



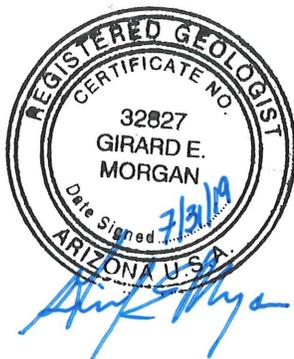
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**REMEDIAL INVESTIGATION WORK PLAN
VERSION 2
Building 1122
ChemResearch Company, Inc.
1101 West Hilton Avenue
Phoenix, Arizona 85007**

**Submitted to:
Arizona Department of Environmental Quality
Mr. Thomas Titus
Remedial Projects Unit
1100 West Washington Street
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**Submitted by:
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**ATC Project No. 1052000111
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1.0 INTRODUCTION AND BACKGROUND

ChemResearch Company, Inc. (CRC) retained ATC Group Services LLC (ATC) to prepare this Remedial Investigation (RI) Work Plan for submittal to the Arizona Department of Environmental Quality (ADEQ) Remedial Projects Unit (RPU). The purpose of the RI Work Plan is to provide a facility history; provide a review of previous environmental investigations and remediation efforts that have been completed at the facility; identify data gaps that need to be addressed in order to prepare the Draft RI Report; develop a Preliminary Site Conceptual Model (SCM); present an investigation methodology that is defensible and meets current regulatory standards and guidelines; develop a phased approach to address known data gaps; and, develop a project schedule that will deliver a Draft RI Report to the Remedial Projects Unit within 18 months of receiving approval of this RI Work Plan.

The statement of justification for conducting the tasks presented in this RI Work Plan is contained in Arizona Administrative Code (AAC) R18-406(A), the purpose of the RI is to:

- Establish the nature and extent of contamination and the sources thereof,
- Identify current and potential impacts to public health, welfare and the environment,
- Identify current and reasonably foreseeable uses of land and waters of the state, and
- Obtain and evaluate any other information necessary for identification and comparison of alternative remedial action.

CRC Building 1122 (Facility) is located in an industrial area at 1122 West Hilton Avenue in Phoenix, Arizona (Figure 1, Site Vicinity Map). The Facility lies in the NW/4 of the SW/4 of Section 18, Township 1 North, Range 2 East of the Gila and Salt River Baseline and Meridian. As depicted on the ADEQ Map provided in Appendix A, the Facility is situated within the extreme southeastern portion of the ADEQ West Van Buren Water Quality Assurance Revolving Fund (WQARF) Registry Site. The Facility is bounded on the north by a Santa Fe Railroad spur; on the east by an industrial building; on the south by West Hilton Avenue; and, on the west by an alleyway that separates it from CRC's Building 1130 which is used primarily as a warehouse (Figure 2, Site Map).

1.1 Facility History

The Facility was developed in an existing industrial area of south Phoenix between 1953 and 1955 by Hezzie and Helen Longwood. The site was originally occupied by the Francis Plating Company. Francis Plating Company's primary operation was hard chrome plating. CRC took over the hard chrome plating business in 1959 and is the current occupant of the Facility (Hargis + Associates, Inc. [H+A], 2006). Prior to the excavation of impacted soil in the vicinity of the East Bay in June of 1995 and West Bay in July of 2017, the process lines operated over trenches and pits the bottom of which was composed of bare soil. Plating operations were relocated to the North Bay subsequent to the excavation of the East Bay in 1995. The North

Bay has always operated over a system of concrete and high density polyethylene liner (HDPL) trenches and pits. The East Bay area concrete lined floor and trenches also employ an HDPL system. The West Bay plating operation was relocated to the East Bay in the spring of 2017. In July 2017, impacted soil beneath the West Bay was excavated, refilled with aggregate base material and covered with six-inches of reinforced concrete to match the existing floor of the Facility (ATC, 2017).

The plating process involves taking various items made of metal and covering that item with a prescribed thickness of another metal such as chrome, nickel, copper, etc. Historically the process involved cleaning or degreasing the item to be plated with solvents containing tetrachloroethylene (PCE) prior to submerging the item in trough containing the metal to be plated in aqueous phase. Modern cleaning solvents do not typically contain PCE.

According to CRC personnel, the use of products containing PCE to clean items prior to plating was discontinued in 1995. PCE is not used currently in the plating operation at the Facility. A list of chemicals stored and used at the Facility is contained in Appendix B.

1.2 Environmental Assessment Summary

In August 1990, Pegler-Welch reportedly advanced eight soil borings in the East Bay (A,B,C and 2), West Bay (3 and 4) and the alley (8) between the Facility and CRC's Building 1130 (Figure 3, Pegler-Welch [1990] Soil Boring Locations Map). Soil samples collected at depths ranging from one to 14 feet below grade (FBG) were analyzed for metals and volatile organic compounds (VOC). Laboratory analysis revealed the presence of total chromium ranging from 26 to 1,100 milligrams per kilogram (mg/kg) and PCE ranging from 0.0102 to 0.053 mg/kg (H+A, 1995). It is not clear as to what triggered an investigation at the facility. Details of this report are based on historical reports (ATC has not located a copy of this report for review). As of the date of this RI Work Plan ATC has been able to locate only seven boring locations (Figure 3).

ADEQ contracted Roy F. Weston (Weston; 1993) to conduct a soil vapor survey in the vicinity of the Facility in October 1992. Forty-four sample locations were sampled at depths of five FBG and five and 15 FBG (Figure 4, ADEQ [1992] Soil Vapor Survey Map). The collected samples were analyzed for VOC. PCE was detected at all but two of the sample locations (Table 1, Summary of Soil Vapor Sample Analytical Data). ADEQ (2019) recommends using 1,567 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) as the soil vapor screening level for PCE. This value ($1,567 \mu\text{g}/\text{m}^3$) was derived from the U.S. Environmental Protection Agency (EPA) Regional Screening Level of $47 \mu\text{g}/\text{m}^3$ for Industrial Air and an attenuation factor of 0.03.

Geotechnical Environmental Consultants, Inc. (GEC) conducted a limited investigation to address comments made by ADEQ to the Remedial Action Plan (RAP)-1 in April 1994 (H+A, 1995). GEC advanced five soil borings (B-1 through B-5) located in the vicinity of the East Bay

(Figure 5, GEC [1994] Soil Boring Locations Map). The soil borings were reportedly advanced to depths of five to 14 FBG. Collected samples were analyzed for chromium. The reported range of total chromium concentrations in soil was from 20.3 to 223 mg/kg (H+A, 1995). As of the date of this RI Work Plan ATC has not been able to locate a copy of the GEC report for review.

In 1995, H+A (1997) advanced 14 shallow (two FBG) soil borings located in the East Bay (SS-09 through SS-16) and West Bay (SS-17 through SS-22) areas (Figure 6, H+A [1995] Soil Boring Locations Map). Soil samples, collected at 0.5 and two FBG, were subjected to analysis of metals and VOC (Table 2, Summary of Soil Sample Laboratory Analytical Data). These samples were collected prior to the excavation of the East Bay area (Section 1.3) and contained detectable concentrations of chromium and PCE (Table 2). Subsequent to the completion of the East Bay excavation H+A collected 11 soil samples (HE-1 through HE-11) at the sidewalls of the excavation and three soil samples (VE-1 through VE-3) at the base of the excavation (Figure 7, Post-Excavation Soil Sample Locations [1995 & 2017] Map). As of the date of this RI Work Plan, ATC has not been able to locate the laboratory reports for soil samples HE-1 through HE-11 and VE-1 through VE-3. In addition to the soil investigation, H+A installed groundwater monitor well CMW-3 located approximately 3,600 feet northwest of the Facility (Figure 8, Groundwater Monitor & Production Well Locations Map). The well was reportedly screened from 70 to 130 FBG. Laboratory analysis of groundwater samples collected at monitor well CMW-3 indicated the presence of dissolved phase PCE, benzene, ethylbenzene, toluene, m,p-xylene, chloroform and total chromium.

At the request of ADEQ (H+A, 1999), H+A advanced exploratory borehole CX-1 (located approximately 20 feet north of groundwater monitor well CMW-1; Figure 3) to a depth of approximately 238 FBG in July 1998. The exploratory borehole was intended to be drilled to a depth sufficient to encounter the first significant fine-grained layer. The first fine-grained layer, described as well-cemented, silty clay, was encountered at approximately 232 FBG and continued to at least 238 FBG (maximum depth of exploration). Upon consultation with ADEQ, it was decided to construct a groundwater monitor well (designated as CMW-1D) screened from approximately 194 to 234 FBG with a blank casing sump from 234 to 235 FBG. The purpose of monitor well CMW-1D was to determine the vertical extent of dissolved phase contaminants and the potential presence of dense non-aqueous phase liquids (DNAPL) trapped by the fine-grained layer encountered at 232 FBG. Following well development, groundwater samples were collected at 220 FBG and the sump at monitor well CMW-1D on three occasions (August 10, August 17 and October 2, 1998) and compared with the results of samples collected at monitor well CMW-1 on the same dates. The laboratory analytical results (Table 3, Summary of Historical Groundwater Gauging and Laboratory Analytical Data) indicated that there is no DNAPL and dissolved phase total chromium, hexavalent chromium

and PCE were not present at concentrations exceeding their ADEQ established Aquifer Water Quality Standards (AWQS).

In December 1998, H+A (1999) installed groundwater monitor wells CMW-4 and CMW-5 between the Facility and monitor well CMW-3 (Figure 8). Both wells were installed to a depth of approximately 90 FBG and screened from approximately 60 to 90 FBG (Appendix C). Results of the initial sampling event at these wells (December 28, 1998) indicated the presence of dissolved phase total chromium and hexavalent chromium at concentrations below their ADEQ established AWQS and dissolved phase PCE at a concentration exceeding its ADEQ established AWQS (Table 3).

In March 2015, Cardno installed groundwater monitor well CMW-1M to a depth of approximately 193 FBG (Appendix C). The well is located approximately 20 feet north of monitor well CMW-1D (Figure 3). The well was screened with the intent to sample the saturated zone at discrete levels to determine the vertical extent of contaminants at the source area. The initial sampling event took place on April 1, 2015. During the initial sampling event groundwater samples were collect at the vadose/saturated zone interface interval (93 FBG) and at 15 foot vertical intervals to a depth of 185 FBG. A review of the laboratory analytical data (Table 3) indicates that dissolved phase PCE, nickel and hexavalent chromium were present in the groundwater sample collected at 185 FBG at concentrations exceeding their ADEQ established AWQS. With the exception of the sample collected at 93 FBG, groundwater samples were collected using a pneumatically operated depth specific sampler. The groundwater sample collected at 93 FBG was collected using a new disposable bailer.

With the approval of ADEQ, ATC conducted a soil investigation of the North Bay and Waste Water Treatment Area (WWTA) in August 2016. ATC advanced 20 hand augered soil borings (Figure 9, ATC [2016] Soil Boring Locations Map) to depths ranging from less than one foot (SB-3) to 11 FBG. Laboratory analysis of the collected samples (Table 2) indicate the presence of adsorbed phase PCE, cadmium, total chromium, lead, nickel and hexavalent chromium.

Groundwater monitoring and sampling has taken place on a periodic basis since July 25, 1995 (Table 3). The most recent event was conducted at monitor wells CMW-1, CMW-1M and CMW-1D on February 15, 2019. The network of wells being monitored and sampled has varied over the years but generally consists of the following wells: CMW-1, CMW-1M, CMW-1D, CMW-2, CMW-3, CMW-4, CMW-5, WVB-1, WVB-2, WVB-3, WVB-4, AVB69-01, AVB69-02, AVB69-02R, AVB88-01 and AVB140-01 (Figure 8). Since October 1995, groundwater levels have dropped approximately 43 feet causing the following wells to be dry: CMW-1, CMW-2, CMW-4, CMW-5, WVB-1, WVB-2, WVB-3 and WVB-4. ATC calculated an average flow direction and gradient using a 3-point solution (monitor wells CMW-1, WVB-1 and WVB-4) on a quarterly basis from October 1995 through January 2012 (after which the aforementioned wells

were dry). The resulting calculations (Table 4, Historical Flow Direction and Gradient) indicate an average gradient of 0.003 on a bearing of 295 degrees (west-northwest; Figure 10, Groundwater Flow Direction Rose Diagram [1995-2012]). Given the location of the source area at the Facility (the East Bay and West Bay) groundwater monitor wells CMW-1, CMW-1M, CMW-1D, WVB-4, CMW-3 through CMW-5, AVB69-01, AVB69-02 and AVB69-02R are located downgradient of the source area. In addition, considering the physical constraints (buildings) and the historic flow direction (west-northwest), groundwater monitor wells CMW-1, CMW-1M and CMW-1D collectively provide adequate source well data. Also, considering the aforementioned physical constraints and strong preferential west-northwest flow direction, groundwater monitor well CMW-2 provided (prior to going dry) a relatively ideal location to monitor the water quality entering the area beneath the Facility.

1.3 Remediation Summary

Remediation at the Facility has consisted of removing impacted soil from beneath the East Bay in 1995 and beneath the West Bay in 2017. In WQARF terminology these excavations would be designated as Early Response Actions. Engineering controls include the concrete floor and trenches lined with HDPL in the North Bay and East Bay and concrete flooring in the West Bay.

Excavation and disposal of impacted soil beneath the East Bay area was conducted by H+A in 1995. The excavated area was limited by the physical constraints (exterior walls and roof support column footers) of the Facility (H+A, 1995). Limited laboratory analysis (Table 2) of the sidewall soil samples (HE-1 through HE-11) and samples collected at the base of the excavation (VE-1 through VE-3; Figure 7) indicate the presence of adsorbed phase total chromium ranging from 13.5 (HE-3) to 4,150 (HE-9) mg/kg. The depth of the samples collected along the sidewalls of the excavation is reported as being near the ground surface by H+A (1995). Soil beneath the concrete flooring in the East Bay area is described as being silty sand from 10 to 12 FBG where cobbles and gravel with sand is encountered. The excavated soil was reportedly containerized in 83 roll-off bins, characterized and disposed of offsite (H+A, 1995).

ATC (2017), completed the excavation of the West Bay area in July 2017. As with the East Bay area, the excavation was limited laterally due to the building foundation and support column footers. Soil underlying the concrete floor consisted of silty sand to a depth of approximately 12 FBG. It was noted the floor trench did not have a concrete base, but was open to the underlying soil (Figure 11, Trench Designs). It was also noted that a cinder block walled pit (with a soil base) and two concrete walled, soil base pits were located along the western wall of the West Bay area (Figure 7). All three of these pits were installed to a depth of approximately 10 FBG. Excavated soil (approximately 226 cubic yards) was loaded into 34 roll-off bins, characterized and disposed of at Southwest Regional Landfill in Buckeye, Arizona (22 roll-off bins) and at the U.S. Ecology facility in Beatty, Nevada (12 roll-off bins). Soil samples

collected along the sidewalls (SW-1 through SW-11) and at the base of the excavation (B-1 through B-12; Figure 7) were found to contain adsorbed phase concentrations of PCE, cadmium, total chromium, lead, nickel and hexavalent chromium (Table 2). The excavation was backfilled with compacted aggregate base course and a six-inch thick layer of reinforced concrete which is doweled into the existing concrete floor to prevent horizontal and vertical movement.

There is evidence (Appendix D and Appendix E) that concentrations of dissolved phase contaminants are decreasing or remaining steady at the source area wells (CMW-1, CMW-1M and CMW-1D). Since the only remediation efforts to date have been the removal of impacted soil at the East Bay and West Bay, the conclusion is that this remediation effort has been effective.

1.4 Site Contaminants

Site contaminants, or chemicals of concern (COC), are contaminants that are detected during environmental investigations that exceed an ADEQ established Tier 1 Cleanup Level for groundwater (the AWQS) or soil (the residential soil remediation levels [rSRL] or Groundwater Protection Levels [GPL]). As mentioned above, ADEQ has not established a Tier 1 Cleanup Level for soil vapor, but has derived a screening level for vapor phase PCE (ADEQ, 2019).

Based on the historical soil vapor (Table 1), soil (Table 2) and groundwater (Table 3) laboratory analytical data, the COC associated with the Facility as of the time this RI Work Plan was prepared appear to be PCE, hexavalent chromium and nickel in groundwater; PCE, hexavalent chromium, lead and cadmium in soil; and, PCE in soil vapor.

It should be noted that ADEQ has established rSRLs for trivalent chromium (120,000 mg/kg) and hexavalent chromium (30 mg/kg), but not total chromium. Some of the historical data in Table 2 presents concentrations of total chromium. These concentrations represent the sum of the trivalent and hexavalent chromium ions and should not be used to “estimate” the respective concentrations of these ions. The only way to determine the actual concentration of hexavalent chromium and chromium is to run analytical test specific to quantifying the concentration of hexavalent chromium (EPA Method 7196A) and chromium (EPA Method 6010B). Trivalent chromium does not have an approved test method and is typically estimated using the difference between the chromium and hexavalent chromium concentrations.

1.5 Contaminant Sources

The sources of the COC observed at the Facility are most likely attributable to the practices performed during the plating process and the fact that historical practices were not particularly geared toward being environmentally friendly. The construction of the trenches in the 1950s (Figure 11) allowed spillage and water used to wash down the floor to saturate the silty sand

horizon directly beneath the floor of the Facility and percolate downward through the underlying cobbles and gravel to eventually impact groundwater. It should be noted that dissolved phase PCE and chromium have been detected in groundwater monitor wells located up-gradient (CMW-2, WVB-2, WVB-3 and AVB40-01; Table 3; Figure 8). This suggested that there may be additional COC source(s) located to the southeast of the Facility.

H+A (2004) conducted a study to determine if potential offsite sources were impacting groundwater in the vicinity of the Facility. The study concluded, based on a very limited data set, that there could be potential sources of the same COC identified at the Facility located up-gradient of the Facility.

1.6 Preliminary Site Conceptual Model

Figure 12, Preliminary Site Conceptual Model, illustrates the potential exposure routes for the known COC to reach a potential receptor. Under the current land use (commercial/industrial) exposure pathways to residential receptors are not applicable. Based on historical use, it is unlikely that there is a scenario where residential housing would be constructed at, or in the vicinity of, the Facility. Given that assumption the potential current and future onsite receptors would include commercial and construction workers. Offsite residential potable groundwater exposure could be a potential current and future pathway.

Based on the historical investigations that have been conducted at the Facility (Section 1.2), the contaminated media at and in the vicinity of the Facility includes soil vapor; surficial (0 to 15 FBG) soil; and, groundwater. Subsurface (>15 FBG) soil is composed primarily of cobbles, gravel and sand and is not likely to have significant amounts of adsorbed phase COC. However, the composition of the subsurface soil may contain soil vapors emanating from the groundwater and the surficial soil. Under these conditions, there may be a potential pathway to both commercial and construction workers onsite.

Figure 13, Site Conceptual Model, depicts the location of impacted soil, soil vapor and groundwater beneath the Facility. The efforts to remove impacted soil beneath the East Bay and West Bay were hampered by the foundation of the building and the footers for the roof supports. Therefore, there is a volume of soil that cannot be removed without jeopardizing the structural integrity of the Facility. Soil vapors have not been investigated since 1992, and the current conditions are unknown. As previously noted, groundwater beneath the Facility is impacted with dissolved phase PCE, hexavalent chromium and nickel.

Based on site visits and conversations with CRC personnel, there are no dry wells or water production wells located onsite. Potable water for the Facility is supplied through the City of Phoenix distribution system.

1.7 Data Gaps

Based on a review of the historical investigations (Section 1.2), remediation efforts (Section 1.3), site COC (Section 1.4), sources of contamination (Section 1.5) and the Preliminary SCM (Section 1.6), ATC has identified the following data gaps that should be addressed in this RI Work Plan:

- Current soil vapor conditions.
- Extent of impacted surficial soil to the east and west of the areas excavated at the East Bay and West Bay.
- Migration, if any, of COC from the southeast (up-gradient) of the Facility.
- The current extent of COC impacted groundwater northwest (down-gradient) of the Facility.
- The determination that natural attenuation of dissolved phase contaminants is taking place at a reasonable rate.

2.0 PROPOSED REMEDIAL INVESTIGATION ACTIVITIES

The activities proposed in the following sections are designed to provide the data necessary to address the data gaps listed in Section 1.7 and define potential exposure routes discussed in Section 1.6 and illustrated on Figure 12. The investigation activities are intended to be utilized in a phased approach and expanded, if necessary, to address conditions that become evident as data is collected and evaluated. If major modifications are deemed necessary to address conditions encountered in the field, ATC will, if directed to do so by the ADEQ RPU Project Manager, prepare a written modification to this RI Work Plan for submittal to ADEQ. Minor modifications to the proposed activities will be communicated with the ADEQ RPU Project Manager via telephone and/or email.

Field activities will be conducted in general accordance with ATC's Standard Operating Procedures (SOP) for indoor air quality (IAQ) sampling, soil vapor sampling, soil sampling, groundwater monitor well installation and groundwater sampling. The SOP are contained in Appendix F.

ATC will notify the ADEQ RPU Project Manager at least 48-hours prior to conducting field activities. It is anticipated that if the ADEQ RPU Project Manager makes a visit to the project site, that they will have in their possession suitable personal protective equipment and read and abide by the HASP. As field data (boring logs, well completion diagrams, etc.) and laboratory data become available it will be transmitted to the ADEQ RPU Project Manager electronically in a timely manner.

2.1 Soil Vapor and Indoor Air

In order to evaluate the current soil vapor and indoor air conditions, ATC and CRC propose to conduct an IAQ survey; collect soil vapor samples from the surficial (0 to 15 FBG) soil horizon; and collect soil vapor samples from the subsurface soil horizon underlying the facility.

The need for, and design, of an IAQ survey will be determined after ATC conducts soil vapor sampling beneath the concrete slab floor of CRC Buildings 1122 and 1130 and consultation with the ADEQ RPU Project Manager. If deemed necessary, an ATC Industrial Hygienist will design the IAQ survey.

To determine the current soil vapor conditions in the vicinity of the Facility, ATC and CRC will collect soil vapor samples at as many as 17 soil vapor sample locations (Figure 14, Proposed Soil Vapor and Soil Sample Locations Map). Depending on the physical access to the selected locations, the soil vapor sample temporary well boring will be advanced using a skid-steer mounted direct-push rig or by hand auger. For the seven soil vapor sample locations within the confines of either CRC Building 1122 or 1130 (SV-1 through SV-7) a temporary soil vapor well will be set immediately below the concrete slab. At the 10 locations situated outside of CRC Buildings 1122 and 1130 (SV-8 through SV-17; Figure 14) temporary soil vapor wells will be constructed at a depth of 15 FBG or direct-push, hand-auger refusal, whichever is shallower. Prior to setting and sampling the temporary well (Appendix G) a soil sample will be collected at the terminus of borings SV-6 through SV-11 and SV-14 and SV-15 (Figure 14) for analysis of cadmium, chromium, lead and nickel utilizing EPA Method 6010B and hexavalent chromium using EPA Method 7196A by an Arizona Department of Health Services (ADHS)-certified laboratory. Construction, equilibration and sampling of the temporary soil vapor well will be conducted in accordance with ADEQ's *Soil Vapor Sampling Guidance* (dated July 10, 2008 and Revised April 21, 2017, Appendix G). As noted in the aforementioned guidance, if a soil vapor well is completed using the direct-push method it will be allowed to equilibrate for a minimum of 30 minutes prior to purging and sampling; if a well is installed in a hand-augered boring it will be allowed to equilibrate a minimum of 48 hours prior to purging and sampling. The collected samples will be analyzed for VOC utilizing EPA Method TO-15 by an ADHS-certified laboratory. If the laboratory analytical data indicates that the known COC in soil vapor (PCE) or another VOC is detected at a concentration that is deemed a COC, ATC and CRC, upon consultation with the ADEQ RPU Project Manager, may expand the scope of work defined in this work plan. Based on comments provided by the ADEQ RPU Project Manager (ADEQ, 2019), ATC will utilize the soil vapor data to calculate the concentrations of VOC in soil using the 3-Phase Partitioning Equation, provided by ADEQ.

Based on the currently available information, the soil stratigraphy beneath the site consists of silty sand from the below the concrete slab floor to a depth of nine to 12 FBG; cobbles, gravel and sand (sometimes termed "river run") to approximately 232 FBG; and, well cemented silty

clay from approximately 232 to at least 238 FBG (H+A, 1999). The current (gauged on February 14, 2019) depth to groundwater at the Facility (groundwater monitor well CMW-1M, Figure 3) is approximately 103 FBG (Table 3). Groundwater monitor well CMW-1 (reportedly screened from 60 to 90 FBG) is currently dry and is screened in the current vadose zone. In order to determine soil vapor conditions in the subsurface soil (>15 FBG) horizon above the water table, ATC and CRC propose to conduct a soil vapor recovery test utilizing monitor well CMW-1 as the extraction well. The test will utilize a trailer mounted 250-cubic foot per minute (cfm) blower equipped with granulated activated carbon (GAC) treatment vessels. The blower will be connected via flexible hose to monitor well CMW-1 and extract soil vapor for two hours at a rate of 150-cfm. After two hours the flow rate will be increased to 250-cfm and continue for an additional six hours, or until a measureable vacuum (0.01 inches of water) is observed at groundwater monitor well CMW-2 (Figure 8). During the test ATC will monitor and record the influent and effluent vapor stream using a photoionization detector. Vacuum readings will be recorded at periodic intervals at monitor wells CMW-1M and CMW-2 during the test period. Soil vapor samples will be collected at two hour operating intervals (total of four samples) and analyzed for VOC utilizing EPA Method TO-15 by an ADHS-certified laboratory. The soil vapor analytical results will be used to determine (Section 1.4) if there are vapor phase COC within the vadose zone and, if the data is of adequate quality, utilize ADEQ's approved methodology (3-Phase Partitioning Equation) to convert soil vapor concentrations to total contaminant concentrations (ADEQ, 2014). The collected test data can also be used to, if warranted, design a vapor extraction system to recover COC within the vadose zone.

2.2 Surficial Soil

Surficial soil is the portion of the soil column that occurs from the surface to a depth of 15 FBG. Surficial soil is a potential exposure pathway of COC due to ingestion and/or dermal contact by onsite workers, construction workers and residents. Since there are no residential properties in proximity of the Facility, the potential receptors would include onsite and construction workers (Figure 12). ADEQ developed soil remediation standards (Arizona Administrative Code Title 18, Chapter 7, Article 2; [Soil Rule]) in December 1997. The standards established risk-based cleanup levels for soil remediation activities. For this RI Work Plan, the COC are defined as those chemical compounds, metallic elements and metallic ions that exceed the residential non-carcinogen or the 10^{-5} risk carcinogen cited in Appendix A of the Soil Rule. Based on the historical data, the current COC in surficial soil are PCE, cadmium and hexavalent chromium.

Historical investigations and remediation of the surficial soil indicate that the majority of COC impacted soil in the vicinity of the East Bay and West Bay has been removed. The remaining COC impacted soil is located beneath the footers of the building and the roof supports and, due to structural integrity of the building concerns, will remain in place (Figure 13). There is a relatively small volume of hexavalent chromium impacted surficial soil situated adjacent to the lined pits in the North Bay (Figure 9 and Table 2). Between the historical investigations and

remediation activities conducted inside of the Facility, ATC and CRC believe that additional investigation is not warranted within the footprint of Building 1122 (Figure 3 through Figure 7 and Figure 9; Table 2) except along the east wall of the building as detailed below.

Subsequent to the collection of the soil vapor samples discussed in Section 2.1, the temporary soil vapor sample well will be removed and the boring will be advanced to refusal (expected to occur at approximately nine to 12 FBG). A soil sample will be collected just above the refusal depth at the eight boring locations shown on Figure 14 (SV-6 through SV-11, SV-14 and SV-15) for analysis of VOC using EPA Method 8260B, hexavalent chromium utilizing EPA Method 7196A and cadmium and nickel utilizing EPA Method 6010B by an ADHS-certified laboratory. The analytical laboratory will be instructed to insure that minimum laboratory detection limits (MDL) are below the applicable ADEQ established rSRL and GPL.

Based on the laboratory analytical data derived from the soil samples collected at up to eight boring locations (Figure 14) and the comparison to the Appendix A standards in the Soil Rule and the GPLs, ATC, CRC and the ADEQ RPU Project Manager will review the laboratory results of this phase of the investigation and determine if additional investigative activities are warranted and technically feasible. If additional investigative activity is warranted, ATC and CRC will, at the request of the ADEQ RPU Project Manager, prepare an addendum to this RI Work Plan that reflects the scope of the additional investigative efforts.

2.3 Subsurface Soil

Subsurface soil is generally defined as the soil column between approximately 15 FBG and the soil bedrock interface. The subsurface soil beneath the facility consists of cobbles, gravel and sand to a depth of approximately 232 FBG, which is underlain by well cemented silty clay to at least 238 FBG (H+A, 1999). Due to the soil type, collecting viable soil samples for laboratory analysis is generally not feasible. Therefore, ATC and CRC are not proposing to collect subsurface soil samples for laboratory analysis. The collection of soil vapor samples, as proposed in Section 2.1, should be sufficient to evaluate the current conditions of the subsurface soil beneath the Facility.

2.4 Groundwater

Groundwater is present at a depth of approximately 103 FBG under unconfined conditions (ATC, 2019). Flow is toward the west-northwest (Figure 10) under a hydraulic gradient of approximately 0.003 (Table 4). Historic sampling data (Table 3) indicates groundwater at and downgradient of the Facility contains dissolved phase COC (PCE, hexavalent chromium and nickel). At source wells (CMW-1M and CMW-1D) it is evident that dissolved phase COC extend to a depth of approximately 185 to 200 FBG (Table 3).

Due to declining groundwater levels (roughly 43 feet since 1995; Table 3), groundwater monitor wells installed by CRC as part of the investigations at the Facility (CMW-1, CMW-2, CMW-4

and CMW-5; Figure 8) and groundwater monitor wells installed on behalf of ADEQ as part of the West Van Buren WQARF Site investigation (WVB-1, WVB-2, WVB-3[AVB146-01] and WVB-4; Figure 8) are currently dry. Monitor well CMW-3 is reportedly completed to a depth of 130 FBG (H+A, 1999), but is located in a fenced backyard and is typically not accessible. The last reported sampling event at well CMW-3 was in April 2003. The reported concentration of dissolved phase PCE was 28 micrograms per liter ($\mu\text{g/L}$); total chromium was reported as non-detect (without a specified MDL); hexavalent chromium and nickel were reportedly not analyzed (Table 3). Groundwater monitor wells located upgradient of the Facility (CMW-2, WVB-2 and WVB-3[AVB146-01]) have not been sampled since January 2012, April 2003 and May 1997, respectively.

As mentioned earlier (Section 1.2), the laboratory data suggests that concentrations of dissolved phase COC at the source area (CMW-1M; Figure 8, Appendix D and Appendix E) have been declining since the excavations of the East Bay and West Bay took place in 1995 and 2017, respectively. At this time the nearest groundwater monitor wells that are downgradient of the release area and deep enough to penetrate the current water table (excluding well CMW-3) are AVB69-01 and AVB69-02R. These wells are nearly 4,000 feet west-northwest of the release area (Figure 8). Monitor well AVB69-01 has a long history of monitoring but samples have only been collecting for laboratory analysis since February of 2017. During the time frame of February 2017 through May 2018 (six events conducted by ATC) dissolved phase COC have not been detected at concentrations exceeding their ADEQ established AWQS (Table 3 and Appendix D). Monitor wells AVB69-02 and AVB69-02R (replacement well for AVB69-02) have a long history of gauging and sampling. Since February 2017, dissolved phase nickel has been the only COC to exceed its AWQS (Table 3 and Appendix D).

Groundwater monitor well AVB88-01 has been included in the monitoring well network for the Facility since April 2003. Based on the areal relationship between the source area and monitor well AVB88-01 (Figure 8), it seems likely that it is not really appropriate to be part of the monitor well network for this RI Work Plan. ATC and CRC do not propose to monitor and sample well AVB88-01 as part of this RI Work Plan.

ADEQ has made mention of using groundwater monitor wells associated with the 19th Avenue Landfill Superfund Site (Figure 8) to aid in delineating the extent of dissolved phase COC. Based on information provided by ADEQ at the Project Kickoff Meeting on March 8, 2019, the only well that appears to be located within the projected COC migration path (based on the historical west-northwest flow direction, Table 4 and Figure 10) from the Facility is DM-4 which is located approximately 2,000 feet due west of the Facility (Figure 8). ATC and CRC will attempt to determine if groundwater monitor well DM-4 has been impacted due to the release at the Facility by reviewing the well monitoring and sampling history. If warranted, attempts will be

made to access the well in order to collect gauging and water quality monitoring data concurrent with data collected at the proposed network of monitor wells. Based on the reported total depth and screened interval at monitor well DM-4 (110 to 150 FBG) it should contain groundwater.

