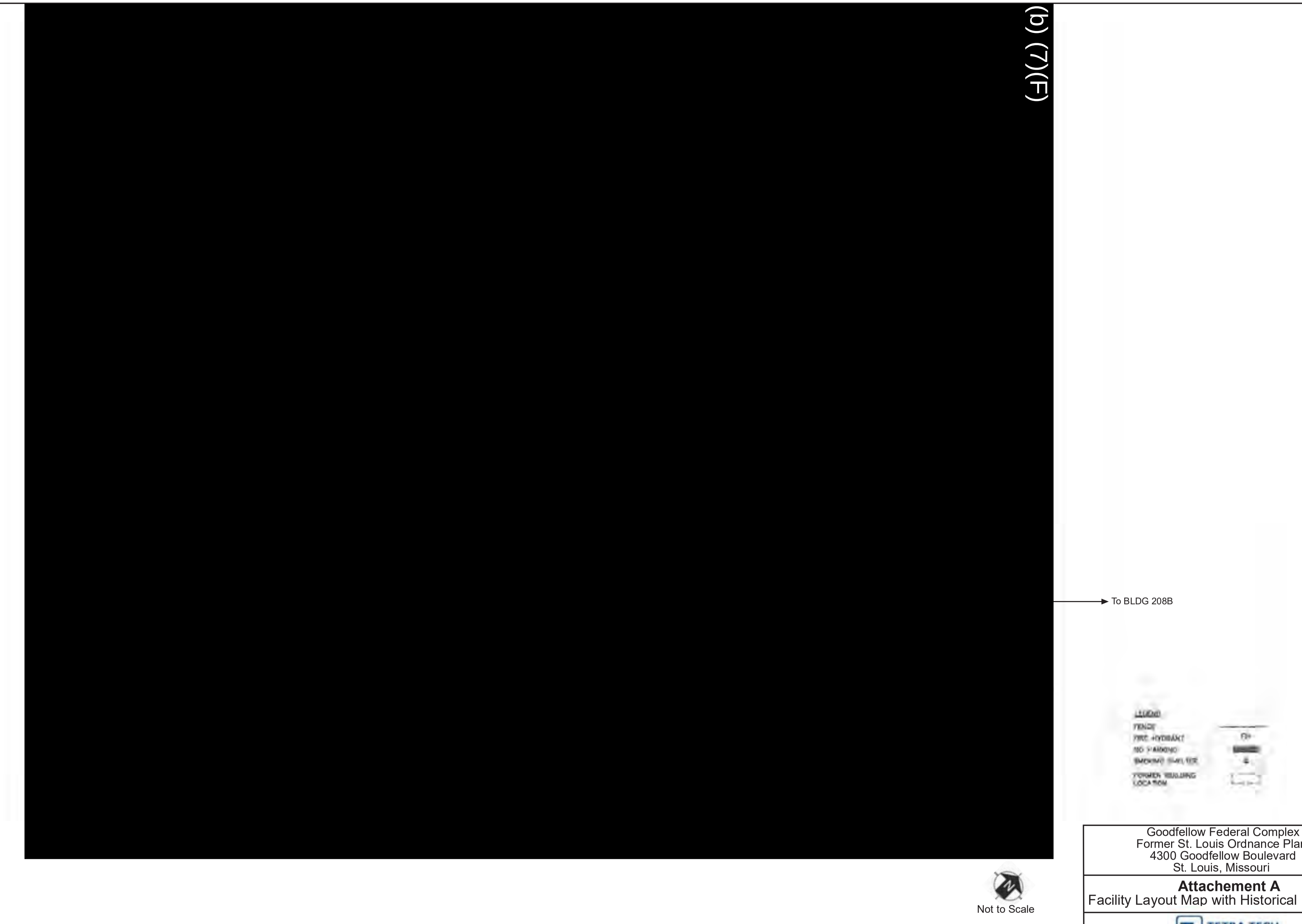
Attachment A
Facility Location Map

TETRA TECH

Date: 6/3/2013
Drawn By: Nick Wiederholt
Project No: S1058.232.001

(b) (7)(F)

[redacted]



Source: SCS Engineers, Figure 2 - Site Plan, March, 2007.

Goodfellow Federal Complex
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Attachement A
Facility Layout Map with Historical Information

TETRA TECH

Date: 3/6/2015 Drawn By: Nick Wiederholt Project No: S1058.232.001

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TABLES

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
101	Administrative building for St. Louis Ordnance Plant (SLOP) Plant No. 1; Thurgood Marshall Academy (charter school)	(b) (7)(F) [redacted]	Possible contaminant sources include building mechanical equipment, transformers, and batteries (SCS, 2008). No PCBs or explosives were detected in soil samples collected near the building. Mercury was detected in subsurface samples (0.038 mg/kg – 0.089 mg/kg) (SCS, 2008).
102 A/B/C	SLOP production of 0.30 caliber ammunition, including brass cartridge annealing and shaping, powder and primer packaging, lead core insertion, and sorting, packaging, and shipping.	[redacted]	Possible contaminant sources include building mechanical equipment, transformers, production equipment (including process piping, sumps, settling tanks, etc.), batteries, scrap metals, and laboratory chemicals associated with the production of small arms ammunition (SCS, 2008). PCB Aroclor 1260, two explosives, lead and mercury were detected in wipe samples. Mercury was detected in paint chips. PCB Aroclor 1260 was detected in soils collected from the basement (0.4 mg/kg – 1.9 mg/kg), Aroclor 1242 was also detected (0.19 mg/kg). Metals (arsenic, copper, lead) and PAHs were also detected above screening levels. Several explosives, phosphorous and cyanide were detected from samples collected from the drain and basement soils. Subsurface soils were sampled outside of 102 A/B/C, no PCBs or explosives were detected. All metals were below screening levels. Mercury was detected in four samples (0.0068 mg/kg – 0.065 mg/kg). Air samples were collected in 2003, mercury was detected (0.00087 mg/m^3) (SCS, 2008). Outside subsurface soil was sampled in the 2016 RI. Minor detections of SVOCs and acetone were found (Tetra Tech, 2016).

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
102 D	SLOP powder packing; warehouse; Department of Defense photo processing (1st floor); office space (2nd floor). According to Mr. Mike Crocker, this building was used as a photo lab from 1970s to 1988. Printing processes are generally associated with use, generation, storage and disposal of solvents.	(b) (7)(F) [redacted]	Possible contaminant sources include building mechanical equipment; production equipment (including process piping) associated with the production of small arms ammunition; and production equipment (including process piping and chemical feed pumps) associated with operation of the former DOD photo laboratory. No PCBs were detected in wipe samples or soil samples from the crawl space. 1,3,5-trinitrobenzene, mercury, and lead were detected in wipe samples. Explosives were not detected in soil from the crawlspace. Mercury was detected in paint chips. Cyanide and phosphorous were detected in sediment samples collected from drains in the crawlspace. Arsenic, silver, PAHs were detected in the crawl space samples. Subsurface soils were sampled outside of 102 D, no PCBs, VOCs or explosives were detected. All metals were below screening levels. Mercury was detected in two samples (0.046 mg/kg, 0.061 mg/kg). Air samples were collected in 2003, mercury was detected (0.0003 to 0.0005 mg/m^3) (SCS, 2008).
102 E	SLOP primer packing; warehouse; office space	[redacted]	Possible contaminant sources include building mechanical equipment; production equipment (including process piping) associated with the production of small arms ammunition. No PCBs were detected in the wipe samples. Mercury and lead were detected in wipe samples. Mercury was detected in paint chips. One shallow soil sample was collected from the crawl space, no PCBs or explosives were detected. Cyanide and phosphorous were detected and all detected metals were below screening criteria. Subsurface soils were sampled outside of 102 E, no PCBs or explosives were detected. All detected metals were below screening levels. An air sample was collected in 2003, mercury was detected (0.0005 mg/m^3) (SCS, 2008).
Former 102 F/G/H	SLOP powder canning and storage, inside blast proof bunkers or south of the production buildings.	Not applicable (N/A) - Removed in 1980; cast-in-place concrete barricade structure surrounding two small (~400-square-foot [ft^2]) wood frame buildings	Possible contaminant sources include containers storing powder associated with the production of small arms ammunition (SCS, 2008). Subsurface soils were sampled outside of 102 F/G/H, no explosives were detected. All detected metals were below screening levels (SCS, 2008).
Former 102 J/K	SLOP lubricating oil storage	N/A - Removed sometime after World War II. It was a one-story, small (~150 ft^2), masonry building.	Possible contaminant sources include containers storing lubricating oil associated with the production of small arms ammunition. Subsurface soil was sampled outside of 102 J, no PCBs or explosives were detected. All detected metals were below screening levels (SCS, 2008). Outside surface and subsurface soil were sampled in the 2016 RI, there were minor detections of SVOCs (Tetra Tech, 2016).

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
103 A/B/C	SLOP brass cartridge annealing and shaping, powder and primer packaging, lead core insertion, and sorting, packaging, and shipping; warehouse; office space	(b) (7)(F) [redacted]	Possible contaminant sources include USTs, building mechanical equipment, transformers, production equipment (including process piping, sumps, settling tanks, etc.), batteries, scrap metals, and laboratory chemicals associated with the production of small arms ammunition. PCB Aroclor 1260, 1,3-trinitrobenzene, mercury, and lead were detected in wipe samples. Shallow soil was sampled from the basement level or crawl space beneath the building. No PCBs or explosives were detected in soil. Cyanide, phosphorous, mercury, several SVOCs and trichlorofluoromethane were detected in the interior soil. Subsurface soil was sampled outside, but near the building. No PCBs or explosives were detected. Mercury and acetone were detected. Air samples were collected in 2003 in 103 C, mercury was detected (0.0012 – 0.0023 mg/m^3) (SCS, 2008). Lead and mercury detected in dust samples from 1st floor. PAHs, mercury and lead detected in basement soil (Tetra Tech, 2013).
103 D	SLOP powder packing; warehouse; office space	[redacted]	Possible contaminant sources include building mechanical equipment and production equipment (including process piping) associated with the production of small arms ammunition. 1,3-Trinitrobenzene, mercury, and lead were detected in wipe samples. Shallow soil was sampled from the basement level or crawl space beneath the building. No PCBs, explosives or cyanide were detected in soil. Phosphorous, mercury, several SVOCs and acetone were detected in the soil. Subsurface soil was sampled outside, but near the building. No PCBs or explosives were detected. Air samples were collected in 2003 in the crawl space, mercury was detected (0.0005 - 0.0008 mg/m^3) (SCS, 2008). Lead has been detected in dust sampling from 2nd floor (Tetra Tech, 2013).

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
103 E	SLOP primer packing	(b) (7)(F)	Possible contaminant sources include building mechanical equipment and production equipment (including process piping) associated with the production of small arms ammunition. 2-Amino-4,6-dinitrotoluene, mercury, and lead were detected in wipe samples. Shallow soil was sampled from the basement level or crawl space beneath the building. No PCBs or explosives were detected in soil. Cyanide, phosphorous, mercury, several SVOCs and trichlorofluoromethane were detected in the soil. Subsurface soil was sampled outside, but near the building. No PCBs or explosives were detected. Air samples were collected in 2003, mercury was detected (0.0003 – 0.0023 mg/m^3). A passive air sample was taken from the air handler room with a mercury vapor concentration of 0.005 mg/m^3. (SCS, 2008). Lead has been detected in dust and soil sampling from basement (Tetra Tech, 2013).
103 F (Former 112)	SLOP lead core processing (melting, shaping, forming) through at least February 1957	Cafeteria. The building has an unfinished basement level.	Possible contaminant sources include building mechanical equipment, transformers, production equipment (including process piping, sumps, settling tanks, etc.), and scrap metals. PCB Aroclor 1260 and lead were detected in wipe samples. Shallow soil was sampled from the basement level or crawl space beneath the building. Explosives were not detected in soil. PCB Aroclor 1260, cyanide, phosphorous, mercury, antimony, arsenic, lead and several PAHs were detected in the soil. Subsurface soil was sampled outside, but near the building. No PCBs or explosives were detected. Air samples were collected in 2003 and 2004 for particulate lead. Detections: 0.0017, 0.0013 and 0.0015 mg/m^3 (SCS, 2008). PCBs detected in destructive concrete sampling on 1st floor. Mercury was not detected in dust from the 1st floor and soil in the crawlspace (Tetra Tech, 2013).
Former 103 F/G/H	SLOP powder canning and storage, inside blast proof bunkers (F/H) or south of the production buildings (G); storage	N/A - Removed in 1980; cast-in-place concrete barricade structure surrounding two small (~400 ft^2) wood frame buildings	Possible contaminant sources include containers storing powder associated with the production of small arms ammunition. Subsurface soil was sampled near the former buildings. No explosives were detected. Mercury was detected (SCS, 2008).
Former 103 J/K	SLOP lubricating oil storage	N/A - Removed sometime after World War II; one-story, small (~150 ft^2), masonry	Possible contaminant sources include containers storing lubricating oil associated with the production of small arms ammunition.

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
104 A/B/C/D	SLOP brass cartridge annealing and shaping, powder and primer packaging, lead core insertion, and sorting, packaging, and shipping; warehouse; office space	(b) (7)(F) [redacted]	Possible contaminant sources include building mechanical equipment, transformers, production equipment (including process piping, sumps, settling tanks, etc.), scrap metals, and laboratory chemicals associated with the production of small arms ammunition. PCB Aroclor 1260, mercury and lead were detected in wipe samples. Shallow soil was sampled from the basement level or crawl space beneath the building. Explosives, cyanide were not detected in soil. PCB Aroclor 1260, phosphorous, mercury, and several SVOCs were detected in the soil. Subsurface soil was sampled outside, but near the building. No PCBs, explosives or cyanide were detected. Phosphorous, mercury, SVOCs, and acetone were detected. Air samples were collected in 2003 for mercury vapors and particulate mercury - none were detected (SCS, 2008). Outside surface and subsurface soil was sampled in the 2016 RI. Aroclor 1260 was detected at 1.2 mg/kg in the surface soil, and at 0.024 mg/kg and 0.045 mg/kg in the subsurface soil. PCBs detected in destructive concrete sampling in basement and lead detected in dust from 2nd floor (Tetra Tech, 2013).
104 E	SLOP powder packing; warehouse; Uncle Sam's Kids daycare; office space	[redacted]	Possible contaminant sources include building mechanical equipment and production equipment (including process piping) associated with the production of small arms ammunition. PCB Aroclor 1260, mercury and lead were detected in wipe samples. Mercury was detected in a paint sample. Shallow soil was sampled from the basement level or crawl space beneath the building. Explosives and cyanide were not detected in soil. PCB Aroclor 1260, phosphorous, mercury, arsenic, and beryllium were detected in the soil. Subsurface soil was sampled outside, but near the building. No PCBs or explosives were detected (SCS, 2008). PAHs and lead were detected in basement soil as part of the occupational assessment in 2013 (Tetra Tech, 2013).

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
104 F	SLOP primer packing; warehouse; office space	(b) (7)(F)	Possible contaminant sources include building mechanical equipment and production equipment (including process piping) associated with the production of small arms ammunition (SCS, 2008). Mercury and lead were detected in wipe samples. Shallow soil was sampled from the basement level or crawl space beneath the building. Explosives were not detected in soil. No PCBs or explosives were detected in soil. Cyanide, phosphorous, and mercury were detected in the soil. Subsurface soil was sampled outside, but near the building. No PCBs or explosives were detected. Mercury and acetone were detected. A water sample was collected from the sump in the basement. No explosives or mercury were detected. Lead was detected in basement soil as part of the occupational assessment in 2013 (Tetra Tech, 2013).
Former 104 G/H/J	SLOP powder canning and storage, inside blast proof bunkers (G/J) or south of the production buildings (H)	N/A - Removed in 1980; cast-in-place concrete barricade structure surrounding two small (~400 ft^2) wood frame buildings	Possible contaminant sources include containers storing powder associated with the production of small arms ammunition. Subsurface soil was sampled within the area of the former buildings. No explosives were detected. Mercury was detected. All other detected metals were below screening levels (SCS, 2008).
Former 104 K	SLOP water softener plant servicing Plant No. 1; salt storage; equipment room; general storage	N/A - Removed in 1980; Free-standing, ~2,000 ft^2	Possible contaminant sources include the basement level salt storage tank and containers storing chemicals associated with operation of the treatment system. Subsurface soil was sampled within the area of the former building. No PCBs were detected. All detected metals were below screening levels (SCS, 2008).
Former 104 L	SLOP chemical storage building servicing Plant No. 1; basement tank storage (aboveground storage tank [AST]) for acids and caustics; truck and work rooms; general storage	N/A - Removed in 1980; Free-standing, ~1,000 ft^2, adjacent rail spur	Possible contaminant sources include ASTs storing acids and caustics associated with the production of small arms ammunition. Subsurface soil was sampled within the area of the former building. Mercury was detected. All other detected metals were below screening levels (SCS, 2008).
Former 104 M/N	SLOP lubricating oil storage	N/A - Removed sometime after World War II; one-story, small (~150 ft^2), masonry	Possible contaminant sources include containers storing lubricating oil associated with the production of small arms ammunition.