Based on the current depth to water in the vicinity of the Facility, it is necessary to drill and install two new groundwater monitor wells (tentatively identified as CMW-2R and WVB-4R) at, or near, the locations shown on Figure 15, Proposed New Groundwater Monitor Well Locations Map. The new wells will be drilled utilizing the Rotosonic method to a depth deep enough to intersect but not penetrate the well cemented silty clay identified at well CMW-1D (estimated to be approximately 230 to 240 FBG). Both wells are located using the historic groundwater flow direction of west-northwest with respect to the Facility. Proposed monitor well CMW-2R will be located within a reasonable radius of currently dry monitor well CMW-2 and is intended to determine the quality of the groundwater entering the vicinity of the Facility. Proposed monitor well WVB-4R will be located within a reasonable proximity of currently dry monitor well WVB-4 and is intended to evaluate groundwater quality at a distance of approximately 1,000 feet downgradient of the Facility. In an effort to define the vertical extent of groundwater contamination, groundwater samples will be collected during drilling operations utilizing a Simulprobe (or equivalent sampling device; Appendix F). Groundwater samples will be collected at 20-foot vertical intervals below the water table until the vertical extent has been delineated to the AWQS established for the COC at the site (PCE, cadmium, chromium, lead, nickel and hexavalent chromium). If the vertical delineation of COC has not been achieved prior to encountering the well cemented silty clay at a depth of approximately 230 to 240 FBG, ATC will consult with the ADEQ RPU Project Manager as to proceeding with drilling and sampling activities. Groundwater samples collected using the Simulprobe (or similar sampling device) will be analyzed for VOC utilizing EPA Method 8260B, cadmium, chromium, lead and nickel using EPA Method 6010C and hexavalent chromium utilizing EPA Method 7196A. The wells will be constructed of Schedule 80 polyvinylchloride with a screened interval extending from no more than 10 feet above static water level to depth to be determined subsequent to evaluation of the laboratory analytical data collected during the well drilling process (Figure 16, Proposed Monitor Well Construction Diagram: CMW-2R and WVB-4R). Figure 17, Cross-Section A-A', illustrates the relationship with the existing and proposed wells parallel to the historic flow direction. The exact location of the proposed monitor wells will be dependent upon securing access to the property through a license agreement. Subsequent to the drilling and completion of proposed monitor wells CMW-2R and WVB-4R, all of the well elevations and coordinate locations will be surveyed by an Arizona-registered land surveyor.

Subsequent to installation of proposed groundwater monitor wells CMW-2R and WVB-4R, the newly installed wells and existing monitor wells CMW-1M, CMW-1D, CMW-3 (if accessible) and AVB69-02R will be gauged and sampled on a quarterly basis for a minimum of four quarters.

The newly installed wells and monitor wells CMW-1M and CMW-1D will be sampled at the vadose/saturated zone interface using a new disposal bailer and at 15-foot vertical intervals to the base of the well at monitor wells CMW-1M, CMW-2R and WVB-4R using a depth-specific, pneumatically operated sampler (Appendix H). Monitor well CMW-1D will be sampled at depths of 200, 215 and 230 FBG utilizing the depth specific sampler. Groundwater monitor wells CMW-3 (if accessible) and AVB69-02R will be sampled using a low-flow protocol with the pump set at the midpoint of the saturated screen interval. Groundwater gauging and sampling procedures are detailed in Appendix F. Collected groundwater samples will be analyzed for dissolved phase VOC utilizing EPA Method 8260B, cadmium, total chromium, lead and nickel using EPA Method 6010B and hexavalent chromium using EPA Method 7196A. The purpose of the well installation and sampling is to confirm currently known COC and confirm the vertical extent of COC impacts.

2.5 Investigative Derived Waste (IDW)

During the course of this RI IDW (soil cuttings, development water and rinseate water) will be generated. This material will be stored in appropriate containers (typically 55-gallon drums or lined roll off bins with lockable lids), labeled and stored onsite. Subsequent to characterization of the material, as required by the specific disposal facility, the waste will be transported to an approved disposal facility by a qualified hauler within 90 days of being generated.

Documentation as to the characterization and disposal of IDW will be presented in the RI Report.

2.6 Non-Field Investigative Activities

Some of the tasks that need to be completed for the Draft RI Report are not entirely associated with field sample collection and laboratory analysis (AAC R18-16-406.C). These tasks include assessing the following factors:

- Physical characteristics of the site, including important surface features, soils, geology, hydrogeology, meteorology, and ecology;
- The extent and general characteristics of the hazardous substance released, including physical state, concentrations, toxicity, propensity to bioaccumulate, persistence, and mobility;
- The extent, general characteristics, and the degree of the source of the release;
- Current and reasonably foreseeable exposure routes for the hazardous substances released, such as inhalation, ingestion and dermal;
- Other factors, such as sensitive populations, that pertain to the characterization of the site or support of the analysis of potential remedies; and

- Current and reasonably foreseeable impacts to aquatic and terrestrial biota.

Actions to assess the aforementioned factors will likely include a combination of site visits, input from a project chemist and/or Risk Assessor and researchers to review available public files regarding the location of potential sensitive populations. Based on the location of the Facility, it is unlikely that there is a potential impact to aquatic and terrestrial biota.

In addition to the topics listed above, AAC R18-16-406.D requires that the RI include the collection of information regarding current and reasonably foreseeable (within 100 years) uses of land and waters of the state that have been or are threatened by the release. In summary, the RI must contain information regarding current and reasonably foreseeable uses of:

- Water for each aquifer that is impacted or threatened to be impacted by the release and the location and uses of existing wells, water management plans.
- Water for each segment of surface water impacted or threatened to be impacted by the release.
- Land impacted, or threatened to be impacted, by the release within the community involvement area.

In order to determine the effects on the aquifers and surface waters, ATC will contact the affected water providers and well owners within and adjacent to the impacted area. Based on current conditions it is unlikely that the Salt River is, or will be, impacted by the CRC Building 1122 releases. ATC will contact current land owners and the City of Phoenix to determine potential future uses of the properties affected, or potentially affected by the CRC Building 1122 releases.

The Draft RI Report will include a Land and Water Resource Study; updating data, if it becomes available through review of historical reports to Tables 1, 2 and 3 presented in this RI Work Plan and likely to be presented in the Draft RI Report; revision of map figures presented in this RI Work Plan, if warranted through additional review of historical documents; revision of the Preliminary CSM as data from the various phases of the field investigations are amassed; and, any other items of note that are unearthed during the execution of this RI Work Plan.

3.0 QUALITY ASSURANCE PROJECT PLAN

As set forth above, the purpose of this RI is to delineate the vertical and lateral extent of vapor, adsorbed and dissolved phase COC associated with the release attributable to the facility. In order to insure the quality of the data that is collected during this investigation, ATC and CRC will follow portions of the ADEQ Remedial Project Section *Quality Assurance Program Plan* (ADEQ, 2017; Appendix I) as a Quality Assurance Project Plan (QAPP) for this project. The following sections detail specific elements of the QAPP that will be used to guide this project.

3.1 Data Quality Objectives

Data quality objectives (DQO) are quantitative and qualitative criteria developed using systematic planning to clarify the objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. The DQO decision making process is described in EPA's *Guidance for the Data Quality Objectives Process*, dated, August 2000. For this project the DQO are intended to address three potential areas of concern:

- Is the quality of the data such that it can be used to make an informed decision or estimate regarding the extent of impacted soil vapor, soil and groundwater?
- Did the sampling design (proposed sample locations and laboratory analyses) perform as intended?
- Was sufficient data collected to support the findings presented in the RI Report?

Based on ATC's experience and professional judgement, the proposed sample locations and laboratory analytical methods are sufficient to delineate the extent of the COC currently found at the Facility. The laboratory analytical methods have MDL that are substantially lower than the ADEQ established rSRL and AWQS. Soil vapor samples will be analyzed using EPA Method TO-15 which has VOC MDL that are well below the unofficial target cleanup levels discussed in Section 1.4. As the investigation progresses the ADEQ RPU Project Manager will be updated as data becomes available and conferred with on a regular basis via telephone. Through this process it is anticipated that changes to this RI Work Plan can be implemented with the goal being to meet the DQO.

3.2 Data Quality Indicators

The data quality indicators (DQI): precision, accuracy, representativeness, completeness, comparability and method detection limits, refer to quality control (QC) criteria established for various aspects of data gathering, sampling or analysis activity. In defining DQI specifically for this project, the level of uncertainty associated with each measurement is defined.

3.2.1 Precision

Precision is the degree of mutual agreement between or among independent measurements of a similar property. Precision is usually reported, depending on the end use of the data, either as relative percent difference (RPD) or standard deviation. The equation for RPD is provided below:

$$\text{RPD} = (\text{Sample} - \text{Sample Duplicate} / 0.5 [\text{Sample} + \text{Sample Duplicate}]) \times 100$$

Field precision will be assessed through the collection and analysis of duplicate samples (one duplicate for every 20 soil samples). Water matrix samples can be readily duplicated due to their homogeneous nature (RPD 20 percent or less of the primary sample result); however, the duplication of soil samples is typically more difficult due to their non-homogeneous nature. Consequently, target soil RPD will be within 35 percent of the primary sample result. Soil vapor samples typically display a wide range of RPD between the primary and duplicate sample even through the samples are collected using a “splitter” in-trained in the recovery/sample collection tubing and are collected virtually simultaneously. Duplicate recoveries beyond these ranges may require further qualification of associated data, but data will not be rejected unless determined unusable by data verification.

Laboratory precision will be based upon laboratory Matrix Spike/ Matrix Spike Duplicate (MS/MSD) analyses. The laboratory will perform MS/MSD analyses at a rate of one for every 20 investigative samples. If one or more sample results fall outside the laboratory acceptance criteria, they will be flagged. Flagged samples will not be re-extracted and analyzed.

3.2.2 Accuracy

Accuracy is the degree of agreement of a measurement with a known or true value. To determine accuracy, a laboratory or field value is compared to a known or true concentration. The field and laboratory accuracy objectives are identified as follows.

Field accuracy will be assessed by evaluating the results of equipment and trip blank samples using the same procedures as laboratory samples. Since the type and area of contamination at the Facility is likely consistent throughout, one equipment blank will be performed for each day of sampling.

Laboratory accuracy is determined by such QC indicators as matrix spikes, surrogate spikes, laboratory control samples (blank spikes) and performance samples. If one or more sample results fall outside the laboratory acceptance criteria, they will be flagged. Flagged samples will not be re-extracted and analyzed.

3.2.3 Representativeness

Representativeness is the expression of the degree to which data accurately and precisely represent a characteristic of an environmental condition or a population. The field and laboratory representativeness objectives are identified as follows.

Field representativeness will be accomplished by adhering to the sampling and analytical procedures (Appendix F) and methods used to avoid false positives and false negatives.

If any deviations occur, they are to be noted in the field record and an assessment is to be made regarding any impact to data representativeness. Laboratory representativeness cannot be quantified, but will be achieved through adherence to prescribed analytical methods and procedures to produce laboratory data representative of site conditions and usable for determinations regarding the Facility. Use of laboratory-specific SOP and sub-sampling routines set forth in the laboratory-specific Quality Assurance (QA) Manual will produce uniform data that represent conditions sufficient for this investigation.

3.2.4 Completeness

Completeness is expressed as the percent of valid usable data actually obtained compared to the amount that was expected. Sometimes, due to a variety of circumstances, either not all samples scheduled to be collected can be collected or else the data from samples cannot be used (for example, samples lost, bottles broken, instrument failures, laboratory mistakes, etc.). The field and laboratory completeness objectives are identified as follows.

Field completeness will be 85 percent or better for non-critical samples and 90 percent or better for critical samples. Samples will be considered critical if they are subject to definitive analyses and compared to the ADEQ established rSRL or AWQS. Non-critical samples will involve field screening samples used to direct the investigation in the field.

The laboratory completeness objective is for 95 percent of the field samples to be analyzed, with greater than 90 percent meeting QA/QC objectives.

3.2.5 Comparability

Comparability expresses the degree of confidence with which one data set can be compared to another. Comparability also refers to the reporting of data in comparable units so direct comparisons are simplified. For example, this avoids comparison of $\mu\text{g}/\text{m}^3$ for PCE compared to PCE reported in parts per million discussions.

Field comparability will be achieved by conducting field work consistently per this RI Work Plan and relevant SOP (Appendix F). This approach will ensure that samples are properly collected, handled, and analyzed for comparable evaluation. On-site sample locations will be documented using global positioning system technology, surveying, and/or field measurements from on-site reference points to assist in comparing data sets collected at various investigative phases.

Laboratory comparability will be achieved when the data are collected and preserved in the same manner followed by analysis with the same standard regulatory method and

laboratory MDL. Laboratory data comparability will therefore be achieved through consistent application of standard EPA methods and associated QC protocols.

3.3 Data Review and Verification

Data verification will be performed by qualified ATC personnel, who will not otherwise be involved in the sampling activities. The data verification will consist of a review of the laboratory reports to identify analytical issues or deficiencies that might affect data quality and the DQO of this project. The data verification will consist of the elements discussed below, and will be performed on 50 percent of the data. A completeness check will be performed on 100 percent of the data.

The analytical laboratory perform an internal data review in accordance with their laboratory-specific QA manual. The vast majority of QA tasks are required by and the results calculated automatically by the laboratory.

3.3.1 Completeness Check

A completeness check will be performed on 100 percent of the laboratory analytical data and shall include a review of:

- Case narrative.
- Chain of custody documentation.
- Sample condition upon receipt report.

The completeness check is designed to ensure that:

- All the collected samples are present.
- QC is present for every sample collected.
- The most technically valid result is reported for each compound.

3.3.2 Data Verification Criteria

Data verification shall be performed on 50 percent of the data and will include, but is not limited to, reviewing the:

- Completeness, as defined above.
- Case narrative, including but not limited to, a description of non-conformances and corrective actions that were taken, plus anomalies, deficiencies and QC problems that are identified by the laboratory.

- Chain of custody documentation and original chain of custody forms with identification numbers and laboratory receipt signatures, dates and times.
- Sample condition upon receipt, including cooler temperature and shipping documentation.
- Timeliness and a check for errors, including requested deliverables, preservation and holding times.
- Sample analysis results, with quantitation limits and reporting limits checked against the DQO and verification of dry weights and dilutions.
- QC summary including but not limited to, method blanks, continuing calibration blanks and preparation blanks; surrogate percent recoveries, spike percent recoveries and relative percent differences; and, laboratory QC check sample and laboratory control sample recoveries.
- Field duplicates, if identified, for which reproducibility shall be evaluated.
- Reporting Limits (RL).
- Laboratory duplicates.

3.3.3 Data Qualifier Flags

The EPA has published standardized data qualifier flags (i.e., B, J, UJ, NJ and R) that are used by the laboratory in qualifying analytical results. Any data that is associated with a QC exceedance will be designated by the laboratory using the EPA data qualifier flags to flag the sample results associated with the exceedance.

The data qualification scheme is the basis for determining whether sample results should be qualified, but the user's judgment is also critical in determining whether data quality and usability have been systematically influenced and whether data points require qualification.

Problems or questions about analytical data quality that may require corrective action will be brought to the attention of the laboratory in writing by ATC. The request may be initiated if QC results exceed method or project criteria; reporting or flagging errors are identified; or, to request information that has not been reported. The laboratory's response shall include a written explanation of the problem, a plan and a schedule for corrective action and/or a re-issuance of laboratory reports or electronic data files. If significant data quality problems have occurred and the data are critical to decision making, samples may be need to be re-collected and re-analyzed.

3.3.4 Data Verification Reports

The ATC reviewer will prepare a data review report for each sample delivery group, including:

- A case narrative including, but not limited to, a list of recommended flags; a listing of the items reviewed and the criteria used to evaluate them; a discussion of any problems or QC exceedances associated with the actual analysis that might impact the sample integrity or data quality; and, a summary of all laboratory contacts in which all communications with the laboratory, if any, are identified.
- The marking of recommended qualifier flags on the laboratory reports and/or in electronic data deliverables. Flags that are marked on hard copy shall be marked directly on copies of the laboratory reports in a contrasting color.

3.4 Data Management

ATC field personnel will maintain a field log to document field activities. Documentation will contain the project name and number, date and identification of personnel completing the document (printed name, signature and initials). Information will be entered on the field log at the time the information is generated.

While being used in the field, the field log will remain with the ATC field personnel at all times. At the end of each field day, the notes will be reviewed and information compared to ensure that the information is accurate and complete. Upon completion of all field activities, the field log will be filed and secured at ATC's Tempe office. Photocopies of the original field log will be used as working documents.

Chain of custody forms will be checked against the sample labels and field notes prior to shipping or delivering the samples to the laboratory. Laboratory analytical reports will be reviewed to ensure that the sample information is accurate. The analytical results will be compiled in one or more tables for the RI Report, and the completed data tables will be double-checked against the laboratory analytical report.

4.0 REMEDIAL INVESTIGATION REPORT

At the conclusion of the RI a Draft RI Report will be submitted to the ADEQ RPU Project Manager for review and comment. The report will contain a narrative of the activities that took place in order to complete the RI, tables and figures to augment the narrative and supporting documentation as appendices. A tentative Table of Contents for the Draft RI Report is presented in Appendix J. It is understood that the tentative Table of Contents is subject to minor changes as the RI progresses. Subsequent to addressing comments by the ADEQ RPU Project Manager and public, the Draft RI Report will be finalized as the RI Report.

5.0 PROJECTED SCHEDULE

The anticipated project schedule for this RI Work Plan is presented in Appendix K. As with any project schedule, there are various factors that may affect the anticipated time line. These factors include, but are not limited to: access to private or municipal properties to install or sample groundwater monitor wells, contractor availability and other factors that are beyond the control of ATC and/or CRC. Adjustments to the project schedule will be discussed with the ADEQ RPU Project Manager via telephone and/or email and an updated schedule will be provided on a quarterly basis (or as requested by ADEQ) throughout the execution of this RI Work Plan.

6.0 COMMUNITY INVOLVEMENT

Community involvement activities associated with the RI activities presented in this RI Work Plan will be conducted in accordance with AAC R18-16-404.D. These activities, as related to the RI, include the following:

- General Public Notice – A public notice for field work will be prepared and distributed to those in the vicinity of the work who may be impacted by the work. The notice will provide a general description of the field work and anticipated adverse impacts (i.e., noise, traffic, disposal of potentially hazardous material, etc.).
- Remedial Objectives – The process for establishing remedial objectives will be followed as outlined by AAC R18-16-406.F through R18-16-406.J. ADEQ will be responsible for preparing the Remedial Objectives Report.

7.0 HEALTH AND SAFETY PLAN

As specified in AAC R18-16-406.B.2.e, a site-specific Health and Safety Plan (HASP) has been prepared by ATC for the field activities to be conducted at the Facility and is included as Appendix L. The HASP is consistent with 29 Code of Federal Regulations 1910.120.

8.0 SAMPLING AND ANALYSIS PLAN

In order to be in compliance with AAC R18-16-406.B.f, ATC prepared a Sampling and Analysis Plan (SAP) that is included as Appendix M. The SAP specifies the sampling protocol, methodology and laboratory requirements that will be utilized during the RI activities conducted at the facility.

9.0 REFERENCES

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- H+A, 1995. Summary Report, Remedial Action Plan RAP-1, ChemResearch Co., Inc., Phoenix, Arizona. October 26.
- Roy F. Weston, 1993. Results of Soil Gas Sampling, West Van Buren Project Area. January 5.

TABLES

TABLE 1
SUMMARY OF SOIL VAPOR SAMPLE LABORATORY ANALYTICAL DATA

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Sample Identification (Sample Date: October 26 to 30, 1992)	BM-01-05	BM-02-05	CL-01-05	CL-02-05	CL-03-05	CL-04-05	CL-05-05	CR-01-05	CR-02-05A	CR-02-05B
Benzene	---	---	---	---	---	---	---	---	---	---
Toluene	---	---	---	---	---	---	---	---	---	---
Ethylbenzene	---	---	---	---	---	---	---	---	---	---
m&p-Xylene	---	---	---	---	---	---	---	---	---	---
o-Xylene	---	---	---	---	---	---	---	---	---	---
1,2-Dichloroethane (1,2-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane (1,1-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene (1,1-DCE)	<10	<10	<10	170	160	200	<10	<10	<10	<10
1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	---	---	---	---
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---	---	---
2-Butanone (MEK)	---	---	---	---	---	---	---	---	---	---
2-Hexanone	---	---	---	---	---	---	---	---	---	---
2-Propanol (IPA)	---	---	---	---	---	---	---	---	---	---
4-Ethyltoluene	---	---	---	---	---	---	---	---	---	---
4-Methyl-2-pentanone (MIBK)	---	---	---	---	---	---	---	---	---	---
Acetone	---	---	---	---	---	---	---	---	---	---
Benzyl Chloride	---	---	---	---	---	---	---	---	---	---
n-Butylbenzene	---	---	---	---	---	---	---	---	---	---
Carbon disulfide	---	---	---	---	---	---	---	---	---	---
Chloroform	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene (1,2 DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cyclohexane	---	---	---	---	---	---	---	---	---	---
1,4-Dioxane	---	---	---	---	---	---	---	---	---	---
Ethanol	---	---	---	---	---	---	---	---	---	---
Ethyl acetate	---	---	---	---	---	---	---	---	---	---
Heptane	---	---	---	---	---	---	---	---	---	---
n-Hexane	---	---	---	---	---	---	---	---	---	---
Isopropylbenzene	---	---	---	---	---	---	---	---	---	---
Methyl tert-butyl ether (MTBE)	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	---	---	---	---	---	---	---	---	---	---
Naphthalene	---	---	---	---	---	---	---	---	---	---
Nonane	---	---	---	---	---	---	---	---	---	---
Octane	---	---	---	---	---	---	---	---	---	---
Propene (Propylene)	---	---	---	---	---	---	---	---	---	---
n-Propylbenzene	---	---	---	---	---	---	---	---	---	---
sec-Butylbenzene	---	---	---	---	---	---	---	---	---	---
Styrene	---	---	---	---	---	---	---	---	---	---
Tetrachloroethene (PCE)	120,000	210,000	76,000	52,000	65,100	67,000	245,000	66,000	460,000	550,000
Trichloroethylene (TCE)	<10	<10	1,500	<10	<10	1,700	<10	<10	4,300	2,700
Dichlorodifluoromethane (F-12)	---	---	---	---	---	---	---	---	---	---
Dichlorotetrafluoroethane (F-114)	---	---	---	---	---	---	---	---	---	---
1,2-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---
1,3-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---
Trans-1,3-Dichloropropene	---	---	---	---	---	---	---	---	---	---
Bromodichloromethane	---	---	---	---	---	---	---	---	---	---
Dibromochloromethane	---	---	---	---	---	---	---	---	---	---
Tetrahydrofuran	---	---	---	---	---	---	---	---	---	---
trans-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (F-11)	---	---	---	---	---	---	---	---	---	---
Trichlorotrifluoroethane (F-113)	---	---	---	---	---	---	---	---	---	---
tert-Butylbenzene	---	---	---	---	---	---	---	---	---	---
1,1,1-Trichloroethane (1,1,1-TCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane (1,1,2-TCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Other VOC Detected	---	---	---	---	---	---	---	---	---	---

Volatile Organic Compound (VOC)
 All results reported in micrograms per cubic meter (µg/m³).

TABLE 1
SUMMARY OF SOIL VAPOR SAMPLE LABORATORY ANALYTICAL DATA

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Sample Identification (Sample Date: October 26 to 30, 1992)	CR-03-05	CR-03-15	CR-04-05	CR-04-15	CR-05-05A	CR-05-05B	CR-06-00	CR-06-05	CR-07-05	CR-08-15
Benzene	---	---	---	---	---	---	---	---	---	---
Toluene	---	---	---	---	---	---	---	---	---	---
Ethylbenzene	---	---	---	---	---	---	---	---	---	---
m&p-Xylene	---	---	---	---	---	---	---	---	---	---
o-Xylene	---	---	---	---	---	---	---	---	---	---
1,2-Dichloroethane (1,2-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane (1,1-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene (1,1-DCE)	210	170	<10	<10	<10	<10	<10	<10	<10	<10
1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	---	---	---	---
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---	---	---
2-Butanone (MEK)	---	---	---	---	---	---	---	---	---	---
2-Hexanone	---	---	---	---	---	---	---	---	---	---
2-Propanol (IPA)	---	---	---	---	---	---	---	---	---	---
4-Ethyltoluene	---	---	---	---	---	---	---	---	---	---
4-Methyl-2-pentanone (MIBK)	---	---	---	---	---	---	---	---	---	---
Acetone	---	---	---	---	---	---	---	---	---	---
Benzyl Chloride	---	---	---	---	---	---	---	---	---	---
n-Butylbenzene	---	---	---	---	---	---	---	---	---	---
Carbon disulfide	---	---	---	---	---	---	---	---	---	---
Chloroform	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene (1,2 DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cyclohexane	---	---	---	---	---	---	---	---	---	---
1,4-Dioxane	---	---	---	---	---	---	---	---	---	---
Ethanol	---	---	---	---	---	---	---	---	---	---
Ethyl acetate	---	---	---	---	---	---	---	---	---	---
Heptane	---	---	---	---	---	---	---	---	---	---
n-Hexane	---	---	---	---	---	---	---	---	---	---
Isopropylbenzene	---	---	---	---	---	---	---	---	---	---
Methyl tert-butyl ether (MTBE)	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	---	---	---	---	---	---	---	---	---	---
Naphthalene	---	---	---	---	---	---	---	---	---	---
Nonane	---	---	---	---	---	---	---	---	---	---
Octane	---	---	---	---	---	---	---	---	---	---
Propene (Propylene)	---	---	---	---	---	---	---	---	---	---
n-Propylbenzene	---	---	---	---	---	---	---	---	---	---
sec-Butylbenzene	---	---	---	---	---	---	---	---	---	---
Styrene	---	---	---	---	---	---	---	---	---	---
Tetrachloroethene (PCE)	330,000	450,000	270,000	800,000	1,100,000	1,100,000	860	500,000	580,000	680,000
Trichloroethylene (TCE)	780	1,800	600	1,840	13,200	12,000	<10	3,100	<10	2,200
Dichlorodifluoromethane (F-12)	---	---	---	---	---	---	---	---	---	---
Dichlorotetrafluoroethane (F-114)	---	---	---	---	---	---	---	---	---	---
1,2-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---
1,3-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---
Trans-1,3-Dichloropropene	---	---	---	---	---	---	---	---	---	---
Bromodichloromethane	---	---	---	---	---	---	---	---	---	---
Dibromochloromethane	---	---	---	---	---	---	---	---	---	---
Tetrahydrofuran	---	---	---	---	---	---	---	---	---	---
trans-1,2-Dichlororoethene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (F-11)	---	---	---	---	---	---	---	---	---	---
Trichlorotrifluoroethane (F-113)	---	---	---	---	---	---	---	---	---	---
tert-Butylbenzene	---	---	---	---	---	---	---	---	---	---
1,1,1-Trichloroethane (1,1,1-TCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane (1,1,2-TCA)	<10	<10	<10	<10	<10	<10	140	<10	<10	<10
Vinyl Chloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Other VOC Detected	---	---	---	---	---	---	---	---	---	---

Volatile Organic Compound (VOC)
All results reported in micrograms per cubic meter (µg/m³).

TABLE 1
SUMMARY OF SOIL VAPOR SAMPLE LABORATORY ANALYTICAL DATA

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Sample Identification (Sample Date: October 26 to 30, 1992)	HL-01-05	HL-02-05	HL-03-05	HL-03A-05A	HL-03A-05B	HL-04-05	HL-05-05	HL-06-05	IW-01A-05	IW-01-05
Benzene	---	---	---	---	---	---	---	---	---	---
Toluene	---	---	---	---	---	---	---	---	---	---
Ethylbenzene	---	---	---	---	---	---	---	---	---	---
m&p-Xylene	---	---	---	---	---	---	---	---	---	---
o-Xylene	---	---	---	---	---	---	---	---	---	---
1,2-Dichloroethane (1,2-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane (1,1-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene (1,1-DCE)	<10	<10	<10	<10	180	<10	<10	<10	<10	<10
1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	---	---	---	---
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---	---	---
2-Butanone (MEK)	---	---	---	---	---	---	---	---	---	---
2-Hexanone	---	---	---	---	---	---	---	---	---	---
2-Propanol (IPA)	---	---	---	---	---	---	---	---	---	---
4-Ethyltoluene	---	---	---	---	---	---	---	---	---	---
4-Methyl-2-pentanone (MIBK)	---	---	---	---	---	---	---	---	---	---
Acetone	---	---	---	---	---	---	---	---	---	---
Benzyl Chloride	---	---	---	---	---	---	---	---	---	---
n-Butylbenzene	---	---	---	---	---	---	---	---	---	---
Carbon disulfide	---	---	---	---	---	---	---	---	---	---
Chloroform	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene (1,2 DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cyclohexane	---	---	---	---	---	---	---	---	---	---
1,4-Dioxane	---	---	---	---	---	---	---	---	---	---
Ethanol	---	---	---	---	---	---	---	---	---	---
Ethyl acetate	---	---	---	---	---	---	---	---	---	---
Heptane	---	---	---	---	---	---	---	---	---	---
n-Hexane	---	---	---	---	---	---	---	---	---	---
Isopropylbenzene	---	---	---	---	---	---	---	---	---	---
Methyl tert-butyl ether (MTBE)	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	---	---	---	---	---	---	---	---	---	---
Naphthalene	---	---	---	---	---	---	---	---	---	---
Nonane	---	---	---	---	---	---	---	---	---	---
Octane	---	---	---	---	---	---	---	---	---	---
Propene (Propylene)	---	---	---	---	---	---	---	---	---	---
n-Propylbenzene	---	---	---	---	---	---	---	---	---	---
sec-Butylbenzene	---	---	---	---	---	---	---	---	---	---
Styrene	---	---	---	---	---	---	---	---	---	---
Tetrachloroethene (PCE)	<10	770,000	<10	310,000	380,000	650,000	260,000	64,600	100,000	75,200
Trichloroethylene (TCE)	<10	<10	<10	2,100	1,300	3,100	<10	<10	<10	<10
Dichlorodifluoromethane (F-12)	---	---	---	---	---	---	---	---	---	---
Dichlorotetrafluoroethane (F-114)	---	---	---	---	---	---	---	---	---	---
1,2-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---
1,3-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---
Trans-1,3-Dichloropropene	---	---	---	---	---	---	---	---	---	---
Bromodichloromethane	---	---	---	---	---	---	---	---	---	---
Dibromochloromethane	---	---	---	---	---	---	---	---	---	---
Tetrahydrofuran	---	---	---	---	---	---	---	---	---	---
trans-1,2-Dichlororoethene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (F-11)	---	---	---	---	---	---	---	---	---	---
Trichlorotrifluoroethane (F-113)	---	---	---	---	---	---	---	---	---	---
tert-Butylbenzene	---	---	---	---	---	---	---	---	---	---
1,1,1-Trichloroethane (1,1,1-TCA)	<10	7,600	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane (1,1,2-TCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Other VOC Detected	---	---	---	---	---	---	---	---	---	---

Volatile Organic Compound (VOC)
 All results reported in micrograms per cubic meter (µg/m³).