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
105 A/B/C/D	SLOP brass cartridge annealing and shaping, powder and primer packaging, lead core insertion, and sorting, packaging, and shipping; basement small arms firing range; warehouse; office space	(b) (7)(F) [redacted]	Possible contaminant sources include building mechanical equipment, transformers, production equipment (including process piping, sumps, settling tanks, etc.), scrap metals, and laboratory chemicals associated with the production of small arms ammunition. PCB Aroclor 1260, nitrobenzene, and lead were detected in wipe samples. Shallow soil was sampled from the basement level or crawl space beneath the building. Explosives were not detected in soil. PCB Aroclor 1260, cyanide, phosphorous, mercury, arsenic, lead and several SVOCs were detected in the soil. Subsurface soil was sampled outside, but near Building 105. No PCBs, explosives or cyanide were detected. Phosphorous, mercury, SVOCs, and acetone were detected. Sump water samples were collected from the basement. No PCBs, explosives, cyanide or VOCs were detected. Phosphorous, mercury, bis(2-ethylhexyl)phthalate were detected. Air samples were collected in 2003 for mercury vapors and none was detected (SCS, 2008). PCBs were detected in destructive concrete sampling in basement to support the occupational assessment in 2013 (Tetra Tech, 2013).
105 E	SLOP powder packing; warehouse; office space	[redacted]	Possible contaminant sources include building mechanical equipment; production equipment (including process piping) associated with the production of small arms ammunition. PCB Aroclor 1260, 2,4-dinitrotoluene, and lead were detected in wipe samples. Shallow soil was sampled from the basement level or crawl space beneath the building. PCBs, explosives, and cyanide were not detected in soil. Phosphorous, mercury, arsenic, and numerous SVOCs were detected in the soil. Subsurface soil was sampled outside, but near the building. No PCBs, explosives or cyanide were detected. Phosphorous, mercury, PAHs, and acetone were detected (SCS, 2008). Lead was detected in dust sampling from 2nd floor in support of the occupational assessment in 2013 (Tetra Tech, 2013).

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
105 F	SLOP primer packing; warehouse; kitchen/cafeteria	(b) (7)(F)	Possible contaminant sources include building mechanical equipment; production equipment (including process piping) associated with the production of small arms ammunition. PCB Aroclor 1260, and lead were detected in wipe samples. No explosives were detected in the wipe samples. Shallow soil was sampled from the basement level or crawl space beneath the building. No PCBs, explosives, cyanide or VOCs were detected in soil. Phosphorous, mercury, and numerous SVOCs were detected in the soil (SCS, 2008). Lead detected in dust sampling from the basement in support of the occupational assessment in 2013 (Tetra Tech, 2013).
Former 105 G/H/J	SLOP powder canning and storage, inside blast proof bunkers (G/J) or south of the production buildings (H); general storage	N/A - Removed in 1980; cast-in-place concrete barricade structure surrounding two small (~400 ft^2) wood frame buildings	Possible contaminant sources include containers storing powder associated with the production of small arms ammunition. Subsurface soil was sampled within the area of the former buildings. No PCBs, explosives or cyanide were detected. Phosphorous, mercury, SVOCs, and VOCs were detected (SCS, 2008).
105 L	SLOP warehouse and kitchen for Plant No. 1; storage	Training classrooms; storage. The building does not have a basement or utility crawl space level.	No potential contaminant sources were identified (SCS, 2008).
Former 105 M/N	SLOP lubricating oil storage	N/A - Removed sometime after World War II; one-story, small (~150 ft^2), masonry	Possible contaminant sources include containers storing lubricating oil associated with the production of small arms ammunition. Subsurface soil was sampled within the area of the former building. No PCBs or TPH were detected. Acetone was detected (SCS, 2008).
106	Guard shack	Guard shack. This building is of more recent construction than other buildings at the Site and does not have a basement or utility crawl space level.	No potential contaminant sources were identified.
107	SLOP personnel building during Plant No. 1 operation; office space	(b) (7)(F)	Possible contaminant sources include transformers (SCS, 2008). Outside surface and subsurface soil were sampled in the 2016 RI, there were no detections of PCBs. PCBs were detected in destructive concrete sampling in the basement in support of the occupational assessment in 2013 (Tetra Tech, 2013).

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
108 A	South electrical substation	(b) (7)(F) [redacted]	Possible contaminant sources include the transformers and other oil filled electrical equipment. PCB Aroclor 1260 was detected in one wipe sample. Subsurface soil was sampled outside, but near the building. PCB Aroclor 1260 and TPH-DRO were detected. Groundwater samples were collected from temporary monitoring wells. PCB Aroclor 1260 and TPH-DRO was detected in one of five groundwater samples (SCS, 2008). Outside surface and subsurface soil was collected between 108 A and 111 in the 2016 RI. PCB Aroclor 1260 was detected at 110 mg/kg in the surface soil. There were no detections of PCBs in the subsurface. One groundwater sample was collected in the 2016 RI. There were no detections of PCBs in the groundwater (Tetra Tech, 2016).
108 B	North electrical substation	[redacted]	Possible contaminant sources include the transformers and other oil filled electrical equipment. PCB Aroclor 1260 was detected in wipe samples. Shallow soil was sampled from the crawl space. PCB Aroclor 1260 and TPH-DRO were detected in soil. Subsurface soil was sampled outside, but near the building. PCB Aroclor 1260 and TPH-DRO were detected. Groundwater samples were collected from temporary monitoring wells. PCB Aroclor 1260 was detected in one of five groundwater samples (SCS, 2008).
110	SLOP tool and gauge shop (forge shop, production, oil extraction, oil/battery/chemical storage); warehouse; office space Containers of cleaning chemicals, paints and other maintenance related items were observed in the maintenance shop in Building 110 during the 2006 Environmental Site Assessment.	[redacted]	Possible contaminant sources include the ASTs, building mechanical equipment, transformers, and oil handling piping and equipment associated with the tool and gauge shop. PCB Aroclor 1260 was not detected in wipe samples; however, lead was detected. Shallow soil was sampled from the basement floor slab in the room that previously contained two ASTs. TPH-DRO and TPH-GRO were not detected in soil. Subsurface soil was sampled outside, but near the building. PCBs were not detected. However, TPH-DRO, TPH-GRO and mercury were detected (SCS, 2008). PCBs were detected in destructive concrete sampling in basement and lead in dust from the basement. Samples were collected to support the occupational assessment in 2013 (Tetra Tech, 2013).

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
Former 111	SLOP boiler house for Plant No. 1	N/A – was located adjacent to 108A. Removed in the 1970s; operated using natural gas	Possible contaminant sources include the building mechanical equipment and equipment associated with the power plant. Subsurface soil was sampled in the area around the former building. PCBs were not detected, however, TPH-DRO and mercury were detected (SCS, 2008).
115	SLOP truck garage for Plant No. 1; former fueling area north of building	(b) (7)(F) [redacted]	Possible contaminant sources include the USTs; building mechanical equipment; and degreasing chemicals, oil, and lubricants associated with the truck garage. PCB Aroclor 1260 was not detected in wipe samples; however, lead was detected. Subsurface soil was sampled outside, but near the former UST basin. PCBs were not detected. However, TPH-DRO, TPH-GRO and mercury were detected. Acetone and 1,1,2,2-tetrachloroethane were also detected. Groundwater was sampled from temporary wells. TPH-GRO and TPH-DRO were detected (SCS, 2008). Lead was detected in dust sampling from the basement in support of the occupational assessment in 2013 (Tetra Tech, 2013).
122 B	SLOP service building for Plant No. 1; maintenance area for building and grounds crews	[redacted]	Possible contaminant sources include the cleaning chemicals, degreasing chemicals, oil, and lubricants associated with operation of the facility (SCS, 2008).
Former 136 A/B/E/F	SLOP fire equipment storage buildings during operation of Plant No. 1	N/A - Demolished in 1970s; free-standing, ~400 ft^2 each. Building 136A, B, and F was located is now covered with an asphalt parking lot. The area where Building 136E was located is a grass-covered landscaped area.	Possible contaminant sources include fuel tanks associated with fire trucks. Subsurface soil was sampled within the former location of 136 A. There were no detections of PCBs, mercury or VOCs. Subsurface soil was sampled within the former location of 136 B. There were no detections of PCBs or mercury; however, acetone was detected. Surface soil was sampled in the area of the former 136 F. There were minor detections of acetone. There were no detections in the subsurface soil (Tetra Tech, 2016).
Former 137 A	SLOP building and grounds workshop during operation of Plant No. 1	N/A - Demolished in 1970s; free-standing, ~400 ft^2. The area where Building 137A was located is now covered with an asphalt parking lot.	Possible contaminant sources include fuel tanks associated with maintenance equipment; containers of paint; cleaning chemicals; and lubricating oils associated with building and grounds maintenance operations. Subsurface soil was sampled in the area of the former building. Acetone was detected (SCS, 2008).

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
141 C	SLOP pump house and mechanical equipment for Plant No. 1	(b) (7)(F)	Possible contaminant sources include mechanical equipment located within the building. Subsurface soil was sampled near Building 141 C. PCBs and mercury were not detected (SCS, 2008).
208 B	Building 208B was originally a substation construction in 1941/42, then converted to a motor pool facility building in 1987,		Possible contaminant sources include the transformers and other oil filled electrical equipment. No sampling has been conducted in this area.
211	Former Building 211 was a Boiler Plant, like Building 111. The EPA aerial report shows coal storage next Building 211 and across the street to the east. No documentation on the fuel source outside the EPA aerial report was discovered. No evidence of tanks or fuel storage have been identified.		Possible contaminant sources include the building mechanical equipment and equipment associated with the power plant. No previous sampling has been conducted in this area.
Utility Tunnels	(b) (7)(F)		Possible contaminant sources include electrical equipment; and impacted sediment and groundwater entering from other areas outside the tunnel system. Wipe samples were collected in the utility complex. No PCBs or explosives were detected; however, lead was detected. Lead was also detected in the paint chip samples. Sediment was collected. PCBs and explosives were not detected. Mercury, arsenic and lead were detected. Tunnel water was also sampled. No explosives were detected. Mercury and lead were detected. In 2003, ambient air samples were collected. Mercury vapor was detected (0.0045 mg/m^3), particulate mercury was not detected (SCS, 2008).

Table 1. Summary of Historical and Current Use by Building

Building	Historical Use	Current Use	Potential COPC Sources and Summary of Previous Sampling
Railroad Track System	An extensive railroad track system was installed to move materials to and from production facilities while Plant No. 1 was in operation. A series of tracks entered the south end of the Site where they branched out and extended to Buildings 102, 103, 104, 105, 110, and 111. With exception of Building 110, the tracks extended to loading docks on the exterior to the buildings. Building 110 contained an indoor loading dock system adjacent to the railroad tracks. The tracks entered Building 110 from the east and ran the entire length of the building. After operation of Plant No. 1 ended the tracks were not utilized at the Site. In some cases, the tracks, ties, and ballast rock were simply paved over (SCS, 2008).	It is not known what percentage of the track system remains in-place at the Site (SCS, 2008).	The railroad track system was utilized to transport large quantities of brass and lead stock to the facility and to ship assembled 0.30 caliber and 0.50 caliber ammunition from the facility. One shallow soil sample was collected near Building 104 beneath an existing railroad track system. No PCBs were detected. Mercury was detected at 0.029 mg/kg and all other metals were below screening levels. Trace concentrations of SVOCs were detected (SCS, 2008).

Table 2
Background Metals Soil Data
Goodfellow Federal Complex
St. Louis, Missouri

Sample Identification:		SS1 ST. VINCENT PARK	SS1 ARMY RESERVES	SS1 SCHNUCKS PLAZA	SS1 CLARA STREET	BKSB-01 (0-0.5)-0902		BKSB-02 (0-0.5)-0902		BKSB-03 (0-0.5)-0902		BKSB-04 (0-0.5)-0902		BKSB-05 (0-0.5)-0902		BKSB-06 (0-0.5)-0902		BKSB-07 (0-0.5)-0902		BKSB-08 (0-0.5)-0902		BKSB-09 (0-0.5)-0902		BKSB-10 (0-0.5)-0902		Exposure Point Concentration
Report:		**SCS, 2008**	**SCS, 2008**	**SCS, 2008**	**SCS, 2008**	**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		
Analyte	**Units**																									
Arsenic	mg/Kg	5.3	7.2	9.2	7.3	7.4		6.3		5.3		3.4		6.8		5.7		10		18		8.1		5.1		9.437
Beryllium	mg/Kg	0.12	0.27	0.26	0.26	0.75		0.66		0.65		0.77		0.71		0.65		0.87		1.4		0.64		0.57		0.766
Cadmium	mg/Kg	0.32	0.47	0.17	0.62	2.4		2.4		2.3		2.4		2.7		2.4		3.2		6.3		2.9		1.9		2.919
Chromium	mg/Kg	9.8	17	16	14	16		17		19		20		17		15		21		43		16		14		21.82
Copper	mg/Kg	12	19	16	26	21		20		17		21		31		25		44		348		37		18		148.3
Lead	mg/Kg	30	64	18	88	60		46		34		52		97		139		183		876		252		78		270
Mercury	mg/Kg	0.031	0.047	0.042	0.084	0.039	J	0.037	J	0.03	J	0.025	J	0.084	J	0.065	J	0.097	J	0.35		0.18		0.03	J	0.132
Nickel	mg/Kg	10	18	17	19	17		19		15		13		19		19		22		40		18		13		21.78
Selenium	mg/Kg	0.64	0.89	0.74	0.92	< 20	U	< 20	U	< 20	U	< 20	U	3.3	J	< 20	U	< 20	U	< 20	U	< 20	U	< 20	U	3.3
Silver	mg/lg	NA	NA	NA	NA	< 5	U	< 5	U	< 5	U	< 5	U	< 5	U	< 5	U	< 5	U	< 5	U	< 5	U	< 5	U	No Value
Thallium	mg/Kg	1.3	1	0.96	3	0.3	J	0.26	J	0.17	J	0.19	J	0.28	J	0.28	J	0.33	J	0.44	J	0.26	J	0.23	J	1.535
Zinc	mg/Kg	53	80	48	140	94		86		60		72		136		176		266		902		258		99		295.2

mg/kg = milligram per kilogram

NA - not analyzed

U - not detected, < - indicates that the analyte may be present at a concentration less than the value listed (i.e., the sample detection limit)

R - rejected, J - estimated value

SCS Engineers, 2008. Combined Preliminary Assessment/Site Inspection Report. August.

URS, 2004. Site-Specific Environmental Baseline Survey. St. Louis Army Ammunition Plant. St. Louis, Missouri. May.

Exposure point concentration is the lower of the 95% UCL as determined by ProUCL and the maximum detected concentration.

Table 3
Background PAH Soil Data
Goodfellow Federal Complex
St. Louis, Missouri

Sample Identification:		BKSB-01 (0-0.5)-0902		BKSB-02 (0-0.5)-0902		BKSB-03 (0-0.5)-0902		BKSB-04 (0-0.5)-0902		BKSB-05 (0-0.5)-0902		BKSB-06 (0-0.5)-0902		BKSB-07 (0-0.5)-0902		BKSB-08 (0-0.5)-0902		BKSB-09 (0-0.5)-0902		BKSB-10 (0-0.5)-0902		Exposure Point Concentration
Report:		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		**URS, 2004**		
Analyte	**Units**																					
Acenaphthene	mg/Kg	0.001	J	0.001	J	0.001	J	< 0.33	U	0.008	J	0.009	J	0.027	J	0.94		0.038	J	0.01	J	0.94
Acenaphthylene	mg/Kg	0.001	J	< 0.33	U	< 0.33	U	< 0.33	U	0.004	J	0.006	J	0.012	J	0.016	J	0.013	J	0.004	J	0.012
Anthracene	mg/Kg	0.004	J	0.005	J	0.004	J	< 0.33	U	0.027	J	0.045	J	0.076	J	2.4		0.14	J	0.034	J	2.40
Benzo(a)anthracene	mg/Kg	0.046	J	0.043	J	0.033	J	0.003	J	0.15	J	0.23	J	0.43		6.2		0.56		0.27	J	3.37
Benzo(a)pyrene	mg/Kg	0.038	J	0.033	J	0.031	J	0.003	J	0.12		0.16		0.31		3.5		0.51		0.16		1.88
Benzo(b)fluoranthene	mg/Kg	0.063	J	0.056	J	0.05	J	0.006	J	0.14	J	0.18	J	0.24	J	4.2		0.41		0.28	J	4.20
Benzo(g,h,i)perylene	mg/Kg	0.031	J	0.028	J	0.023	J	< 0.062	U	0.086		0.18		0.2		2.1		0.32		0.13		1.76
Benzo(k)fluoranthene	mg/Kg	0.019	J	0.023	J	0.013	J	0.002	J	0.082	J	0.053	J	0.25	J	2.1		0.28	J	0.037	J	1.16
Chrysene	mg/Kg	0.042	J	0.045	J	0.036	J	0.005	J	0.14	J	0.22	J	0.39		6.0		0.47		0.2	J	6.00
Dibenz(a,h)anthracene	mg/Kg	0.015	J	0.013	J	0.014	J	< 0.062	U	0.058	J	0.086		0.13		1.3		0.21		0.08		1.10
Fluoranthene	mg/Kg	0.08	J	0.073	J	0.063	J	0.008	J	0.27	J	0.37	J	0.88		13		1.1		0.46		7.09
Fluorene	mg/Kg	0.001	J	0.001	J	0.001	J	< 0.33	U	0.009	J	0.013	J	0.029	J	1		0.049	J	0.014	J	1.00
Indeno(1,2,3-cd)pyrene	mg/Kg	0.024	J	0.023	J	0.022	J	< 0.33	U	0.072	J	0.1	J	0.16	J	1.7		0.27	J	0.1	J	1.41
Naphthalene	mg/Kg	< 0.33	U	< 0.33	U	< 0.33	U	< 0.33	U	0.003	J	0.002	J	< 0.33		0.13	J	0.018	J	0.002	J	0.13
Phenanthrene	mg/Kg	0.031	J	0.031	J	0.025	J	0.003	J	0.15	J	0.2	J	0.46		13		0.7		0.24	J	13.00
Pyrene	mg/Kg	0.069	J	0.068	J	0.55	J	0.008	J	0.24	J	0.33		0.66		11		0.86		0.39		11.00

mg/kg = milligram per kilogram

NA - Not Analyzed

U - not detected, < - indicates that the analyte may be present at a concentration less than the value listed (i.e., the sample detection limit)

R - rejected, J - estimated value

URS, 2004. Site-Specific Environmental Baseline Survey. St. Louis Army Ammunition Plant. St. Louis, Missouri. May.

Exposure point concentration is the lower of the 95% UCL as determined by ProUCL and the maximum detected concentration.

Table 4
Exposure Pathways
Commercial/Industrial Workers, Trench Workers, Construction Workers, and Residents
Gooodfellow Federal Complex
St. Louis, Missouri

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Expsoure Pathway
Current/Future	Soil (0-2 feet bgs)	Soil	Surface Soil (0-2 feet bgs) (Outdoors)	Commercial/ Industrial Worker	Adult	Dermal Contact	Quant.	Currently, some buildings are used for commerical office space, storage purposes or are vacant. Direct contact with unpaved surface soil is considered a complete pathway. Future redevelopment commercial/industrial use could result in surface soil (paved and unpaved) available for direct contact.
						Incidental Ingestion	Quant.	Currently, some buildings are used for commerical office space, storage purposes or are vacant. Direct contact with unpaved surface soil is considered a complete pathway. Future redevelopment commercial/industrial use could result in surface soil (paved and unpaved) available for direct contact.
				Construction Worker	Adult	Dermal Contact	None	Potentially complete pathway, but potential exposure is accounted for by quantitatively evaluating this pathway from combined surface and subsurface soil.
						Incidental Ingestion	None	Potentially complete pathway, but potential exposure is accounted for by quantitatively evaluating this pathway from combined surface and subsurface soil.
				Resident	Adult	Dermal Contact	Quant.	If the site was redeveloped for residential use, surface soil would be available for direct contact.
						Incidental Ingestion	Quant.	If the site was redeveloped for residential use, surface soil would be available for direct contact.
					Child	Dermal Contact	Quant.	If the site was redeveloped for residential use, surface soil would be available for direct contact.
						Incidental Ingestion	Quant.	If the site was redeveloped for residential use, surface soil would be available for direct contact.
		Particulates	Respirable particulates suspended from surface soil (0-2 ft bgs) (Outdoors)	Commercial/ Industrial Worker	Adult	Inhalation	Quant.	Currently, some buildings are used for commerical office space, storage purposes or are vacant. Direct contact with unpaved surface soil is considered a complete pathway. Future redevelopment commercial/industrial use could result in surface soil (paved and unpaved) available for direct contact.
				Construction Worker	Adult	Inhalation	None	Potentially complete pathway, but potential exposure is accounted for by quantitatively evaluating this pathway from combined surface and subsurface soil.
				Resident	Adult	Inhalation	Quant.	If the site was redeveloped for residential use, surface soil would be available for direct contact.
					Child	Inhalation	Quant.	If the site was redeveloped for residential use, surface soil would be available for direct contact.

Table 4
Exposure Pathways
Commercial/Industrial Workers, Trench Workers, Construction Workers, and Residents
Gooodfellow Federal Complex
St. Louis, Missouri

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Expsoure Pathway
Current/Future	Soil (0-10 ft bgs)	Soil	Surface and subsurface soil (0 -10 ft bgs) (Outdoors)	Commercial/ Industrial Worker	Adult	Dermal Contact	None	Pathway for soil expsoure is focused on top 2 feet for commercial/industrial activities. This includes maintenance activities.
					Adult	Incidental Ingestion	None	Pathway for soil expsoure is focused on top 2 feet for commercial/industrial activities. This includes maintenance activities.
				Construction Worker	Adult	Dermal Contact	Quant.	Direct contact with subsurface soils may result during redevelopment of the site and maintenance of utilities.
					Adult	Incidental Ingestion	Quant.	Direct contact with subsurface soils may result during redevelopment of the site and maintenance of utilities.
				Resident	Adult	Dermal Contact	Quant.	If the site was redeveloped for residential use, subsurface soil could be available for direct contact assuming significant disturbance of site soils during redevelopment.
					Adult	Incidental Ingestion	Quant.	If the site was redeveloped for residential use, subsurface soil could be available for direct contact assuming significant disturbance of site soils during redevelopment.
					Child	Dermal Contact	Quant.	If the site was redeveloped for residential use, subsurface soil could be available for direct contact assuming significant disturbance of site soils during redevelopment.
					Child	Incidental Ingestion	Quant.	If the site was redeveloped for residential use, subsurface soil could be available for direct contact assuming significant disturbance of site soils during redevelopment.
		Particulates	Respirable particulates suspended from surface soil (0-10 ft bgs) (Outdoors)	Commercial/ Industrial Worker	Adult	Inhalation	None	Pathway for soil expsoure is focused on top 2 feet for commercial/industrial activities. This includes maintenance activities.
				Construction Worker	Adult	Inhalation	Quant.	During construction activities, inhalation of dry soil particulates could occur.
				Resident	Adult	Inhalation	Quant.	If the site was redeveloped for residential use, subsurface soil may be unearthed and made available for direct contact during redevelopment.
					Child	Inhalation	Quant.	If the site was redeveloped for residential use, subsurface soil may be unearthed and made available for direct contact during redevelopment.
		Vapor (Soil Gas)	Vapors from surface soil (soil gas) (0-10 ft bgs) (Outdoors)	Commercial/ Industrial Worker	Adult	Inhalation	Quant.	Although commercial/industrial expsoures are focused on top 2 feet of soil, VOCs could migrate through the soil column.
				Construction Worker	Adult	Inhalation	Quant.	Quantitatively evaluated, assuming surface and subsurface soil may be completely redistributed during construction activities.
				Resident	Adult	Inhalation	Quant.	Quantitatively evaluated, assuming surface and subsurface soil may be completely redistributed after redevelopment for residential use.

Table 4
Exposure Pathways
Commercial/Industrial Workers, Trench Workers, Construction Workers, and Residents
Gooodfellow Federal Complex
St. Louis, Missouri

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Expsoure Pathway
					Child	Inhalation	Quant.	Quantitatively evaluated, assuming surface and subsurface soil may be completely redistributed after redevelopment for residential use.
		Vapor (Soil Gas)	Vapors from surface soil (soil gas) (0-10 ft bgs) (Indoor air vapor intrusion)	Commercial/ Industrial Worker	Adult	Inhalation	Quant.	Potentially complete pathway and quantitatively evaluated.
				Construction Worker	Adult	Inhalation	None	Construction activities are assumed to be restricted to the outdoors.
				Resident	Adult	Inhalation	Quant.	Potentially complete pathway and quantitatively evaluated.
					Child	Inhalation	Quant.	Potentially complete pathway and quantitatively evaluated.
Current/Future	Groundwater	Groundwater	Shallow Groundwater	Commercial/ Industrial Worker	Adult	Dermal Contact	None	Groundwater would not be expected to be available for direct contact.
					Adult	Ingestion	None	Groundwater not used as drinking water.
				Trench Worker	Adult	Dermal Contact	Quant.	Construction/Trenching activities could result in groundwater pooling in the bottom of the trench.
					Adult	Incidental Ingestion	Quant.	Construction/Trenching activities could result in groundwater pooling in the bottom of the trench.
				Resident	Adult	Dermal Contact	Quant.	Groundwater not used as drinking water; however domestic use of groundwater will be assumed for the HHRA.
					Adult	Ingestion	Quant.	Groundwater not used as drinking water; however domestic use of groundwater will be assumed for the HHRA.
					Adult	Inhalation	Quant.	Groundwater not used as drinking water; however domestic use of groundwater will be assumed for the HHRA.
					Child	Dermal Contact	Quant.	Groundwater not used as drinking water; however domestic use of groundwater will be assumed for the HHRA.
					Child	Ingestion	Quant.	Groundwater not used as drinking water; however domestic use of groundwater will be assumed for the HHRA.
					Child	Inhalation	Quant.	Groundwater not used as drinking water; however domestic use of groundwater will be assumed for the HHRA.
		Vapors	Vapors from groundwater (outdoors)	Commercial/ Industrial Worker	Adult	Inhalation	None	Potentially complete pathway, but insignificant relative to inhalation of vapors from groundwater in indoor air.
				Trench Worker	Adult	Inhalation	Quant.	Construction/Trenching activities could result in groundwater pooling in the bottom of the trench.
				Resident	Adult	Inhalation	None	Potentially complete pathway, but insignificant relative to inhalation of vapors from groundwater in indoor air.
					Child	Inhalation	None	Potentially complete pathway, but insignificant relative to inhalation of vapors from groundwater in indoor air.
			Vapors from groundwater (Indoor Air Vapor Intrusion)	Commercial/ Industrial Worker	Adult	Inhalation	Quant.	Potentially complete pathway and quantitatively evaluated.
				Trench Worker	Adult	Inhalation	None	Construction activities are assumed to be restricted to the outdoors.
				Resident	Adult	Inhalation	Quant.	Potentially complete pathway and quantitatively evaluated.
					Child	Inhalation	Quant.	Potentially complete pathway and quantitatively evaluated.

Table 4
Exposure Pathways
Commercial/Industrial Workers, Trench Workers, Construction Workers, and Residents
Gooodfellow Federal Complex
St. Louis, Missouri

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Expsoure Pathway
	Soil Gas	Vapors	Vapors from groundwater (Indoor Air Vapor Intrusion)	Commercial/ Industrial Worker	Adult	Inhalation	Quant.	Potentially complete pathway and quantitatively evaluated.
				Trench Worker	Adult	Inhalation	None	Construction activities are assumed to be restricted to the outdoors.
				Resident	Adult	Inhalation	Quant.	Potentially complete pathway and quantitatively evaluated.
					Child	Inhalation	Quant.	Potentially complete pathway and quantitatively evaluated.
Current/Future	Soil (0-2 feet bgs)	Soil	Soil in Crawl Spaces and Basements (0-2 ft bgs) (Indoors)	Commercial/ Industrial Worker	Adult	Dermal Contact	Quant.	Crawl spaces and basements are not paved, with exposed soil. Areas contain utilities and mechanical support for buildings. Commercial/Industrial workers could be exposed performaring maintenance or repairs.
						Incidental Ingestion	Quant.	Crawl spaces and basements are not paved, with exposed soil. Areas contain utilities and mechanical support for buildings. Commercial/Industrial workers could be exposed performaring maintenance or repairs.
				Construction Worker	Adult	Dermal Contact	None	Construction activities are assumed to be restricted to the outdoors.
						Incidental Ingestion	None	Construction activities are assumed to be restricted to the outdoors.
				Resident	Adult	Dermal Contact	None	Crawl spaces and basements contain utilities and mechanical support for buildings. Areas would not be re-developed for residential use.
						Incidental Ingestion	None	Crawl spaces and basements contain utilities and mechanical support for buildings. Areas would not be re-developed for residential use.
					Child	Dermal Contact	None	Crawl spaces and basements contain utilities and mechanical support for buildings. Areas would not be re-developed for residential use.
						Incidental Ingestion	None	Crawl spaces and basements contain utilities and mechanical support for buildings. Areas would not be re-developed for residential use.
		Particulates	Respirable particulates suspended from surface soil in Crawl Spaces (0-2 ft bgs) (Indoors)	Commercial/ Industrial Worker	Adult	Inhalation	Quant.	Dust could be generated during maintenance activities.
				Construction Worker	Adult	Inhalation	None	Construction activities are assumed to be restricted to the outdoors.
				Resident	Adult	Inhalation	None	Crawl spaces and basements contain utilities and mechanical support for buildings. Areas would not be re-developed for residential use.
					Child	Inhalation	None	Crawl spaces and basements contain utilities and mechanical support for buildings. Areas would not be re-developed for residential use.
		Vapor (Soil Gas)	Vapors from surface soil in Crawl Spaces	Commercial/ Industrial Worker	Adult	Inhalation	Quant.	Expsoure could occur during maintenance activities.

Table 4
Exposure Pathways
Commercial/Industrial Workers, Trench Workers, Construction Workers, and Residents
Gooodfellow Federal Complex
St. Louis, Missouri

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Expsoure Pathway
			(soil gas) (0-2 ft bgs) (Indoors)	Construction Worker	Adult	Inhalation	None	Construction activities are assumed to be restricted to the outdoors.
				Resident	Adult	Inhalation	None	Crawl spaces and basements contain utilities and mechanical support for buildings. Areas would not be re-developed for residential use.
					Child	Inhalation	None	Crawl spaces and basements contain utilities and mechanical support for buildings. Areas would not be re-developed for residential use.

Notes:
Exposures to a construction worker are considered protective of exposures to a utility/maintenance worker.
Exposures to a commercial/Industrial worker are considered protective of exposures to a trespasser.
Exposures to concrete, paint or asbestos not considered in the HHRA.
bgs = below ground surface
Quant. = Quantitative. Exposure route quantitatively analyzed in the HHRA.