TABLE 1
SUMMARY OF SOIL VAPOR SAMPLE LABORATORY ANALYTICAL DATA

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Sample Identification (Sample Date: October 26 to 30, 1992)	IW-02-05A	IW-02-05B	IW-03-05	IW-04-05	IW-05-05	IW-06-05	IW-07-05	IW-08-05A	IW-08-05B	IW-09-05
Benzene	---	---	---	---	---	---	---	---	---	---
Toluene	---	---	---	---	---	---	---	---	---	---
Ethylbenzene	---	---	---	---	---	---	---	---	---	---
m&p-Xylene	---	---	---	---	---	---	---	---	---	---
o-Xylene	---	---	---	---	---	---	---	---	---	---
1,2-Dichloroethane (1,2-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane (1,1-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene (1,1-DCE)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	---	---	---	---
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---	---	---
2-Butanone (MEK)	---	---	---	---	---	---	---	---	---	---
2-Hexanone	---	---	---	---	---	---	---	---	---	---
2-Propanol (IPA)	---	---	---	---	---	---	---	---	---	---
4-Ethyltoluene	---	---	---	---	---	---	---	---	---	---
4-Methyl-2-pentanone (MIBK)	---	---	---	---	---	---	---	---	---	---
Acetone	---	---	---	---	---	---	---	---	---	---
Benzyl Chloride	---	---	---	---	---	---	---	---	---	---
n-Butylbenzene	---	---	---	---	---	---	---	---	---	---
Carbon disulfide	---	---	---	---	---	---	---	---	---	---
Chloroform	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene (1,2 DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cyclohexane	---	---	---	---	---	---	---	---	---	---
1,4-Dioxane	---	---	---	---	---	---	---	---	---	---
Ethanol	---	---	---	---	---	---	---	---	---	---
Ethyl acetate	---	---	---	---	---	---	---	---	---	---
Heptane	---	---	---	---	---	---	---	---	---	---
n-Hexane	---	---	---	---	---	---	---	---	---	---
Isopropylbenzene	---	---	---	---	---	---	---	---	---	---
Methyl tert-butyl ether (MTBE)	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	---	---	---	---	---	---	---	---	---	---
Naphthalene	---	---	---	---	---	---	---	---	---	---
Nonane	---	---	---	---	---	---	---	---	---	---
Octane	---	---	---	---	---	---	---	---	---	---
Propene (Propylene)	---	---	---	---	---	---	---	---	---	---
n-Propylbenzene	---	---	---	---	---	---	---	---	---	---
sec-Butylbenzene	---	---	---	---	---	---	---	---	---	---
Styrene	---	---	---	---	---	---	---	---	---	---
Tetrachloroethene (PCE)	200,000	240,000	200,000	190,000	110,000	220,000	87,000	59,000	61,000	94,000
Trichloroethylene (TCE)	<10	<10	<10	<10	<10	<10	<10	60	<10	<10
Dichlorodifluoromethane (F-12)	---	---	---	---	---	---	---	---	---	---
Dichlorotetrafluoroethane (F-114)	---	---	---	---	---	---	---	---	---	---
1,2-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---
1,3-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---
Trans-1,3-Dichloropropene	---	---	---	---	---	---	---	---	---	---
Bromodichloromethane	---	---	---	---	---	---	---	---	---	---
Dibromochloromethane	---	---	---	---	---	---	---	---	---	---
Tetrahydrofuran	---	---	---	---	---	---	---	---	---	---
trans-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (F-11)	---	---	---	---	---	---	---	---	---	---
Trichlorotrifluoroethane (F-113)	---	---	---	---	---	---	---	---	---	---
tert-Butylbenzene	---	---	---	---	---	---	---	---	---	---
1,1,1-Trichloroethane (1,1,1-TCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane (1,1,2-TCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Other VOC Detected	---	---	---	---	---	---	---	---	---	---

Volatile Organic Compound (VOC)
All results reported in micrograms per cubic meter (µg/m³).

TABLE 1
SUMMARY OF SOIL VAPOR SAMPLE LABORATORY ANALYTICAL DATA

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Sample Identification (Sample Date: October 26 to 30, 1992)		IW-11-05	IW-11-15	IW-12-15	MI-01-05	MI-02-05A	MI-02-05B	MI-03-05	PM-01-05A	PM-01-05B	PM-02-05A	
Volatile Organic Compound (VOC) All results reported in micrograms per cubic meter (µg/m ³).	Benzene	---	---	---	---	---	---	---	---	---	---	
	Toluene	---	---	---	---	---	---	---	---	---	---	
	Ethylbenzene	---	---	---	---	---	---	---	---	---	---	
	m&p-Xylene	---	---	---	---	---	---	---	---	---	---	
	o-Xylene	---	---	---	---	---	---	---	---	---	---	
	1,2-Dichloroethane (1,2-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	1,1-Dichloroethane (1,1-DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	1,1-Dichloroethene (1,1-DCE)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---	---
	1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---	---
	1,3-Butadiene	---	---	---	---	---	---	---	---	---	---	---
	2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---	---	---	---
	2-Butanone (MEK)	---	---	---	---	---	---	---	---	---	---	---
	2-Hexanone	---	---	---	---	---	---	---	---	---	---	---
	2-Propanol (IPA)	---	---	---	---	---	---	---	---	---	---	---
	4-Ethyltoluene	---	---	---	---	---	---	---	---	---	---	---
	4-Methyl-2-pentanone (MIBK)	---	---	---	---	---	---	---	---	---	---	---
	Acetone	---	---	---	---	---	---	---	---	---	---	---
	Benzyl Chloride	---	---	---	---	---	---	---	---	---	---	---
	n-Butylbenzene	---	---	---	---	---	---	---	---	---	---	---
	Carbon disulfide	---	---	---	---	---	---	---	---	---	---	---
	Chloroform	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	cis-1,2-Dichloroethene (1,2 DCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Cyclohexane	---	---	---	---	---	---	---	---	---	---	---
	1,4-Dioxane	---	---	---	---	---	---	---	---	---	---	---
	Ethanol	---	---	---	---	---	---	---	---	---	---	---
	Ethyl acetate	---	---	---	---	---	---	---	---	---	---	---
	Heptane	---	---	---	---	---	---	---	---	---	---	---
	n-Hexane	---	---	---	---	---	---	---	---	---	---	---
	Isopropylbenzene	---	---	---	---	---	---	---	---	---	---	---
	Methyl tert-butyl ether (MTBE)	---	---	---	---	---	---	---	---	---	---	---
	Methylcyclohexane	---	---	---	---	---	---	---	---	---	---	---
	Naphthalene	---	---	---	---	---	---	---	---	---	---	---
	Nonane	---	---	---	---	---	---	---	---	---	---	---
	Octane	---	---	---	---	---	---	---	---	---	---	---
	Propene (Propylene)	---	---	---	---	---	---	---	---	---	---	---
	n-Propylbenzene	---	---	---	---	---	---	---	---	---	---	---
	sec-Butylbenzene	---	---	---	---	---	---	---	---	---	---	---
	Styrene	---	---	---	---	---	---	---	---	---	---	---
	Tetrachloroethene (PCE)	44,100	200,000	190,000	460,000	640,000	730,000	680,000	28,500	26,700	44,100	
	Trichloroethylene (TCE)	<10	120	<10	<10	14,200	11,100	1,500	<10	<10	<10	<10
	Dichlorodifluoromethane (F-12)	---	---	---	---	---	---	---	---	---	---	---
	Dichlorotetrafluoroethane (F-114)	---	---	---	---	---	---	---	---	---	---	---
	1,2-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---	---
	1,3-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---	---
Trans-1,3-Dichloropropene	---	---	---	---	---	---	---	---	---	---	---	
Bromodichloromethane	---	---	---	---	---	---	---	---	---	---	---	
Dibromochloromethane	---	---	---	---	---	---	---	---	---	---	---	
Tetrahydrofuran	---	---	---	---	---	---	---	---	---	---	---	
trans-1,2-Dichlororoethene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	
Trichlorofluoromethane (F-11)	---	---	---	---	---	---	---	---	---	---	---	
Trichlorotrifluoroethane (F-113)	---	---	---	---	---	---	---	---	---	---	---	
tert-Butylbenzene	---	---	---	---	---	---	---	---	---	---	---	
1,1,1-Trichloroethane (1,1,1-TCA)	<10	<10	<10	<10	<10	<10	<10	140	120	90		
1,1,2-Trichloroethane (1,1,2-TCA)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	
Vinyl Chloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	
Other VOC Detected	---	---	---	---	---	---	---	---	---	---	---	

TABLE 1
SUMMARY OF SOIL VAPOR SAMPLE LABORATORY ANALYTICAL DATA

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Sample Identification (Sample Date: October 26 to 30, 1992)		PM-02-05B	SO-01-05	SO-02-05	SO-03-05	SO-03-15	SO-04-05
Volatile Organic Compound (VOC) All results reported in micrograms per cubic meter (µg/m ³).	Benzene	---	---	---	---	---	---
	Toluene	---	---	---	---	---	---
	Ethylbenzene	---	---	---	---	---	---
	m&p-Xylene	---	---	---	---	---	---
	o-Xylene	---	---	---	---	---	---
	1,2-Dichloroethane (1,2-DCA)	<10	<10	<10	<10	<10	<10
	1,1-Dichloroethane (1,1-DCA)	<10	<10	<10	<10	<10	<10
	1,1-Dichloroethene (1,1-DCE)	<10	<10	<10	<10	<10	80
	1,2,4-Trimethylbenzene	---	---	---	---	---	---
	1,3,5-Trimethylbenzene	---	---	---	---	---	---
	1,3-Butadiene	---	---	---	---	---	---
	2,2,4-Trimethylpentane	---	---	---	---	---	---
	2-Butanone (MEK)	---	---	---	---	---	---
	2-Hexanone	---	---	---	---	---	---
	2-Propanol (IPA)	---	---	---	---	---	---
	4-Ethyltoluene	---	---	---	---	---	---
	4-Methyl-2-pentanone (MIBK)	---	---	---	---	---	---
	Acetone	---	---	---	---	---	---
	Benzyl Chloride	---	---	---	---	---	---
	n-Butylbenzene	---	---	---	---	---	---
	Carbon disulfide	---	---	---	---	---	---
	Chloroform	<10	<10	<10	<10	<10	<10
	cis-1,2-Dichloroethene (1,2 DCA)	<10	<10	<10	<10	<10	<10
	Cyclohexane	---	---	---	---	---	---
	1,4-Dioxane	---	---	---	---	---	---
	Ethanol	---	---	---	---	---	---
	Ethyl acetate	---	---	---	---	---	---
	Heptane	---	---	---	---	---	---
	n-Hexane	---	---	---	---	---	---
	Isopropylbenzene	---	---	---	---	---	---
	Methyl tert-butyl ether (MTBE)	---	---	---	---	---	---
	Methylcyclohexane	---	---	---	---	---	---
	Naphthalene	---	---	---	---	---	---
	Nonane	---	---	---	---	---	---
	Octane	---	---	---	---	---	---
	Propene (Propylene)	---	---	---	---	---	---
	n-Propylbenzene	---	---	---	---	---	---
	sec-Butylbenzene	---	---	---	---	---	---
	Styrene	---	---	---	---	---	---
	Tetrachloroethene (PCE)	42,700	48,000	2,900	12,900	13,700	75,000
	Trichloroethylene (TCE)	<10	<10	<10	<10	<10	<10
	Dichlorodifluoromethane (F-12)	---	---	---	---	---	---
	Dichlorotetrafluoroethane (F-114)	---	---	---	---	---	---
	1,2-Dichlorobenzene	---	---	---	---	---	---
	1,3-Dichlorobenzene	---	---	---	---	---	---
	Trans-1,3-Dichloropropene	---	---	---	---	---	---
	Bromodichloromethane	---	---	---	---	---	---
	Dibromochloromethane	---	---	---	---	---	---
	Tetrahydrofuran	---	---	---	---	---	---
	trans-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (F-11)	---	---	---	---	---	---	
Trichlorotrifluoroethane (F-113)	---	---	---	---	---	---	
tert-Butylbenzene	---	---	---	---	---	---	
1,1,1-Trichloroethane (1,1,1-TCA)	70	<10	<10	80	230	<10	
1,1,2-Trichloroethane (1,1,2-TCA)	<10	<10	<10	<10	<10	<10	
Vinyl Chloride	<10	<10	<10	<10	<10	<10	
Other VOC Detected	---	---	---	---	---	---	

Notes: --- -Not analyzed
 <10 - Analyte not detected above specified minimum laboratory method reporting limit (MRL).
Bold - Concentration exceeds minimum laboratory MRL.
Bold - Concentration exceeds the Arizona Department of Environmental Quality recommended screening level of 1,567 µg/m³.

TABLE 2
SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL DATA

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Sample Identification	Sample Date	Approximate sample Depth (FBG)	PCE	Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
			EPA Method 8260B	EPA Method 9012B	EPA Method 6010B			EPA Method 3060A/7196A	
All results reported in milligrams per kilogram (mg/kg).									
A	8/1990	---	---	---	---	---	---	---	---
B	8/1990	---	---	---	---	---	---	---	---
C	8/1990	---	---	---	---	---	---	---	---
2	8/1990	---	---	---	---	---	---	---	---
3	8/1990	---	---	---	---	---	---	---	---
4	8/1990	---	---	---	---	---	---	---	---
8	8/1990	---	---	---	---	---	---	---	---
B-1	4/1994	---	---	---	---	---	---	---	---
B-2	4/1994	---	---	---	---	---	---	---	---
B-3	4/1994	---	---	---	---	---	---	---	---
B-4	4/1994	---	---	---	---	---	---	---	---
B-5	4/1994	---	---	---	---	---	---	---	---
SS-09	5/16/1995	0.5	---	---	---	8,810	---	---	---
SS-09	5/16/1995	2	---	---	<0.3	4,860	6	---	---
SS-10	5/16/1995	0.5	---	---	---	15.3	---	---	---
SS-10	5/16/1995	2	---	---	---	9.6	---	---	---
SS-11	5/16/1995	0.5	---	---	2.7	4,660	628	---	---
SS-11	5/16/1995	2	---	---	---	841	---	---	---
SS-12	5/16/1995	0.5	---	---	---	296	---	---	---
SS-12	5/16/1995	2	---	---	<0.3	11.1	6	---	---
SS-13	5/16/1995	0.5	---	---	---	9,320	---	---	---
SS-13	5/16/1995	2	---	---	---	9,880	---	---	---
SS-13 Duplicate	5/16/1995	2	---	---	---	9,290	---	---	---
SS-14	5/16/1995	0.5	---	---	---	208	---	---	---
SS-14 Duplicate	5/16/1995	0.5	---	---	---	143	---	---	---
SS-14	5/16/1995	2	---	---	---	17	---	---	---
SS-15	5/16/1995	0.5	---	---	---	32,000	---	---	---
SS-15	5/16/1995	2	---	---	---	6,540	---	---	---
SS-16	5/16/1995	0.5	---	---	<0.3	40	16	---	---
SS-16	5/16/1995	2	---	---	---	14.5	---	---	---
SS-17	5/1995	0-5	---	---	---	663	---	---	---
SS-17	5/1995	5	0.20	---	---	---	---	---	---
SS-17	5/1995	5-9.5	---	---	---	33.4	---	---	---
SS-17	5/1995	9.5	0.15	---	---	---	---	---	---
SS-18	5/1995	0-5	---	---	---	183	---	---	---
SS-18	5/1995	5	0.14	---	---	---	---	---	---
SS-18	5/1995	5-9.5	---	---	---	8.5	---	---	---
SS-18	5/1995	9.5	0.22	---	---	---	---	---	---
SS-19	5/1995	0-5	---	---	---	40.2	---	---	---
SS-19	5/1995	5	0.21	---	---	---	---	---	---
SS-19	5/1995	5-10	---	---	---	36.6	---	---	---
SS-19	5/1995	9.5	0.09	---	---	---	---	---	---
SS-20	5/1995	0-5	---	---	---	293	---	---	---
SS-20 a (b)	5/1995	0-5	---	---	---	300	---	---	---
SS-20	5/1995	5.5	3,500	---	---	---	---	---	---
SS-20	5/1995	5-6.5	---	---	---	302	---	---	---
SS-20	5/1995	6.5	180	---	---	---	---	---	---
SS-21	5/1995	0-5	---	---	---	15.3	---	---	---
SS-21	5/1995	5	0.17	---	---	---	---	---	---
SS-21	5/1995	5-9.5	---	---	---	14.4	---	---	---
SS-21	5/1995	9.5	0.21	---	---	---	---	---	---
SS-22	5/1995	0-5	---	---	---	14.4	---	---	---
SS-22	5/1995	5	0.42	---	---	---	---	---	---
HE-1	6/12/1995	---	---	---	<0.3	39.6	9	---	---
HE-2	6/12/1995	---	---	---	---	15.5	---	---	---
HE-3	6/12/1995	---	---	---	---	13.5	---	---	---
HE-3 Duplicate	6/12/1995	---	---	---	---	18.7	---	---	---
HE-4	6/12/1995	---	---	---	---	17.8	---	---	---
HE-5	6/12/1995	---	---	---	---	14.2	---	---	---
HE-6	6/12/1995	---	---	---	<0.3	19.6	9	---	---
HE-7	6/12/1995	---	---	---	---	17.8	---	---	---
HE-8	6/12/1995	---	---	---	---	776	---	---	---
HE-9	6/12/1995	---	---	---	---	4,150	---	---	---

TABLE 2
SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL DATA

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Sample Identification	Sample Date	Approximate sample Depth (FBG)	PCE	Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
			EPA Method 8260B	EPA Method 9012B	EPA Method 6010B			EPA Method 3060A/7196A	
All results reported in milligrams per kilogram (mg/kg).									
HE-10	6/12/1995	---	---	---	---	987	---	---	---
HE-11	6/12/1995	---	---	---	---	1,760	---	---	---
HE-11 Duplicate	6/12/1995	---	---	---	---	2,160	---	---	---
VE-1	6/12/1995	---	---	---	---	690	---	---	---
VE-2	6/12/1995	---	---	---	---	210	---	---	---
VE-3	6/12/1995	---	---	---	---	538	---	---	---
SB-1-5	6/30/2016	5	0.239	<0.250	<0.500	17.6	6.7	13.3	<2.0
SB-1A-10	7/1/2016	10	<0.0212	<0.250	<0.500	142	3.19	16.9	111
SB-1A-10 Duplicate	7/1/2016	10	0.0224	---	---	---	---	---	161
SB-1A-11	7/1/2016	11	0.0246	<0.250	0.578	130	3.85	19.9	70.9
SB-2-5	6/30/2016	5	0.0769	<0.250	5.59	1,280	5.78	85.7	744
SB-2-10	6/30/2016	10	<0.0252	<0.250	0.609	246	3.50	19.5	63.8
SB-2-11	6/30/2016	11	0.0351	<0.250	1.22	452	4.69	18.4	111
SB-3A-5 (1)	7/1/2016	5	0.0417	<0.250	<0.500	24.4	5.68	32.4	<2.0
SB-3A-10 (2)	7/1/2016	10	<0.0238	<0.250	<0.500	14.1	3.27	16.0	<2.0
SB-4-5	6/30/2016	5	0.0358	<0.250	<0.500	105	6.01	34.6	236
SB-4-10	6/30/2016	10	<0.022	<0.250	<0.500	167	3.09	15.1	94.2
SB-4-11	6/30/2016	11	0.0416	<0.250	<0.500	129	5.09	16.9	131
SB-5-3	8/8/2016	3	0.198	<0.250	<0.500	39.9	18.8	25.0	11.2
SB-5-5	8/8/2016	5	0.250	<0.250	<0.500	24.0	8.90	26.1	2.36
SB-5-11	8/8/2016	11	0.193	<0.250	<0.500	39.7	41.5	13.8	6.36
SB-6-3	8/8/2016	3	<0.0222	<0.250	<0.500	22.4	6.31	27.5	<2.0
SB-6-5	8/8/2016	5	0.0279	<0.250	<0.500	21.8	6.11	26.8	<2.0
SB-6-10	8/8/2016	10	<0.0205	<0.250	<0.500	33.2	5.36	16.3	<2.0
SB-7-3	8/8/2016	3	<0.0258	<0.250	<0.500	28.2	7.96	31.5	<2.0
SB-7-5	8/8/2016	5	<0.0225	<0.250	<0.500	19.2	6.51	26.1	<2.0
SB-7-9	8/8/2016	9	0.0197	<0.250	<0.500	20.3	6.24	22.9	<2.0
SB-8-3	8/8/2016	3	0.194	<0.250	1.16	67.7	15.3	36.1	2.48
SB-8-5	8/8/2016	5	0.0485	<0.250	<0.500	17.4	6.61	25.8	<2.0
SB-8-10	8/8/2016	10	0.0727	<0.250	<0.500	15.3	4.09	13.8	<2.0
SB-9-3	8/8/2016	3	0.0394	<0.250	<0.500	17.2	7.05	26.7	<2.0
SB-9-5	8/8/2016	5	<0.0275	<0.250	<0.500	18.9	6.69	27.9	<2.0
SB-9-11	8/8/2016	11	<0.0202	<0.250	<0.500	22.1	4.6	15.4	<2.0
SB-9-11 (Duplicate-1)	8/8/2016	11	<0.0242	---	---	---	---	---	<2.0
SB-10-3	8/8/2016	3	0.0332	<0.250	<0.500	19.1	6.62	26.8	<2.0
SB-10-5	8/8/2016	5	0.0367	<0.250	<0.500	16.8	6.17	29.6	<2.0
SB-10-11	8/8/2016	11	<0.0238	<0.250	<0.500	28.9	2.98	9.52	12.2
SB-11-2	8/10/2016	2	0.0627	<0.250	<0.500	34.4	8.27	28.8	<2.0
SB-11-5	8/10/2016	5	0.0402	<0.250	<0.500	12.5	4.46	22.9	<2.0
SB-11-9	8/10/2016	9	0.181	<0.250	<0.500	18.5	5.60	24.6	<2.0
SB-12-2	8/9/2016	2	<0.0192	<0.250	0.747	17.6	6.90	45.2	<2.0
SB-12-5	8/9/2016	5	0.0365	<0.250	1.61	1,270	6.70	484	6.84
SB-12-9	8/9/2016	9	0.0464	4.20	1.27	117	6.49	351	<2.0
SB-13-2	8/9/2016	2	0.279	<0.250	7.69	95.9	41.0	102	3.48
SB-13A-5	8/9/2016	5	<0.0192	2.63	27.6	61.7	6.82	376	2.56
SB-13A-9	8/9/2016	9	0.0290	<0.250	12.1	53.9	7.63	226	<2.0
SB-14-2	8/9/2016	2	0.0627	2.48	10.9	719	75.3	216	25.1
SB-14-5	8/9/2016	5	0.0659	1.20	2.30	2,090	239	94.6	47.8
SB-14-10	8/9/2016	10	<0.0230	0.337	4.55	135	50.8	398	6.88
SB-15-2	8/9/2016	2	0.0385	<0.250	<0.500	36.1	7.58	33.5	<2.0
SB-15-5	8/9/2016	5	0.0440	<0.250	<0.500	35.4	5.91	33.0	<2.0
SB-15-9	8/9/2016	9	0.0243	<0.250	<0.500	34.2	6.09	33.9	<2.0
SB-16-2	8/10/2016	2	0.0226	<0.250	<0.500	28.2	6.96	31.9	<2.0
SB-16-5	8/10/2016	5	0.0328	<0.250	<0.500	22.7	6.59	33.9	<2.0
SB-16-9	8/10/2016	9	<0.0208	<0.250	<0.500	15.5	2.69	15.3	<2.0
SB-16-9 (Duplicate-2)	8/10/2016	9	<0.0180	---	---	---	---	---	<2.0

TABLE 2
SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL DATA

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Sample Identification	Sample Date	Approximate sample Depth (FBG)	PCE	Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
			EPA Method 8260B	EPA Method 9012B	EPA Method 6010B			EPA Method 3060A/7196A	
All results reported in milligrams per kilogram (mg/kg).									
SB-17-2	8/9/2016	2	0.090	<0.250	<0.500	56.5	9.90	34.2	3.56
SB-17-5	8/9/2016	5	<0.0230	<0.250	0.657	42.8	7.62	67.6	3.96
SB-17-9	8/9/2016	9	<0.0202	<0.250	0.523	31.2	5.19	30.8	<2.0
SW-1 (EAST)	7/18/2017	6	13.1	0.262	6.94	215	56.0	158	0.760(E4)
SW-2 (SOUTH)	7/18/2017	6	0.103	<0.250	0.0899(E4)	23.3	5.22	57.1	0.680(E4)
SW-3 (SOUTH)	7/18/2017	6	<0.0290	0.0692(E4)	<0.500	30.5	4.30	329	0.960(E4)
SW-4 (WEST)	7/18/2017	6	0.0139(E4)	<0.250	0.147(E4)	31.6	3.52	65.7	1.64(E4)
SW-5 (EAST)	7/18/2017	6	0.0455	<0.250	24.5	26.0	4.62	710	<2.00
SW-6 (EAST)	7/18/2017	6	0.585	<0.250	0.118(E4)	106	42.7	38.5	0.640(E4)
SW-7 (EAST)	7/18/2017	6	0.00924(E4)	<0.250	<0.500	27.2	85.9	92.1	1.12(E4)
SW-8 (EAST)	7/18/2017	6	0.0171(E4)	<0.250	<0.500	46.0	82.4	239	<2.00
SW-9 (WEST)	7/18/2017	6	0.0732	<0.250	0.798	128	9.84	24.8	2.92
SW-10 (NORTH)	7/18/2017	6	<0.0250	<0.250	<0.500	26.4	67.2	42.3	1.28(E4)
SW-11 (WEST)	7/18/2017	6	<0.0288	<0.250	0.516	252	6.20	122	<2.00
B-1 (SOUTH)	7/18/2017	12	0.0465	0.222(E4)	1.62	18.0	2.56	197	0.640(E4)
B-2 (SOUTH)	7/18/2017	12	0.0384	0.810	27.6	82.8	22.6	319	<2.00
B-3	7/18/2017	12	0.0160(E4)	0.347	21.3	21.8	4.47	205	<2.00
DUPLICATE	7/18/2017	12	<0.0285	----	----	----	----	----	<2.00
B-4	7/18/2017	12	0.0269	<0.250	1.77	192	14.5	55.1	<2.00
B-5	7/18/2017	12	0.0253	0.0983(E4)	1.59	279	15.3	96.4	<2.00
B-6	7/18/2017	12	0.0209(E4)	<0.250	<0.500	8.13	43.1	9.33	<2.00
B-7	7/18/2017	12	0.0153(E4)	<0.250	<0.500	29.6	111	90.6	1.44(E4)
B-8	7/18/2017	12	0.103	0.235(E4)	20.1	38.7	11.0	361	0.920(E4)
B-9	7/18/2017	12	0.0572	1.72	74.3	83.2	17.9	891	<2.00
B-10	7/18/2017	12	0.0387	0.217(E4)	2.92	245	21.1	110	4.04
B-11	7/18/2017	12	0.267	<0.250	<0.0500	14.1	87.3	14.7	0.840(E4)
B-12	7/18/2017	12	<0.0438	<0.250	<0.0500	373	17.7	46.8	0.760(E4)
ADEQ Residential Soil Remediation Levels (rSRL)			5.1	1,200	39	NE	400	1,600	30
ADEQ Non-Residential Soil Remediation Levels (nrSRL)			13	12,000	510	NE	800	20,000	65
ADEQ Minimum Groundwater Protection Levels (GPL)			0.80	NE	29	NE	290	NE	NE
Notes:	FBG	- Feet below grade.							
	PCE	- Tetrachloroethylene							
	EPA	- Environmental Protection Agency							
	---	- Not available or not analyzed.							
	<0.3	- Analyte not detected above specified minimum laboratory method detection limit.							
	(1)	- Labeled SB-3-5 on Chain of Custody.							
	(2)	- Labeled SB-3-10 on Chain of Custody.							
	ADEQ	- Arizona Department of Environmental Quality							
	NE	- Not established.							
	Bold	- Concentration exceeds ADEQ established rSRL or GPL.							

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	100
CMW-1	---	7/25/1995	1,064.13	---	1,003.13	89	---	---	480	---	---	19,300	---	---	---
CMW-1	10/16/1995	---	1,064.13	---	1,003.13	89	58.91	1,005.22	---	---	---	---	---	---	---
CMW-1	11/22/1995	---	1,064.13	---	1,003.13	89	54.09	1,010.04	---	---	---	---	---	---	---
CMW-1	12/14/1995	12/14/1995	1,064.13	---	1,003.13	89	52.18	1,011.95	450	---	---	15,600	---	---	---
CMW-1	1/12/1996	---	1,064.13	---	1,003.13	89	50.81	1,013.32	---	---	---	---	---	---	---
CMW-1	2/16/1996	---	1,064.13	---	1,003.13	89	50.43	1,013.70	---	---	---	---	---	---	---
CMW-1	3/22/1996	3/22/1996	1,064.13	---	1,003.13	89	52.06	1,012.07	190	---	---	5,600	---	---	---
CMW-1	4/16/1996	---	1,064.13	---	1,003.13	89	---	---	---	---	---	---	---	---	---
CMW-1	5/15/1996	---	1,064.13	---	1,003.13	89	61.20	1,002.93	---	---	---	---	---	---	---
CMW-1	6/27/1996	6/27/1996	1,064.13	---	1,003.13	89	64.52	999.61	1,300	---	---	25,000	---	---	---
CMW-1	7/12/1996	---	1,064.13	---	1,003.13	89	65.44	998.69	---	---	---	---	---	---	---
CMW-1	8/16/1996	---	1,064.13	---	1,003.13	89	65.48	998.65	---	---	---	---	---	---	---
CMW-1	9/24/1996	9/30/1996	1,064.13	---	1,003.13	89	65.56	998.57	870	---	---	5,200	---	---	---
CMW-1	10/17/1996	---	1,064.13	---	1,003.13	89	63.58	1,000.55	---	---	---	---	---	---	---
CMW-1	11/27/1996	---	1,064.13	---	1,003.13	89	59.66	1,004.47	---	---	---	---	---	---	---
CMW-1	12/24/1996	12/10/1996	1,064.13	---	1,003.13	89	58.01	1,006.12	180	---	---	3,300	---	---	---
CMW-1	1/15/1997	---	1,064.13	---	1,003.13	89	57.28	1,006.85	---	---	---	---	---	---	---
CMW-1	2/21/1997	---	1,064.13	---	1,003.13	89	59.72	1,004.41	---	---	---	---	---	---	---
CMW-1	3/25/1997	3/25/1997	1,064.13	---	1,003.13	89	62.80	1,001.33	860	---	---	17,000	---	---	---
CMW-1	4/24/1997	---	1,064.13	---	1,003.13	89	66.74	997.39	---	---	---	---	---	---	---
CMW-1	5/23/1997	---	1,064.13	---	1,003.13	89	68.14	995.99	---	---	---	---	---	---	---
CMW-1	6/27/1997	6/27/1997	1,064.13	---	1,003.13	89	71.16	992.97	140	---	---	11,000	---	---	---
CMW-1	7/31/1997	---	1,064.13	---	1,003.13	89	73.23	990.90	---	---	---	---	---	---	---
CMW-1	8/27/1997	---	1,064.13	---	1,003.13	89	74.38	989.75	---	---	---	---	---	---	---
CMW-1	9/23/1997	9/23/1997	1,064.13	---	1,003.13	89	70.36	993.77	1,800	---	---	23,000	---	---	---
CMW-1	10/24/1997	---	1,064.13	---	1,003.13	89	67.38	996.75	---	---	---	---	---	---	---
CMW-1	11/24/1997	---	1,064.13	---	1,003.13	89	65.66	998.47	---	---	---	---	---	---	---
CMW-1	12/17/1997	12/10/1997	1,064.13	---	1,003.13	89	63.90	1,000.23	970	---	---	6,700	---	---	---
CMW-1	1/29/1998	---	1,064.13	---	1,003.13	89	62.80	1,001.33	---	---	---	---	---	---	---
CMW-1	2/25/1998	---	1,064.13	---	1,003.13	89	61.96	1,002.17	---	---	---	---	---	---	---
CMW-1	3/12/1998	3/12/1998	1,064.13	---	1,003.13	89	61.01	1,003.12	330	---	---	8,500	---	---	---
CMW-1	4/13/1998	---	1,064.13	---	1,003.13	89	63.90	1,000.23	---	---	---	---	---	---	---
CMW-1	5/13/1998	---	1,064.13	---	1,003.13	89	65.56	998.57	---	---	---	---	---	---	---
CMW-1	6/12/1998	6/12/1998	1,064.13	---	1,003.13	89	67.84	996.29	300	---	---	3,100	---	---	---
CMW-1	7/16/1998	---	1,064.13	---	1,003.13	89	70.43	993.70	---	---	---	---	---	---	---
CMW-1	---	8/10/1998	1,064.13	---	1,003.13	89	---	---	400	---	---	17,000	---	---	22,000
CMW-1	---	8/17/1998	1,064.13	---	1,003.13	89	---	---	150	---	---	14,000	---	---	17,000
CMW-1	8/19/1998	---	1,064.13	---	1,003.13	89	72.79	991.34	---	---	---	---	---	---	---
CMW-1	10/9/1998	10/2/1998	1,064.13	---	1,003.13	89	73.33	990.80	220	---	---	2,300	---	---	3,200
CMW-1	11/13/1998	---	1,064.13	---	1,003.13	89	68.22	995.91	---	---	---	---	---	---	---
CMW-1	12/4/1998	12/4/1998	1,064.13	---	1,003.13	89	66.66	997.47	640	---	---	4,100	---	---	3,500
CMW-1	12/28/1998	12/21/1998	1,064.13	---	1,003.13	89	---	---	220	---	---	2,300	---	---	---
CMW-1	1/22/1999	---	1,064.13	---	1,003.13	89	63.66	1,000.47	---	---	---	---	---	---	---
CMW-1	2/12/1999	---	1,064.13	---	1,003.13	89	63.20	1,000.93	---	---	---	---	---	---	---
CMW-1	3/4/1999	3/4/1999	1,064.13	---	1,003.13	89	63.44	1,000.69	450	---	---	16,000	---	---	---
CMW-1	4/19/1999	---	1,064.13	---	1,003.13	89	66.82	997.31	---	---	---	---	---	---	---
CMW-1	5/12/1999	---	1,064.13	---	1,003.13	89	71.00	993.13	---	---	---	---	---	---	---
CMW-1	6/17/1999	6/17/1999	1,064.13	---	1,003.13	89	73.91	990.22	620	---	---	9,900	---	---	---
CMW-1	7/13/1999	---	1,064.13	---	1,003.13	89	76.01	988.12	---	---	---	---	---	---	---
CMW-1	8/12/1999	---	1,064.13	---	1,003.13	89	76.78	987.35	---	---	---	---	---	---	---
CMW-1	9/23/1999	9/23/1999	1,064.13	---	1,003.13	89	77.88	986.25	32	---	---	2,900	---	---	---

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	
CMW-1	10/13/1999	---	1,064.13	---	1,003.13	89	75.82	988.31	---	---	---	---	---	---	---
CMW-1	11/17/1999	---	1,064.13	---	1,003.13	89	73.40	990.73	---	---	---	---	---	---	---
CMW-1	12/14/1999	12/14/1999	1,064.13	---	1,003.13	89	73.22	990.91	150	---	---	2,200	---	---	---
CMW-1	1/14/2000	---	1,064.13	---	1,003.13	89	73.66	990.47	---	---	---	---	---	---	---
CMW-1	2/15/2000	---	1,064.13	---	1,003.13	89	74.45	989.68	---	---	---	---	---	---	---
CMW-1	3/10/2000	3/10/2000	1,064.13	---	1,003.13	89	74.61	989.52	140	---	---	1,700	---	---	---
CMW-1	4/7/2000	---	1,064.13	---	1,003.13	89	75.48	988.65	---	---	---	---	---	---	---
CMW-1	5/19/2000	---	1,064.13	---	1,003.13	89	77.56	986.57	---	---	---	---	---	---	---
CMW-1	6/22/2000	6/22/2000	1,064.13	---	1,003.13	89	79.09	985.04	19	---	---	260	---	---	---
CMW-1	7/17/2000	---	1,064.13	---	1,003.13	89	80.25	983.88	---	---	---	---	---	---	---
CMW-1	8/14/2000	---	1,064.13	---	1,003.13	89	81.50	982.63	---	---	---	---	---	---	---
CMW-1	9/21/2000	9/21/2000	1,064.13	---	1,003.13	89	81.61	982.52	43	---	---	4,900	---	---	---
CMW-1	10/20/2000	---	1,064.13	---	1,003.13	89	79.00	985.13	---	---	---	---	---	---	---
CMW-1	11/16/2000	---	1,064.13	---	1,003.13	89	73.89	990.24	---	---	---	---	---	---	---
CMW-1	12/11/2000	12/11/2000	1,064.13	---	1,003.13	89	71.88	992.25	43	---	---	8,000	---	---	---
CMW-1	1/14/2001	---	1,064.13	---	1,003.13	89	69.84	994.29	---	---	---	---	---	---	---
CMW-1	4/17/2001	4/17/2001	1,064.13	---	1,003.13	89	71.44	992.69	590	---	---	12,000	---	---	---
CMW-1	10/30/2001	10/30/2001	1,064.13	---	1,003.13	89	78.50	985.63	590	---	---	2,300	---	---	---
CMW-1	1/14/2002	---	1,064.13	---	1,003.13	89	77.03	987.10	---	---	---	---	---	---	---
CMW-1	4/2/2002	4/2/2002	1,064.13	---	1,003.13	89	82.40	981.73	32	---	---	1,100	---	---	---
CMW-1	5/28/2002	---	1,064.13	---	1,003.13	89	85.82	978.31	---	---	---	---	---	---	---
CMW-1	6/26/2002	---	1,064.13	---	1,003.13	89	87.37	976.76	---	---	---	---	---	---	---
CMW-1	7/10/2002	7/10/2002	1,064.13	---	1,003.13	89	87.70	976.43	44	---	---	360	---	---	---
CMW-1	12/5/2002	---	1,064.13	---	1,003.13	89	83.90	980.23	---	---	---	---	---	---	---
CMW-1	1/14/2003	1/14/2003	1,064.13	---	1,003.13	89	80.65	983.48	61	---	---	370	---	---	---
CMW-1	4/29/2003	4/29/2003	1,064.13	---	1,003.13	89	81.24	982.89	51	---	---	480	---	---	---
CMW-1	9/22/2003	---	1,064.13	---	1,003.13	89	91.13	973.00	---	---	---	---	---	---	---
CMW-1	12/4/2003	12/4/2003	1,064.13	---	1,003.13	89	85.54	978.59	240	---	---	5,100	---	---	---
CMW-1	3/30/2004	3/29/2004	1,064.13	---	1,003.13	89	84.02	980.11	71	---	---	6,200	---	---	---
CMW-1	6/29/2004	---	1,064.13	---	1,003.13	89	89.50	974.63	---	---	---	---	---	---	---
CMW-1	12/28/2004	---	1,064.13	---	1,003.13	89	88.89	975.24	---	---	---	---	---	---	---
CMW-1	4/7/2005	4/13/2005	1,064.13	---	1,003.13	89	72.44	991.69	160	---	---	5,900	---	---	---
CMW-1	7/5/2005	7/11/2005	1,064.13	---	1,003.13	89	85.35	978.78	46	---	---	6,500	---	---	---
CMW-1	10/11/2005	10/17/2005	1,064.13	---	1,003.13	89	86.78	977.35	140	---	---	6,000	---	---	---
CMW-1	1/31/2006	2/2/2006	1,064.13	---	1,003.13	89	79.46	984.67	70	---	---	8,700	---	---	---
CMW-1	3/30/2006	3/30/2006	1,064.13	---	1,003.13	89	80.60	983.53	62	---	---	7,600	---	---	---
CMW-1	11/28/2006	11/28/2006	1,064.13	---	1,003.13	89	86.92	977.21	280	---	---	35,000	---	---	---
CMW-1	1/31/2007	1/31/2007	1,064.13	---	1,003.13	89	83.45	980.68	550	---	---	34,000	---	---	---
CMW-1	4/16/2007	4/16/2007	1,064.13	---	1,003.13	89	86.80	977.33	320	---	---	33,000	---	---	---
CMW-1	1/14/2008	1/14/2008	1,064.13	---	1,003.13	89	86.22	977.91	390	---	---	18,000	---	---	18,000
CMW-1	4/29/2008	4/29/2008	1,064.13	---	1,003.13	89	83.20	980.93	250	---	---	35,000	---	---	32,000
CMW-1	1/6/2009	1/6/2009	1,064.13	---	1,003.13	89	81.57	982.56	220	---	---	32,000	---	---	30,000
CMW-1	4/14/2009	4/14/2009	1,064.13	---	1,003.13	89	81.06	983.07	150	---	---	32,000	---	---	29,000
CMW-1	1/27/2010	1/24/2010	1,064.13	---	1,003.13	89	82.35	981.78	340	---	---	18,000	---	---	16,000
CMW-1	4/6/2010	4/6/2010	1,064.13	---	1,003.13	89	75.04	989.09	120	---	---	13,000	---	---	12,000
CMW-1	7/13/2010	7/13/2010	1,064.13	---	1,003.13	89	81.85	982.28	94	---	---	25,000	---	---	17,000
CMW-1	10/28/2010	10/28/2010	1,064.13	---	1,003.13	89	80.68	983.45	95.8	---	---	6,120	---	---	5,180
CMW-1	1/25/2011	1/25/2011	1,064.13	---	1,003.13	89	74.28	989.85	113	---	---	6,160	---	---	5,880
CMW-1	4/28/2011	4/28/2011	1,064.13	---	1,003.13	89	81.67	982.46	152	---	---	11,700	---	---	11,300
CMW-1	7/28/2011	---	1,064.13	---	1,003.13	89	87.08	977.05	---	---	---	---	---	---	---
CMW-1	10/25/2011	10/25/2011	1,064.13	---	1,003.13	89	86.52	977.61	286	---	---	3,940	---	---	3,540
CMW-1	1/30/2012	1/30/2012	1,064.13	---	1,003.13	89	80.75	983.38	274	---	---	7,360	---	---	6,620

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Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	100
CMW-1	4/30/2012	---	1,064.13	---	1,003.13	89	87.88	976.25	---	---	---	---	---	---	---
CMW-1	1/29/2013	---	1,064.13	---	1,003.13	89	86.91	977.22	---	---	---	---	---	---	---
CMW-1	7/12/2013	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	9/15/2014	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	2/11/2015	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	2/22/2017	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	5/17/2017	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	8/28/2017	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	11/15/2017	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	2/14/2018	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	5/15/2018	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	8/15/2018	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	11/15/2018	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1	2/14/2019	---	1,064.13	---	1,003.13	89	Dry	---	---	---	---	---	---	---	---
CMW-1M	4/1/2015	4/1/2015	1064.39 (1)	93	1004.39	193	93	971.39	460	<5.0	<5.0	1,400	18	<20	940
CMW-1M	7/28/2015	7/28/2015	1064.39 (1)	104	1004.39	193	104	960.39	189	<5.0	<2.0	1,280	23.4	41.4	1,140
CMW-1M	2/16/2016	2/16/2016	1064.39 (1)	98	1004.39	193	98	966.39	196	8.67	2.19	27,700	<5.0	209	25,600
CMW-1M	11/7/2016	11/7/2016	1064.39 (1)	108	1004.39	193	108	956.39	81.2	NA	NA	NA	NA	NA	254
CMW-1M	2/22/2017	2/24/2017	1064.39 (1)	105	1004.39	193	102.52	961.87	179	2.46	<2.00	9,250	3.39E4	53.2	9,140
CMW-1M	5/17/2017	5/17/2017	1064.39 (1)	100	1004.39	193	100.42	963.97	175	<5.00	3.31	34,100	<5.00	706	30,200
CMW-1M	8/29/2017	8/29/2017	1064.39 (1)	105	1004.39	193	104.82	959.57	48.2	<5.00	<2.00	1,120	<5.00	119	933
CMW-1M	11/15/2017	11/15/2017	1064.39 (1)	106	1004.39	193	105.94	958.45	74.6	<5.00	<2.00	448	<5.00	59.5	427
CMW-1M	2/14/2018	2/14/2018	1064.39 (1)	106	1004.39	193	104.76	959.63	1.45	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
CMW-1M (DUP)	2/14/2018	2/14/2018	1064.39 (1)	106	1004.39	193	104.76	959.63	1.33	---	---	---	---	---	<10.0
CMW-1M	5/15/2018	5/15/2018	1064.39 (1)	109	1004.39	193	108.91	955.48	72.9	<5.00	<2.00	178	<5.00	17.2	251
CMW-1M	8/15/2018	8/15/2018	1064.39 (1)	112	1004.39	193	111.91	952.48	56.3	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
CMW-1M	11/15/2018	11/15/2018	1064.39 (1)	105	1004.39	193	105.41	958.98	101	<5.00	<2.00	530	<5.00	16.5	536
CMW-1M	2/14/2019	2/14/2019	1064.39 (1)	103	1004.39	193	102.32	962.07	102	<5.00	1.39 E4	10,500	15.8	57.6	9,900
CMW-1M	4/1/2015	4/1/2015	1064.39 (1)	115	1004.39	193	93	971.39	180	<5.00	<5.0	5,900	36	180	4,700
CMW-1M	7/28/2015	7/28/2015	1064.39 (1)	115	1004.39	193	104	960.39	53.2	<5.00	<2.0	817	30.3	27.1	821
CMW-1M	2/16/2016	2/16/2016	1064.39 (1)	115	1004.39	193	98	966.39	101	<5.00	<2.0	12,200	<5.0	128	15,800
CMW-1M	11/7/2016	11/7/2016	1064.39 (1)	115	1004.39	193	108	956.39	43.9	NA	NA	NA	NA	NA	181
CMW-1M	2/22/2017	2/24/2017	1064.39 (1)	115	1004.39	193	102.52	961.87	115	<5.00	<2.00	4,760	3.95E4	27.6	4,840
CMW-1M	5/17/2017	5/17/2017	1064.39 (1)	115	1004.39	193	100.42	963.97	115	<5.00	3.31	7,900	<5.0	706	7,440
CMW-1M-DUP	5/17/2017	5/17/2017	1064.39 (1)	115	1004.39	193	100.42	963.97	72.9	<5.00	<2.00	7,900	5.73	141	7,440
CMW-1M	8/29/2017	8/29/2017	1064.39 (1)	115	1004.39	193	104.82	959.57	27.2	<5.00	<2.00	794	<5.00	43.6	728
CMW-1M	11/15/2017	11/15/2017	1064.39 (1)	115	1004.39	193	105.94	958.45	30.2	<5.00	<2.00	340	<5.00	36.6	320
CMW-1M	2/14/2018	2/14/2018	1064.39 (1)	115	1004.39	193	104.76	959.63	1.54	<5.00	<2.00	21.6	5.30	12.5	<10.0
CMW-1M	5/15/2018	5/15/2018	1064.39 (1)	115	1004.39	193	108.91	955.48	26.5	<5.00	<2.00	163	<5.00	19.6	160
CMW-1M	8/15/2018	8/15/2018	1064.39 (1)	115	1004.39	193	111.91	952.48	31.1	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
CMW-1M	11/15/2018	11/15/2018	1064.39 (1)	115	1004.39	193	105.41	958.98	56.6	<5.00	<2.00	361	<5.00	11.5	371
CMW-1M	2/14/2019	2/15/2019	1064.39 (1)	115	1004.39	193	102.32	962.07	159	<5.00	2.12	9,860	6.13	68.1	8,970
CMW-1M	4/1/2015	4/1/2015	1064.39 (1)	130	1004.39	193	93	971.39	140	<5.00	<5.0	3,800	25	290	3,400
CMW-1M	7/28/2015	7/28/2015	1064.39 (1)	130	1004.39	193	104	960.39	28.0	<5.00	<2.00	431	23.3	31.4	461
CMW-1M	2/16/2016	2/16/2016	1064.39 (1)	130	1004.39	193	98	966.39	122	<5.00	<2.00	12,900	<5.0	146	11,600
CMW-1M	11/7/2016	11/7/2016	1064.39 (1)	130	1004.39	193	108	956.39	34.8	NA	NA	NA	NA	NA	164
CMW-1M	2/22/2017	2/24/2017	1064.39 (1)	130	1004.39	193	102.52	961.87	68.0	<5.00	<2.00	2,590	3.65E4	27.1	2,260
CMW-1M	5/17/2017	5/17/2017	1064.39 (1)	130	1004.39	193	100.42	963.97	40.7	<5.00	<2.00	3,730	<5.00	69.2	3,660
CMW-1M	8/29/2017	8/29/2017	1064.39 (1)	130	1004.39	193	104.82	959.57	18.5	<5.00	<2.00	521	<5.00	52.5	457

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)															
CMW-1M	11/15/2017	11/15/2017	1064.39 (1)	130	1004.39	193	105.94	958.45	19.1	<5.00	<2.00	193	6.36	24.8	167
CMW-1M	2/14/2018	2/14/2018	1064.39 (1)	130	1004.39	193	104.76	959.63	1.18	<5.00	<2.00	10.6	<5.00	<10.0	<10.0
CMW-1M	5/15/2018	5/15/2018	1064.39 (1)	130	1004.39	193	108.91	955.48	18.1	<5.00	<2.00	84.0	<5.00	19.0	84.0
CMW-1M	8/15/2018	8/15/2018	1064.39 (1)	130	1004.39	193	111.91	952.48	13.7	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
CMW-1M	11/15/2018	11/15/2018	1064.39 (1)	130	1004.39	193	105.41	958.98	42.3	<5.00	<2.00	219	<5.00	10.4	223
CMW-1M	2/14/2019	2/15/2019	1064.39 (1)	130	1004.39	193	102.32	962.07	25.6	<5.00	0.868 E4	823	3.12 E4	39.4	723
CMW-1M	4/1/2015	4/1/2015	1064.39 (1)	145	1004.39	193	93	971.39	91	<5.00	<5.00	2,400	22	260	2,000
CMW-1M-DUP	4/1/2015	4/1/2015	1064.39 (1)	145	1004.39	193	93	971.39	94	<5.00	<5.00	2,400	20	290	1,700
CMW-1M	7/28/2015	7/28/2015	1064.39 (1)	145	1004.39	193	104	960.39	18.8	<5.00	<2.00	285	21.4	22.6	295
CMW-1M	2/16/2016	2/16/2016	1064.39 (1)	145	1004.39	193	98	966.39	81.9	<5.00	<2.00	11,100	<5.0	132	14,300
CMW-1M-DUP	2/16/2016	2/16/2016	1064.39 (1)	145	1004.39	193	98	966.39	77.8	<5.00	<2.00	9,960	<5.0	115	11,200
CMW-1M	11/7/2016	11/7/2016	1064.39 (1)	145	1004.39	193	108	956.39	37.2	NA	NA	NA	NA	NA	177
CMW-1M	2/22/2017	2/24/2017	1064.39 (1)	145	1004.39	193	102.52	961.87	48.5	<5.00	<2.00	1,770	3.25E4	30.7	1,710
CMW-1M-DUP	2/22/2017	2/24/2017	1064.39 (1)	145	1004.39	193	102.52	961.87	45.3	NA	NA	NA	NA	NA	1,670
CMW-1M	5/17/2017	5/17/2017	1064.39 (1)	145	1004.39	193	100.42	963.97	24.1	<5.00	<2.00	2,610	<5.00	59.3	2,490
CMW-1M	8/29/2017	8/29/2017	1064.39 (1)	145	1004.39	193	104.82	959.57	11.0	<5.00	<2.00	395	<5.00	51.5	156
CMW-1M-DUP	8/29/2017	8/29/2017	1064.39 (1)	145	1004.39	193	104.82	959.57	11.0	<5.00	<2.00	328	<5.00	24.2	310
CMW-1M	11/15/2017	11/15/2017	1064.39 (1)	145	1004.39	193	105.94	958.45	13.1	<5.00	<2.00	132	<5.00	27.6	100
CMW-1M-DUP	11/15/2017	11/15/2017	1064.39 (1)	145	1004.39	193	105.94	958.45	14.5	<5.00	<2.00	155	6.69	49.1	101
CMW-1M	2/14/2018	2/14/2018	1064.39 (1)	145	1004.39	193	104.76	959.63	<1.00	<5.00	<2.00	25.9	<5.00	17.0	<10.0
CMW-1M	5/15/2018	5/15/2018	1064.39 (1)	145	1004.39	193	108.91	955.48	14.3	<5.00	<2.00	96.8	<5.00	31.8	74.0
CMW-1M-DUP	5/15/2018	5/15/2018	1064.39 (1)	145	1004.39	193	108.91	955.48	14.6	---	---	---	---	---	59.0
CMW-1M	8/15/2018	8/15/2018	1064.39 (1)	145	1004.39	193	111.91	952.80	12.5	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
CMW-1M	11/15/2018	11/15/2018	1064.39 (1)	145	1004.39	193	105.41	958.98	25.9	<5.00	<2.00	135	<5.00	9.95 E4	136
CMW-1M-DUP	11/15/2018	11/15/2018	1064.39 (1)	145	1004.39	193	105.41	958.98	103	---	---	---	---	---	512
CMW-1M	2/14/2019	2/15/2019	1064.39 (1)	145	1004.39	193	102.32	962.07	19.6	<5.00	<2.00	573	<5.00	12.7	510
CMW-1M-DUP	2/14/2019	2/15/2019	1064.39 (1)	145	1004.39	193	102.32	962.07	19.3	---	---	---	---	---	502
CMW-1M	4/1/2015	4/1/2015	1064.39 (1)	160	1004.39	193	93	971.39	84	<5.00	<5.00	2,100	20	230	1,500
CMW-1M	7/28/2015	7/28/2015	1064.39 (1)	160	1004.39	193	104	960.39	13.0	<5.00	<2.00	270	22.9	45.9	263
CMW-1M	2/16/2016	2/16/2016	1064.39 (1)	160	1004.39	193	98	966.39	91.4	<5.00	<2.00	8,970	<5.0	97.7	9,900
CMW-1M	11/7/2016	11/7/2016	1064.39 (1)	160	1004.39	193	108	956.39	39.9	NA	NA	NA	NA	NA	131
CMW-1M-DUP	11/7/2016	11/7/2016	1064.39 (1)	160	1004.39	193	108	956.39	35.7	NA	NA	NA	NA	NA	149
CMW-1M	2/22/2017	2/24/2017	1064.39 (1)	160	1004.39	193	102.52	961.87	44.9	<5.00	<2.00	1,490	<5.00	28.4	1,490
CMW-1M	5/17/2017	5/17/2017	1064.39 (1)	160	1004.39	193	100.42	963.97	25.4	<5.00	<2.00	2,150	<5.00	59.7	2,080
CMW-1M	8/29/2017	8/29/2017	1064.39 (1)	160	1004.39	193	104.82	959.57	10.8	<5.00	<2.00	290	<5.00	23.0	296
CMW-1M	11/15/2017	11/15/2017	1064.39 (1)	160	1004.39	193	105.94	958.45	8.83	<5.00	<2.00	119	<5.00	23.4	100
CMW-1M	2/14/2018	2/14/2018	1064.39 (1)	160	1004.39	193	104.76	959.63	<1.00	<5.00	<2.00	19.5	<5.00	11.9	<10.0
CMW-1M	5/15/2018	5/15/2018	1064.39 (1)	160	1004.39	193	108.91	955.48	17.9	<5.00	<2.00	67.9	<5.00	29.1	70.0
CMW-1M	8/15/2018	8/15/2018	1064.39 (1)	160	1004.39	193	111.91	952.48	11.7	<5.00	<2.00	12.7	<5.00	20.8	<10.0
CMW-1M-DUP	8/15/2018	8/15/2018	1064.39 (1)	160	1004.39	193	111.91	952.48	12.4	---	---	---	---	---	<10.0
CMW-1M	11/15/2018	11/15/2018	1064.39 (1)	160	1004.39	193	105.41	958.98	35.0	<5.00	<2.00	152	<5.00	13.8	149
CMW-1M	2/14/2019	2/15/2019	1064.39 (1)	160	1004.39	193	102.32	962.07	15.1	<5.00	<2.00	462	3.50 E4	14.3	419
CMW-1M	4/1/2015	4/1/2015	1064.39 (1)	175	1004.39	193	93	971.39	90	<5.00	<5.00	2,200	22.00	250	2,000
CMW-1M	7/28/2015	7/28/2015	1064.39 (1)	175	1004.39	193	104	960.39	14.9	<5.00	<2.00	269	22.80	40.6	254
CMW-1M	2/16/2016	2/16/2016	1064.39 (1)	175	1004.39	193	98	966.39	91.3	<5.00	<2.00	9,320	<5.0	103	9,120
CMW-1M	11/7/2016	11/7/2016	1064.39 (1)	175	1004.39	193	108	956.39	37.4	NA	NA	NA	NA	NA	154
CMW-1M	2/22/2017	2/24/2017	1064.39 (1)	175	1004.39	193	102.52	961.87	42.6	<5.00	<2.00	1,580	4.73E4	78.8	1,510
CMW-1M	5/17/2017	5/17/2017	1064.39 (1)	175	1004.39	193	100.42	963.97	25.2	<5.00	<2.00	2,290	<5.00	116	2,070
CMW-1M	8/29/2017	8/29/2017	1064.39 (1)	175	1004.39	193	104.82	959.57	11.6	<5.00	<2.00	279	<5.00	19.1	231

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SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	100
CMW-1M	11/15/2017	11/15/2017	1064.39 (1)	175	1004.39	193	105.94	958.45	40.4	<5.00	<2.00	130	6.41	48.1	199
CMW-1M	2/14/2018	2/14/2018	1064.39 (1)	175	1004.39	193	104.76	959.63	<1.00	<5.00	<2.00	21.4	<5.00	12.9	<10.0
CMW-1M	5/15/2018	5/15/2018	1064.39 (1)	175	1004.39	193	108.91	955.48	10.6	<5.00	<2.00	62.8	<5.00	25.5	61.0
CMW-1M	8/15/2018	8/15/2018	1064.39 (1)	175	1004.39	193	111.91	952.48	8.48	<5.00	<2.00	<10.0	<5.00	12.5	<10.0
CMW-1M	11/15/2018	11/15/2018	1064.39 (1)	175	1004.39	193	105.41	958.98	30.7	<5.00	1.40 E4	139	<5.00	42.8	129
CMW-1M	2/14/2019	2/15/2019	1064.39 (1)	175	1004.39	193	102.32	962.07	15.9	<5.00	0.906 E4	458	<5.00	28.8	361
CMW-1M	4/1/2015	4/1/2015	1064.39 (1)	185	1004.39	193	93	971.39	85	<5.00	<5.00	2,200	23	280	1,800
CMW-1M	7/28/2015	7/28/2015	1064.39 (1)	185	1004.39	193	104	960.39	13.6	<5.00	14.4	261	26.6	77.9	239
CMW-1M	2/16/2016	2/16/2016	1064.39 (1)	185	1004.39	193	98	966.39	74.0	<5.00	<2.00	9,100	<5.0	93.1	11,100
CMW-1M	11/7/2016	11/7/2016	1064.39 (1)	185	1004.39	193	108	956.39	29.4	NA	NA	NA	NA	NA	131
CMW-1M	2/22/2017	2/24/2017	1064.39 (1)	185	1004.39	193	102.52	961.87	42.8	<5.00	0.770E4	1,390	4.62E4	137	1,400
CMW-1M	5/17/2017	5/17/2017	1064.39 (1)	185	1004.39	193	100.42	963.97	26.2	<5.00	0.770E4	2,250	7.67	402	2,060
CMW-1M	8/29/2017	8/29/2017	1064.39 (1)	185	1004.39	193	104.82	959.57	11.3	<5.00	<2.00	262	<5.00	60.9	248
CMW-1M	11/15/2017	11/15/2017	1064.39 (1)	185	1004.39	193	105.94	958.45	14.8	<5.00	<2.00	132	7.14	102	109
CMW-1M	2/14/2018	2/14/2018	1064.39 (1)	185	1004.39	193	104.76	959.63	<1.00	<5.00	<2.00	25.1	<5.00	16.8	<10.0
CMW-1M	5/15/2018	5/15/2018	1064.39 (1)	185	1004.39	193	108.91	955.48	13.1	<5.00	<2.00	68.4	<5.00	47.8	73.0
CMW-1M	8/15/2018	8/15/2018	1064.39 (1)	185	1004.39	193	111.91	952.48	10.9	<5.00	<2.00	17.8	<5.00	69.1	<10.0
CMW-1M	11/15/2018	11/15/2018	1064.39 (1)	185	1004.39	193	105.41	958.98	37.9	<5.00	1.30 E4	158	<5.00	24.3	102
CMW-1M	2/14/2019	2/15/2019	1064.39 (1)	185	1004.39	193	102.32	962.07	962.07	19.7	<5.00	1.09 E4	5.76	32.1	439
CMW-1D	---	8/10/1998	1,064.64	---	870.64	233	---	---	1.7	---	---	<50	---	---	48
CMW-1D	---	8/17/1998	1,064.64	---	870.64	233	---	---	1.7	---	---	<50	---	---	49
CMW-1D	8/19/1998	---	1,064.64	---	870.64	233	73.86	990.78	---	---	---	---	---	---	---
CMW-1D	10/9/1998	10/2/1998	1,064.64	---	870.64	233	74.21	990.43	3.5	---	---	<50	---	---	41
CMW-1D	11/13/1998	11/13/1998	1,064.64	---	870.64	233	69.08	995.56	<0.5	---	---	<50	---	---	<25
CMW-1D	12/4/1998	---	1,064.64	---	870.64	233	67.58	997.06	<0.5	---	---	<50	---	---	<25
CMW-1D	1/22/1999	---	1,064.64	---	870.64	233	64.51	1,000.13	---	---	---	---	---	---	---
CMW-1D	2/12/1999	---	1,064.64	---	870.64	233	64.08	1,000.56	---	---	---	---	---	---	---
CMW-1D	3/4/1999	3/4/1999	1,064.64	---	870.64	233	64.35	1,000.29	ND	---	---	ND	---	---	---
CMW-1D	4/19/1999	---	1,064.64	---	870.64	233	67.74	996.90	---	---	---	---	---	---	---
CMW-1D	5/12/1999	---	1,064.64	---	870.64	233	72.18	992.46	---	---	---	---	---	---	---
CMW-1D	6/17/1999	6/17/1999	1,064.64	---	870.64	233	74.99	989.65	ND	---	---	ND	---	---	---
CMW-1D	7/13/1999	---	1,064.64	---	870.64	233	77.05	987.59	---	---	---	---	---	---	---
CMW-1D	8/12/1999	---	1,064.64	---	870.64	233	77.80	986.84	---	---	---	---	---	---	---
CMW-1D	9/23/1999	9/23/1999	1,064.64	---	870.64	233	78.88	985.76	ND	---	---	ND	---	---	---
CMW-1D	10/13/1999	---	1,064.64	---	870.64	233	76.81	987.83	---	---	---	---	---	---	---
CMW-1D	11/17/1999	---	1,064.64	---	870.64	233	74.35	990.29	---	---	---	---	---	---	---
CMW-1D	12/14/1999	12/14/1999	1,064.64	---	870.64	233	74.04	990.60	ND	---	---	ND	---	---	---
CMW-1D	1/14/2000	---	1,064.64	---	870.64	233	74.48	990.16	---	---	---	---	---	---	---
CMW-1D	2/15/2000	---	1,064.64	---	870.64	233	75.37	989.27	---	---	---	---	---	---	---
CMW-1D	3/10/2000	3/10/2000	1,064.64	---	870.64	233	75.52	989.12	ND	---	---	ND	---	---	---
CMW-1D	4/7/2000	---	1,064.64	---	870.64	233	76.46	988.18	---	---	---	---	---	---	---
CMW-1D	5/19/2000	---	1,064.64	---	870.64	233	78.58	986.06	---	---	---	---	---	---	---
CMW-1D	6/22/2000	6/22/2000	1,064.64	---	870.64	233	80.11	984.53	ND	---	---	ND	---	---	---
CMW-1D	8/14/2000	---	1,064.64	---	870.64	233	82.54	982.10	---	---	---	---	---	---	---
CMW-1D	9/21/2000	9/21/2000	1,064.64	---	870.64	233	79.78	984.86	ND	---	---	ND	---	---	---
CMW-1D	10/20/2000	---	1,064.64	---	870.64	233	79.78	984.86	---	---	---	---	---	---	---
CMW-1D	11/16/2000	---	1,064.64	---	870.64	233	74.65	989.99	---	---	---	---	---	---	---
CMW-1D	12/11/2000	12/11/2000	1,064.64	---	870.64	233	72.60	992.04	0.5	---	---	ND	---	---	---
CMW-1D	1/14/2001	---	1,064.64	---	870.64	233	70.60	994.04	---	---	---	---	---	---	---
CMW-1D	4/17/2001	4/17/2001	1,064.64	---	870.64	233	72.65	991.99	0.5	---	---	ND	---	---	---