Table 5
Exposure Parameters
Commercial/Industrial Workers, Trench Workers, Construction Workers, and Residents
Gooodfellow Federal Complex
St. Louis, Missouri

Exposure Parameters	Units	Commercial/ Industrial Workers	Source	Adult Resident	Child Resident	Combined (Inhalation Exposure)	Age Adjusted Factors	Source	Trench Worker	Source	Construction Worker	Source
Exposure Duration (ED)	years	25	USEPA, 2014	20	6	26	--	USEPA, 2014	0.12	Assume 6 weeks	1	USEPA RSLs 2019
Exposure Frequency (EF)	days/year	250	USEPA, 2014	350	350	350	--	USEPA, 2014	225	USEPA, 2014	225	USEPA, 2014
Exposure Time (ET)	hrs/day	8	USEPA, 2014	24	24	24	--	USEPA, 2014	8	USEPA RSLs 2019	8	USEPA RSLs 2019
Body Weight (BW)	kg	80	USEPA, 2014	80	15	--	--	USEPA, 2014	80	USEPA 2014; VDEQ, 2018	80	USEPA 2014; VDEQ, 2018
Water Ingestion Rate (IRw)	L/day	--	--	2.5	0.78	--	--	USEPA, 2014	--	--	--	--
Soil Ingestion Rate (IRs)	mg/day	100	USEPA, 2014	100	200	--	--	USEPA, 2014	--	--	330	USEPA RSLs 2019
Age-Adjusted Soil Ingestion	mg/kg	--	--	--	--	--	36,750	--	--	--	--	--
Skin Surface Area for soil contact (SAs)	cm^2	3,527	USEPA, 2014	6,032	2,373	--	--	USEPA, 2014	--	--	3,527	USEPA RSLs 2019
Age-Adjusted Dermal Contact Factor	mg/kg	--	--	--	--	--	103,390	--	--	--	--	--
Soil Adherence Factor (AF)	mg/cm^2	0.12	USEPA, 2014	0.07	0.2	--	--	USEPA, 2014	--	--	0.30	USEPA RSLs 2019
Skin Surface Area (Bathing)	cm^2	--	--	19,652	6,365	--	--	USEPA, 2014	--	--	--	--
Exposure Time (Bathing)	hrs/day	--	--	0.71	0.54	--	--	USEPA, 2014	--	--	--	--
Averaging Time for Noncarcinogens (ATnc)	days	9,125	ED x 365	7,300	2,190	9,490	--	ED x 365	44	ED x 365	365	ED x 365
Averaging Time for Carcinogens (ATc)	days	25,550	70 yrs x 365 days	25,550	25,550	25,550	--	70 yrs x 365 days	25,550	70 yrs x 365 days	25,550	70 yrs x 365 days
Skin Surface Area for water exposure (Trench)	cm^2	--	--	--	--	--	--	--	3,527	VDEQ, 2018	--	--
Water Exposure Time (Trench)	hrs/event	--	--	--	--	--	--	--	4	Assumed	--	--

Notes:

Default assumptions will be used in the adult and Integrated Exposure Uptake Biokinetic Model(IEUBK) lead models. The target blood lead level will be 5 micrograms per deciliter (µg/dL).

Trench deminsions are assumed to be 5 ft wide, 10 ft deep and 10 ft long although other dimension scenarios may be considered in the risk assessment.

References:

USEPA, 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Expsoure Factors. OSWER Directive 9200.1-120. February 6, 2014.

USEPA,.2019. Inputs for Regional Screening Level Calculator

VDEQ, 2018. Virginia Unified Risk Assessment Model (VURAM) Version 2.0. Virginia Department of Environmental Quality.

Table 6
Trench Model Inputs
Trench Workers
Gooodfellow Federal Complex
St. Louis, Missouri

Input Parameters	Value Used	Units	Reference
Length of the trench	10	ft	Assumed, but can be modified based on site conditions
Width of the trench	5	ft	Assumed, but can be modified based on site conditions
Depth of the trench	10	ft	Assumed, but can be modified based on site conditions
Area of the trench (A)	4.6	m^2	Length of the trench x Width of the trench
Fraction of floor through which contaminanat can enter (F)	1	unitless	Default (VADEQ 2018)
Air changes per hour (ACH)	2	h^{-1}	Default (VADEQ 2018)
Volume of trench (V)	14.2	m^3	Length of the trench x Width of the trench x Depth of the trench
Ideal gas constant (R)	8.2E-05	atm-m^3/mole-K	--
Average system absolute temperature (T)	2.98E+02	K	Default (VADEQ 2018)
Molecular weight of oxygen (MW_{O2})	32	g/mol	--
Molecular weight of water (MW_{H2O})	18	g/mol	--
Liquid-phase mass transfer coefficient of oxygen at 25 °C (k_L, O_2)	0.002	cm/s	VADEQ 2018
Gas-phase mass transfer coefficient of water vapor at 25 °C (k_G, H_2O)	0.833	cm/s	VADEQ 2018
Conversion Factor (CF1)	1.00E-03	L/cm^3	--
Conversion Factor (CF2)	1.00E+04	cm^2/m^2	--
Conversion Factor (CF3)	3600	s/hr	--

Compound	Henry's Law Constant (H) (atm-m^3/mole)	Molecular Weight (Mw_i)	Liquid-phase Mass Transfer Coefficient (k_L)	Gas-phase Mass Transfer Coefficient (k_G)	Overall Mass Transfer Coefficient (K)	Volatilization Factor (VF)

Reference:

VDEQ, 2018. Virginia Unified Risk Assessment Model (VURAM) Version 2.0. Virginia Department of Environmental Quality.

Notes

Formulas:
$k_L = (MW_{O2} / MWi)$ ^ 0.5 * (T / 298) * $k_{L,}O_2$
$k_G = (MW_{H2O} / MWi)$ ^ 0.335 * (T / 298) ^ 1.005 * $k_{G,}H_2O$
K = 1 / [(1 / k_L) + (R * T) / (H * k_G)]
VF = (K * A * F * CF1 * CF2 * CF3) / (ACH * V)

ATTACHMENT A

(b) (7)(F)

[redacted]

→ To BLDG 208B

LEGEND

FENCE	—•—•—
FIRE HYDRANT	FH
NO PARKING	▬
SMOKING SHELTER	■
FORMER BUILDING LOCATION	⬚

Not to Scale

Goodfellow Federal Complex
Former St. Louis Ordnance Plant
4300 Goodfellow Boulevard
St. Louis, Missouri

Figure 2
Facility Layout Map with Historical Information

TETRA TECH

Date: 3/6/2015 Drawn By: Nick Wiederholt Project No: S1058.232.001

Source: SCS Engineers, Figure 2 - Site Plan, March, 2007.

X:\S\1058\227\FH10\Figure2_030615.FH10

ATTACHMENT B

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UCL Statistics for Uncensored Full Data Sets

User Selected Options
Date/Time of Computation        ProUCL 5.11/10/2020 4:52:16 PM
From File                       Background UCLs input PAHs.xls
Full Precision                  OFF
Confidence Coefficient              95%
Number of Bootstrap Operations     2000


Benzoi(a)anthracene

General Statistics
Total Number of Observations                          10 Number of Distinct Observations                                10
                                                         Number of Missing Observations                                  0
Minimum                                            0.003 Mean                                                        0.797
Maximum                                              6.2 Median                                                       0.19
SD                                                 1.908 Std. Error of Mean                                          0.603
Coefficient of Variation                           2.395 Skewness                                                    3.108

Normal GOF Test
Shapiro Wilk Test Statistic                        0.451 Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                     0.842 Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                          0.449 Lilliefors GOF Test
5% Lilliefors Critical Value                       0.262 Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                           95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                              1.902   95% Adjusted-CLT UCL (Chen-1995)                          2.422
                                                           95% Modified-t UCL (Johnson-1978)                         2.001

Gamma GOF Test
A-D Test Statistic                                 0.743 Anderson-Darling Gamma GOF Test
5% A-D Critical Value                              0.799 Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                 0.265 Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                              0.285 Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE)                                         0.38 k star (bias corrected MLE)                                 0.333
Theta hat (MLE)                                    2.095 Theta star (bias corrected MLE)                             2.393
nu hat (MLE)                                       7.606 nu star (bias corrected)                                    6.657
MLE Mean (bias corrected)                          0.797 MLE Sd (bias corrected)                                     1.381
                                                         Approximate Chi Square Value (0.05)                         1.984
Adjusted Level of Significance                    0.0267 Adjusted Chi Square Value                                   1.573

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)       2.672   95% Adjusted Gamma UCL (use when n<50)                    3.371

Lognormal GOF Test
Shapiro Wilk Test Statistic                        0.967 Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                     0.842 Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                          0.148 Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                       0.262 Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                            -5.809 Mean of logged Data                                        -1.972
Maximum of Logged Data                             1.825 SD of logged Data                                           2.047