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	
CMW-1D	10/30/2001	10/30/2001	1,064.64	---	870.64	233	79.26	985.38	ND	---	---	ND	---	---	---
CMW-1D	1/14/2002	---	1,064.64	---	870.64	233	77.95	986.69	---	---	---	---	---	---	---
CMW-1D	4/2/2002	4/2/2002	1,064.64	---	870.64	233	83.38	981.26	1.4	---	---	ND	---	---	---
CMW-1D	5/28/2002	---	1,064.64	---	870.64	233	86.89	977.75	---	---	---	---	---	---	---
CMW-1D	6/26/2002	---	1,064.64	---	870.64	233	88.35	976.29	---	---	---	---	---	---	---
CMW-1D	7/10/2002	7/10/2002	1,064.64	---	870.64	233	88.90	975.74	ND	---	---	ND	---	---	---
CMW-1D	9/12/2002	9/12/2002	1,064.64	---	870.64	233	---	---	ND	---	---	ND	---	---	---
CMW-1D	12/5/2002	---	1,064.64	---	870.64	233	90.40	974.24	---	---	---	---	---	---	---
CMW-1D	1/14/2003	1/14/2003	1,064.64	---	870.64	233	84.66	979.98	ND	---	---	ND	---	---	---
CMW-1D	4/29/2003	4/29/2003	1,064.64	---	870.64	233	81.30	983.34	ND	---	---	ND	---	---	---
CMW-1D	9/22/2003	---	1,064.64	---	870.64	233	82.19	982.45	---	---	---	---	---	---	---
CMW-1D	12/4/2003	---	1,064.64	---	870.64	233	93.11	971.53	---	---	---	---	---	---	---
CMW-1D	3/30/2004	---	1,064.64	---	870.64	233	86.17	978.47	---	---	---	---	---	---	---
CMW-1D	6/29/2004	---	1,064.64	---	870.64	233	84.92	979.72	---	---	---	---	---	---	---
CMW-1D	10/11/2004	---	1,064.64	---	870.64	233	95.36	969.28	---	---	---	---	---	---	---
CMW-1D	12/28/2004	---	1,064.64	---	870.64	233	97.75	966.89	---	---	---	---	---	---	---
CMW-1D	4/7/2005	4/13/2005	1,064.64	---	870.64	233	89.58	975.06	ND	---	---	ND	---	---	---
CMW-1D	7/5/2005	---	1,064.64	---	870.64	233	73.10	991.54	---	---	---	---	---	---	---
CMW-1D	10/11/2005	---	1,064.64	---	870.64	233	86.30	978.34	---	---	---	---	---	---	---
CMW-1D	1/31/2006	---	1,064.64	---	870.64	233	87.50	977.14	---	---	---	---	---	---	---
CMW-1D	3/30/2006	---	1,064.64	---	870.64	233	80.16	984.48	---	---	---	---	---	---	---
CMW-1D	7/12/2006	8/24/2006	1,064.64	---	870.64	233	81.50	983.14	ND	---	---	ND	---	---	---
CMW-1D	11/28/2006	---	1,064.64	---	870.64	233	87.68	976.96	---	---	---	---	---	---	---
CMW-1D	1/31/2007	---	1,064.64	---	870.64	233	84.15	980.49	---	---	---	---	---	---	---
CMW-1D	4/16/2007	---	1,064.64	---	870.64	233	87.70	976.94	---	---	---	---	---	---	---
CMW-1D	7/25/2007	7/25/2007	1,064.64	---	870.64	233	95.65	968.99	ND	---	---	ND	---	---	---
CMW-1D	10/17/2007	---	1,064.64	---	870.64	233	96.40	968.24	---	---	---	---	---	---	---
CMW-1D	1/14/2008	---	1,064.64	---	870.64	233	87.07	977.57	---	---	---	---	---	---	---
CMW-1D	4/29/2008	---	1,064.64	---	870.64	233	84.08	980.56	---	---	---	---	---	---	---
CMW-1D	7/28/2008	---	1,064.64	---	870.64	233	91.32	973.32	---	---	---	---	---	---	---
CMW-1D	---	8/28/2008	1,064.64	---	870.64	233	---	---	ND	---	---	ND	---	---	ND
CMW-1D	10/14/2008	---	1,064.64	---	870.64	233	89.70	974.94	---	---	---	---	---	---	---
CMW-1D	1/6/2009	---	1,064.64	---	870.64	233	82.27	982.37	---	---	---	---	---	---	---
CMW-1D	4/14/2009	---	1,064.64	---	870.64	233	81.92	982.72	---	---	---	---	---	---	---
CMW-1D	7/30/2009	7/30/2009	1,064.64	---	870.64	233	89.40	975.24	ND	---	---	ND	---	---	ND
CMW-1D	10/22/2009	---	1,064.64	---	870.64	233	89.25	975.39	---	---	---	---	---	---	---
CMW-1D	1/27/2010	---	1,064.64	---	870.64	233	83.02	981.62	---	---	---	---	---	---	---
CMW-1D	4/6/2010	---	1,064.64	---	870.64	233	75.74	988.90	---	---	---	---	---	---	---
CMW-1D	7/13/2010	7/13/2010	1,064.64	---	870.64	233	82.68	981.96	ND	---	---	ND	---	---	ND
CMW-1D	10/28/2010	---	1,064.64	---	870.64	233	81.35	983.29	---	---	---	---	---	---	---
CMW-1D	1/25/2011	---	1,064.64	---	870.64	233	75.00	989.64	---	---	---	---	---	---	---
CMW-1D	4/28/2011	---	1,064.64	---	870.64	233	82.52	982.12	---	---	---	---	---	---	---
CMW-1D	7/28/2011	7/28/2011	1,064.64	---	870.64	233	87.96	976.68	ND	---	---	ND	---	---	ND
CMW-1D	10/25/2011	---	1,064.64	---	870.64	233	87.28	977.36	---	---	---	---	---	---	---
CMW-1D	1/30/2012	---	1,064.64	---	870.64	233	81.47	983.17	---	---	---	---	---	---	---
CMW-1D	4/30/2012	---	1,064.64	---	870.64	233	87.90	976.74	---	---	---	---	---	---	---
CMW-1D	7/24/2012	7/24/2012	1,064.64	---	870.64	233	94.37	970.27	ND	---	---	ND	---	---	ND
CMW-1D	10/29/2012	---	1,064.64	---	870.64	233	94.37	970.27	---	---	---	---	---	---	---
CMW-1D	1/29/2013	---	1,064.64	---	870.64	233	87.59	977.05	---	---	---	---	---	---	---
CMW-1D	4/29/2013	---	1,064.64	---	870.64	233	92.87	971.77	---	---	---	---	---	---	---
CMW-1D	7/12/2013	7/12/2013	1,064.64	---	870.64	233	97.56	967.08	ND	---	---	---	---	---	---
CMW-1D	8/20/2014	9/15/2014	1,064.64	---	870.64	233	102.45	962.19	<0.500	---	---	<10.0	---	---	<5.0

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SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)															
CMW-1D	2/11/2015	---	1,064.64	---	870.64	233	90.78	973.86	---	---	---	---	---	---	---
CMW-1D	7/29/2015	7/29/2015	1,064.64	200	870.64	233	103.80	960.84	<1.0	<5.00	<2.00	<10.0	25.8	<10.0	<10.0
CMW-1D	2/22/2017	2/24/2017	1,064.64	200	870.64	233	102.44	962.20	<1.0	<5.00	<2.00	7.73E4	8.17	6.32E4	5.00E4
CMW-1D	5/17/2017	5/17/2017	1,064.64	200	870.64	233	100.48	964.16	<1.00	<5.00	<2.00	7.670	<5.00	135	<10.0
CMW-1D	8/30/2017	8/30/2017	1,064.64	200	870.64	233	104.98	959.66	<1.00	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
CMW-1D	11/15/2017	11/15/2017	1,064.64	200	870.64	233	106.03	958.61	<1.00	<5.00	<2.00	<10.0	5.06	<10.0	<10.0
CMW-1D	2/15/2018	2/15/2018	1,064.64	200	870.64	233	104.74	959.90	15.6	<5.00	<2.00	620	<5.00	21.2	633
CMW-1D	5/15/2018	5/15/2018	1,064.64	200	870.64	233	108.90	955.74	<1.00	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
CMW-1D	8/15/2018	8/15/2018	1,064.64	200	870.64	233	112.00	952.64	<1.00	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
CMW-1D	11/15/2018	11/15/2018	1,064.64	200	870.64	233	105.44	959.20	0.724 E4	<5.00	<2.00	4.01 E4	<5.00	<10.0	<10.0
CMW-1D	2/14/2019	2/14/2019	1,064.64	200	870.64	233	102.42	962.22	0.471 E4	<5.00	<2.00	20.3	11.9	12.9	<10.0
CMW-1D (bot)	---	8/10/1998	1,064.64	232	870.64	233	---	---	<0.5	---	---	---	---	---	---
CMW-1D (bot)	---	8/17/1998	1,064.64	232	870.64	233	---	---	1.7	---	---	---	---	---	---
CMW-1D (bot)	---	10/2/1998	1,064.64	232	870.64	233	---	---	1.8	---	---	---	---	---	---
CMW-1D (bot)	---	11/13/1998	1,064.64	232	870.64	233	---	---	<0.5	---	---	---	---	---	---
CMW-1D (bot)	7/12/2013	7/12/2014	1,064.64	232	870.64	233	97.56	967.08	0.076	---	---	---	---	---	---
CMW-1D (bot)	8/20/2014	9/15/2014	1,064.64	232	870.64	233	102.45	962.19	4.85	---	---	---	---	---	---
CMW-2	10/16/1995	---	1,064.51	---	1,003.51	88	58.67	1,005.84	---	---	---	---	---	---	---
CMW-2	11/22/1995	---	1,064.51	---	1,003.51	88	53.97	1,010.54	---	---	---	---	---	---	---
CMW-2	12/14/1995	12/14/1995	1,064.51	---	1,003.51	88	52.11	1,012.40	6.8	---	---	ND	---	---	---
CMW-2	1/12/1996	---	1,064.51	---	1,003.51	88	50.72	1,013.79	---	---	---	---	---	---	---
CMW-2	2/16/1996	---	1,064.51	---	1,003.51	88	50.37	1,014.14	---	---	---	---	---	---	---
CMW-2	3/22/1996	3/22/1996	1,064.51	---	1,003.51	88	51.80	1,012.71	34	---	---	ND	---	---	---
CMW-2	4/16/1996	---	1,064.51	---	1,003.51	88	56.45	1,008.06	---	---	---	---	---	---	---
CMW-2	5/15/1996	---	1,064.51	---	1,003.51	88	60.78	1,003.73	---	---	---	---	---	---	---
CMW-2	6/27/1996	6/27/1996	1,064.51	---	1,003.51	88	63.66	1,000.85	22	---	---	ND	---	---	---
CMW-2	7/12/1996	---	1,064.51	---	1,003.51	88	64.94	999.57	---	---	---	---	---	---	---
CMW-2	8/16/1996	---	1,064.51	---	1,003.51	88	65.04	999.47	---	---	---	---	---	---	---
CMW-2	9/24/1996	9/30/1996	1,064.51	---	1,003.51	88	65.12	999.39	4.4	---	---	ND	---	---	---
CMW-2	10/17/1996	---	1,064.51	---	1,003.51	88	63.26	1,001.25	---	---	---	---	---	---	---
CMW-2	11/27/1996	12/10/1996	1,064.51	---	1,003.51	88	59.55	1,004.96	21	---	---	ND	---	---	---
CMW-2	12/24/1996	---	1,064.51	---	1,003.51	88	57.99	1,006.52	---	---	---	---	---	---	---
CMW-2	1/15/1997	---	1,064.51	---	1,003.51	88	57.20	1,007.31	---	---	---	---	---	---	---
CMW-2	2/21/1997	---	1,064.51	---	1,003.51	88	59.70	1,004.81	---	---	---	---	---	---	---
CMW-2	3/25/1997	3/25/1997	1,064.51	---	1,003.51	88	62.57	1,001.94	26	---	---	ND	---	---	---
CMW-2	4/24/1997	---	1,064.51	---	1,003.51	88	66.26	998.25	---	---	---	---	---	---	---
CMW-2	5/23/1997	---	1,064.51	---	1,003.51	88	67.58	996.93	---	---	---	---	---	---	---
CMW-2	6/27/1997	6/27/1997	1,064.51	---	1,003.51	88	70.32	994.19	15	---	---	ND	---	---	---
CMW-2	7/31/1997	---	1,064.51	---	1,003.51	88	72.31	992.20	---	---	---	---	---	---	---
CMW-2	8/27/1997	---	1,064.51	---	1,003.51	88	73.40	991.11	---	---	---	---	---	---	---
CMW-2	9/23/1997	9/23/1997	1,064.51	---	1,003.51	88	69.74	994.77	33	---	---	ND	---	---	---
CMW-2	10/24/1997	---	1,064.51	---	1,003.51	88	67.68	996.83	---	---	---	---	---	---	---
CMW-2	11/24/1997	---	1,064.51	---	1,003.51	88	65.44	999.07	---	---	---	---	---	---	---
CMW-2	12/17/1997	12/10/1997	1,064.51	---	1,003.51	88	64.10	1,000.41	34	---	---	ND	---	---	---
CMW-2	1/29/1998	---	1,064.51	---	1,003.51	88	62.64	1,001.87	---	---	---	---	---	---	---
CMW-2	2/25/1998	---	1,064.51	---	1,003.51	88	61.62	1,002.89	---	---	---	---	---	---	---
CMW-2	3/12/1998	3/12/1998	1,064.51	---	1,003.51	88	60.88	1,003.63	20	---	---	ND	---	---	---
CMW-2	4/13/1998	---	1,064.51	---	1,003.51	88	63.42	1,001.09	---	---	---	---	---	---	---
CMW-2	5/13/1998	---	1,064.51	---	1,003.51	88	65.08	999.43	---	---	---	---	---	---	---
CMW-2	6/12/1998	6/12/1998	1,064.51	---	1,003.51	88	67.33	997.18	44	---	---	ND	---	---	---

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
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Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	
CMW-2	7/16/1998	---	1,064.51	---	1,003.51	88	69.50	995.01	---	---	---	---	---	---	---
CMW-2	8/19/1998	---	1,064.51	---	1,003.51	88	71.80	992.71	---	---	---	---	---	---	---
CMW-2	10/9/1998	10/2/1998	1,064.51	---	1,003.51	88	72.55	991.96	46	---	---	ND	---	---	---
CMW-2	11/13/1998	---	1,064.51	---	1,003.51	88	67.80	996.71	---	---	---	---	---	---	---
CMW-2	12/4/1998	12/4/1998	1,064.51	---	1,003.51	88	66.38	998.13	80	---	---	<50	---	---	<25
CMW-2	12/28/1998	12/21/1998	1,064.51	---	1,003.51	88	---	---	46	---	---	ND	---	---	---
CMW-2	1/22/1999	---	1,064.51	---	1,003.51	88	63.53	1,000.98	---	---	---	---	---	---	---
CMW-2	2/12/1999	---	1,064.51	---	1,003.51	88	63.08	1,001.43	---	---	---	---	---	---	---
CMW-2	3/4/1999	3/4/1999	1,064.51	---	1,003.51	88	63.30	1,001.21	78	---	---	ND	---	---	---
CMW-2	4/19/1999	---	1,064.51	---	1,003.51	88	66.88	997.63	---	---	---	---	---	---	---
CMW-2	5/12/1999	---	1,064.51	---	1,003.51	88	70.32	994.19	---	---	---	---	---	---	---
CMW-2	6/17/1999	6/17/1999	1,064.51	---	1,003.51	88	73.06	991.45	13	---	---	ND	---	---	---
CMW-2	7/13/1999	---	1,064.51	---	1,003.51	88	75.05	989.46	---	---	---	---	---	---	---
CMW-2	8/12/1999	---	1,064.51	---	1,003.51	88	75.80	988.71	---	---	---	---	---	---	---
CMW-2	9/23/1999	9/23/1999	1,064.51	---	1,003.51	88	76.85	987.66	28	---	---	ND	---	---	---
CMW-2	10/13/1999	---	1,064.51	---	1,003.51	88	75.08	989.43	---	---	---	---	---	---	---
CMW-2	11/17/1999	---	1,064.51	---	1,003.51	88	73.08	991.43	---	---	---	---	---	---	---
CMW-2	12/14/1999	12/14/1999	1,064.51	---	1,003.51	88	72.70	991.81	59	---	---	ND	---	---	---
CMW-2	1/14/2000	---	1,064.51	---	1,003.51	88	72.99	991.52	---	---	---	---	---	---	---
CMW-2	2/15/2000	---	1,064.51	---	1,003.51	88	73.91	990.60	---	---	---	---	---	---	---
CMW-2	3/10/2000	3/10/2000	1,064.51	---	1,003.51	88	74.05	990.46	11	---	---	ND	---	---	---
CMW-2	4/7/2000	---	1,064.51	---	1,003.51	88	74.77	989.74	---	---	---	---	---	---	---
CMW-2	5/19/2000	---	1,064.51	---	1,003.51	88	76.69	987.82	---	---	---	---	---	---	---
CMW-2	6/22/2000	6/22/2000	1,064.51	---	1,003.51	88	78.17	986.34	22	---	---	ND	---	---	---
CMW-2	7/17/2000	---	1,064.51	---	1,003.51	88	79.30	985.21	---	---	---	---	---	---	---
CMW-2	8/14/2000	---	1,064.51	---	1,003.51	88	80.57	983.94	---	---	---	---	---	---	---
CMW-2	9/21/2000	9/21/2000	1,064.51	---	1,003.51	88	80.79	983.72	32	---	---	ND	---	---	---
CMW-2	10/20/2000	---	1,064.51	---	1,003.51	88	78.45	986.06	---	---	---	---	---	---	---
CMW-2	11/16/2000	---	1,064.51	---	1,003.51	88	73.49	991.02	---	---	---	---	---	---	---
CMW-2	12/11/2000	12/11/2000	1,064.51	---	1,003.51	88	71.60	992.91	150	---	---	ND	---	---	---
CMW-2	1/14/2001	---	1,064.51	---	1,003.51	88	69.63	994.88	---	---	---	---	---	---	---
CMW-2	4/17/2001	4/17/2001	1,064.51	---	1,003.51	88	70.95	993.56	82	---	---	ND	---	---	---
CMW-2	10/30/2001	10/30/2001	1,064.51	---	1,003.51	88	78.00	986.51	91	---	---	ND	---	---	---
CMW-2	1/14/2002	---	1,064.51	---	1,003.51	88	76.55	987.96	---	---	---	---	---	---	---
CMW-2	4/2/2002	4/2/2002	1,064.51	---	1,003.51	88	81.73	982.78	6.6	---	---	ND	---	---	---
CMW-2	5/28/2002	---	1,064.51	---	1,003.51	88	85.03	979.48	---	---	---	---	---	---	---
CMW-2	6/26/2002	---	1,064.51	---	1,003.51	88	86.46	978.05	---	---	---	---	---	---	---
CMW-2	7/10/2002	7/10/2002	1,064.51	---	1,003.51	88	87.02	977.49	10	---	---	ND	---	---	---
CMW-2	12/5/2002	---	1,064.51	---	1,003.51	88	83.58	980.93	---	---	---	---	---	---	---
CMW-2	1/14/2003	1/14/2003	1,064.51	---	1,003.51	88	80.55	983.96	79	---	---	60	---	---	---
CMW-2	4/29/2003	4/29/2003	1,064.51	---	1,003.51	88	80.82	983.69	91	---	---	ND	---	---	---
CMW-2	9/22/2003	---	1,064.51	---	1,003.51	88	91.51	973.00	---	---	---	---	---	---	---
CMW-2	12/4/2003	12/4/2003	1,064.51	---	1,003.51	88	85.29	979.22	110	---	---	ND	---	---	---
CMW-2	3/30/2004	3/29/2004	1,064.51	---	1,003.51	88	83.58	980.93	89	---	---	ND	---	---	---
CMW-2	6/29/2004	---	1,064.51	---	1,003.51	88	88.65	975.86	---	---	---	---	---	---	---
CMW-2	4/7/2005	4/13/2005	1,064.51	---	1,003.51	88	72.26	992.25	190	---	---	ND	---	---	---
CMW-2	7/5/2005	7/11/2005	1,064.51	---	1,003.51	88	84.68	979.83	58	---	---	36	---	---	---
CMW-2	10/11/2005	10/17/2005	1,064.51	---	1,003.51	88	86.36	978.15	74	---	---	ND	---	---	---
CMW-2	1/31/2006	2/2/2006	1,064.51	---	1,003.51	88	79.32	985.19	150	---	---	ND	---	---	---
CMW-2	3/30/2006	3/30/2006	1,064.51	---	1,003.51	88	80.24	984.27	150	---	---	ND	---	---	---
CMW-2	11/28/2006	---	1,064.51	---	1,003.51	88	86.78	977.73	---	---	---	---	---	---	---
CMW-2	1/31/2007	1/31/2007	1,064.51	---	1,003.51	88	83.33	981.18	120	---	---	ND	---	---	---

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)						
All concentrations reported in micrograms per liter (µg/L).															
CMW-2	4/16/2007	4/16/2007	1,064.51	---	1,003.51	88	86.38	978.13	65	---	---	16	---	---	---
CMW-2	1/14/2008	1/14/2008	1,064.51	---	1,003.51	88	86.27	978.24	110	---	---	72	---	---	ND
CMW-2	4/29/2008	4/29/2008	1,064.51	---	1,003.51	88	81.73	982.78	170	---	---	ND	---	---	ND
CMW-2	1/6/2009	1/6/2009	1,064.51	---	1,003.51	88	81.46	983.05	130	---	---	ND	---	---	ND
CMW-2	4/14/2009	4/14/2009	1,064.51	---	1,003.51	88	80.52	983.99	150	---	---	ND	---	---	ND
CMW-2	1/27/2010	1/24/2010	1,064.51	---	1,003.51	88	82.18	982.33	84	---	---	ND	---	---	ND
CMW-2	4/6/2010	4/6/2010	1,064.51	---	1,003.51	88	74.94	989.57	120	---	---	ND	---	---	ND
CMW-2	7/13/2010	7/13/2010	1,064.51	---	1,003.51	88	81.18	983.33	83	---	---	ND	---	---	ND
CMW-2	10/28/2010	10/28/2010	1,064.51	---	1,003.51	88	80.30	984.21	52.1	---	---	ND	---	---	ND
CMW-2	1/25/2011	1/25/2011	1,064.51	---	1,003.51	88	74.18	990.33	54.1	---	---	ND	---	---	ND
CMW-2	4/28/2011	4/28/2011	1,064.51	---	1,003.51	88	81.05	983.46	46.6	---	---	ND	---	---	ND
CMW-2	7/28/2011	7/28/2011	1,064.51	---	1,003.51	88	86.48	978.03	20.7	---	---	ND	---	---	ND
CMW-2	10/25/2011	10/25/2011	1,064.51	---	1,003.51	88	86.11	978.40	23.6	---	---	ND	---	---	ND
CMW-2	1/30/2012	1/30/2012	1,064.51	---	1,003.51	88	80.53	983.98	38	---	---	ND	---	---	ND
CMW-2	4/30/2012	---	1,064.51	---	1,003.51	88	86.49	978.02	---	---	---	---	---	---	---
CMW-2	1/29/2013	---	1,064.51	---	1,003.51	88	86.80	977.71	---	---	---	---	---	---	---
CMW-2	7/12/2013	---	1,064.51	---	1,003.51	88	Dry	---	---	---	---	---	---	---	---
CMW-2	8/20/2014	---	1,064.51	---	1,003.51	88	Dry	---	---	---	---	---	---	---	---
CMW-2	2/11/2015	---	1,064.51	---	1,003.51	88	Dry	---	---	---	---	---	---	---	---
CMW-2	2/22/2017	---	1,064.51	---	1,003.51	88	Dry	---	---	---	---	---	---	---	---
CMW-2	5/17/2017	---	1,064.51	---	1,003.51	88	Dry	---	---	---	---	---	---	---	---
CMW-3	6/27/1997	6/27/1997	---	---	---	130	---	971.02	23	---	---	ND	---	---	---
CMW-3	7/31/1997	---	---	---	---	130	---	968.28	---	---	---	---	---	---	---
CMW-3	8/27/1997	---	---	---	---	130	---	966.65	---	---	---	---	---	---	---
CMW-3	9/23/1997	9/23/1997	---	---	---	130	---	980.56	23	---	---	ND	---	---	---
CMW-3	10/24/1997	---	---	---	---	130	---	986.08	---	---	---	---	---	---	---
CMW-3	11/24/1997	---	---	---	---	130	---	989.46	---	---	---	---	---	---	---
CMW-3	12/17/1997	12/10/1997	---	---	---	130	---	991.74	36	---	---	ND	---	---	---
CMW-3	1/29/1998	---	---	---	---	130	---	991.67	---	---	---	---	---	---	---
CMW-3	2/25/1998	---	---	---	---	130	---	994.04	---	---	---	---	---	---	---
CMW-3	3/12/1998	3/12/1998	---	---	---	130	---	990.74	62	---	---	60	---	---	---
CMW-3	4/13/1998	---	---	---	---	130	---	981.80	---	---	---	---	---	---	---
CMW-3	5/13/1998	---	---	---	---	130	---	977.46	---	---	---	---	---	---	---
CMW-3	6/12/1998	6/12/1998	---	---	---	130	---	975.38	43	---	---	ND	---	---	---
CMW-3	7/16/1998	---	---	---	---	130	---	971.81	---	---	---	---	---	---	---
CMW-3	8/19/1998	---	---	---	---	130	---	968.56	---	---	---	---	---	---	---
CMW-3	10/9/1998	10/12/1998	---	---	---	130	---	975.79	39	---	---	ND	---	---	---
CMW-3	11/13/1998	---	---	---	---	130	---	985.54	---	---	---	---	---	---	---
CMW-3	12/4/1998	12/21/1998	---	---	---	130	---	987.36	40	---	---	<50	---	---	<25
CMW-3	1/22/1999	---	---	---	---	130	---	992.74	---	---	---	---	---	---	---
CMW-3	3/4/1999	3/4/1999	---	---	---	130	---	992.30	31	---	---	ND	---	---	---
CMW-3	4/19/1999	---	---	---	---	130	---	979.14	---	---	---	---	---	---	---
CMW-3	5/12/1999	---	---	---	---	130	---	973.04	---	---	---	---	---	---	---
CMW-3	6/17/1999	6/17/1999	---	---	---	130	---	969.72	24	---	---	ND	---	---	---
CMW-3	7/13/1999	---	---	---	---	130	---	965.93	---	---	---	---	---	---	---
CMW-3	8/12/1999	---	---	---	---	130	---	964.98	---	---	---	---	---	---	---
CMW-3	9/23/1999	9/23/1999	---	---	---	130	---	963.62	16	---	---	ND	---	---	---
CMW-3	10/13/1999	---	---	---	---	130	---	972.55	---	---	---	---	---	---	---
CMW-3	11/17/1999	---	---	---	---	130	---	980.02	---	---	---	---	---	---	---
CMW-3	12/14/1999	12/14/1999	---	---	---	130	---	976.90	16	---	---	ND	---	---	---
CMW-3	1/14/2000	---	---	---	---	130	---	976.06	---	---	---	---	---	---	---

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Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	
CMW-3	2/15/2000	---	---	---	---	130	---	975.51	---	---	---	---	---	---	---
CMW-3	3/10/2000	3/10/2000	---	---	---	130	---	974.52	19	---	---	ND	---	---	---
CMW-3	4/7/2000	---	---	---	---	130	---	970.54	---	---	---	---	---	---	---
CMW-3	5/19/2000	---	---	---	---	130	---	966.26	---	---	---	---	---	---	---
CMW-3	6/22/2000	6/22/2000	---	---	---	130	---	963.71	22	---	---	ND	---	---	---
CMW-3	7/17/2000	---	---	---	---	130	---	961.96	---	---	---	---	---	---	---
CMW-3	8/14/2000	---	---	---	---	130	---	960.33	---	---	---	---	---	---	---
CMW-3	9/21/2000	9/21/2000	---	---	---	130	---	963.74	24	---	---	ND	---	---	---
CMW-3	10/20/2000	---	---	---	---	130	---	973.72	---	---	---	---	---	---	---
CMW-3	11/16/2000	---	---	---	---	130	---	980.36	---	---	---	---	---	---	---
CMW-3	12/11/2000	12/11/2000	---	---	---	130	---	983.84	27	---	---	ND	---	---	---
CMW-3	1/14/2001	---	---	---	---	130	---	986.96	---	---	---	---	---	---	---
CMW-3	4/17/2001	4/17/2001	---	---	---	130	---	975.90	33	---	---	ND	---	---	---
CMW-3	10/30/2001	10/30/2001	---	---	---	130	---	975.74	36	---	---	ND	---	---	---
CMW-3	1/14/2002	---	---	---	---	130	---	974.54	---	---	---	---	---	---	---
CMW-3	4/2/2002	4/2/2002	---	---	---	130	---	961.76	16	---	---	ND	---	---	---
CMW-3	5/28/2002	---	---	---	---	130	---	956.06	---	---	---	---	---	---	---
CMW-3	6/26/2002	---	---	---	---	130	---	954.01	---	---	---	---	---	---	---
CMW-3	7/10/2002	7/10/2002	---	---	---	130	---	953.44	21	---	---	ND	---	---	---
CMW-3	9/12/2002	9/12/2002	---	---	---	130	---	955.70	21	---	---	ND	---	---	---
CMW-3	12/5/2002	---	---	---	---	130	---	970.86	---	---	---	---	---	---	---
CMW-3	1/14/2003	1/14/2003	---	---	---	130	---	975.82	36	---	---	ND	---	---	---
CMW-3	4/29/2003	4/29/2003	---	---	---	130	---	966.80	28	---	---	ND	---	---	---
CMW-3	9/22/2003	---	---	---	---	130	---	949.38	---	---	---	---	---	---	---
CMW-3	12/4/2003	---	---	---	---	130	---	970.10	---	---	---	---	---	---	---
CMW-3	3/30/2004	---	---	---	---	130	---	963.31	---	---	---	---	---	---	---
CMW-3	2/22/2017	---	---	---	---	130	CNA	---	---	---	---	---	---	---	---
CMW-3	5/17/2017	---	---	---	---	130	CNA	---	---	---	---	---	---	---	---
CMW-4	12/28/1998	12/28/1998	1,057.65	---	997.65	88	66.47	991.18	91	---	---	90	---	---	85
CMW-4	1/22/1999	---	1,057.65	---	997.65	88	64.80	992.85	---	---	---	---	---	---	---
CMW-4	2/12/1999	---	1,057.65	---	997.65	88	64.60	993.05	---	---	---	---	---	---	---
CMW-4	3/4/1999	3/4/1999	1,057.65	---	997.65	88	66.47	991.18	120	---	---	120	---	---	---
CMW-4	4/19/1999	---	1,057.65	---	997.65	88	76.12	981.53	---	---	---	---	---	---	---
CMW-4	5/12/1999	---	1,057.65	---	997.65	88	82.15	975.50	---	---	---	---	---	---	---
CMW-4	6/17/1999	6/17/1999	1,057.65	---	997.65	88	85.42	972.23	110	---	---	100	---	---	---
CMW-4	7/13/1999	---	1,057.65	---	997.65	88	88.81	968.84	---	---	---	---	---	---	---
CMW-4	8/12/1999	---	1,057.65	---	997.65	88	89.62	968.03	---	---	---	---	---	---	---
CMW-4	10/13/1999	---	1,057.65	---	997.65	88	83.99	973.66	---	---	---	---	---	---	---
CMW-4	11/17/1999	---	1,057.65	---	997.65	88	77.38	980.27	---	---	---	---	---	---	---
CMW-4	12/14/1999	12/14/1999	1,057.65	---	997.65	88	78.80	978.85	49	---	---	ND	---	---	---
CMW-4	1/14/2000	---	1,057.65	---	997.65	88	79.47	978.18	---	---	---	---	---	---	---
CMW-4	2/15/2000	---	1,057.65	---	997.65	88	80.82	976.83	---	---	---	---	---	---	---
CMW-4	3/10/2000	3/10/2000	1,057.65	---	997.65	88	81.32	976.33	52	---	---	ND	---	---	---
CMW-4	4/7/2000	---	1,057.65	---	997.65	88	84.91	972.74	---	---	---	---	---	---	---
CMW-4	5/19/2000	---	1,057.65	---	997.65	88	88.78	968.87	---	---	---	---	---	---	---
CMW-4	10/20/2000	---	1,057.65	---	997.65	88	83.41	974.24	---	---	---	---	---	---	---
CMW-4	11/16/2000	---	1,057.65	---	997.65	88	76.87	980.78	---	---	---	---	---	---	---
CMW-4	12/11/2000	12/11/2000	1,057.65	---	997.65	88	73.46	984.19	42	---	---	ND	---	---	---
CMW-4	1/14/2001	---	1,057.65	---	997.65	88	70.55	987.10	---	---	---	---	---	---	---
CMW-4	4/17/2001	4/17/2001	1,057.65	---	997.65	88	79.38	978.27	75	---	---	70	---	---	---
CMW-4	10/30/2001	10/30/2001	1,057.65	---	997.65	88	81.62	976.03	58	---	---	60	---	---	---

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 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	
CMW-4	1/14/2002	---	1,057.65	---	997.65	88	82.39	975.26	---	---	---	---	---	---	---
CMW-4	12/5/2002	---	1,057.65	---	997.65	88	86.38	971.27	---	---	---	---	---	---	---
CMW-4	1/14/2003	1/14/2003	1,057.65	---	997.65	88	81.70	975.95	59	---	---	ND	---	---	---
CMW-4	4/29/2003	4/29/2003	1,057.65	---	997.65	88	88.00	969.65	46	---	---	ND	---	---	---
CMW-4	9/22/2003	---	1,057.65	---	997.65	88	89.65	968.00	---	---	---	---	---	---	---
CMW-4	12/4/2003	12/4/2003	1,057.65	---	997.65	88	87.18	970.47	60	---	---	ND	---	---	---
CMW-4	3/30/2004	---	1,057.65	---	997.65	88	91.00	966.65	---	---	---	---	---	---	---
CMW-4	6/29/2004	---	1,057.65	---	997.65	88	90.65	967.00	---	---	---	---	---	---	---
CMW-4	4/7/2005	4/13/2005	1,057.65	---	997.65	88	72.66	984.99	52	---	---	62	---	---	---
CMW-4	1/31/2006	2/2/2006	1,057.65	---	997.65	88	78.46	979.19	120	---	---	110	---	---	---
CMW-4	3/30/2006	3/30/2006	1,057.65	---	997.65	88	87.10	970.55	73	---	---	85	---	---	---
CMW-4	1/31/2007	1/31/2007	1,057.65	---	997.65	88	84.20	973.45	69	---	---	45	---	---	---
CMW-4	1/14/2008	1/14/2008	1,057.65	---	997.65	88	87.05	970.60	27	---	---	27	---	---	ND
CMW-4	1/6/2009	1/6/2009	1,057.65	---	997.65	88	82.71	974.94	64	---	---	53	---	---	ND
CMW-4	1/27/2010	1/24/2010	1,057.65	---	997.65	88	83.34	974.31	43	---	---	31	---	---	ND
CMW-4	4/6/2010	4/6/2010	1,057.65	---	997.65	88	79.40	978.25	38	---	---	43	---	---	41
CMW-4	10/28/2010	10/28/2010	1,057.65	---	997.65	88	84.50	973.15	64.6	---	---	310	---	---	308
CMW-4	1/25/2011	1/25/2011	1,057.65	---	997.65	88	74.95	982.70	82.6	---	---	435	---	---	429
CMW-4	1/30/2012	1/30/2012	1,057.65	---	997.65	88	82.71	974.94	24.5	---	---	227	---	---	170
CMW-4	1/29/2013	---	1,057.65	---	997.65	88	87.70	969.95	---	---	---	---	---	---	---
CMW-4	7/12/2013	---	1,057.65	---	997.65	88	Dry	---	---	---	---	---	---	---	---
CMW-4	8/20/2014	---	1,057.65	---	997.65	88	Dry	---	---	---	---	---	---	---	---
CMW-4	2/11/2015	---	1,057.65	---	997.65	88	Dry	---	---	---	---	---	---	---	---
CMW-4	2/22/2017	---	1,057.65	---	997.65	88	Dry	---	---	---	---	---	---	---	---
CMW-4	5/17/2017	---	1,057.65	---	997.65	88	Dry	---	---	---	---	---	---	---	---
CMW-5	12/28/1998	12/28/1998	1,061.31	---	1,001.31	89	67.85	993.46	88	---	---	70	---	---	77
CMW-5	1/22/1999	---	1,061.31	---	1,001.31	89	66.23	995.08	---	---	---	---	---	---	---
CMW-5	2/12/1999	---	1,061.31	---	1,001.31	89	65.88	995.43	---	---	---	---	---	---	---
CMW-5	3/4/1999	3/4/1999	1,061.31	---	1,001.31	89	66.35	994.96	100	---	---	80	---	---	---
CMW-5	4/19/1999	---	1,061.31	---	1,001.31	89	73.13	988.18	---	---	---	---	---	---	---
CMW-5	5/12/1999	---	1,061.31	---	1,001.31	89	79.79	981.52	---	---	---	---	---	---	---
CMW-5	6/17/1999	6/17/1999	1,061.31	---	1,001.31	89	82.80	978.51	67	---	---	ND	---	---	---
CMW-5	7/13/1999	---	1,061.31	---	1,001.31	89	85.85	975.46	---	---	---	---	---	---	---
CMW-5	8/12/1999	---	1,061.31	---	1,001.31	89	86.88	974.43	---	---	---	---	---	---	---
CMW-5	9/23/1999	9/23/1999	1,061.31	---	1,001.31	89	88.20	973.11	30	---	---	160	---	---	---
CMW-5	10/13/1999	---	1,061.31	---	1,001.31	89	82.93	978.38	---	---	---	---	---	---	---
CMW-5	11/17/1999	---	1,061.31	---	1,001.31	89	78.07	983.24	---	---	---	---	---	---	---
CMW-5	12/14/1999	12/14/1999	1,061.31	---	1,001.31	89	78.83	982.48	100	---	---	100	---	---	---
CMW-5	1/14/2000	---	1,061.31	---	1,001.31	89	79.50	981.81	---	---	---	---	---	---	---
CMW-5	2/15/2000	---	1,061.31	---	1,001.31	89	80.43	980.88	---	---	---	---	---	---	---
CMW-5	3/10/2000	3/10/2000	1,061.31	---	1,001.31	89	80.68	980.63	26	---	---	ND	---	---	---
CMW-5	4/7/2000	---	1,061.31	---	1,001.31	89	83.35	977.96	---	---	---	---	---	---	---
CMW-5	5/19/2000	---	1,061.31	---	1,001.31	89	86.59	974.72	---	---	---	---	---	---	---
CMW-5	6/22/2000	6/22/2000	1,061.31	---	1,001.31	89	88.47	972.84	27	---	---	ND	---	---	---
CMW-5	10/20/2000	---	1,061.31	---	1,001.31	89	84.02	977.29	---	---	---	---	---	---	---
CMW-5	11/16/2000	---	1,061.31	---	1,001.31	89	77.97	983.34	---	---	---	---	---	---	---
CMW-5	12/11/2000	12/11/2000	1,061.31	---	1,001.31	89	74.96	986.35	30	---	---	---	---	---	---
CMW-5	1/14/2001	---	1,061.31	---	1,001.31	89	72.15	989.16	---	---	---	---	---	---	---
CMW-5	4/17/2001	4/17/2001	1,061.31	---	1,001.31	89	78.16	983.15	94	---	---	70	---	---	---
CMW-5	10/30/2001	10/30/2001	1,061.31	---	1,001.31	89	82.40	978.91	69	---	---	---	---	---	---
CMW-5	1/14/2002	---	1,061.31	---	1,001.31	89	82.10	979.21	---	---	---	---	---	---	---

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	
CMW-5	12/5/2002	---	1,061.31	---	1,001.31	89	87.58	973.73	---	---	---	---	---	---	---
CMW-5	1/14/2003	1/14/2003	1,061.31	---	1,001.31	89	83.20	978.11	35	---	---	ND	---	---	---
CMW-5	4/29/2003	4/29/2003	1,061.31	---	1,001.31	89	87.64	973.67	26	---	---	ND	---	---	---
CMW-5	9/22/2003	---	1,061.31	---	1,001.31	89	90.31	971.00	---	---	---	---	---	---	---
CMW-5	12/4/2003	12/4/2003	1,061.31	---	1,001.31	89	88.55	972.76	23	---	---	ND	---	---	---
CMW-5	3/30/2004	---	1,061.31	---	1,001.31	89	91.31	970.00	---	---	---	---	---	---	---
CMW-5	6/29/2004	---	1,061.31	---	1,001.31	89	91.31	970.00	---	---	---	---	---	---	---
CMW-5	4/7/2005	4/13/2005	1,061.31	---	1,001.31	89	75.31	986.00	42	---	---	50	---	---	---
CMW-5	1/31/2006	2/2/2006	1,061.31	---	1,001.31	89	81.31	980.00	47	---	---	40	---	---	---
CMW-5	3/30/2006	3/30/2006	1,061.31	---	1,001.31	89	86.45	974.86	42	---	---	44	---	---	---
CMW-5	1/31/2007	1/31/2007	1,061.31	---	1,001.31	89	85.73	975.58	34	---	---	23	---	---	---
CMW-5	1/14/2008	---	1,061.31	---	1,001.31	89	88.85	972.46	---	---	---	---	---	---	---
CMW-5	1/6/2009	1/6/2009	1,061.31	---	1,001.31	89	84.28	977.03	21	---	---	29	---	---	26
CMW-5	4/14/2009	4/14/2009	1,061.31	---	1,001.31	89	88.35	972.96	38	---	---	300	---	---	18
CMW-5	1/27/2010	1/24/2010	1,061.31	---	1,001.31	89	84.88	976.43	15	---	---	20	---	---	15
CMW-5	4/6/2010	4/6/2010	1,061.31	---	1,001.31	89	79.80	981.51	---	---	---	---	---	---	38
CMW-5	10/28/2010	10/28/2010	1,061.31	---	1,001.31	89	85.44	975.87	17	---	---	53	---	---	52
CMW-5	1/25/2011	1/25/2011	1,061.31	---	1,001.31	89	76.62	984.69	40.7	---	---	179	---	---	171
CMW-5	1/30/2012	1/30/2012	1,061.31	---	1,001.31	89	83.74	977.57	11.7	---	---	49	---	---	40
CMW-5	7/12/2013	---	1,061.31	---	1,001.31	89	Dry	---	---	---	---	---	---	---	---
CMW-5	8/20/2014	---	1,061.31	---	1,001.31	89	Dry	---	---	---	---	---	---	---	---
CMW-5	2/11/2015	---	1,061.31	---	1,001.31	89	Dry	---	---	---	---	---	---	---	---
CMW-5	2/22/2017	---	1,061.31	---	1,001.31	89	Dry	---	---	---	---	---	---	---	---
CMW-5	5/17/2017	---	1,061.31	---	1,001.31	89	Dry	---	---	---	---	---	---	---	---
WVB-1	10/16/1995	---	1,062.27	---	1,020.27	88	58.51	1,003.76	---	---	---	---	---	---	---
WVB-1	11/22/1995	---	1,062.27	---	1,020.27	88	53.29	1,008.98	---	---	---	---	---	---	---
WVB-1	12/14/1995	---	1,062.27	---	1,020.27	88	51.36	1,010.91	---	---	---	---	---	---	---
WVB-1	1/12/1996	---	1,062.27	---	1,020.27	88	50.04	1,012.23	---	---	---	---	---	---	---
WVB-1	2/16/1996	---	1,062.27	---	1,020.27	88	48.12	1,014.15	---	---	---	---	---	---	---
WVB-1	3/22/1996	---	1,062.27	---	1,020.27	88	51.70	1,010.57	---	---	---	---	---	---	---
WVB-1	4/16/1996	---	1,062.27	---	1,020.27	88	57.28	1,004.99	---	---	---	---	---	---	---
WVB-1	5/15/1996	---	1,062.27	---	1,020.27	88	62.12	1,000.15	---	---	---	---	---	---	---
WVB-1	6/27/1996	---	1,062.27	---	1,020.27	88	65.60	996.67	---	---	---	---	---	---	---
WVB-1	7/12/1996	---	1,062.27	---	1,020.27	88	66.39	995.88	---	---	---	---	---	---	---
WVB-1	8/16/1996	---	1,062.27	---	1,020.27	88	66.17	996.10	---	---	---	---	---	---	---
WVB-1	9/24/1996	---	1,062.27	---	1,020.27	88	66.08	996.19	---	---	---	---	---	---	---
WVB-1	10/17/1996	---	1,062.27	---	1,020.27	88	63.40	998.87	---	---	---	---	---	---	---
WVB-1	12/24/1996	---	1,062.27	---	1,020.27	88	57.28	1,004.99	---	---	---	---	---	---	---
WVB-1	1/15/1997	---	1,062.27	---	1,020.27	88	56.68	1,005.59	---	---	---	---	---	---	---
WVB-1	2/21/1997	---	1,062.27	---	1,020.27	88	59.70	1,002.57	---	---	---	---	---	---	---
WVB-1	3/25/1997	---	1,062.27	---	1,020.27	88	63.62	998.65	---	---	---	---	---	---	---
WVB-1	4/24/1997	---	1,062.27	---	1,020.27	88	67.78	994.49	---	---	---	---	---	---	---
WVB-1	5/23/1997	---	1,062.27	---	1,020.27	88	69.04	993.23	---	---	---	---	---	---	---
WVB-1	6/27/1997	---	1,062.27	---	1,020.27	88	72.08	990.19	---	---	---	---	---	---	---
WVB-1	7/31/1997	---	1,062.27	---	1,020.27	88	74.07	988.20	---	---	---	---	---	---	---
WVB-1	8/27/1997	---	1,062.27	---	1,020.27	88	75.62	986.65	---	---	---	---	---	---	---
WVB-1	9/23/1997	---	1,062.27	---	1,020.27	88	70.54	991.73	---	---	---	---	---	---	---
WVB-1	10/24/1997	---	1,062.27	---	1,020.27	88	67.54	994.73	---	---	---	---	---	---	---
WVB-1	12/17/1997	---	1,062.27	---	1,020.27	88	63.60	998.67	---	---	---	---	---	---	---
WVB-1	1/29/1998	---	1,062.27	---	1,020.27	88	62.64	999.63	---	---	---	---	---	---	---
WVB-1	2/25/1998	---	1,062.27	---	1,020.27	88	61.44	1,000.83	---	---	---	---	---	---	---

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
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Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	
WVB-1	3/12/1998	---	1,062.27	---	1,020.27	88	60.54	1,001.73	---	---	---	---	---	---	---
WVB-1	4/13/1998	---	1,062.27	---	1,020.27	88	64.30	997.97	---	---	---	---	---	---	---
WVB-1	5/13/1998	---	1,062.27	---	1,020.27	88	66.32	995.95	---	---	---	---	---	---	---
WVB-1	6/12/1998	---	1,062.27	---	1,020.27	88	68.85	993.42	---	---	---	---	---	---	---
WVB-1	7/16/1998	---	1,062.27	---	1,020.27	88	70.86	991.41	---	---	---	---	---	---	---
WVB-1	8/19/1998	---	1,062.27	---	1,020.27	88	73.84	988.43	---	---	---	---	---	---	---
WVB-1	10/9/1998	---	1,062.27	---	1,020.27	88	74.35	987.92	---	---	---	---	---	---	---
WVB-1	11/13/1998	---	1,062.27	---	1,020.27	88	68.04	994.23	---	---	---	---	---	---	---
WVB-1	12/4/1998	---	1,062.27	---	1,020.27	88	66.44	995.83	---	---	---	---	---	---	---
WVB-1	1/22/1999	---	1,062.27	---	1,020.27	88	63.21	999.06	---	---	---	---	---	---	---
WVB-1	2/12/1999	---	1,062.27	---	1,020.27	88	62.85	999.42	---	---	---	---	---	---	---
WVB-1	3/4/1999	---	1,062.27	---	1,020.27	88	63.22	999.05	---	---	---	---	---	---	---
WVB-1	4/19/1999	---	1,062.27	---	1,020.27	88	68.05	994.22	---	---	---	---	---	---	---
WVB-1	6/17/1999	---	1,062.27	---	1,020.27	88	75.19	987.08	---	---	---	---	---	---	---
WVB-1	7/13/1999	---	1,062.27	---	1,020.27	88	77.30	984.97	---	---	---	---	---	---	---
WVB-1	8/12/1999	---	1,062.27	---	1,020.27	88	77.99	984.28	---	---	---	---	---	---	---
WVB-1	10/13/1999	---	1,062.27	---	1,020.27	88	76.40	985.87	---	---	---	---	---	---	---
WVB-1	11/17/1999	---	1,062.27	---	1,020.27	88	73.60	988.67	---	---	---	---	---	---	---
WVB-1	12/14/1999	---	1,062.27	---	1,020.27	88	73.35	988.92	---	---	---	---	---	---	---
WVB-1	1/14/2000	---	1,062.27	---	1,020.27	88	74.02	988.25	---	---	---	---	---	---	---
WVB-1	2/15/2000	---	1,062.27	---	1,020.27	88	75.08	987.19	---	---	---	---	---	---	---
WVB-1	3/10/2000	---	1,062.27	---	1,020.27	88	76.12	986.15	---	---	---	---	---	---	---
WVB-1	9/22/2000	---	1,062.27	---	1,020.27	88	82.56	979.71	---	---	---	---	---	---	---
WVB-1	10/20/2000	---	1,062.27	---	1,020.27	88	79.08	983.19	---	---	---	---	---	---	---
WVB-1	11/16/2000	---	1,062.27	---	1,020.27	88	73.40	988.87	---	---	---	---	---	---	---
WVB-1	12/11/2000	---	1,062.27	---	1,020.27	88	71.26	991.01	---	---	---	---	---	---	---
WVB-1	1/14/2001	---	1,062.27	---	1,020.27	88	69.16	993.11	---	---	---	---	---	---	---
WVB-1	4/18/2001	---	1,062.27	---	1,020.27	88	72.09	990.18	---	---	---	---	---	---	---
WVB-1	10/30/2001	---	1,062.27	---	1,020.27	88	78.49	983.78	---	---	---	---	---	---	---
WVB-1	1/14/2002	---	1,062.27	---	1,020.27	88	77.23	985.04	---	---	---	---	---	---	---
WVB-1	4/2/2002	---	1,062.27	---	1,020.27	88	83.72	978.55	---	---	---	---	---	---	---
WVB-1	12/5/2002	---	1,062.27	---	1,020.27	88	83.64	978.63	---	---	---	---	---	---	---
WVB-1	1/14/2003	---	1,062.27	---	1,020.27	88	80.21	982.06	---	---	---	---	---	---	---
WVB-1	4/29/2003	---	1,062.27	---	1,020.27	88	81.51	980.76	---	---	---	---	---	---	---
WVB-1	12/4/2003	---	1,062.27	---	1,020.27	88	84.95	977.32	---	---	---	---	---	---	---
WVB-1	3/30/2004	---	1,062.27	---	1,020.27	88	84.40	977.87	---	---	---	---	---	---	---
WVB-1	6/29/2004	---	1,062.27	---	1,020.27	88	87.60	974.67	---	---	---	---	---	---	---
WVB-1	4/7/2005	---	1,062.27	---	1,020.27	88	70.38	991.89	---	---	---	---	---	---	---
WVB-1	7/5/2005	---	1,062.27	---	1,020.27	88	86.28	975.99	---	---	---	---	---	---	---
WVB-1	10/11/2005	---	1,062.27	---	1,020.27	88	86.65	975.62	---	---	---	---	---	---	---
WVB-2	1/14/2001	---	---	---	---	---	---	998.09	---	---	---	---	---	---	---
WVB-2	4/18/2001	---	---	---	---	---	---	997.51	---	---	---	---	---	---	---
WVB-2	10/30/2001	---	---	---	---	---	---	991.45	---	---	---	---	---	---	---
WVB-2	1/14/2002	---	---	---	---	---	---	991.74	---	---	---	---	---	---	---
WVB-2	4/2/2002	---	---	---	---	---	---	987.71	---	---	---	---	---	---	---
WVB-2	5/28/2002	---	---	---	---	---	---	985.38	---	---	---	---	---	---	---
WVB-2	6/26/2002	---	---	---	---	---	---	984.33	---	---	---	---	---	---	---
WVB-2	7/10/2002	---	---	---	---	---	---	983.94	---	---	---	---	---	---	---
WVB-2	9/12/2002	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WVB-2	12/5/2002	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WVB-2	1/14/2003	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	100
WVB-2	4/29/2003	---	---	---	---	---	---	---	<0.5	<10	<20	2,800	7.5	220	---
WVB-2	9/22/2003	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WVB-2	12/4/2003	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WVB-2	3/30/2004	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WVB-2	6/29/2004	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WVB-2	1/31/2007	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WVB-3 (AVB46-01)	12/2/1992	---	---	---	---	---	---	---	---	---	---	204	---	---	<20
WVB-3 (AVB46-01)	4/11/1994	---	---	---	---	---	---	---	0.2	---	---	<10	---	---	<20
WVB-3 (AVB46-01)	10/12/1994	---	---	---	---	---	---	---	4.7	---	---	---	---	---	---
WVB-3 (AVB46-01)	5/2/1995	---	---	---	---	---	---	---	<0.5	---	---	---	---	---	<25
WVB-3 (AVB46-01)	12/13/1995	---	---	---	---	---	---	---	1.9	---	---	10	---	---	---
WVB-3 (AVB46-01)	4/17/1996	---	---	---	---	---	---	---	<0.5	---	---	22	---	---	---
WVB-3 (AVB46-01)	11/13/1996	---	---	---	---	---	---	---	<0.5	---	---	23	---	---	---
WVB-3 (AVB46-01)	5/14/1997	---	---	---	---	---	---	---	<1.0	---	---	2,690	---	---	---
WVB-4	10/16/1995	---	1,062.87	---	1,017.87	84	60.33	1,002.54	---	---	---	---	---	---	---
WVB-4	11/22/1995	---	1,062.87	---	1,017.87	84	53.21	1,009.66	---	---	---	---	---	---	---
WVB-4	12/14/1995	---	1,062.87	---	1,017.87	84	52.64	1,010.23	---	---	---	---	---	---	---
WVB-4	1/12/1996	---	1,062.87	---	1,017.87	84	51.05	1,011.82	---	---	---	---	---	---	---
WVB-4	2/16/1996	---	1,062.87	---	1,017.87	84	50.79	1,012.08	---	---	---	---	---	---	---
WVB-4	3/22/1996	---	1,062.87	---	1,017.87	84	53.52	1,009.35	---	---	---	---	---	---	---
WVB-4	4/16/1996	---	1,062.87	---	1,017.87	84	59.20	1,003.67	---	---	---	---	---	---	---
WVB-4	5/15/1996	---	1,062.87	---	1,017.87	84	63.71	999.16	---	---	---	---	---	---	---
WVB-4	6/27/1996	---	1,062.87	---	1,017.87	84	67.05	995.82	---	---	---	---	---	---	---
WVB-4	7/12/1996	---	1,062.87	---	1,017.87	84	68.27	994.60	---	---	---	---	---	---	---
WVB-4	8/16/1996	---	1,062.87	---	1,017.87	84	68.36	994.51	---	---	---	---	---	---	---
WVB-4	9/24/1996	---	1,062.87	---	1,017.87	84	68.08	994.79	---	---	---	---	---	---	---
WVB-4	10/17/1996	---	1,062.87	---	1,017.87	84	65.36	997.51	---	---	---	---	---	---	---
WVB-4	11/27/1996	---	1,062.87	---	1,017.87	84	60.67	1,002.20	---	---	---	---	---	---	---
WVB-4	1/15/1997	---	1,062.87	---	1,017.87	84	58.30	1,004.57	---	---	---	---	---	---	---
WVB-4	2/21/1997	---	1,062.87	---	1,017.87	84	61.28	1,001.59	---	---	---	---	---	---	---
WVB-4	3/25/1997	---	1,062.87	---	1,017.87	84	65.30	997.57	---	---	---	---	---	---	---
WVB-4	4/24/1997	---	1,062.87	---	1,017.87	84	69.68	993.19	---	---	---	---	---	---	---
WVB-4	5/23/1997	---	1,062.87	---	1,017.87	84	71.26	991.61	---	---	---	---	---	---	---
WVB-4	6/27/1997	---	1,062.87	---	1,017.87	84	74.48	988.39	---	---	---	---	---	---	---
WVB-4	7/31/1997	---	1,062.87	---	1,017.87	84	76.76	986.11	---	---	---	---	---	---	---
WVB-4	8/27/1997	---	1,062.87	---	1,017.87	84	78.04	984.83	---	---	---	---	---	---	---
WVB-4	9/23/1997	---	1,062.87	---	1,017.87	84	72.48	990.39	---	---	---	---	---	---	---
WVB-4	10/24/1997	---	1,062.87	---	1,017.87	84	69.16	993.71	---	---	---	---	---	---	---
WVB-4	11/24/1997	---	1,062.87	---	1,017.87	84	66.74	996.13	---	---	---	---	---	---	---
WVB-4	12/17/1997	---	1,062.87	---	1,017.87	84	65.06	997.81	---	---	---	---	---	---	---
WVB-4	1/29/1998	---	1,062.87	---	1,017.87	84	63.70	999.17	---	---	---	---	---	---	---
WVB-4	2/25/1998	---	1,062.87	---	1,017.87	84	62.98	999.89	---	---	---	---	---	---	---
WVB-4	3/12/1998	---	1,062.87	---	1,017.87	84	62.26	1,000.61	---	---	---	---	---	---	---
WVB-4	4/13/1998	---	1,062.87	---	1,017.87	84	66.60	996.27	---	---	---	---	---	---	---
WVB-4	5/13/1998	---	1,062.87	---	1,017.87	84	68.96	993.91	---	---	---	---	---	---	---
WVB-4	6/12/1998	---	1,062.87	---	1,017.87	84	71.22	991.65	---	---	---	---	---	---	---
WVB-4	7/16/1998	---	1,062.87	---	1,017.87	84	73.80	989.07	---	---	---	---	---	---	---
WVB-4	8/19/1998	---	1,062.87	---	1,017.87	84	76.44	986.43	---	---	---	---	---	---	---
WVB-4	10/9/1998	---	1,062.87	---	1,017.87	84	76.06	986.81	---	---	---	---	---	---	---
WVB-4	11/13/1998	---	1,062.87	---	1,017.87	84	69.79	993.08	---	---	---	---	---	---	---

TABLE 3
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 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	
WVB-4	12/4/1998	---	1,062.87	---	1,017.87	84	68.14	994.73	---	---	---	---	---	---	---
WVB-4	1/22/1999	---	1,062.87	---	1,017.87	84	64.42	998.45	---	---	---	---	---	---	---
WVB-4	2/12/1999	---	1,062.87	---	1,017.87	84	64.00	998.87	---	---	---	---	---	---	---
WVB-4	3/4/1999	---	1,062.87	---	1,017.87	84	64.28	998.59	---	---	---	---	---	---	---
WVB-4	4/19/1999	---	1,062.87	---	1,017.87	84	69.95	992.92	---	---	---	---	---	---	---
WVB-4	5/19/1999	---	1,062.87	---	1,017.87	84	73.90	988.97	---	---	---	---	---	---	---
WVB-4	6/17/1999	---	1,062.87	---	1,017.87	84	76.94	985.93	---	---	---	---	---	---	---
WVB-4	7/13/1999	---	1,062.87	---	1,017.87	84	79.41	983.46	---	---	---	---	---	---	---
WVB-4	8/12/1999	---	1,062.87	---	1,017.87	84	80.30	982.57	---	---	---	---	---	---	---
WVB-4	9/23/1999	---	1,062.87	---	1,017.87	84	81.50	981.37	---	---	---	---	---	---	---
WVB-4	10/13/1999	---	1,062.87	---	1,017.87	84	78.40	984.47	---	---	---	---	---	---	---
WVB-4	11/17/1999	---	1,062.87	---	1,017.87	84	75.00	987.87	---	---	---	---	---	---	---
WVB-4	12/14/1999	---	1,062.87	---	1,017.87	84	75.10	987.77	---	---	---	---	---	---	---
WVB-4	1/14/2000	---	1,062.87	---	1,017.87	84	75.55	987.32	---	---	---	---	---	---	---
WVB-4	2/15/2000	---	1,062.87	---	1,017.87	84	76.44	986.43	---	---	---	---	---	---	---
WVB-4	3/10/2000	---	1,062.87	---	1,017.87	84	76.57	986.30	---	---	---	---	---	---	---
WVB-4	4/7/2000	---	1,062.87	---	1,017.87	84	78.12	984.75	---	---	---	---	---	---	---
WVB-4	5/19/2000	---	1,062.87	---	1,017.87	84	80.66	982.21	---	---	---	---	---	---	---
WVB-4	7/17/2000	---	1,062.87	---	1,017.87	84	83.72	979.15	---	---	---	---	---	---	---
WVB-4	8/14/2000	---	1,062.87	---	1,017.87	84	85.00	977.87	---	---	---	---	---	---	---
WVB-4	9/22/2000	---	1,062.87	---	1,017.87	84	84.52	978.35	---	---	---	---	---	---	---
WVB-4	10/20/2000	---	1,062.87	---	1,017.87	84	80.96	981.91	---	---	---	---	---	---	---
WVB-4	11/16/2000	---	1,062.87	---	1,017.87	84	75.42	987.45	---	---	---	---	---	---	---
WVB-4	12/11/2000	---	1,062.87	---	1,017.87	84	72.86	990.01	---	---	---	---	---	---	---
WVB-4	1/14/2001	---	1,062.87	---	1,017.87	84	70.64	992.23	---	---	---	---	---	---	---
WVB-4	4/18/2001	---	1,062.87	---	1,017.87	84	73.80	989.07	---	---	---	---	---	---	---
WVB-4	10/30/2001	---	1,062.87	---	1,017.87	84	79.95	982.92	---	---	---	---	---	---	---
WVB-4	1/14/2002	---	1,062.87	---	1,017.87	84	83.87	979.00	---	---	---	---	---	---	---
WVB-4	4/2/2002	---	1,062.87	---	1,017.87	84	78.70	984.17	---	---	---	---	---	---	---
WVB-4	5/28/2002	---	1,062.87	---	1,017.87	84	89.20	973.67	---	---	---	---	---	---	---
WVB-4	6/26/2002	---	1,062.87	---	1,017.87	84	91.10	971.77	---	---	---	---	---	---	---
WVB-4	7/10/2002	---	1,062.87	---	1,017.87	84	92.00	970.87	---	---	---	---	---	---	---
WVB-4	12/5/2002	---	1,062.87	---	1,017.87	84	85.28	977.59	---	---	---	---	---	---	---
WVB-4	1/14/2003	---	1,062.87	---	1,017.87	84	81.58	981.29	---	---	---	---	---	---	---
WVB-4	4/29/2003	4/29/2003	1,062.87	---	1,017.87	84	83.39	979.48	240	---	---	ND	---	---	---
WVB-4	12/4/2003	12/4/2003	1,062.87	---	1,017.87	84	86.54	976.33	59	---	---	ND	---	---	---
WVB-4	3/30/2004	3/29/2004	1,062.87	---	1,017.87	84	86.08	976.79	94	---	---	ND	---	---	---
WVB-4	6/29/2004	---	1,062.87	---	1,017.87	84	93.00	969.87	---	---	---	---	---	---	---
WVB-4	12/28/2004	1/4/2005	1,062.87	---	1,017.87	84	89.90	972.97	37	---	---	ND	---	---	---
WVB-4	4/7/2005	4/13/2005	1,062.87	---	1,017.87	84	73.46	989.41	460	---	---	420	---	---	---
WVB-4	7/5/2005	7/11/2005	1,062.87	---	1,017.87	84	87.70	975.17	160	---	---	140	---	---	---
WVB-4	10/11/2005	10/17/2005	1,062.87	---	1,017.87	84	88.82	974.05	150	---	---	890	---	---	---
WVB-4	1/31/2006	2/2/2006	1,062.87	---	1,017.87	84	80.00	982.87	310	---	---	840	---	---	---
WVB-4	3/30/2006	3/30/2006	1,062.87	---	1,017.87	84	82.45	980.42	340	---	---	830	---	---	---
WVB-4	11/28/2006	11/28/2006	1,062.87	---	1,017.87	84	88.15	974.72	44	---	---	230	---	---	---
WVB-4	1/31/2007	1/31/2007	1,062.87	---	1,017.87	84	84.13	978.74	39	---	---	140	---	---	---
WVB-4	4/16/2007	4/16/2014	1,062.87	---	1,017.87	84	88.93	973.94	33	---	---	ND	---	---	---
WVB-4	1/14/2008	1/14/2008	1,062.87	---	1,017.87	84	87.20	975.67	34	---	---	38	---	---	<10
WVB-4	4/29/2008	4/9/2008	1,062.87	---	1,017.87	84	---	---	360	---	---	20	---	---	<10
WVB-4	10/14/2008	10/14/2008	1,062.87	---	1,017.87	84	---	---	---	---	---	---	---	---	<10
WVB-4	1/6/2009	1/6/2009	1,062.87	---	1,017.87	84	82.58	980.29	76	---	---	47	---	---	<10
WVB-4	4/14/2009	4/14/2009	1,062.87	---	1,017.87	84	83.68	979.19	200	---	---	310	---	---	18