Assuming Lognormal Distribution
```

95% H-UCL	48.62	90% Chebyshev (MVUE) UCL	2.16
95% Chebyshev (MVUE) UCL	2.811	97.5% Chebyshev (MVUE) UCL	3.715
99% Chebyshev (MVUE) UCL	5.489		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.789	95% Jackknife UCL	1.902
95% Standard Bootstrap UCL	1.726	95% Bootstrap-t UCL	9.912
95% Hall's Bootstrap UCL	6.446	95% Percentile Bootstrap UCL	1.971
95% BCA Bootstrap UCL	2.596		
90% Chebyshev(Mean, Sd) UCL	2.606	95% Chebyshev(Mean, Sd) UCL	3.426
97.5% Chebyshev(Mean, Sd) UCL	4.564	99% Chebyshev(Mean, Sd) UCL	6.798

Suggested UCL to Use	
95% Adjusted Gamma UCL	**3.371**

Benzo(a)pyrene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	0.003	Mean	0.487
Maximum	3.5	Median	0.14
SD	1.07	Std. Error of Mean	0.338
Coefficient of Variation	2.2	Skewness	3.042

Normal GOF Test

Shapiro Wilk Test Statistic	0.487	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.391	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.107	95% Adjusted-CLT UCL (Chen-1995)	1.391
		95% Modified-t UCL (Johnson-1978)	1.161

Gamma GOF Test

A-D Test Statistic	0.652	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.79	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.233	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.283	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.43	k star (bias corrected MLE)	0.368
Theta hat (MLE)	1.132	Theta star (bias corrected MLE)	1.324
nu hat (MLE)	8.595	nu star (bias corrected)	7.35
MLE Mean (bias corrected)	0.487	MLE Sd (bias corrected)	0.803
		Approximate Chi Square Value (0.05)	2.365
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	1.904

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1.512	95% Adjusted Gamma UCL (use when n<50)	1.878

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.969	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.158	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.809	Mean of logged Data	-2.234
Maximum of Logged Data	1.253	SD of logged Data	1.91

Assuming Lognormal Distribution

95% H-UCL	17.94	90% Chebyshev (MVUE) UCL	1.32
95% Chebyshev (MVUE) UCL	1.71	97.5% Chebyshev (MVUE) UCL	2.251
99% Chebyshev (MVUE) UCL	3.314		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.043	95% Jackknife UCL	1.107
95% Standard Bootstrap UCL	1.008	95% Bootstrap-t UCL	4.826

95% Hall's Bootstrap UCL	3.348	95% Percentile Bootstrap UCL	1.125
95% BCA Bootstrap UCL	1.466		
90% Chebyshev(Mean, Sd) UCL	1.502	95% Chebyshev(Mean, Sd) UCL	1.962
97.5% Chebyshev(Mean, Sd) UCL	2.6	99% Chebyshev(Mean, Sd) UCL	3.854

Suggested UCL to Use	
95% Adjusted Gamma UCL	**1.878**

Benzo(b)fluoranthene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.006	Mean	0.563
Maximum	4.2	Median	0.16
SD	1.284	Std. Error of Mean	0.406
Coefficient of Variation	2.283	Skewness	3.107

Normal GOF Test

Shapiro Wilk Test Statistic	0.454	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.447	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.307	95% Adjusted-CLT UCL (Chen-1995)	1.657
		95% Modified-t UCL (Johnson-1978)	1.373

Gamma GOF Test

A-D Test Statistic	0.91	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.784	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.284	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.282	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.464	k star (bias corrected MLE)	0.392
Theta hat (MLE)	1.212	Theta star (bias corrected MLE)	1.436
nu hat (MLE)	9.284	nu star (bias corrected)	7.832
MLE Mean (bias corrected)	0.563	MLE Sd (bias corrected)	0.899
		Approximate Chi Square Value (0.05)	2.638
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	2.144

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.67	95% Adjusted Gamma UCL (use when n<50)	2.055

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.95	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.171	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.116	Mean of logged Data	-1.96
Maximum of Logged Data	1.435	SD of logged Data	1.7

Assuming Lognormal Distribution

95% H-UCL	8.464	90% Chebyshev (MVUE) UCL	1.232
95% Chebyshev (MVUE) UCL	1.582	97.5% Chebyshev (MVUE) UCL	2.069
99% Chebyshev (MVUE) UCL	3.025		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.23	95% Jackknife UCL	1.307
95% Standard Bootstrap UCL	1.198	95% Bootstrap-t UCL	6.761

95% Hall's Bootstrap UCL	4.467	95% Percentile Bootstrap UCL	1.368
95% BCA Bootstrap UCL	1.802		
90% Chebyshev(Mean, Sd) UCL	1.781	95% Chebyshev(Mean, Sd) UCL	2.333
97.5% Chebyshev(Mean, Sd) UCL	3.099	99% Chebyshev(Mean, Sd) UCL	4.603

Suggested UCL to Use	
99% Chebyshev (Mean, Sd) UCL	**4.603**
Recommended UCL exceeds the maximum observation	

Benzo(k)fluoranthene

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General Statistics
Total Number of Observations                          10  Number of Distinct Observations                                   10
                                                          Number of Missing Observations                                     0
Minimum                                            0.002  Mean                                                           0.286
Maximum                                              2.1  Median                                                         0.045
SD                                                 0.645  Std. Error of Mean                                             0.204
Coefficient of Variation                           2.256  Skewness                                                       3.028

Normal GOF Test
Shapiro Wilk Test Statistic                        0.486  Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                     0.842  Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                          0.404  Lilliefors GOF Test
5% Lilliefors Critical Value                       0.262  Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                            95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                               0.66    95% Adjusted-CLT UCL (Chen-1995)                               0.83
                                                            95% Modified-t UCL (Johnson-1978)                             0.692

Gamma GOF Test
A-D Test Statistic                                 0.713  Anderson-Darling Gamma GOF Test
5% A-D Critical Value                              0.795  Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                 0.241  Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                              0.284  Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE)                                        0.401  k star (bias corrected MLE)                                    0.347
Theta hat (MLE)                                    0.714  Theta star (bias corrected MLE)                                0.824
nu hat (MLE)                                       8.011  nu star (bias corrected)                                       6.941
MLE Mean (bias corrected)                          0.286  MLE Sd (bias corrected)                                        0.485
                                                          Approximate Chi Square Value (0.05)                            2.138
Adjusted Level of Significance                    0.0267  Adjusted Chi Square Value                                      1.706

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)       0.928    95% Adjusted Gamma UCL (use when n<50)                       1.163

Lognormal GOF Test
Shapiro Wilk Test Statistic                        0.979  Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                     0.842  Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                          0.126  Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                       0.262  Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                            -6.215  Mean of logged Data                                           -2.895
Maximum of Logged Data                             0.742  SD of logged Data                                              1.929

Assuming Lognormal Distribution
  95% H-UCL                                        10.21    90% Chebyshev (MVUE) UCL                                     0.703
  95% Chebyshev (MVUE) UCL                         0.912   97.5% Chebyshev (MVUE) UCL                                    1.201
  99% Chebyshev (MVUE) UCL                         1.769

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs
  95% CLT UCL                                      0.621    95% Jackknife UCL                                             0.66
  95% Standard Bootstrap UCL                       0.605    95% Bootstrap-t UCL                                          2.312
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95% Hall's Bootstrap UCL	2.098	95% Percentile Bootstrap UCL	0.677
95% BCA Bootstrap UCL	0.877		
90% Chebyshev(Mean, Sd) UCL	0.898	95% Chebyshev(Mean, Sd) UCL	1.175
97.5% Chebyshev(Mean, Sd) UCL	1.56	99% Chebyshev(Mean, Sd) UCL	2.316

Suggested UCL to Use	
95% Adjusted Gamma UCL	**1.163**

Chrysene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.005	Mean	0.755
Maximum	6	Median	0.17
SD	1.85	Std. Error of Mean	0.585
Coefficient of Variation	2.45	Skewness	3.121

Normal GOF Test

Shapiro Wilk Test Statistic	0.44	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.461	Lilliefors GOF Test
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.827	95% Adjusted-CLT UCL (Chen-1995)	2.334
		95% Modified-t UCL (Johnson-1978)	1.923

Gamma GOF Test

A-D Test Statistic	0.905	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.798	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.292	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.285	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.387	k star (bias corrected MLE)	0.338
Theta hat (MLE)	1.949	Theta star (bias corrected MLE)	2.234
nu hat (MLE)	7.747	nu star (bias corrected)	6.757
MLE Mean (bias corrected)	0.755	MLE Sd (bias corrected)	1.299
		Approximate Chi Square Value (0.05)	2.038
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	1.619

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.502	95% Adjusted Gamma UCL (use when n<50)	3.15

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.159	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.298	Mean of logged Data	-1.989
Maximum of Logged Data	1.792	SD of logged Data	1.905

Assuming Lognormal Distribution

95% H-UCL	22.3	90% Chebyshev (MVUE) UCL	1.672
95% Chebyshev (MVUE) UCL	2.165	97.5% Chebyshev (MVUE) UCL	2.85
99% Chebyshev (MVUE) UCL	4.196		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.717	95% Jackknife UCL	1.827
95% Standard Bootstrap UCL	1.671	95% Bootstrap-t UCL	10.12

95% Hall's Bootstrap UCL	6.382	95% Percentile Bootstrap UCL	1.898
95% BCA Bootstrap UCL	2.522		
90% Chebyshev(Mean, Sd) UCL	2.509	95% Chebyshev(Mean, Sd) UCL	3.304
97.5% Chebyshev(Mean, Sd) UCL	4.407	99% Chebyshev(Mean, Sd) UCL	6.574

Suggested UCL to Use	
99% Chebyshev (Mean, Sd) UCL	**6.574**
Recommended UCL exceeds the maximum observation	

Fluoranthene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.008	Mean	1.63
Maximum	13	Median	0.32
SD	4.012	Std. Error of Mean	1.269
Coefficient of Variation	2.461	Skewness	3.114

Normal GOF Test

Shapiro Wilk Test Statistic	0.444	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.453	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.956	95% Adjusted-CLT UCL (Chen-1995)	5.052
		95% Modified-t UCL (Johnson-1978)	4.164

Gamma GOF Test

A-D Test Statistic	0.827	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.801	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.268	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.285	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.367	k star (bias corrected MLE)	0.324
Theta hat (MLE)	4.44	Theta star (bias corrected MLE)	5.037
nu hat (MLE)	7.343	nu star (bias corrected)	6.474
MLE Mean (bias corrected)	1.63	MLE Sd (bias corrected)	2.866
		Approximate Chi Square Value (0.05)	1.887
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	1.488

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	5.595	95% Adjusted Gamma UCL (use when n<50)	7.092

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.969	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.14	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4.828	Mean of logged Data	-1.328
Maximum of Logged Data	2.565	SD of logged Data	2.012

Assuming Lognormal Distribution

95% H-UCL	76.45	90% Chebyshev (MVUE) UCL	3.877
95% Chebyshev (MVUE) UCL	5.039	97.5% Chebyshev (MVUE) UCL	6.653
99% Chebyshev (MVUE) UCL	9.823		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.717	95% Jackknife UCL	3.956
95% Standard Bootstrap UCL	3.557	95% Bootstrap-t UCL	21.8

95% Hall's Bootstrap UCL	14.18	95% Percentile Bootstrap UCL	4.11
95% BCA Bootstrap UCL	5.458		
90% Chebyshev(Mean, Sd) UCL	5.436	95% Chebyshev(Mean, Sd) UCL	7.16
97.5% Chebyshev(Mean, Sd) UCL	9.553	99% Chebyshev(Mean, Sd) UCL	14.25

Suggested UCL to Use	
95% Adjusted Gamma UCL	**7.092**

Phenanthrene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	0.003	Mean	1.484
Maximum	13	Median	0.175
SD	4.052	Std. Error of Mean	1.281
Coefficient of Variation	2.731	Skewness	3.145

Normal GOF Test

Shapiro Wilk Test Statistic	0.412	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.477	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.833	95% Adjusted-CLT UCL (Chen-1995)	4.954
		95% Modified-t UCL (Johnson-1978)	4.046

Gamma GOF Test

A-D Test Statistic	1.012	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.818	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.294	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.288	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.29	k star (bias corrected MLE)	0.27
Theta hat (MLE)	5.114	Theta star (bias corrected MLE)	5.501
nu hat (MLE)	5.803	nu star (bias corrected)	5.396
MLE Mean (bias corrected)	1.484	MLE Sd (bias corrected)	2.857
		Approximate Chi Square Value (0.05)	1.339
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	1.022

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.979	95% Adjusted Gamma UCL (use when n<50)	7.831

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.962	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.141	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.809	Mean of logged Data	-1.995
Maximum of Logged Data	2.565	SD of logged Data	2.291

Assuming Lognormal Distribution

95% H-UCL	198.6	90% Chebyshev (MVUE) UCL	3.215
95% Chebyshev (MVUE) UCL	4.212	97.5% Chebyshev (MVUE) UCL	5.595
99% Chebyshev (MVUE) UCL	8.313		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.592	95% Jackknife UCL	3.833
95% Standard Bootstrap UCL	3.516	95% Bootstrap-t UCL	39.39

95% Hall's Bootstrap UCL	22.38	95% Percentile Bootstrap UCL	4.002
95% BCA Bootstrap UCL	5.258		
90% Chebyshev(Mean, Sd) UCL	5.328	95% Chebyshev(Mean, Sd) UCL	7.07
97.5% Chebyshev(Mean, Sd) UCL	9.487	99% Chebyshev(Mean, Sd) UCL	14.23

Suggested UCL to Use	
99% Chebyshev (Mean, Sd) UCL	**14.23**
Recommended UCL exceeds the maximum observation	

Pyrene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.008	Mean	1.418
Maximum	11	Median	0.36
SD	3.378	Std. Error of Mean	1.068
Coefficient of Variation	2.383	Skewness	3.123

Normal GOF Test

Shapiro Wilk Test Statistic	0.442	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.466	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.376	95% Adjusted-CLT UCL (Chen-1995)	4.302
		95% Modified-t UCL (Johnson-1978)	3.552

Gamma GOF Test

A-D Test Statistic	0.867	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.793	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.306	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.284	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.411	k star (bias corrected MLE)	0.355
Theta hat (MLE)	3.446	Theta star (bias corrected MLE)	3.997
nu hat (MLE)	8.228	nu star (bias corrected)	7.093
MLE Mean (bias corrected)	1.418	MLE Sd (bias corrected)	2.38
		Approximate Chi Square Value (0.05)	2.222
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	1.779

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4.525	95% Adjusted Gamma UCL (use when n<50)	5.652

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.951	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.183	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4.828	Mean of logged Data	-1.243
Maximum of Logged Data	2.398	SD of logged Data	1.906

Assuming Lognormal Distribution

95% H-UCL	47.22	90% Chebyshev (MVUE) UCL	3.528
95% Chebyshev (MVUE) UCL	4.57	97.5% Chebyshev (MVUE) UCL	6.016
99% Chebyshev (MVUE) UCL	8.856		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.175	95% Jackknife UCL	3.376
95% Standard Bootstrap UCL	3.105	95% Bootstrap-t UCL	18.86

95% Hall's Bootstrap UCL	12.47	95% Percentile Bootstrap UCL	3.52
95% BCA Bootstrap UCL	4.537		
90% Chebyshev(Mean, Sd) UCL	4.622	95% Chebyshev(Mean, Sd) UCL	6.074
97.5% Chebyshev(Mean, Sd) UCL	8.089	99% Chebyshev(Mean, Sd) UCL	12.05

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL **12.05**

Recommended UCL exceeds the maximum observation

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.11/10/2020 4:57:42 PM
From File	Background UCLs input PAHs.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Acenaphthene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	8
Number of Detects	9	Number of Non-Detects	1
Number of Distinct Detects	7	Number of Distinct Non-Detects	1
Minimum Detect	0.001	Minimum Non-Detect	0.33
Maximum Detect	0.94	Maximum Non-Detect	0.33
Variance Detects	0.0959	Percent Non-Detects	10%
Mean Detects	0.115	SD Detects	0.31
Median Detects	0.009	CV Detects	2.692
Skewness Detects	2.99	Kurtosis Detects	8.956
Mean of Logged Detects	-4.646	SD of Logged Detects	2.218

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.424	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.487	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.105	KM Standard Error of Mean	0.0935
KM SD	0.279	95% KM (BCA) UCL	0.294
95% KM (t) UCL	0.276	95% KM (Percentile Bootstrap) UCL	0.287
95% KM (z) UCL	0.258	95% KM Bootstrap t UCL	3.23
90% KM Chebyshev UCL	0.385	95% KM Chebyshev UCL	0.512
97.5% KM Chebyshev UCL	0.689	99% KM Chebyshev UCL	1.035

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.168	Anderson-Darling GOF Test	
5% A-D Critical Value	0.815	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.331	Kolmogorov-Smirnov GOF	
5% K-S Critical Value	0.303	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.281	k star (bias corrected MLE)	0.261
Theta hat (MLE)	0.41	Theta star (bias corrected MLE)	0.44
nu hat (MLE)	5.053	nu star (bias corrected)	4.702
Mean (detects)	0.115		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

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)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.001	Mean	0.105
Maximum	0.94	Median	0.0095
SD	0.294	CV	2.812
k hat (MLE)	0.291	k star (bias corrected MLE)	0.27
Theta hat (MLE)	0.359	Theta star (bias corrected MLE)	0.387
nu hat (MLE)	5.817	nu star (bias corrected)	5.405
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (5.40, α)	1.344	Adjusted Chi Square Value (5.40, β)	1.026
95% Gamma Approximate UCL (use when n>=50)	0.42	95% Gamma Adjusted UCL (use when n<50)	0.55

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.105	SD (KM)	0.279
Variance (KM)	0.0777	SE of Mean (KM)	0.0935
k hat (KM)	0.141	k star (KM)	0.165

nu hat (KM)	2.822	nu star (KM)	3.309
theta hat (KM)	0.742	theta star (KM)	0.633
80% gamma percentile (KM)	0.123	90% gamma percentile (KM)	0.314
95% gamma percentile (KM)	0.565	99% gamma percentile (KM)	1.278
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (3.31, α)	0.469	Adjusted Chi Square Value (3.31, β)	0.326
95% Gamma Approximate KM-UCL (use when n>=50)	0.738	95% Gamma Adjusted KM-UCL (use when n<50)	1.064
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.879	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.179	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	0.104	Mean in Log Scale	-4.685
SD in Original Scale	0.294	SD in Log Scale	2.095
95% t UCL (assumes normality of ROS data)	0.275	95% Percentile Bootstrap UCL	0.289
95% BCA Bootstrap UCL	0.384	95% Bootstrap t UCL	3.688
95% H-UCL (Log ROS)	4.215		
Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	-4.703	KM Geo Mean	0.00907
KM SD (logged)	2.04	95% Critical H Value (KM-Log)	5.493
KM Standard Error of Mean (logged)	0.702	95% H-UCL (KM -Log)	3.046
KM SD (logged)	2.04	95% Critical H Value (KM-Log)	5.493
KM Standard Error of Mean (logged)	0.702		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.12	Mean in Log Scale	-4.361
SD in Original Scale	0.292	SD in Log Scale	2.276
95% t UCL (Assumes normality)	0.289	95% H-Stat UCL	17.04
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Lognormal Distributed at 5% Significance Level			

Suggested UCL to Use	
99% KM (Chebyshev) UCL	**1.035**
Warning: Recommended UCL exceeds the maximum observation	

Acenaphthylene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	7
Number of Detects	7	Number of Non-Detects	3
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	0.001	Minimum Non-Detect	0.33
Maximum Detect	0.016	Maximum Non-Detect	0.33
Variance Detects	3.17E-05	Percent Non-Detects	30%
Mean Detects	0.008	SD Detects	0.00563
Median Detects	0.006	CV Detects	0.703
Skewness Detects	0.291	Kurtosis Detects	-1.721
Mean of Logged Detects	-5.138	SD of Logged Detects	0.964

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.917	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.21	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.008	KM Standard Error of Mean	0.00213
KM SD	0.00521	95% KM (BCA) UCL	0.0117
95% KM (t) UCL	0.0119	95% KM (Percentile Bootstrap) UCL	0.0115
95% KM (z) UCL	0.0115	95% KM Bootstrap t UCL	0.0125
90% KM Chebyshev UCL	0.0144	95% KM Chebyshev UCL	0.0173
97.5% KM Chebyshev UCL	0.0213	99% KM Chebyshev UCL	0.0292

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.329	Anderson-Darling GOF Test
5% A-D Critical Value	0.718	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.223	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.316	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.762	k star (bias corrected MLE)	1.102
Theta hat (MLE)	0.00454	Theta star (bias corrected MLE)	0.00726
nu hat (MLE)	24.66	nu star (bias corrected)	15.43
Mean (detects)	0.008		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

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)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.001	Mean	0.00884
Maximum	0.016	Median	0.01
SD	0.00483	CV	0.547
k hat (MLE)	2.344	k star (bias corrected MLE)	1.708
Theta hat (MLE)	0.00377	Theta star (bias corrected MLE)	0.00517
nu hat (MLE)	46.89	nu star (bias corrected)	34.16
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (34.16, α)	21.79	Adjusted Chi Square Value (34.16, β)	20.09
95% Gamma Approximate UCL (use when n>=50)	0.0139	95% Gamma Adjusted UCL (use when n<50)	0.015

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.008	SD (KM)	0.00521
Variance (KM)	2.71E-05	SE of Mean (KM)	0.00213
k hat (KM)	2.358	k star (KM)	1.717

nu hat (KM)	47.16	nu star (KM)	34.34
theta hat (KM)	0.00339	theta star (KM)	0.00466
80% gamma percentile (KM)	0.0122	90% gamma percentile (KM)	0.0161
95% gamma percentile (KM)	0.0199	99% gamma percentile (KM)	0.0284

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (34.34, α)	21.94	Adjusted Chi Square Value (34.34, β)	20.23
95% Gamma Approximate KM-UCL (use when n>=50)	0.0125	95% Gamma Adjusted KM-UCL (use when n<50)	0.0136

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.899	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.203	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00773	Mean in Log Scale	-5.138
SD in Original Scale	0.00521	SD in Log Scale	0.868
95% t UCL (assumes normality of ROS data)	0.0108	95% Percentile Bootstrap UCL	0.0104
95% BCA Bootstrap UCL	0.0105	95% Bootstrap t UCL	0.011
95% H-UCL (Log ROS)	0.0195		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.138	KM Geo Mean	0.00587
KM SD (logged)	0.893	95% Critical H Value (KM-Log)	2.887
KM Standard Error of Mean (logged)	0.364	95% H-UCL (KM -Log)	0.0206
KM SD (logged)	0.893	95% Critical H Value (KM-Log)	2.887
KM Standard Error of Mean (logged)	0.364		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0551	Mean in Log Scale	-4.137
SD in Original Scale	0.076	SD in Log Scale	1.794
95% t UCL (Assumes normality)	0.0991	95% H-Stat UCL	1.492

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use	
95% KM (t) UCL	**0.0119**

Anthracene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
Number of Detects	9	Number of Non-Detects	1
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	0.004	Minimum Non-Detect	0.33
Maximum Detect	2.4	Maximum Non-Detect	0.33
Variance Detects	0.62	Percent Non-Detects	10%
Mean Detects	0.304	SD Detects	0.787
Median Detects	0.034	CV Detects	2.591
Skewness Detects	2.982	Kurtosis Detects	8.92
Mean of Logged Detects	-3.345	SD of Logged Detects	2.053

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.436	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.471	Lilliefors GOF Test
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.278	KM Standard Error of Mean	0.238