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
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Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
									All concentrations reported in micrograms per liter (µg/L).						
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	
WVB-4	1/24/2010	1/24/2010	1,062.87	---	1,017.87	84	83.16	979.71	16	---	---	44	---	---	<10
WVB-4	4/6/2010	4/6/2010	1,062.87	---	1,017.87	84	76.90	985.97	190	---	---	220	---	---	180
WVB-4	7/13/2010	7/13/2010	1,062.87	---	1,017.87	84	85.00	977.87	250	---	---	1,100	---	---	670
WVB-4	10/28/2010	10/28/2010	1,062.87	---	1,017.87	84	82.51	980.36	147	---	---	384	---	---	378
WVB-4	1/25/2011	1/25/2011	1,062.87	---	1,017.87	84	75.02	987.85	257	---	---	1,560	---	---	1,500
WVB-4	4/28/2011	4/28/2011	1,062.87	---	1,017.87	84	84.39	978.48	82.7	---	---	618	---	---	599
WVB-4	1/30/2012	1/30/2012	1,062.87	---	1,017.87	84	81.65	981.22	27.9	---	---	402	---	---	251
WVB-4	7/12/2013	---	1,062.87	---	1,017.87	84	Dry	---	---	---	---	---	---	---	---
WVB-4	8/20/2014	---	1,062.87	---	1,017.87	84	Dry	---	---	---	---	---	---	---	---
WVB-4	2/11/2015	---	1,062.87	---	1,017.87	84	Dry	---	---	---	---	---	---	---	---
WVB-4	2/22/2017	---	1,062.87	---	1,017.87	84	Dry	---	---	---	---	---	---	---	---
WVB-4	5/17/2017	---	1,062.87	---	1,017.87	84	Dry	---	---	---	---	---	---	---	---
AVB69-01	4/29/2003	---	1,057.22	---	804.22	---	107.65	949.57	---	---	---	---	---	---	---
AVB69-01	9/22/2003	---	1,057.22	---	804.22	---	127.91	929.31	---	---	---	---	---	---	---
AVB69-01	12/4/2003	---	1,057.22	---	804.22	---	86.70	970.52	---	---	---	---	---	---	---
AVB69-01	3/30/2004	---	1,057.22	---	804.22	---	115.44	941.78	---	---	---	---	---	---	---
AVB69-01	6/29/2004	---	1,057.22	---	804.22	---	129.84	927.38	---	---	---	---	---	---	---
AVB69-01	10/11/2004	---	1,057.22	---	804.22	---	104.12	953.10	---	---	---	---	---	---	---
AVB69-01	12/28/2004	---	1,057.22	---	804.22	---	89.72	967.50	---	---	---	---	---	---	---
AVB69-01	4/7/2005	---	1,057.22	---	804.22	---	73.82	983.40	---	---	---	---	---	---	---
AVB69-01	7/5/2005	---	1,057.22	---	804.22	---	120.48	936.74	---	---	---	---	---	---	---
AVB69-01	10/11/2005	---	1,057.22	---	804.22	---	90.46	966.76	---	---	---	---	---	---	---
AVB69-01	1/31/2006	---	1,057.22	---	804.22	---	79.06	978.16	---	---	---	---	---	---	---
AVB69-01	3/30/2006	---	1,057.22	---	804.22	---	109.48	947.74	---	---	---	---	---	---	---
AVB69-01	7/12/2006	---	1,057.22	---	804.22	---	125.36	931.86	---	---	---	---	---	---	---
AVB69-01	11/28/2006	---	1,057.22	---	804.22	---	88.90	968.32	---	---	---	---	---	---	---
AVB69-01	1/31/2007	---	1,057.22	---	804.22	---	83.91	973.31	---	---	---	---	---	---	---
AVB69-01	4/16/2007	---	1,057.22	---	804.22	---	113.65	943.57	---	---	---	---	---	---	---
AVB69-01	7/25/2007	---	1,057.22	---	804.22	---	129.10	928.12	---	---	---	---	---	---	---
AVB69-01	10/17/2007	---	1,057.22	---	804.22	---	100.98	956.24	---	---	---	---	---	---	---
AVB69-01	1/14/2008	---	1,057.22	---	804.22	---	86.85	970.37	---	---	---	---	---	---	---
AVB69-01	4/29/2008	---	1,057.22	---	804.22	---	113.59	943.63	---	---	---	---	---	---	---
AVB69-01	7/28/2008	---	1,057.22	---	804.22	---	123.01	934.21	---	---	---	---	---	---	---
AVB69-01	10/14/2008	---	1,057.22	---	804.22	---	93.80	963.42	---	---	---	---	---	---	---
AVB69-01	1/6/2009	---	1,057.22	---	804.22	---	82.22	975.00	---	---	---	---	---	---	---
AVB69-01	4/14/2009	---	1,057.22	---	804.22	---	106.58	950.64	---	---	---	---	---	---	---
AVB69-01	7/30/2009	---	1,057.22	---	804.22	---	118.58	938.64	---	---	---	---	---	---	---
AVB69-01	10/22/2009	---	1,057.22	---	804.22	---	95.55	961.67	---	---	---	---	---	---	---
AVB69-01	1/24/2010	---	1,057.22	---	804.22	---	82.78	974.44	---	---	---	---	---	---	---
AVB69-01	4/6/2010	---	1,057.22	---	804.22	---	90.10	967.12	---	---	---	---	---	---	---
AVB69-01	7/13/2010	---	1,057.22	---	804.22	---	116.42	940.80	---	---	---	---	---	---	---
AVB69-01	10/28/2010	---	1,057.22	---	804.22	---	84.31	972.91	---	---	---	---	---	---	---
AVB69-01	1/25/2011	---	1,057.22	---	804.22	---	75.23	981.99	---	---	---	---	---	---	---
AVB69-01	4/28/2011	---	1,057.22	---	804.22	---	112.41	944.81	---	---	---	---	---	---	---
AVB69-01	7/28/2011	---	1,057.22	---	804.22	---	115.18	942.04	---	---	---	---	---	---	---
AVB69-01	10/25/2011	---	1,057.22	---	804.22	---	91.11	966.11	---	---	---	---	---	---	---
AVB69-01	1/30/2012	---	1,057.22	---	804.22	---	82.51	974.71	---	---	---	---	---	---	---
AVB69-01	4/30/2012	---	1,057.22	---	804.22	---	115.78	941.44	---	---	---	---	---	---	---
AVB69-01	7/24/2012	---	1,057.22	---	804.22	---	118.44	938.78	---	---	---	---	---	---	---
AVB69-01	10/29/2012	---	1,057.22	---	804.22	---	112.90	944.32	---	---	---	---	---	---	---
AVB69-01	1/29/2013	---	1,057.22	---	804.22	---	87.35	969.87	---	---	---	---	---	---	---

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
 ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	100
									All concentrations reported in micrograms per liter (µg/L).						
AVB69-01	4/29/2013	---	1,057.22	---	804.22	---	120.28	936.94	---	---	---	---	---	---	---
AVB69-01	7/12/2013	---	1,057.22	---	804.22	---	126.00	931.22	---	---	---	---	---	---	---
AVB69-01	8/20/2014	---	1,057.22	---	804.22	---	124.45	932.77	---	---	---	---	---	---	---
AVB69-01	2/11/2015	---	1,057.22	---	804.22	---	107.48	949.74	---	---	---	---	---	---	---
AVB69-01	2/22/2017	2/23/2017	1,057.22	115	804.22	124	103.77	953.45	<1.00	<5.00	<2.00	8.33	<5.00	<10.0	<10.0
AVB69-01	5/17/2017	5/19/2017	1,057.22	115	804.22	124	123.41	933.81	<1.00	<5.00	<2.00	12.90	<5.00	<10.0	<10.0
AVB69-01	8/28/2017	8/28/2017	1,057.22	124	804.22	126	130.70	926.52	<1.00	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
AVB69-01	11/16/2017	11/16/2017	1,057.22	118	804.22	126	110.66	946.56	1.65	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
AVB69-01	2/15/2018	2/15/2018	1,057.22	118	804.22	126	110.66	946.56	1.60	<5.00	<2.00	<10.0	<5.00	<10.0	<10.0
AVB69-01	5/17/2018	5/17/2018	1,057.22	122	804.22	126	122.22	935.00	2.73	<5.00	<2.00	43.2	8.83	75.3	<10.0
AVB69-02	4/29/2003	4/29/2003	---	---	---	---	---	963.33	26	---	---	ND	---	---	---
AVB69-02	9/22/2003	9/22/2003	---	---	---	---	---	945.37	30	---	---	80	---	---	---
AVB69-02	12/4/2003	12/4/2003	---	---	---	---	---	969.07	32	---	---	ND	---	---	---
AVB69-02	3/30/2004	3/29/2003	---	---	---	---	---	959.39	24	---	---	ND	---	---	---
AVB69-02	7/30/2004	7/30/2004	---	---	---	---	---	942.19	18	---	---	3,600	---	---	---
AVB69-02	10/11/2004	10/14/2004	---	---	---	---	---	951.23	24	---	---	420	---	---	---
AVB69-02	12/28/2004	1/4/2005	---	---	---	---	---	966.57	22	---	---	80	---	---	---
AVB69-02	4/7/2005	4/13/2005	---	---	---	---	---	982.71	28	---	---	16	---	---	---
AVB69-02	7/5/2005	7/11/2005	---	---	---	---	---	953.16	21	---	---	29	---	---	---
AVB69-02	10/11/2005	10/17/2005	---	---	---	---	---	964.89	21	---	---	ND	---	---	---
AVB69-02	1/31/2006	2/2/2006	---	---	---	---	---	977.43	24	---	---	ND	---	---	---
AVB69-02	3/30/2006	3/30/2006	---	---	---	---	---	963.55	24	---	---	780	---	---	---
AVB69-02	---	8/24/2006	---	---	---	---	---	---	26	---	---	250	---	---	---
AVB69-02	11/28/2006	11/28/2006	---	---	---	---	---	967.24	18	---	---	ND	---	---	---
AVB69-02	1/31/2007	1/31/2007	---	---	---	---	---	972.73	21	---	---	110	---	---	---
AVB69-02	4/16/2007	4/16/2007	---	---	---	---	---	956.59	21	---	---	60	---	---	---
AVB69-02	7/25/2007	7/25/2007	---	---	---	---	---	943.71	13	---	---	19	---	---	---
AVB69-02	10/17/2007	10/17/2007	---	---	---	---	---	954.44	15	---	---	ND	---	---	<10
AVB69-02	1/14/2008	1/14/2008	---	---	---	---	---	969.23	17	---	---	ND	---	---	<10
AVB69-02	4/29/2008	4/29/2008	---	---	---	---	---	957.44	19	---	---	35	---	---	<10
AVB69-02	7/28/2008	8/28/2008	---	---	---	---	---	947.90	23	---	---	45	---	---	<10
AVB69-02	10/14/2008	10/14/2008	---	---	---	---	---	961.21	15	---	---	9.8	---	---	<10
AVB69-02	1/6/2009	1/6/2009	---	---	---	---	---	973.83	15	---	---	ND	---	---	<10
AVB69-02	4/14/2009	4/14/2009	---	---	---	---	---	961.66	19	---	---	64	---	---	<10
AVB69-02	7/30/2009	7/30/2009	---	---	---	---	---	950.97	14	---	---	ND	---	---	<10
AVB69-02	10/22/2009	10/22/2009	---	---	---	---	---	961.66	13	---	---	ND	---	---	<10
AVB69-02	1/24/2010	1/24/2010	---	---	---	---	---	973.61	11	---	---	ND	---	---	<10
AVB69-02	4/6/2010	4/6/2010	---	---	---	---	---	976.45	11	---	---	ND	---	---	<10
AVB69-02	7/13/2010	7/13/2010	---	---	---	---	---	956.58	13	---	---	17	---	---	<5
AVB69-02	10/28/2010	10/28/2010	---	---	---	---	---	970.94	9.34	---	---	ND	---	---	6
AVB69-02	1/25/2011	1/25/2011	---	---	---	---	---	981.50	8.43	---	---	ND	---	---	<5
AVB69-02	4/28/2011	4/28/2011	---	---	---	---	---	959.07	9.23	---	---	98	---	---	41
AVB69-02	7/28/2011	7/28/2011	---	---	---	---	---	954.21	6.45	---	---	42.9	---	---	14
AVB69-02	10/25/2011	10/25/2011	---	---	---	---	---	965.32	7.2	---	---	ND	---	---	<5
AVB69-02	1/30/2012	1/30/2012	---	---	---	---	---	974.43	6.53	---	---	ND	---	---	<5
AVB69-02	4/30/2012	4/30/2012	---	---	---	---	---	953.69	6.17	---	---	ND	---	---	<5
AVB69-02	10/29/2012	10/29/2012	---	---	---	---	---	---	4.59	---	---	ND	---	---	<5
AVB69-02	1/29/2013	1/29/2013	---	---	---	---	---	---	6.15	---	---	ND	---	---	9.5
AVB69-02	4/29/2013	4/29/2013	---	---	---	---	---	---	7.23	---	---	ND	---	---	<5
AVB69-02	7/12/2013	7/12/2013	---	---	---	---	---	---	3.79	---	---	ND	---	---	---

TABLE 3
SUMMARY OF HISTORICAL GROUNDWATER GAUGING AND LABORATORY ANALYTICAL DATA
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Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	100
All concentrations reported in micrograms per liter (µg/L).															
AVB69-02R	10/29/2012	---	1,057.48	---	982.48	---	119.98	937.50	---	---	---	---	---	---	---
AVB69-02R	1/29/2013	---	1,057.48	---	982.48	---	88.31	969.17	---	---	---	---	---	---	---
AVB69-02R	4/29/2013	---	1,057.48	---	982.48	---	107.42	950.06	---	---	---	---	---	---	---
AVB69-02R	7/12/2013	---	1,057.48	---	982.48	---	112.56	944.92	---	---	---	---	---	---	---
AVB69-02R	8/20/2014	9/15/2014	1,057.48	---	982.48	---	111.17	946.31	3.94	---	---	<10.0	---	---	<5.0
AVB69-02R	CNL	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AVB69-02R	2/23/2017	2/23/2017	1,057.48	>200	982.48	152	105.19	952.29	1.05	<5.00	<2.00	<10.00	<5.00	<10.00	<10.00
AVB69-02R	5/17/2017	5/19/2017	1,057.48	>200	982.48	156	113.52	943.96	<1.00	<5.00	<2.00	7,670	<5.00	135	<10.00
AVB69-02R	8/28/2017	8/28/2017	1,057.48	>200	982.48	159	119.33	938.15	3.14	<5.00	<2.00	<10.00	<5.00	<10.00	<10.00
AVB69-02R	11/16/2017	11/16/2017	1,057.48	>200	982.48	154	108.84	948.64	<1.00	<5.00	<2.00	<10.00	<5.00	<10.00	<10.00
AVB69-02R	2/15/2018	2/15/2018	1,057.48	>200	982.48	158	115.34	942.14	<1.00	<5.00	<2.00	<10.00	<5.00	<10.00	<10.00
AVB69-02R	5/15/2018	5/17/2018	1,057.48	>200	982.48	158	133.70	923.78	<1.00	<5.00	<2.00	<10.00	<5.00	<10.00	<10.00
AVB88-01	4/29/2003	4/29/2003	1,048.78	---	980.78	124	87.37	961.41	63	---	---	ND	---	---	---
AVB88-01	9/22/2003	9/22/2003	1,048.78	---	980.78	124	109.06	939.72	3.5	---	---	ND	---	---	---
AVB88-01	12/4/2003	12/4/2003	1,048.78	---	980.78	124	86.86	961.92	32	---	---	ND	---	---	---
AVB88-01	3/30/2004	3/30/2004	1,048.78	---	980.78	124	89.46	959.32	46	---	---	---	---	---	---
AVB88-01	6/29/2004	---	1,048.78	---	980.78	124	108.84	939.94	---	---	---	---	---	---	---
AVB88-01	7/30/2004	7/30/2004	1,048.78	---	980.78	124	---	---	3.9	---	---	ND	---	---	---
AVB88-01	10/11/2004	10/11/2004	1,048.78	---	980.78	124	109.65	939.13	3.6	---	---	ND	---	---	---
AVB88-01	12/28/2004	1/4/2005	1,048.78	---	980.78	124	---	---	2.4	---	---	ND	---	---	---
AVB88-01	4/7/2005	4/13/2005	1,048.78	---	980.78	124	70.88	977.90	25	---	---	ND	---	---	---
AVB88-01	7/5/2005	7/11/2005	1,048.78	---	980.78	124	97.72	951.06	5.7	---	---	ND	---	---	---
AVB88-01	10/11/2005	10/17/2005	1,048.78	---	980.78	124	92.50	956.28	0.66	---	---	ND	---	---	---
AVB88-01	1/31/2006	2/2/2006	1,048.78	---	980.78	124	77.94	970.84	48	---	---	ND	---	---	---
AVB88-01	3/30/2006	3/30/2006	1,048.78	---	980.78	124	85.78	963.00	50	---	---	ND	---	---	---
AVB88-01	---	8/24/2006	1,048.78	---	980.78	124	---	---	1.8	---	---	ND	---	---	---
AVB88-01	11/28/2006	11/28/2006	1,048.78	---	980.78	124	90.44	958.34	34	---	---	ND	---	---	---
AVB88-01	1/31/2007	1/31/2007	1,048.78	---	980.78	124	84.40	964.38	87	---	---	ND	---	---	---
AVB88-01	4/16/2007	4/16/2007	1,048.78	---	980.78	124	96.24	952.54	120	---	---	---	---	---	---
AVB88-01	7/25/2007	7/25/2007	1,048.78	---	980.78	124	111.31	937.47	20	---	---	8.3	---	---	---
AVB88-01	10/17/2007	10/17/2007	1,048.78	---	980.78	124	107.50	941.28	15	---	---	13	---	---	9.6
AVB88-01	1/14/2008	1/14/2008	1,048.78	---	980.78	124	85.40	963.38	---	---	---	ND	---	---	<10
AVB88-01	4/29/2008	4/29/2008	1,048.78	---	980.78	124	91.18	957.60	20	---	---	ND	---	---	<10
AVB88-01	7/28/2008	---	1,048.78	---	980.78	124	103.38	945.40	---	---	---	---	---	---	---
AVB88-01	---	8/28/2008	1,048.78	---	980.78	124	---	---	2.4	---	---	ND	---	---	<10
AVB88-01	10/14/2008	10/14/2008	1,048.78	---	980.78	124	97.78	951.00	12	---	---	<10	---	---	5.3
AVB88-01	1/6/2009	1/6/2009	1,048.78	---	980.78	124	81.84	966.94	27	---	---	ND	---	---	<10
AVB88-01	4/14/2009	4/14/2009	1,048.78	---	980.78	124	90.07	958.71	12	---	---	ND	---	---	<10
AVB88-01	7/30/2009	7/30/2009	1,048.78	---	980.78	124	105.02	943.76	1.7	---	---	ND	---	---	<10
AVB88-01	10/22/2009	10/22/2009	1,048.78	---	980.78	124	99.08	949.70	29	---	---	ND	---	---	<10
AVB88-01	1/24/2010	1/24/2010	1,048.78	---	980.78	124	83.10	965.68	44	---	---	ND	---	---	<10
AVB88-01	4/6/2010	4/6/2010	1,048.78	---	980.78	124	78.56	970.22	47	---	---	ND	---	---	<10
AVB88-01	7/13/2010	7/13/2010	1,048.78	---	980.78	124	93.20	955.58	10	---	---	ND	---	---	<5
AVB88-01	10/28/2010	10/28/2010	1,048.78	---	980.78	124	86.37	962.41	2.42	---	---	ND	---	---	<5
AVB88-01	1/25/2011	1/25/2011	1,048.78	---	980.78	124	75.00	973.78	27.4	---	---	ND	---	---	<5
AVB88-01	4/28/2011	4/28/2011	1,048.78	---	980.78	124	92.89	955.89	8.77	---	---	ND	---	---	<5
AVB88-01	7/28/2011	7/28/2011	1,048.78	---	980.78	124	102.52	946.26	---	---	---	ND	---	---	28.9
AVB88-01	10/25/2011	10/25/2011	1,048.78	---	980.78	124	96.80	951.98	7.18	---	---	ND	---	---	<5
AVB88-01	1/30/2012	1/30/2012	1,048.78	---	980.78	124	85.53	963.25	14.3	---	---	ND	---	---	9
AVB88-01	4/30/2012	4/30/2012	1,048.78	---	980.78	124	100.51	948.27	22.1	---	---	43	---	---	42
AVB88-01	7/24/2012	7/24/2012	1,048.78	---	980.78	124	99.43	949.35	4.43	---	---	14.9	---	---	14.7

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Well Identification	Monitor Date	Sample Date	Well TOC Elevation (feet above msl)	Approximate Sample Depth (feet below TOC)	Approximate Top of Screen Elevation (feet above msl)	Approximate Total Well Depth (feet below TOC)	Depth to Groundwater (feet below TOC)	Groundwater Elevation (feet above msl)	PCE	Total Cyanide	Cadmium	Chromium (Total)	Lead	Nickel	Hexavalent Chromium
									EPA Method 8260B	EPA Method 9012B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 6010B	EPA Method 7196A
ADEQ AQUIFER WATER QUALITY STANDARDS (AWQS)									5	200	5	100	50	100	100
AVB88-01	10/29/2012	10/29/2012	1,048.78	---	980.78	124	100.82	947.96	18	---	---	41.5	---	---	36.4
AVB88-01	1/29/2013	1/29/2013	1,048.78	---	980.78	124	88.33	960.45	23.5	---	---	41.6	---	---	34
AVB88-01	4/29/2013	4/29/2013	1,048.78	---	980.78	124	103.64	945.14	12.3	---	---	32.3	---	---	32
AVB88-01	7/12/2013	7/12/2013	1,048.78	---	980.78	124	112.12	936.66	5.93	---	---	33.6	---	---	---
AVB88-01	8/20/2014	9/15/2014	1,048.78	---	980.78	124	118.48	930.30	11.1	---	---	58.1	---	---	45.3
AVB88-01	2/11/2015	---	1,048.78	---	980.78	124	91.50	957.28	---	---	---	---	---	---	---
AVB88-01	2/22/2017	2/22/2017	1,048.78	114	980.78	124	104.94	943.84	1.3	<5.00	<2.00	37.8	<5.00	<10.0	35
AVB88-01	5/17/2017	5/19/2017	1,048.78	114	980.78	124	109.38	939.40	9.25	<5.00	<2.00	54.3	7.8	12.9	33
AVB88-01	8/28/2017	---	1,048.78	---	980.78	124	Dry	---	---	---	---	---	---	---	---
AVB88-01	11/15/2017	11/16/2017	1,048.78	119	980.78	124	114.17	934.61	11.3	<5.00	<2.00	32.5	<5.00	<10.0	24.0
AVB88-01	2/15/2018	2/15/2018	1,048.78	116	980.78	124	112.36	936.42	9.87	<5.00	<2.00	38.7	<5.00	<10.0	37.0
AVB88-01	5/17/2018	---	1,048.78	---	980.78	124	Dry	---	---	---	---	---	---	---	---
AVB140-01	---	9/18/2008	---	---	---	---	---	---	<0.50	---	---	<10	---	---	---
AVB140-01	---	6/15/2010	---	---	---	---	---	---	<0.50	---	---	---	---	---	---
AVB140-01	---	9/16/2010	---	---	---	---	---	---	---	---	---	12	---	---	---
AVB140-01	---	3/16/2011	---	---	---	---	---	---	---	---	---	---	---	---	---
AVB140-01	---	9/19/2001	---	---	---	---	---	---	---	---	---	---	---	---	---
AVB140-01	---	3/13/2012	---	---	---	---	---	---	---	---	---	---	---	---	---
AVB140-01	---	9/17/2012	---	---	---	---	---	---	---	---	---	---	---	---	---
AVB140-01	---	9/18/2013	---	---	---	---	---	---	---	---	---	---	---	---	---
AVB140-01 Duplicate	---	9/18/2013	---	---	---	---	---	---	---	---	---	14	---	---	---
AVB140-01	---	1st Qtr 2013	---	---	---	---	---	---	<0.50	---	---	---	---	---	---
AVB140-01	---	3/26/2014	---	---	---	---	---	---	---	---	---	---	---	---	---
Notes:	TOC	- Top of casing.													
	msl	- Mean sea level.													
	PCE	- Tetrachloroethylene													
	EPA	- Environmental Protection Agency													
	ADEQ	- Arizona Department of Environmental Quality													
	---	- Not reported, not measured, not applicable.													
	(1)	- TOC elevation estimated based on monitor well CMW-1 and CMW-1D TOC elevations.													
	<5.00	- Analyte not detected above specified minimum laboratory method reporting limit.													
	NA	- Not analyzed.													
	E4	- Concentration estimated. Analyte was detected below laboratory minimum reporting level (MRL) but above the method detection limit (MDL).													
	ND	- Not detected at unspecified minimum laboratory reporting limit.													
	CNA	- Could not access well. Well located in a fenced yard at 1841 West Sonora Street.													
	Bold	- Concentration equals or exceeds ADEQ established AWQS.													
		- Depth to groundwater, groundwater elevation and laboratory analytical data collected prior to 8/20/14 was collected by others and is reproduced herein as presented within previous reports.													

TABLE 4
HISTORICAL FLOW DIRECTION AND GRADIENT

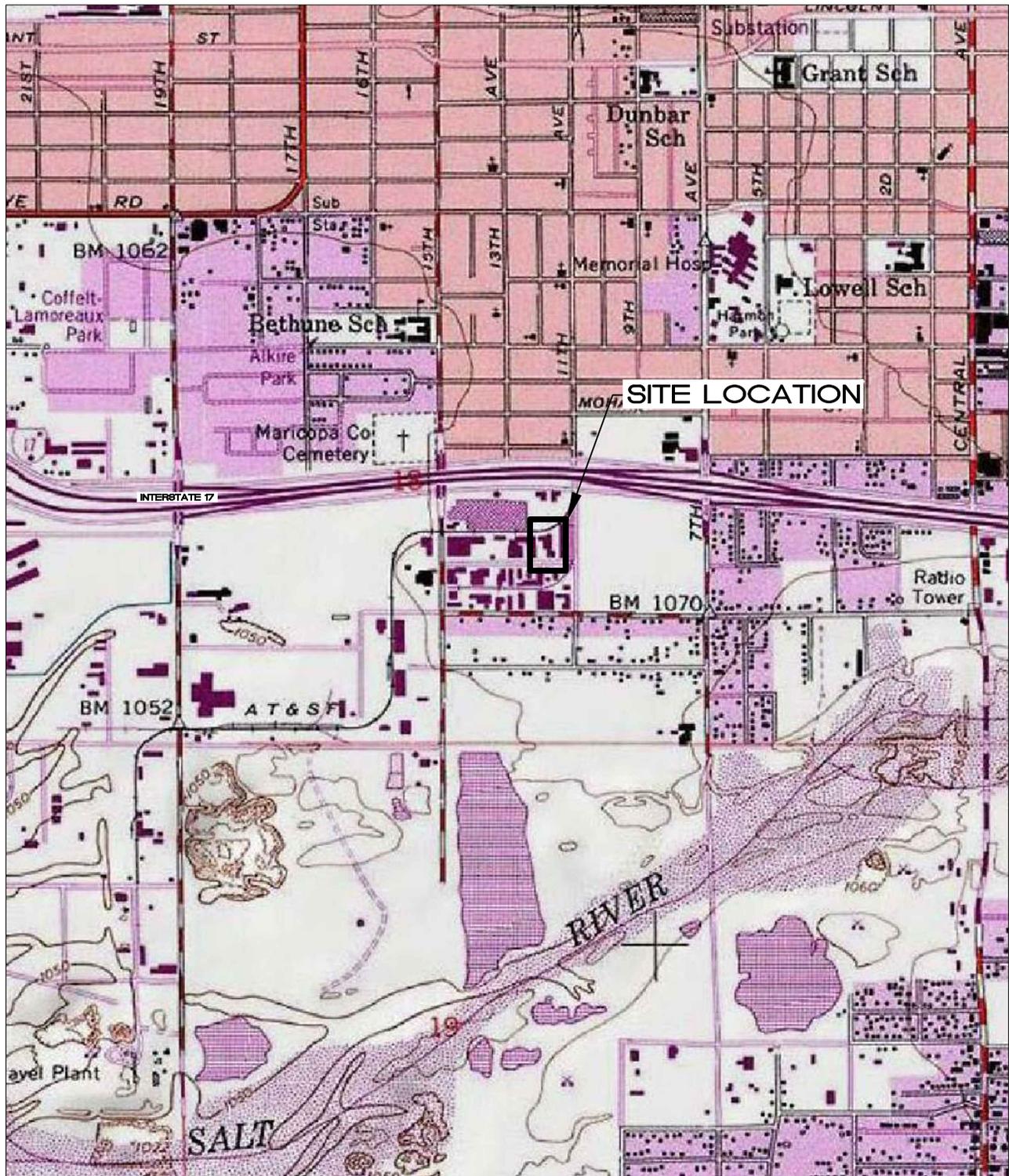
ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Gauging Date	Bearing (degrees)	Hydraulic Gradient
10/16/1995	298	0.003
1/12/1996	291	0.002
7/12/1996	292	0.004
10/17/1996	298	0.003
1/15/1997	300	0.003
4/24/1997	300	0.002
7/31/1997	299	0.005
10/24/1997	294	0.003
1/29/1998	288	0.002
4/13/1998	299	0.004
7/16/1998	305	0.005
10/9/1998	292	0.004
1/22/1999	300	0.002
4/19/1999	293	0.004
7/13/1999	294	0.005
10/13/1999	296	0.004
1/14/2000	300	0.002
10/20/2000	298	0.004
1/14/2001	299	0.002
4/17/2001	295	0.004
10/30/2001	294	0.003
1/14/2002	317	0.009
4/2/2002	191	0.005
1/14/2003	296	0.002
4/29/2003	297	0.004
4/7/2005	334	0.003
7/5/2005	289	0.004
10/11/2005	301	0.003
1/31/2006	294	0.002
1/31/2007	286	0.002
1/27/2010	282	0.002
4/6/2010	306	0.003
7/13/2010	298	0.005
10/28/2010	305	0.003
1/25/2011	299	0.002
4/28/2011	301	0.004
1/30/2012	283	0.020
Average	295	0.003

Note:

Flow direction (bearing) and hydraulic gradient determined using 3-Point Solution based on data collected at monitor wells CMW-1, WVB-1 and WVB-4.

FIGURES



NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

SITE VICINITY MAP

CHEMRESEARCH COMPANY, INC.
1122 WEST HILTON AVENUE
PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111

DATE: 3/29/19

FIGURE

APPROVED BY: GEM

DRAWN BY: TV

1



9185 S. Farmer Ave., Ste. #111
Tempe, Arizona 85284-2912

Ph: (480) 894-2056 *** Fax: (480) 894-2497



LEGEND

- BUILDING
- ROADWAY
- RAILROAD

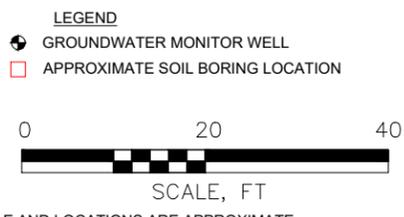
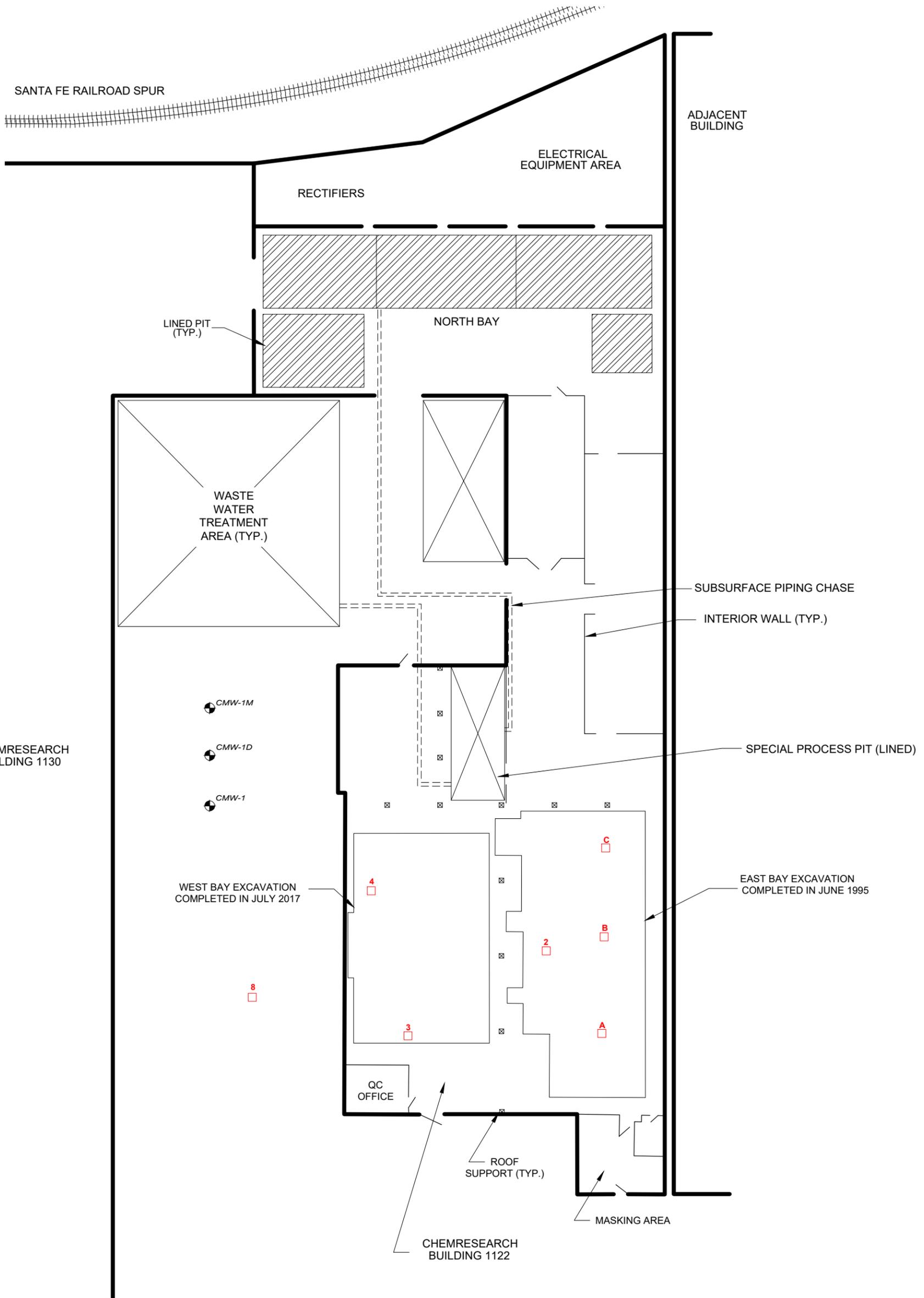


NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

SITE MAP

CHEMRESEARCH COMPANY, INC.
 1122 WEST HILTON AVENUE
 PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 3/29/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	2
9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		



NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

PEGLER-WELCH (1990) SOIL BORING LOCATIONS MAP

CHEMRESEARCH COMPANY, INC.
 1122 W. HILTON AVENUE
 PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 3/29/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	3
 9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		



LEGEND

- BUILDING
- ROADWAY
- RAILROAD
- SOIL VAPOR SAMPLE LOCATION WITH TETRACHLOROETHYLENE CONCENTRATION IN µg/m³ AT 15 FEET BELOW GROUND SURFACE.
- NOT ANALYZED.