KM SD	0.709	95% KM (BCA) UCL	0.75
95% KM (t) UCL	0.713	95% KM (Percentile Bootstrap) UCL	0.747
95% KM (z) UCL	0.669	95% KM Bootstrap t UCL	7.712
90% KM Chebyshev UCL	0.991	95% KM Chebyshev UCL	1.314
97.5% KM Chebyshev UCL	1.762	99% KM Chebyshev UCL	2.643

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.071	Anderson-Darling GOF Test
5% A-D Critical Value	0.804	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.302	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.301	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.317	k star (bias corrected MLE)	0.286
Theta hat (MLE)	0.958	Theta star (bias corrected MLE)	1.064
nu hat (MLE)	5.711	nu star (bias corrected)	5.14
Mean (detects)	0.304		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

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)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.004	Mean	0.275
Maximum	2.4	Median	0.0305
SD	0.748	CV	2.725
k hat (MLE)	0.314	k star (bias corrected MLE)	0.287
Theta hat (MLE)	0.874	Theta star (bias corrected MLE)	0.958
nu hat (MLE)	6.284	nu star (bias corrected)	5.732
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (5.73, α)	1.505	Adjusted Chi Square Value (5.73, β)	1.162
95% Gamma Approximate UCL (use when n>=50)	1.046	95% Gamma Adjusted UCL (use when n<50)	1.354

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.278	SD (KM)	0.709
Variance (KM)	0.502	SE of Mean (KM)	0.238
k hat (KM)	0.154	k star (KM)	0.174

nu hat (KM)	3.071	nu star (KM)	3.483
theta hat (KM)	1.808	theta star (KM)	1.595
80% gamma percentile (KM)	0.337	90% gamma percentile (KM)	0.836
95% gamma percentile (KM)	1.48	99% gamma percentile (KM)	3.298
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (3.48, α)	0.529	Adjusted Chi Square Value (3.48, β)	0.37
95% Gamma Approximate KM-UCL (use when n>=50)	1.829	95% Gamma Adjusted KM-UCL (use when n<50)	2.615
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.899	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.163	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	0.276	Mean in Log Scale	-3.382
SD in Original Scale	0.747	SD in Log Scale	1.939
95% t UCL (assumes normality of ROS data)	0.709	95% Percentile Bootstrap UCL	0.741
95% BCA Bootstrap UCL	0.985	95% Bootstrap t UCL	8.461
95% H-UCL (Log ROS)	6.631		
Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	-3.398	KM Geo Mean	0.0335
KM SD (logged)	1.889	95% Critical H Value (KM-Log)	5.128
KM Standard Error of Mean (logged)	0.65	95% H-UCL (KM -Log)	5.031
KM SD (logged)	1.889	95% Critical H Value (KM-Log)	5.128
KM Standard Error of Mean (logged)	0.65		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.29	Mean in Log Scale	-3.191
SD in Original Scale	0.744	SD in Log Scale	1.996
95% t UCL (Assumes normality)	0.721	95% H-Stat UCL	10.88
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Lognormal Distributed at 5% Significance Level			
Suggested UCL to Use			
99% KM (Chebyshev) UCL	**2.643**		
Warning: Recommended UCL exceeds the maximum observation			

Benzo(g,h,i)perylene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
Number of Detects	9	Number of Non-Detects	1
Number of Distinct Detects	9	Number of Distinct Non-Detects	1
Minimum Detect	0.023	Minimum Non-Detect	0.062
Maximum Detect	2.1	Maximum Non-Detect	0.062
Variance Detects	0.443	Percent Non-Detects	10%
Mean Detects	0.344	SD Detects	0.666
Median Detects	0.13	CV Detects	1.934
Skewness Detects	2.878	Kurtosis Detects	8.444
Mean of Logged Detects	-2.115	SD of Logged Detects	1.431

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.522	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.403	Lilliefors GOF Test
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.313	KM Standard Error of Mean	0.202
KM SD	0.603	95% KM (BCA) UCL	0.707
95% KM (t) UCL	0.683	95% KM (Percentile Bootstrap) UCL	0.698
95% KM (z) UCL	0.645	95% KM Bootstrap t UCL	2.363
90% KM Chebyshev UCL	0.919	95% KM Chebyshev UCL	1.194
97.5% KM Chebyshev UCL	1.575	99% KM Chebyshev UCL	2.325

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.745	Anderson-Darling GOF Test
5% A-D Critical Value	0.764	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.251	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.292	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.591	k star (bias corrected MLE)	0.468
Theta hat (MLE)	0.583	Theta star (bias corrected MLE)	0.736
nu hat (MLE)	10.63	nu star (bias corrected)	8.42
Mean (detects)	0.344		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

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)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.311
Maximum	2.1	Median	0.108
SD	0.636	CV	2.048
k hat (MLE)	0.527	k star (bias corrected MLE)	0.436
Theta hat (MLE)	0.59	Theta star (bias corrected MLE)	0.714
nu hat (MLE)	10.54	nu star (bias corrected)	8.711
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (8.71, α)	3.153	Adjusted Chi Square Value (8.71, β)	2.601
95% Gamma Approximate UCL (use when n>=50)	0.859	95% Gamma Adjusted UCL (use when n<50)	1.041

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.313	SD (KM)	0.603
Variance (KM)	0.364	SE of Mean (KM)	0.202
k hat (KM)	0.269	k star (KM)	0.255

nu hat (KM)	5.374	nu star (KM)	5.095
theta hat (KM)	1.163	theta star (KM)	1.227
80% gamma percentile (KM)	0.457	90% gamma percentile (KM)	0.937
95% gamma percentile (KM)	1.504	99% gamma percentile (KM)	3.011
Gamma Kaplan-Meier (KM) Statistics			
Approximate Chi Square Value (5.09, α)	1.196	Adjusted Chi Square Value (5.09, β)	0.903
95% Gamma Approximate KM-UCL (use when n>=50)	1.331	95% Gamma Adjusted KM-UCL (use when n<50)	1.763
Lognormal GOF Test on Detected Observations Only			
Shapiro Wilk Test Statistic	0.922	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.162	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level	
Detected Data appear Lognormal at 5% Significance Level			
Lognormal ROS Statistics Using Imputed Non-Detects			
Mean in Original Scale	0.313	Mean in Log Scale	-2.264
SD in Original Scale	0.636	SD in Log Scale	1.429
95% t UCL (assumes normality of ROS data)	0.681	95% Percentile Bootstrap UCL	0.699
95% BCA Bootstrap UCL	0.907	95% Bootstrap t UCL	2.47
95% H-UCL (Log ROS)	1.976		
Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	-2.264	KM Geo Mean	0.104
KM SD (logged)	1.356	95% Critical H Value (KM-Log)	3.877
KM Standard Error of Mean (logged)	0.455	95% H-UCL (KM -Log)	1.504
KM SD (logged)	1.356	95% Critical H Value (KM-Log)	3.877
KM Standard Error of Mean (logged)	0.455		
DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.313	Mean in Log Scale	-2.251
SD in Original Scale	0.635	SD in Log Scale	1.416
95% t UCL (Assumes normality)	0.681	95% H-Stat UCL	1.904
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Gamma Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM Bootstrap t UCL	**2.363**	**Gamma Adjusted KM-UCL (use when k<=1 and 15 < n <**	**1.763**

Dibenz(a,h)anthracene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
Number of Detects	9	Number of Non-Detects	1
Number of Distinct Detects	9	Number of Distinct Non-Detects	1
Minimum Detect	0.013	Minimum Non-Detect	0.062
Maximum Detect	1.3	Maximum Non-Detect	0.062
Variance Detects	0.171	Percent Non-Detects	10%
Mean Detects	0.212	SD Detects	0.413
Median Detects	0.08	CV Detects	1.951
Skewness Detects	2.866	Kurtosis Detects	8.382
Mean of Logged Detects	-2.664	SD of Logged Detects	1.501

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.525	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.391	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.193	KM Standard Error of Mean	0.125
KM SD	0.374	95% KM (BCA) UCL	0.452
95% KM (t) UCL	0.423	95% KM (Percentile Bootstrap) UCL	0.427
95% KM (z) UCL	0.399	95% KM Bootstrap t UCL	1.528
90% KM Chebyshev UCL	0.569	95% KM Chebyshev UCL	0.74
97.5% KM Chebyshev UCL	0.976	99% KM Chebyshev UCL	1.441

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.731	Anderson-Darling GOF Test	
5% A-D Critical Value	0.766	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.229	Kolmogorov-Smirnov GOF	
5% K-S Critical Value	0.293	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.561	k star (bias corrected MLE)	0.448
Theta hat (MLE)	0.377	Theta star (bias corrected MLE)	0.472
nu hat (MLE)	10.1	nu star (bias corrected)	8.069
Mean (detects)	0.212		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

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)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.192
Maximum	1.3	Median	0.069
SD	0.395	CV	2.06
k hat (MLE)	0.523	k star (bias corrected MLE)	0.433
Theta hat (MLE)	0.366	Theta star (bias corrected MLE)	0.443
nu hat (MLE)	10.46	nu star (bias corrected)	8.657
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (8.66, α)	3.121	Adjusted Chi Square Value (8.66, β)	2.572
95% Gamma Approximate UCL (use when n>=50)	0.531	95% Gamma Adjusted UCL (use when n<50)	0.645

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.193	SD (KM)	0.374
Variance (KM)	0.14	SE of Mean (KM)	0.125
k hat (KM)	0.267	k star (KM)	0.254

nu hat (KM)	5.339	nu star (KM)	5.07
theta hat (KM)	0.723	theta star (KM)	0.762
80% gamma percentile (KM)	0.282	90% gamma percentile (KM)	0.579
95% gamma percentile (KM)	0.931	99% gamma percentile (KM)	1.865

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.07, α)	1.185	Adjusted Chi Square Value (5.07, β)	0.894
95% Gamma Approximate KM-UCL (use when n>=50)	0.826	95% Gamma Adjusted KM-UCL (use when n<50)	1.095

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.912	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.18	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.193	Mean in Log Scale	-2.787
SD in Original Scale	0.394	SD in Log Scale	1.468
95% t UCL (assumes normality of ROS data)	0.421	95% Percentile Bootstrap UCL	0.427
95% BCA Bootstrap UCL	0.571	95% Bootstrap t UCL	1.556
95% H-UCL (Log ROS)	1.365		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.789	KM Geo Mean	0.0615
KM SD (logged)	1.407	95% Critical H Value (KM-Log)	3.993
KM Standard Error of Mean (logged)	0.478	95% H-UCL (KM -Log)	1.078
KM SD (logged)	1.407	95% Critical H Value (KM-Log)	3.993
KM Standard Error of Mean (logged)	0.478		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.194	Mean in Log Scale	-2.745
SD in Original Scale	0.394	SD in Log Scale	1.438
95% t UCL (Assumes normality)	0.422	95% H-Stat UCL	1.267

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use			
95% KM Bootstrap t UCL	**1.528**	**Gamma Adjusted KM-UCL (use when k<=1 and 15 < n <**	**1.095**

Fluorene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	8
Number of Detects	9	Number of Non-Detects	1
Number of Distinct Detects	7	Number of Distinct Non-Detects	1
Minimum Detect	0.001	Minimum Non-Detect	0.33
Maximum Detect	1	Maximum Non-Detect	0.33
Variance Detects	0.108	Percent Non-Detects	10%
Mean Detects	0.124	SD Detects	0.329
Median Detects	0.013	CV Detects	2.65
Skewness Detects	2.987	Kurtosis Detects	8.941
Mean of Logged Detects	-4.511	SD of Logged Detects	2.261

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.43	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.479	Lilliefors GOF Test
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.113	KM Standard Error of Mean	0.0993
KM SD	0.296	95% KM (BCA) UCL	0.307
95% KM (t) UCL	0.295	95% KM (Percentile Bootstrap) UCL	0.307
95% KM (z) UCL	0.276	95% KM Bootstrap t UCL	3.396
90% KM Chebyshev UCL	0.411	95% KM Chebyshev UCL	0.546
97.5% KM Chebyshev UCL	0.733	99% KM Chebyshev UCL	1.101

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.051	Anderson-Darling GOF Test
5% A-D Critical Value	0.813	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.308	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.302	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.287	k star (bias corrected MLE)	0.265
Theta hat (MLE)	0.433	Theta star (bias corrected MLE)	0.468
nu hat (MLE)	5.158	nu star (bias corrected)	4.772
Mean (detects)	0.124		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

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)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.001	Mean	0.113
Maximum	1	Median	0.0115
SD	0.312	CV	2.769
k hat (MLE)	0.296	k star (bias corrected MLE)	0.274
Theta hat (MLE)	0.381	Theta star (bias corrected MLE)	0.412
nu hat (MLE)	5.914	nu star (bias corrected)	5.473
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (5.47, α)	1.377	Adjusted Chi Square Value (5.47, β)	1.054
95% Gamma Approximate UCL (use when n>=50)	0.448	95% Gamma Adjusted UCL (use when n<50)	0.585

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.113	SD (KM)	0.296
Variance (KM)	0.0876	SE of Mean (KM)	0.0993
k hat (KM)	0.146	k star (KM)	0.169

nu hat (KM)	2.923	nu star (KM)	3.38
theta hat (KM)	0.774	theta star (KM)	0.67
80% gamma percentile (KM)	0.135	90% gamma percentile (KM)	0.34
95% gamma percentile (KM)	0.607	99% gamma percentile (KM)	1.366

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (3.38, α)	0.493	Adjusted Chi Square Value (3.38, β)	0.343
95% Gamma Approximate KM-UCL (use when n>=50)	0.775	95% Gamma Adjusted KM-UCL (use when n<50)	1.114

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.891	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.189	Lilliefors GOF Test
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.112	Mean in Log Scale	-4.552
SD in Original Scale	0.312	SD in Log Scale	2.135
95% t UCL (assumes normality of ROS data)	0.293	95% Percentile Bootstrap UCL	0.308
95% BCA Bootstrap UCL	0.411	95% Bootstrap t UCL	3.741
95% H-UCL (Log ROS)	6.063		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.568	KM Geo Mean	0.0104
KM SD (logged)	2.084	95% Critical H Value (KM-Log)	5.599
KM Standard Error of Mean (logged)	0.719	95% H-UCL (KM -Log)	4.448
KM SD (logged)	2.084	95% Critical H Value (KM-Log)	5.599
KM Standard Error of Mean (logged)	0.719		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.128	Mean in Log Scale	-4.24
SD in Original Scale	0.31	SD in Log Scale	2.297
95% t UCL (Assumes normality)	0.308	95% H-Stat UCL	21.86

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use	
99% KM (Chebyshev) UCL	**1.101**
Warning: Recommended UCL exceeds the maximum observation	

Indeno(1,2,3-cd)pyrene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
Number of Detects	9	Number of Non-Detects	1
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	0.022	Minimum Non-Detect	0.33
Maximum Detect	1.7	Maximum Non-Detect	0.33
Variance Detects	0.292	Percent Non-Detects	10%
Mean Detects	0.275	SD Detects	0.54
Median Detects	0.1	CV Detects	1.969
Skewness Detects	2.879	Kurtosis Detects	8.439
Mean of Logged Detects	-2.352	SD of Logged Detects	1.406

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.516	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.392	Lilliefors GOF Test
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.257	KM Standard Error of Mean	0.164
KM SD	0.487	95% KM (BCA) UCL	0.579
95% KM (t) UCL	0.557	95% KM (Percentile Bootstrap) UCL	0.569
95% KM (z) UCL	0.526	95% KM Bootstrap t UCL	2.113
90% KM Chebyshev UCL	0.748	95% KM Chebyshev UCL	0.97
97.5% KM Chebyshev UCL	1.278	99% KM Chebyshev UCL	1.884

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.855	Anderson-Darling GOF Test
5% A-D Critical Value	0.764	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.292	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.585	k star (bias corrected MLE)	0.464
Theta hat (MLE)	0.469	Theta star (bias corrected MLE)	0.591
nu hat (MLE)	10.54	nu star (bias corrected)	8.359
Mean (detects)	0.275		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

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)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.022	Mean	0.252
Maximum	1.7	Median	0.086
SD	0.515	CV	2.043
k hat (MLE)	0.594	k star (bias corrected MLE)	0.482
Theta hat (MLE)	0.424	Theta star (bias corrected MLE)	0.522
nu hat (MLE)	11.88	nu star (bias corrected)	9.647
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (9.65, α)	3.722	Adjusted Chi Square Value (9.65, β)	3.11
95% Gamma Approximate UCL (use when n>=50)	0.653	95% Gamma Adjusted UCL (use when n<50)	0.781

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.257	SD (KM)	0.487
Variance (KM)	0.237	SE of Mean (KM)	0.164
k hat (KM)	0.278	k star (KM)	0.261

nu hat (KM)	5.558	nu star (KM)	5.224
theta hat (KM)	0.924	theta star (KM)	0.983
80% gamma percentile (KM)	0.378	90% gamma percentile (KM)	0.768
95% gamma percentile (KM)	1.226	99% gamma percentile (KM)	2.439

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.22, α)	1.257	Adjusted Chi Square Value (5.22, β)	0.954
95% Gamma Approximate KM-UCL (use when n>=50)	1.067	95% Gamma Adjusted KM-UCL (use when n<50)	1.406

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.896	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.17	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.254	Mean in Log Scale	-2.377
SD in Original Scale	0.513	SD in Log Scale	1.328
95% t UCL (assumes normality of ROS data)	0.552	95% Percentile Bootstrap UCL	0.565
95% BCA Bootstrap UCL	0.743	95% Bootstrap t UCL	2.378
95% H-UCL (Log ROS)	1.211		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.388	KM Geo Mean	0.0918
KM SD (logged)	1.294	95% Critical H Value (KM-Log)	3.736
KM Standard Error of Mean (logged)	0.446	95% H-UCL (KM -Log)	1.062
KM SD (logged)	1.294	95% Critical H Value (KM-Log)	3.736
KM Standard Error of Mean (logged)	0.446		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.264	Mean in Log Scale	-2.297
SD in Original Scale	0.511	SD in Log Scale	1.337
95% t UCL (Assumes normality)	0.56	95% H-Stat UCL	1.356

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use			
95% KM Bootstrap t UCL	**2.113**	**Gamma Adjusted KM-UCL (use when k<=1 and 15 < n <**	**1.406**

Naphthalene

General Statistics

Total Number of Observations	10	Number of Distinct Observations	5
Number of Detects	5	Number of Non-Detects	5
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	0.002	Minimum Non-Detect	0.33
Maximum Detect	0.13	Maximum Non-Detect	0.33
Variance Detects	0.00311	Percent Non-Detects	50%
Mean Detects	0.031	SD Detects	0.0558
Median Detects	0.003	CV Detects	1.799
Skewness Detects	2.157	Kurtosis Detects	4.689
Mean of Logged Detects	-4.859	SD of Logged Detects	1.819

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.636	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.392	Lilliefors GOF Test
5% Lilliefors Critical Value	0.343	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.031	KM Standard Error of Mean		0.0249
KM SD	0.0499	95% KM (BCA) UCL	N/A	
95% KM (t) UCL	0.0767	95% KM (Percentile Bootstrap) UCL	N/A	
95% KM (z) UCL	0.072	95% KM Bootstrap t UCL	N/A	
90% KM Chebyshev UCL	0.106	95% KM Chebyshev UCL		0.14
97.5% KM Chebyshev UCL	0.187	99% KM Chebyshev UCL		0.279

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.65	Anderson-Darling GOF Test
5% A-D Critical Value	0.716	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.336	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.373	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.464	k star (bias corrected MLE)	0.319
Theta hat (MLE)	0.0668	Theta star (bias corrected MLE)	0.0972
nu hat (MLE)	4.639	nu star (bias corrected)	3.189
Mean (detects)	0.031		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

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)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.002	Mean	0.0349
Maximum	0.13	Median	0.0114
SD	0.0481	CV	1.378
k hat (MLE)	0.64	k star (bias corrected MLE)	0.515
Theta hat (MLE)	0.0546	Theta star (bias corrected MLE)	0.0678
nu hat (MLE)	12.8	nu star (bias corrected)	10.3
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (10.30, α)	4.128	Adjusted Chi Square Value (10.30, β)	3.475
95% Gamma Approximate UCL (use when n>=50)	0.0871	95% Gamma Adjusted UCL (use when n<50)	0.103

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.031	SD (KM)	0.0499
Variance (KM)	0.00249	SE of Mean (KM)	0.0249
k hat (KM)	0.386	k star (KM)	0.337

nu hat (KM)	7.728	nu star (KM)	6.743
theta hat (KM)	0.0802	theta star (KM)	0.092
80% gamma percentile (KM)	0.0488	90% gamma percentile (KM)	0.09
95% gamma percentile (KM)	0.137	99% gamma percentile (KM)	0.256

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (6.74, α)	2.03	Adjusted Chi Square Value (6.74, β)	1.613
95% Gamma Approximate KM-UCL (use when n>=50)	0.103	95% Gamma Adjusted KM-UCL (use when n<50)	0.13

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.825	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.299	Lilliefors GOF Test
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0253	Mean in Log Scale	-4.859
SD in Original Scale	0.0418	SD in Log Scale	1.644
95% t UCL (assumes normality of ROS data)	0.0496	95% Percentile Bootstrap UCL	0.0475
95% BCA Bootstrap UCL	0.0576	95% Bootstrap t UCL	0.131
95% H-UCL (Log ROS)	0.361		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.859	KM Geo Mean	0.00776
KM SD (logged)	1.627	95% Critical H Value (KM-Log)	4.503
KM Standard Error of Mean (logged)	0.813	95% H-UCL (KM -Log)	0.335
KM SD (logged)	1.627	95% Critical H Value (KM-Log)	4.503
KM Standard Error of Mean (logged)	0.813		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.098	Mean in Log Scale	-3.331
SD in Original Scale	0.0798	SD in Log Scale	2.017
95% t UCL (Assumes normality)	0.144	95% H-Stat UCL	10.56

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use			
95% KM Bootstrap t UCL	**N/A**	**Gamma Adjusted KM-UCL (use when k<=1 and 15 < n <**	**0.13**

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UCL Statistics for Uncensored Full Data Sets

User Selected Options
Date/Time of Computation          ProUCL 5.11/10/2020 5:18:19 PM
From File                         Background metals UCL input.xls
Full Precision                    OFF
Confidence Coefficient                95%
Number of Bootstrap Operations       2000

Arsenic

General Statistics
Total Number of Observations                            14  Number of Distinct Observations                               13
                                                            Number of Missing Observations                                 0
Minimum                                                3.4  Mean                                                       7.507
Maximum                                                 18  Median                                                         7
SD                                                   3.479  Std. Error of Mean                                          0.93
Coefficient of Variation                             0.463  Skewness                                                   2.266

Normal GOF Test
Shapiro Wilk Test Statistic                          0.776  Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                       0.874  Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                            0.227  Lilliefors GOF Test
5% Lilliefors Critical Value                         0.226  Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                              95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                                9.154    95% Adjusted-CLT UCL (Chen-1995)                         9.638
                                                              95% Modified-t UCL (Johnson-1978)                        9.247

Gamma GOF Test
A-D Test Statistic                                   0.534  Anderson-Darling Gamma GOF Test
5% A-D Critical Value                                0.737  Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic                                   0.178  Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                                0.229  Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics
k hat (MLE)                                          6.716  k star (bias corrected MLE)                                5.324
Theta hat (MLE)                                      1.118  Theta star (bias corrected MLE)                             1.41
nu hat (MLE)                                           188  nu star (bias corrected)                                   149.1
MLE Mean (bias corrected)                            7.507  MLE Sd (bias corrected)                                    3.253
                                                            Approximate Chi Square Value (0.05)                        121.9
Adjusted Level of Significance                      0.0312  Adjusted Chi Square Value                                  118.6

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)         9.184    95% Adjusted Gamma UCL (use when n<50)                   9.437

Lognormal GOF Test
Shapiro Wilk Test Statistic                          0.941  Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                       0.874  Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                            0.151  Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                         0.226  Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                               1.224  Mean of logged Data                                         1.94
Maximum of Logged Data                                2.89  SD of logged Data                                          0.387
```

Assuming Lognormal Distribution

95% H-UCL	9.267	90% Chebyshev (MVUE) UCL	9.811
95% Chebyshev (MVUE) UCL	10.88	97.5% Chebyshev (MVUE) UCL	12.36
99% Chebyshev (MVUE) UCL	15.27		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	9.036	95% Jackknife UCL	9.154
95% Standard Bootstrap UCL	8.979	95% Bootstrap-t UCL	10.26
95% Hall's Bootstrap UCL	16.45	95% Percentile Bootstrap UCL	9.093
95% BCA Bootstrap UCL	9.643		
90% Chebyshev(Mean, Sd) UCL	10.3	95% Chebyshev(Mean, Sd) UCL	11.56
97.5% Chebyshev(Mean, Sd) UCL	13.31	99% Chebyshev(Mean, Sd) UCL	16.76

Suggested UCL to Use	
95% Adjusted Gamma UCL	**9.437**

Beryllium

General Statistics

Total Number of Observations	14	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	0.12	Mean	0.613
Maximum	1.4	Median	0.65
SD	0.323	Std. Error of Mean	0.0863
Coefficient of Variation	0.527	Skewness	0.704

Normal GOF Test

Shapiro Wilk Test Statistic	0.901	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.176	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.766	95% Adjusted-CLT UCL (Chen-1995)	0.772
		95% Modified-t UCL (Johnson-1978)	0.768

Gamma GOF Test

A-D Test Statistic	0.78	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.742	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.247	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.23	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.27	k star (bias corrected MLE)	2.617
Theta hat (MLE)	0.187	Theta star (bias corrected MLE)	0.234
nu hat (MLE)	91.56	nu star (bias corrected)	73.27
MLE Mean (bias corrected)	0.613	MLE Sd (bias corrected)	0.379
		Approximate Chi Square Value (0.05)	54.56
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	52.42

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.823	95% Adjusted Gamma UCL (use when n<50)	0.857

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.877	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.269	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.12	Mean of logged Data	-0.65
Maximum of Logged Data	0.336	SD of logged Data	0.643

Assuming Lognormal Distribution

95% H-UCL	0.962	90% Chebyshev (MVUE) UCL	0.971
95% Chebyshev (MVUE) UCL	1.124	97.5% Chebyshev (MVUE) UCL	1.338
99% Chebyshev (MVUE) UCL	1.757		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.755	95% Jackknife UCL	0.766
95% Standard Bootstrap UCL	0.75	95% Bootstrap-t UCL	0.778
95% Hall's Bootstrap UCL	0.814	95% Percentile Bootstrap UCL	0.753
95% BCA Bootstrap UCL	0.759		
90% Chebyshev(Mean, Sd) UCL	0.872	95% Chebyshev(Mean, Sd) UCL	0.989
97.5% Chebyshev(Mean, Sd) UCL	1.152	99% Chebyshev(Mean, Sd) UCL	1.472

Suggested UCL to Use	
95% Student's-t UCL	**0.766**

Cadmium

General Statistics

Total Number of Observations	14	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	0.17	Mean	2.177
Maximum	6.3	Median	2.4
SD	1.568	Std. Error of Mean	0.419
Coefficient of Variation	0.72	Skewness	1.129

Normal GOF Test

Shapiro Wilk Test Statistic	0.852	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.186	Lilliefors GOF Test
5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.919	95% Adjusted-CLT UCL (Chen-1995)	3.001
		95% Modified-t UCL (Johnson-1978)	2.94

Gamma GOF Test

A-D Test Statistic	0.973	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.75	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.275	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.233	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.546	k star (bias corrected MLE)	1.262
Theta hat (MLE)	1.408	Theta star (bias corrected MLE)	1.725
nu hat (MLE)	43.29	nu star (bias corrected)	35.35
MLE Mean (bias corrected)	2.177	MLE Sd (bias corrected)	1.938
		Approximate Chi Square Value (0.05)	22.74
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	21.41

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.384	95% Adjusted Gamma UCL (use when n<50)	3.595

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.841	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.299	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.226	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.772	Mean of logged Data	0.421
Maximum of Logged Data	1.841	SD of logged Data	1.03

Assuming Lognormal Distribution

95% H-UCL	5.829	90% Chebyshev (MVUE) UCL	4.664
95% Chebyshev (MVUE) UCL	5.664	97.5% Chebyshev (MVUE) UCL	7.052
99% Chebyshev (MVUE) UCL	9.779		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.866	95% Jackknife UCL	2.919
95% Standard Bootstrap UCL	2.852	95% Bootstrap-t UCL	3.081
95% Hall's Bootstrap UCL	3.469	95% Percentile Bootstrap UCL	2.919
95% BCA Bootstrap UCL	3.049		
90% Chebyshev(Mean, Sd) UCL	3.434	95% Chebyshev(Mean, Sd) UCL	4.003
97.5% Chebyshev(Mean, Sd) UCL	4.794	99% Chebyshev(Mean, Sd) UCL	6.346

Suggested UCL to Use	
95% Student's-t UCL	**2.919**

Chromium

General Statistics

Total Number of Observations	14	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	9.8	Mean	18.2
Maximum	43	Median	16.5
SD	7.654	Std. Error of Mean	2.046
Coefficient of Variation	0.421	Skewness	2.896

Normal GOF Test

Shapiro Wilk Test Statistic	0.645	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.286	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	21.82	95% Adjusted-CLT UCL (Chen-1995)	23.26
		95% Modified-t UCL (Johnson-1978)	22.09

Gamma GOF Test

A-D Test Statistic	1.248	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.735	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.251	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.229	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	9.046	k star (bias corrected MLE)	7.155
Theta hat (MLE)	2.012	Theta star (bias corrected MLE)	2.544
nu hat (MLE)	253.3	nu star (bias corrected)	200.3
MLE Mean (bias corrected)	18.2	MLE Sd (bias corrected)	6.804
		Approximate Chi Square Value (0.05)	168.6
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	164.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	21.63	95% Adjusted Gamma UCL (use when n<50)	22.13

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.825	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.229	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	2.282	Mean of logged Data	2.845
Maximum of Logged Data	3.761	SD of logged Data	0.322

Assuming Lognormal Distribution

95% H-UCL	21.49	90% Chebyshev (MVUE) UCL	22.77
95% Chebyshev (MVUE) UCL	24.9	97.5% Chebyshev (MVUE) UCL	27.87
99% Chebyshev (MVUE) UCL	33.7		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	21.56	95% Jackknife UCL	21.82
95% Standard Bootstrap UCL	21.51	95% Bootstrap-t UCL	26.26
95% Hall's Bootstrap UCL	36.94	95% Percentile Bootstrap UCL	21.93
95% BCA Bootstrap UCL	23.41		
90% Chebyshev(Mean, Sd) UCL	24.34	95% Chebyshev(Mean, Sd) UCL	27.12
97.5% Chebyshev(Mean, Sd) UCL	30.98	99% Chebyshev(Mean, Sd) UCL	38.55

Suggested UCL to Use			
95% Student's-t UCL	**21.82**	**or 95% Modified-t UCL**	**22.09**

Copper

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	12	Mean	46.79
Maximum	348	Median	21
SD	87.13	Std. Error of Mean	23.29
Coefficient of Variation	1.862	Skewness	3.678

Normal GOF Test

Shapiro Wilk Test Statistic	0.382	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.441	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	88.02	95% Adjusted-CLT UCL (Chen-1995)	109.5
		95% Modified-t UCL (Johnson-1978)	91.84

Gamma GOF Test

A-D Test Statistic	2.551	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.759	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.323	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.235	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	1.048	k star (bias corrected MLE)	0.871
Theta hat (MLE)	44.64	Theta star (bias corrected MLE)	53.71
nu hat (MLE)	29.34	nu star (bias corrected)	24.39
MLE Mean (bias corrected)	46.79	MLE Sd (bias corrected)	50.13
		Approximate Chi Square Value (0.05)	14.14
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	13.12

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	80.67	95% Adjusted Gamma UCL (use when n<50)	86.98

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.701	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.234	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	2.485	Mean of logged Data	3.298
Maximum of Logged Data	5.852	SD of logged Data	0.811

Assuming Lognormal Distribution

95% H-UCL	65.87	90% Chebyshev (MVUE) UCL	61.73
95% Chebyshev (MVUE) UCL	73.16	97.5% Chebyshev (MVUE) UCL	89.03
99% Chebyshev (MVUE) UCL	120.2		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	85.09	95% Jackknife UCL	88.02
95% Standard Bootstrap UCL	84.87	95% Bootstrap-t UCL	384.8
95% Hall's Bootstrap UCL	249	95% Percentile Bootstrap UCL	92.57
95% BCA Bootstrap UCL	119.1		
90% Chebyshev(Mean, Sd) UCL	116.6	95% Chebyshev(Mean, Sd) UCL	148.3
97.5% Chebyshev(Mean, Sd) UCL	192.2	99% Chebyshev(Mean, Sd) UCL	278.5

Suggested UCL to Use	
95% Chebyshev (Mean, Sd) UCL	**148.3**

Lead

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	18	Mean	144.1
Maximum	876	Median	71
SD	220.4	Std. Error of Mean	58.89
Coefficient of Variation	1.529	Skewness	3.231

Normal GOF Test

Shapiro Wilk Test Statistic	0.543	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.299	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	248.4	95% Adjusted-CLT UCL (Chen-1995)	295.3
		95% Modified-t UCL (Johnson-1978)	256.8

Gamma GOF Test

A-D Test Statistic	0.867	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.228	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.235	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.023	k star (bias corrected MLE)	0.852
Theta hat (MLE)	140.8	Theta star (bias corrected MLE)	169.2
nu hat (MLE)	28.65	nu star (bias corrected)	23.85
MLE Mean (bias corrected)	144.1	MLE Sd (bias corrected)	156.1
		Approximate Chi Square Value (0.05)	13.73
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	12.72

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	250.2	95% Adjusted Gamma UCL (use when n<50)	270

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.147	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.89	Mean of logged Data	4.408
Maximum of Logged Data	6.775	SD of logged Data	0.985

Assuming Lognormal Distribution

95% H-UCL	284	90% Chebyshev (MVUE) UCL	236.1
95% Chebyshev (MVUE) UCL	285.4	97.5% Chebyshev (MVUE) UCL	353.9
99% Chebyshev (MVUE) UCL	488.4		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	240.9	95% Jackknife UCL	248.4
95% Standard Bootstrap UCL	240	95% Bootstrap-t UCL	520.7
95% Hall's Bootstrap UCL	589.8	95% Percentile Bootstrap UCL	251.7
95% BCA Bootstrap UCL	301.9		
90% Chebyshev(Mean, Sd) UCL	320.7	95% Chebyshev(Mean, Sd) UCL	400.8
97.5% Chebyshev(Mean, Sd) UCL	511.9	99% Chebyshev(Mean, Sd) UCL	730

Suggested UCL to Use	
95% Adjusted Gamma UCL	**270**

Mercury

```
General Statistics
Total Number of Observations                               14 Number of Distinct Observations                            12
                                                              Number of Missing Observations                              0
Minimum                                                 0.025 Mean                                                   0.0815
Maximum                                                  0.35 Median                                                 0.0445
SD                                                     0.0877 Std. Error of Mean                                     0.0234
Coefficient of Variation                                1.076 Skewness                                                2.593

Normal GOF Test
Shapiro Wilk Test Statistic                             0.647 Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value                          0.874 Data Not Normal at 5% Significance Level
Lilliefors Test Statistic                               0.287 Lilliefors GOF Test
5% Lilliefors Critical Value                            0.226 Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level

Assuming Normal Distribution
  95% Normal UCL                                                95% UCLs (Adjusted for Skewness)
  95% Student's-t UCL                                   0.123   95% Adjusted-CLT UCL (Chen-1995)                      0.137
                                                                95% Modified-t UCL (Johnson-1978)                     0.126

Gamma GOF Test
A-D Test Statistic                                      0.962 Anderson-Darling Gamma GOF Test
5% A-D Critical Value                                   0.749 Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic                                      0.219 Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value                                   0.232 Detected data appear Gamma Distributed at 5% Significance Level
Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics
k hat (MLE)                                             1.659 k star (bias corrected MLE)                             1.351
Theta hat (MLE)                                        0.0491 Theta star (bias corrected MLE)                        0.0603
nu hat (MLE)                                            46.46 nu star (bias corrected)                                37.84
MLE Mean (bias corrected)                              0.0815 MLE Sd (bias corrected)                                0.0701
                                                              Approximate Chi Square Value (0.05)                     24.75
Adjusted Level of Significance                         0.0312 Adjusted Chi Square Value                               23.35

Assuming Gamma Distribution
  95% Approximate Gamma UCL (use when n>=50)            0.125   95% Adjusted Gamma UCL (use when n<50)                0.132

Lognormal GOF Test
Shapiro Wilk Test Statistic                             0.889 Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value                          0.874 Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic                               0.185 Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value                            0.226 Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level

Lognormal Statistics
Minimum of Logged Data                                 -3.689 Mean of logged Data                                    -2.838
Maximum of Logged Data                                  -1.05 SD of logged Data                                       0.762

Assuming Lognormal Distribution
  95% H-UCL                                             0.131   90% Chebyshev (MVUE) UCL                              0.126
  95% Chebyshev (MVUE) UCL                              0.148  97.5% Chebyshev (MVUE) UCL                             0.179
  99% Chebyshev (MVUE) UCL                               0.24

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level
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Nonparametric Distribution Free UCLs

95% CLT UCL	0.12	95% Jackknife UCL	0.123
95% Standard Bootstrap UCL	0.119	95% Bootstrap-t UCL	0.202
95% Hall's Bootstrap UCL	0.292	95% Percentile Bootstrap UCL	0.124
95% BCA Bootstrap UCL	0.139		
90% Chebyshev(Mean, Sd) UCL	0.152	95% Chebyshev(Mean, Sd) UCL	0.184
97.5% Chebyshev(Mean, Sd) UCL	0.228	99% Chebyshev(Mean, Sd) UCL	0.315

Suggested UCL to Use	
95% Adjusted Gamma UCL	**0.132**

Nickel

General Statistics

Total Number of Observations	14	Number of Distinct Observations	8
		Number of Missing Observations	0
Minimum	10	Mean	18.5
Maximum	40	Median	18
SD	6.937	Std. Error of Mean	1.854
Coefficient of Variation	0.375	Skewness	2.416

Normal GOF Test

Shapiro Wilk Test Statistic	0.727	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.328	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	21.78	95% Adjusted-CLT UCL (Chen-1995)	22.83
		95% Modified-t UCL (Johnson-1978)	21.98

Gamma GOF Test

A-D Test Statistic	0.914	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.735	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.282	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.229	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.12	k star (bias corrected MLE)	7.995
Theta hat (MLE)	1.829	Theta star (bias corrected MLE)	2.314
nu hat (MLE)	283.2	nu star (bias corrected)	223.9
MLE Mean (bias corrected)	18.5	MLE Sd (bias corrected)	6.543
		Approximate Chi Square Value (0.05)	190.2
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	186.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	21.77	95% Adjusted Gamma UCL (use when n<50)	22.25

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.879	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.26	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.303	Mean of logged Data	2.868
Maximum of Logged Data	3.689	SD of logged Data	0.314

Assuming Lognormal Distribution

95% H-UCL	21.81	90% Chebyshev (MVUE) UCL	23.1
95% Chebyshev (MVUE) UCL	25.22	97.5% Chebyshev (MVUE) UCL	28.17
99% Chebyshev (MVUE) UCL	33.95		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	21.55	95% Jackknife UCL	21.78
95% Standard Bootstrap UCL	21.35	95% Bootstrap-t UCL	23.82
95% Hall's Bootstrap UCL	36.46	95% Percentile Bootstrap UCL	21.79
95% BCA Bootstrap UCL	22.79		
90% Chebyshev(Mean, Sd) UCL	24.06	95% Chebyshev(Mean, Sd) UCL	26.58
97.5% Chebyshev(Mean, Sd) UCL	30.08	99% Chebyshev(Mean, Sd) UCL	36.95

Suggested UCL to Use			
95% Student's-t UCL	**21.78**	**or 95% Modified-t UCL**	**21.98**
or 95% H-UCL	**21.81**		

Thallium

General Statistics

Total Number of Observations	14	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	0.17	Mean	0.643
Maximum	3	Median	0.29
SD	0.766	Std. Error of Mean	0.205
Coefficient of Variation	1.192	Skewness	2.576

Normal GOF Test

Shapiro Wilk Test Statistic	0.632	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.319	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.005	95% Adjusted-CLT UCL (Chen-1995)	1.13
		95% Modified-t UCL (Johnson-1978)	1.029

Gamma GOF Test

A-D Test Statistic	1.302	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.753	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.297	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.233	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	1.356	k star (bias corrected MLE)	1.113
Theta hat (MLE)	0.474	Theta star (bias corrected MLE)	0.578
nu hat (MLE)	37.96	nu star (bias corrected)	31.16
MLE Mean (bias corrected)	0.643	MLE Sd (bias corrected)	0.609
		Approximate Chi Square Value (0.05)	19.4
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	18.18

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.032	95% Adjusted Gamma UCL (use when n<50)	1.102

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.851	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.261	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	-1.772	Mean of logged Data	-0.854
Maximum of Logged Data	1.099	SD of logged Data	0.848

Assuming Lognormal Distribution

95% H-UCL	1.111	90% Chebyshev (MVUE) UCL	1.019
95% Chebyshev (MVUE) UCL	1.213	97.5% Chebyshev (MVUE) UCL	1.482
99% Chebyshev (MVUE) UCL	2.012		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0.98	95% Jackknife UCL	1.005
95% Standard Bootstrap UCL	0.968	95% Bootstrap-t UCL	1.44
95% Hall's Bootstrap UCL	2.104	95% Percentile Bootstrap UCL	0.994
95% BCA Bootstrap UCL	1.167		
90% Chebyshev(Mean, Sd) UCL	1.257	95% Chebyshev(Mean, Sd) UCL	1.535
97.5% Chebyshev(Mean, Sd) UCL	1.921	99% Chebyshev(Mean, Sd) UCL	2.68

Suggested UCL to Use	
95% Chebyshev (Mean, Sd) UCL	**1.535**

Zinc

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	48	Mean	176.4
Maximum	902	Median	96.5
SD	220.2	Std. Error of Mean	58.86
Coefficient of Variation	1.248	Skewness	3.14

Normal GOF Test

Shapiro Wilk Test Statistic	0.567	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.286	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	280.7	95% Adjusted-CLT UCL (Chen-1995)	326
		95% Modified-t UCL (Johnson-1978)	288.9

Gamma GOF Test

A-D Test Statistic	0.985	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.751	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.21	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.233	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.473	k star (bias corrected MLE)	1.205
Theta hat (MLE)	119.7	Theta star (bias corrected MLE)	146.4
nu hat (MLE)	41.25	nu star (bias corrected)	33.75
MLE Mean (bias corrected)	176.4	MLE Sd (bias corrected)	160.7
		Approximate Chi Square Value (0.05)	21.46
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	20.17

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	277.4	95% Adjusted Gamma UCL (use when n<50)	295.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.172	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.871	Mean of logged Data	4.797
Maximum of Logged Data	6.805	SD of logged Data	0.789

Assuming Lognormal Distribution

95% H-UCL	283.4	90% Chebyshev (MVUE) UCL	268.8
95% Chebyshev (MVUE) UCL	317.7	97.5% Chebyshev (MVUE) UCL	385.6
99% Chebyshev (MVUE) UCL	518.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	273.2	95% Jackknife UCL	280.7
95% Standard Bootstrap UCL	268.8	95% Bootstrap-t UCL	478.4
95% Hall's Bootstrap UCL	605.9	95% Percentile Bootstrap UCL	288.8
95% BCA Bootstrap UCL	353.3		
90% Chebyshev(Mean, Sd) UCL	353	95% Chebyshev(Mean, Sd) UCL	433
97.5% Chebyshev(Mean, Sd) UCL	544	99% Chebyshev(Mean, Sd) UCL	762.1

Suggested UCL to Use

95% Adjusted Gamma UCL	295.2

UCL Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.11/10/2020 5:19:46 PM
From File	Background metals UCL input.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Selenium

General Statistics

Total Number of Observations	14	Number of Distinct Observations	6
Number of Detects	5	Number of Non-Detects	9
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	0.64	Minimum Non-Detect	20
Maximum Detect	3.3	Maximum Non-Detect	20
Variance Detects	1.265	Percent Non-Detects	64.29%
Mean Detects	1.298	SD Detects	1.125
Median Detects	0.89	CV Detects	0.867
Skewness Detects	2.179	Kurtosis Detects	4.8
Mean of Logged Detects	0.0493	SD of Logged Detects	0.656

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.648	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.432	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.343	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.298	KM Standard Error of Mean	0.503
KM SD	1.006	95% KM (BCA) UCL	2.236
95% KM (t) UCL	2.189	95% KM (Percentile Bootstrap) UCL	2.103
95% KM (z) UCL	2.125	95% KM Bootstrap t UCL	8.117
90% KM Chebyshev UCL	2.807	95% KM Chebyshev UCL	3.491
97.5% KM Chebyshev UCL	4.44	99% KM Chebyshev UCL	6.304

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.846	Anderson-Darling GOF Test	
5% A-D Critical Value	0.684	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.418	Kolmogorov-Smirnov GOF	
5% K-S Critical Value	0.36	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.518	k star (bias corrected MLE)	1.141
Theta hat (MLE)	0.515	Theta star (bias corrected MLE)	1.138
nu hat (MLE)	25.18	nu star (bias corrected)	11.41
Mean (detects)	1.298		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

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)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.326
Maximum	3.3	Median	0.905
SD	1.038	CV	0.783
k hat (MLE)	1.157	k star (bias corrected MLE)	0.957
Theta hat (MLE)	1.146	Theta star (bias corrected MLE)	1.386
nu hat (MLE)	32.4	nu star (bias corrected)	26.79
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (26.79, α)	15.99	Adjusted Chi Square Value (26.79, β)	14.89
95% Gamma Approximate UCL (use when n>=50)	2.222	95% Gamma Adjusted UCL (use when n<50)	2.386

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.298	SD (KM)	1.006
Variance (KM)	1.012	SE of Mean (KM)	0.503
k hat (KM)	1.664	k star (KM)	1.355
nu hat (KM)	46.6	nu star (KM)	37.95
theta hat (KM)	0.78	theta star (KM)	0.958
80% gamma percentile (KM)	2.03	90% gamma percentile (KM)	2.773
95% gamma percentile (KM)	3.499	99% gamma percentile (KM)	5.15

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (37.95, α)	24.84	Adjusted Chi Square Value (37.95, β)	23.44
95% Gamma Approximate KM-UCL (use when n>=50)	1.983	95% Gamma Adjusted KM-UCL (use when n<50)	2.101

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.757	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.38	Lilliefors GOF Test
5% Lilliefors Critical Value	0.343	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.259	Mean in Log Scale	0.0493
SD in Original Scale	0.859	SD in Log Scale	0.604
95% t UCL (assumes normality of ROS data)	1.666	95% Percentile Bootstrap UCL	1.639
95% BCA Bootstrap UCL	1.703	95% Bootstrap t UCL	1.922
95% H-UCL (Log ROS)	1.827		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.0493	KM Geo Mean	1.051
KM SD (logged)	0.587	95% Critical H Value (KM-Log)	2.171
KM Standard Error of Mean (logged)	0.294	95% H-UCL (KM -Log)	1.777
KM SD (logged)	0.587	95% Critical H Value (KM-Log)	2.171
KM Standard Error of Mean (logged)	0.294		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	6.892	Mean in Log Scale	1.498
SD in Original Scale	4.372	SD in Log Scale	1.178
95% t UCL (Assumes normality)	8.961	95% H-Stat UCL	24.62

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use	
95% KM (Chebyshev) UCL	**3.491**
Warning: Recommended UCL exceeds the maximum observation	

APPENDIX E

ELECTRONIC COPIES OF HISTORIC SAMPLING AND TESTING REPORTS

Most, if not all, of the content in Appendix E is posted at gsa.gov/goodfellowreading room. Due to the large file size, GSA extracted them here. If you want to receive Appendix E content, please make a request by emailing r6environmental@gsa.gov or calling 816-391-8462.