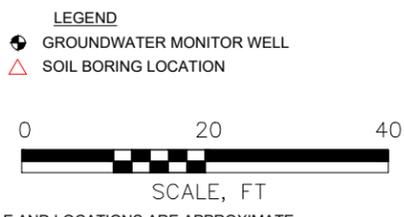
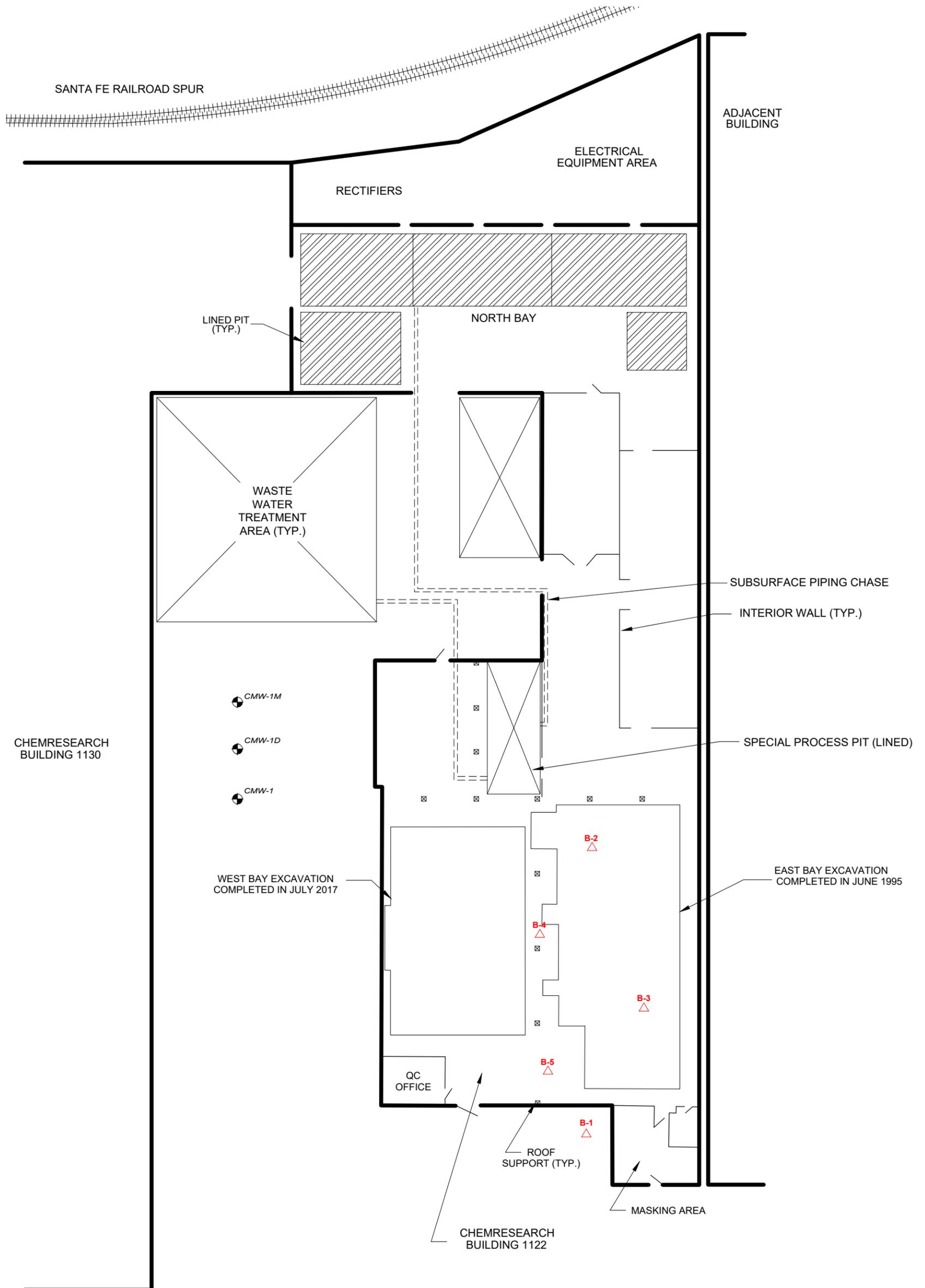
NOTES: DETECTIONS LISTED WITH ONE VALUE REPRESENT FIVE FOOT DEPTH RESULTS UNLESS OTHERWISE NOTED. SCALE AND LOCATIONS ARE APPROXIMATE.



ADEQ (1992) SOIL VAPOR SURVEY MAP

CHEMRESEARCH COMPANY, INC.
1122 WEST HILTON AVENUE
PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 4/1/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	4
9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		

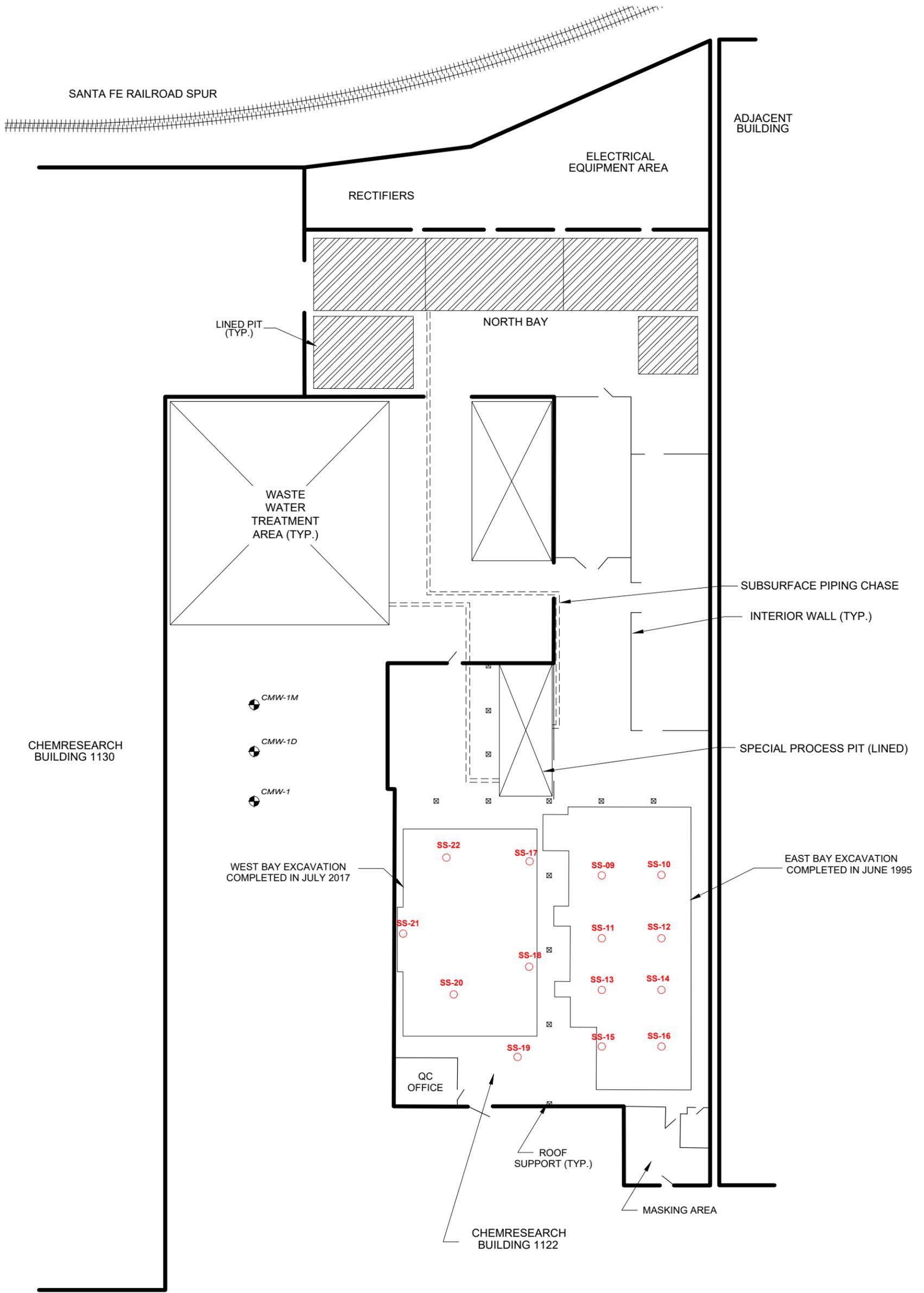


NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

GEC (1994) SOIL BORING LOCATIONS MAP

CHEMRESEARCH COMPANY, INC.
 1122 W. HILTON AVENUE
 PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 3/29/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	5
9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		



LEGEND
 ● GROUNDWATER MONITOR WELL
 ○ SOIL BORING LOCATION



NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

H+A (1995) SOIL BORING LOCATIONS MAP

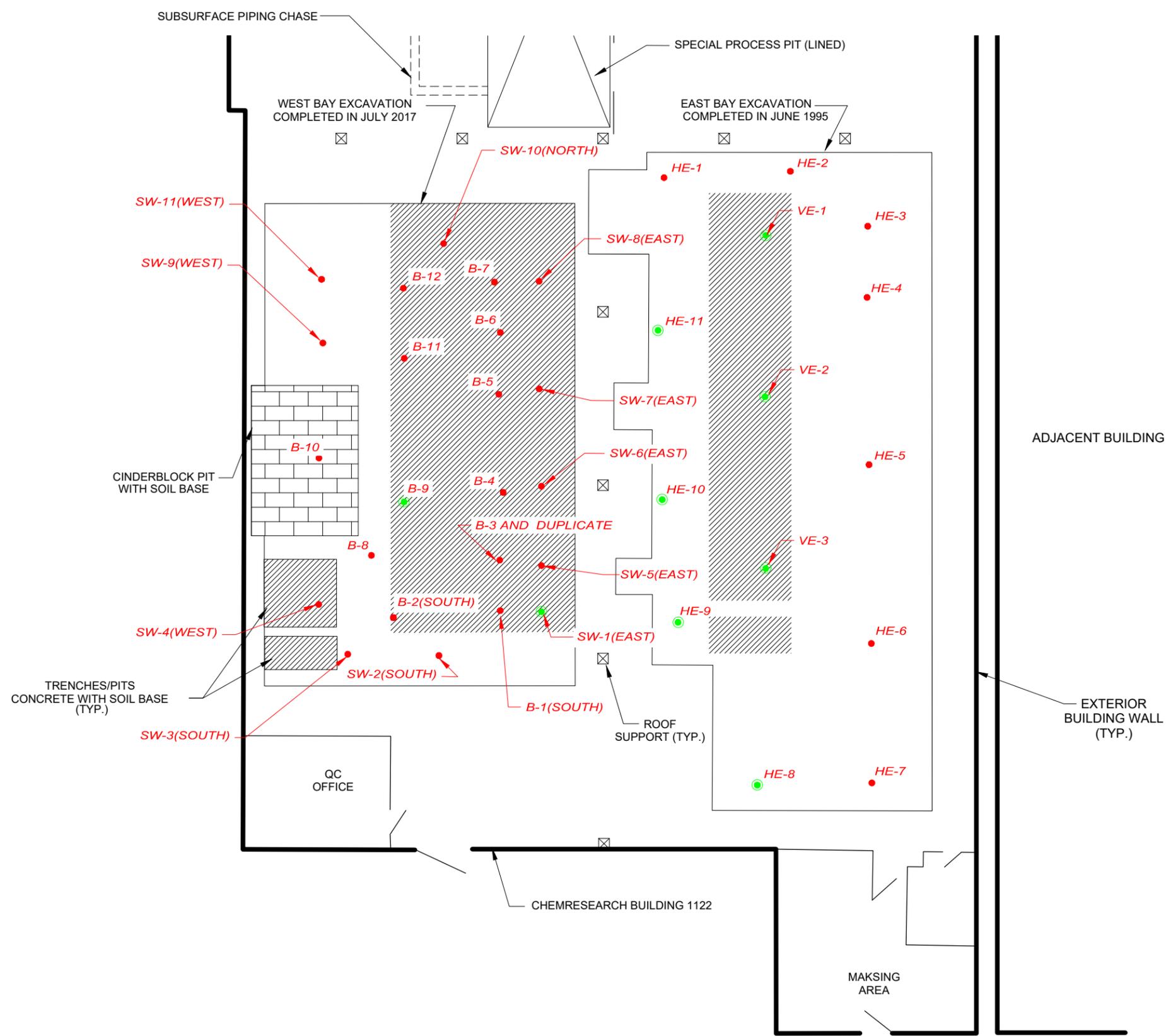
CHEMRESEARCH COMPANY, INC.
 1122 W. HILTON AVENUE
 PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 3/29/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	6
 9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		

S:\Projects-BST\ChemResearch Company (34.463.18)\2019\RI\Work Plan_1052000111_Phase 4\Cadd\7_POSTEX.dwg

CHEMRESEARCH BUILDING 1130

CMW-1D
CMW-1



LEGEND

- POST-EXCAVATION SOIL SAMPLE LOCATION
- POST-EXCAVATION SOIL SAMPLE EXCEEDS PCE, CADMIUM AND OR HEXAVALENT CHROMIUM RESIDENTIAL SOIL REMEDIATION LEVELS



NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

POST-EXCAVATION SOIL SAMPLE LOCATIONS (1995 & 2017) MAP

CHEMRESEARCH COMPANY, INC.
1122 W. HILTON AVENUE
PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111
APPROVED BY: GEM

DATE: 5/2/19
DRAWN BY: BK

FIGURE 7

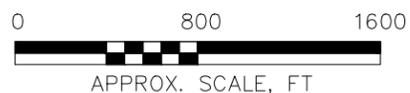
ATC
9185 S. Farmer Ave., Ste. #111
Tempe, Arizona 85284-2912
Ph: (480) 894-2056 *** Fax: (480) 894-2497



LEGEND

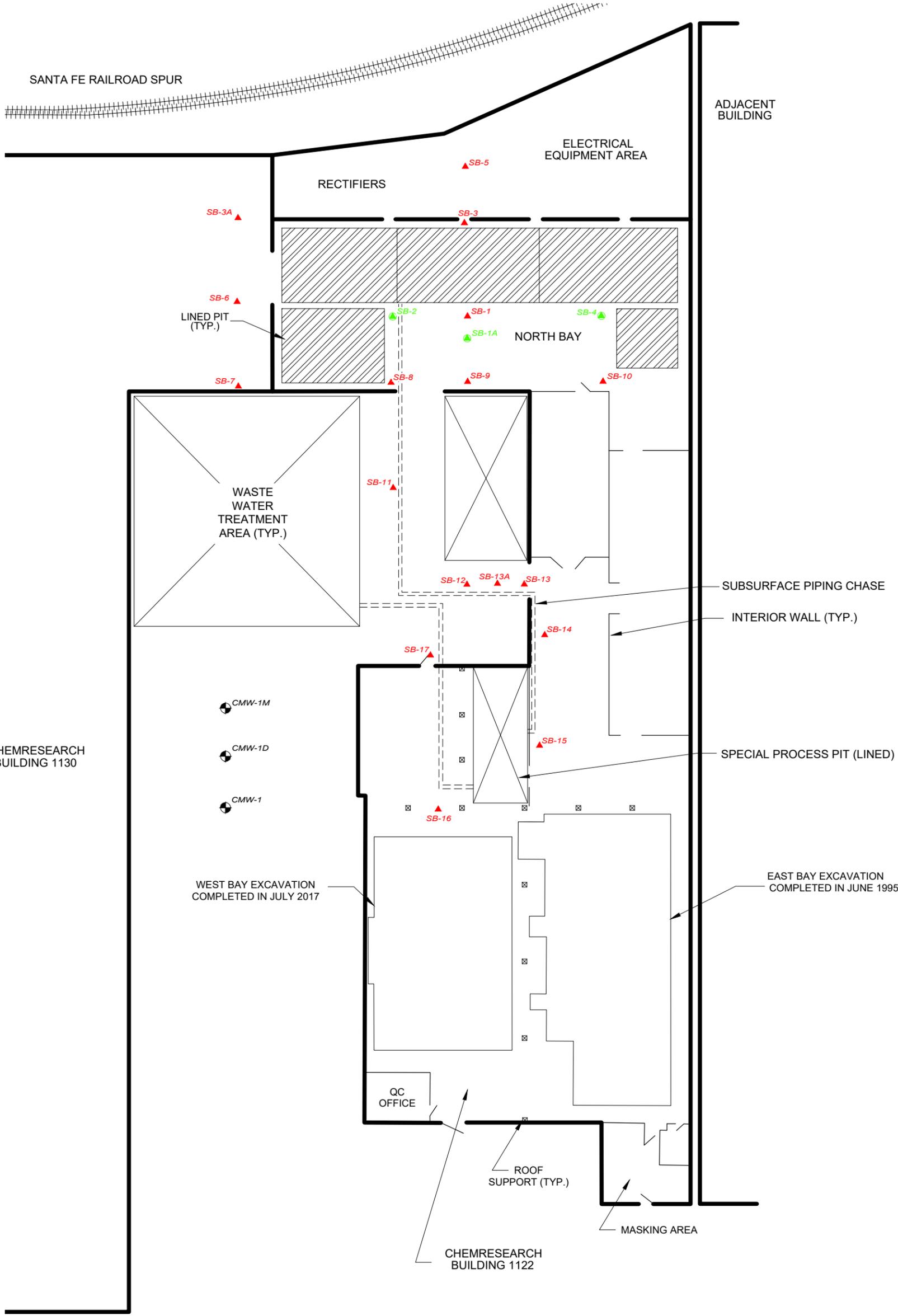
- ◆ PROPOSED GROUNDWATER MONITOR WELL LOCATION
- GROUNDWATER MONITOR WELL (INSTALLED BY ADEQ)
- GROUNDWATER MONITOR WELL (INSTALLED BY CHEMRESEARCH CO. INC.)
- ROOSEVELT IRRIGATION DISTRICT PRODUCTION WELL
- ◆ 19TH AVENUE LANDFILL SUPERFUND SITE MONITOR WELL

NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.



**GROUNDWATER MONITOR & PRODUCTION
WELL LOCATIONS MAP**
 CHEMRESEARCH COMPANY, INC.
 1122 WEST HILTON AVENUE
 PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 5/2/19	FIGURE
APPROVED BY: GEM	DRAWN BY: BK	8
9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		



LEGEND

- ▲ NORTH PLATING LINE/WASTE WATER TREATMENT AREA INVESTIGATION BORING
- ▲ SOIL SAMPLE EXCEEDS HEXAVALENT CHROMIUM RESIDENTIAL SOIL REMEDIATION LEVEL
- ⊕ GROUNDWATER MONITOR WELL

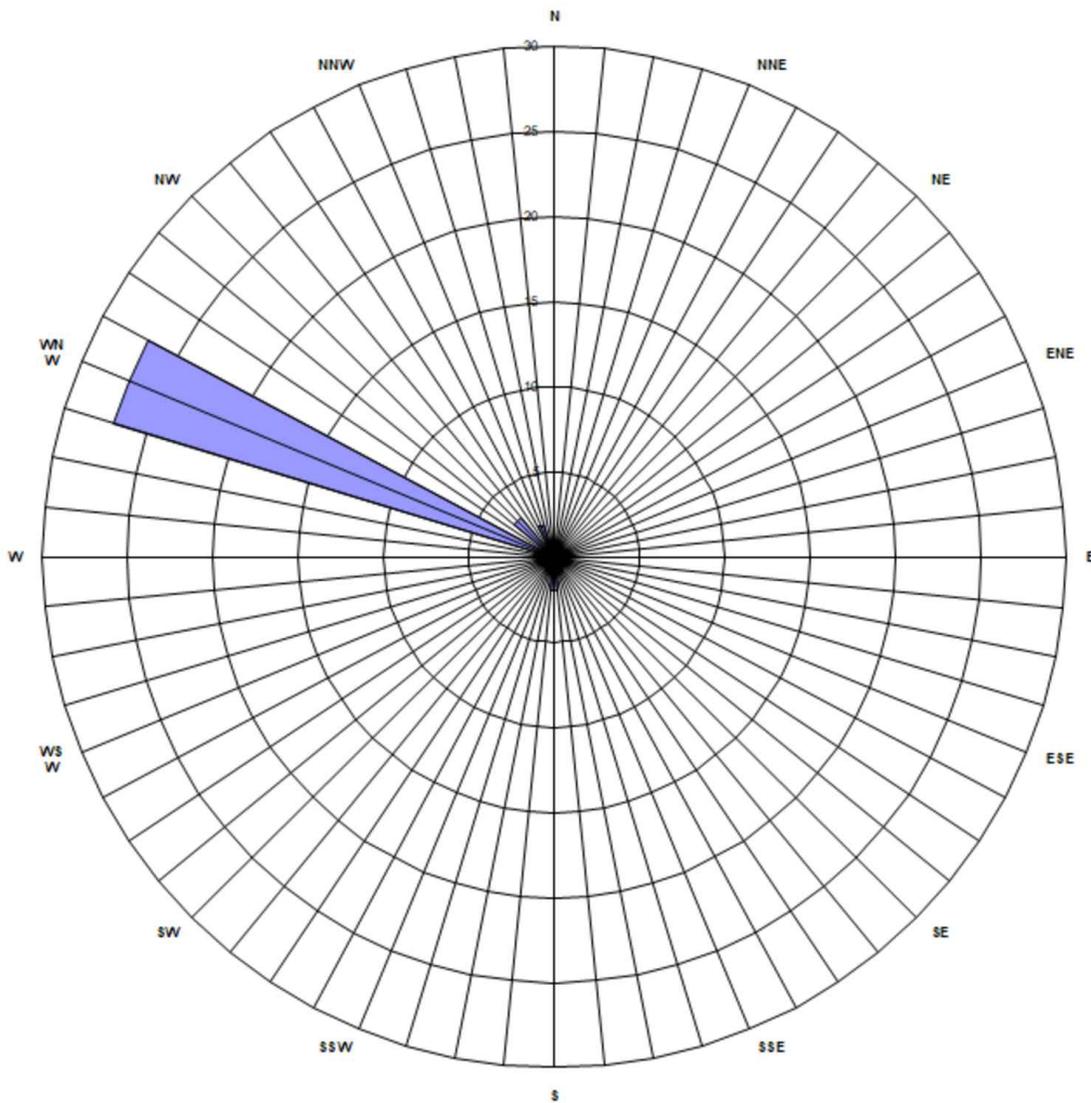


NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

ATC (2016) SOIL BORING LOCATIONS MAP

CHEMRESEARCH COMPANY, INC.
1122 W. HILTON AVENUE
PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 4/1/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	9
9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		



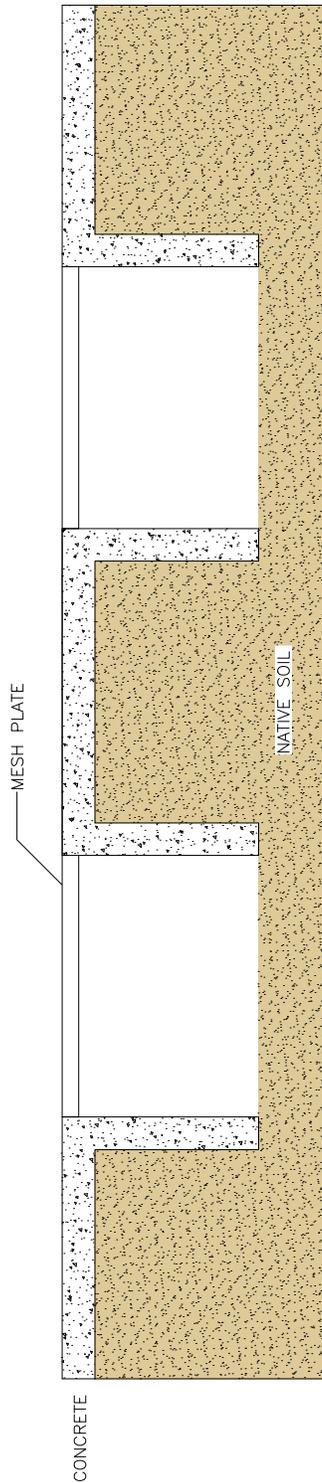

 HISTORICAL GROUNDWATER FLOW DIRECTION
 DERIVED USING MONITOR WELL DATA COLLECTED
 AT CMW-1, WVB-1 AND WVB-4.

**GROUNDWATER FLOW DIRECTION
 ROSE DIAGRAM (1995-2012)**
 CHEMRESEARCH COMPANY, INC.
 1122 WEST HILTON AVENUE
 PHOENIX, ARIZONA 85007

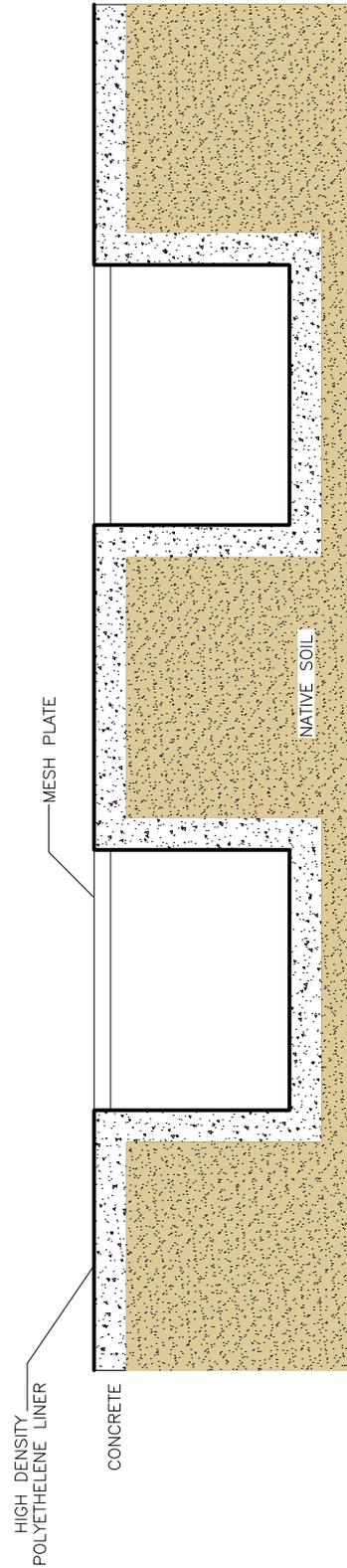
PROJECT NUMBER: 1052000111	DATE: 4/1/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	10


 9185 S. Farmer Ave., Ste. #111
 Tempe, Arizona 85284-2912
 Ph: (480) 894-2056 *** Fax: (480) 894-2497

ATYPICAL TRENCH PROFILE DESIGN CIRCA 1950'S



CURRENT TRENCH PROFILE DESIGN



NOTE: NOT TO SCALE.

TRENCH DESIGNS

CHEMRESEARCH COMPANY, INC.
1122 WEST HILTON AVENUE
PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111

DATE: 4/2/19

FIGURE

APPROVED BY: GEM

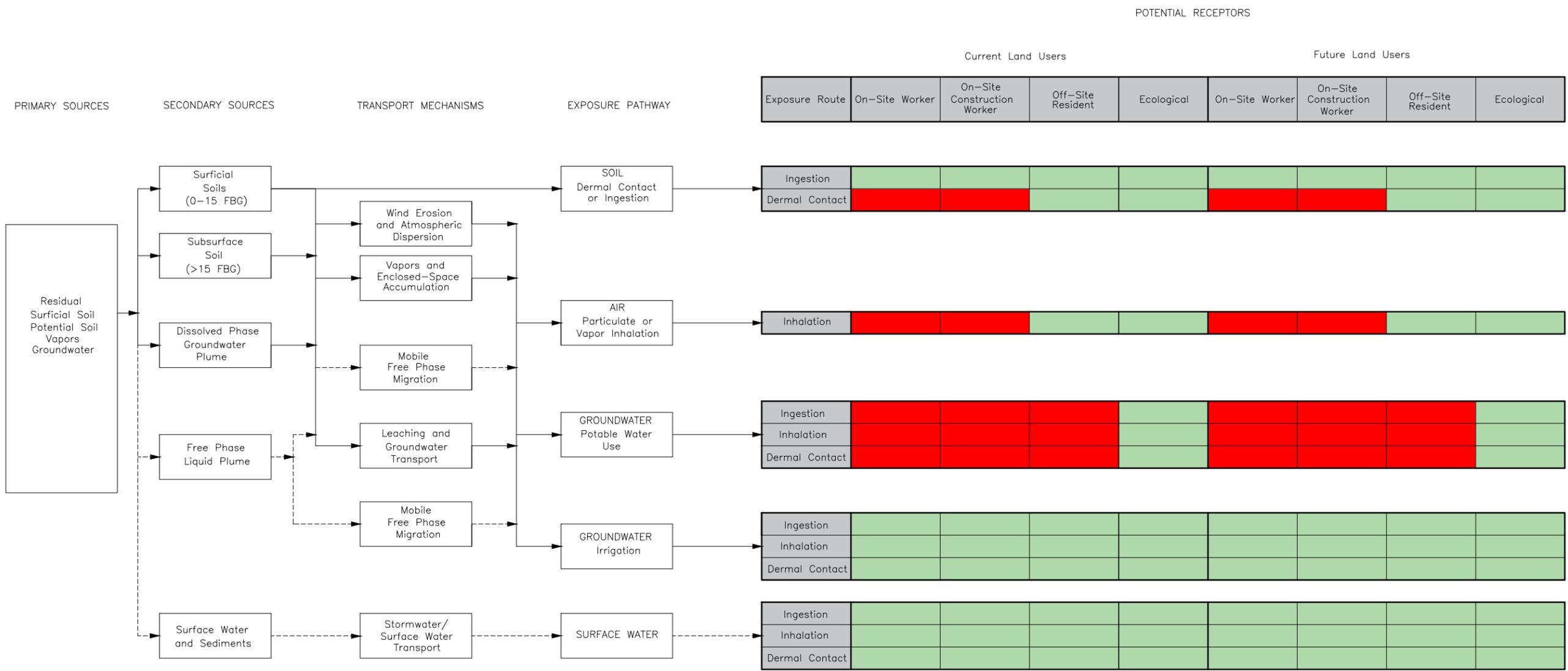
DRAWN BY: TV

11



9185 S. Farmer Ave., Ste. #111
Tempe, Arizona 85284-2912

Ph: (480) 894-2056 *** Fax: (480) 894-2497



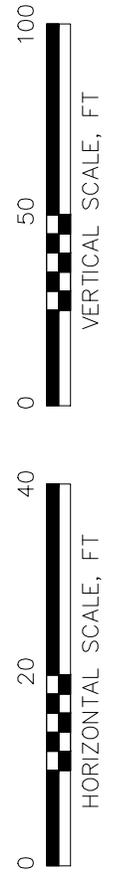
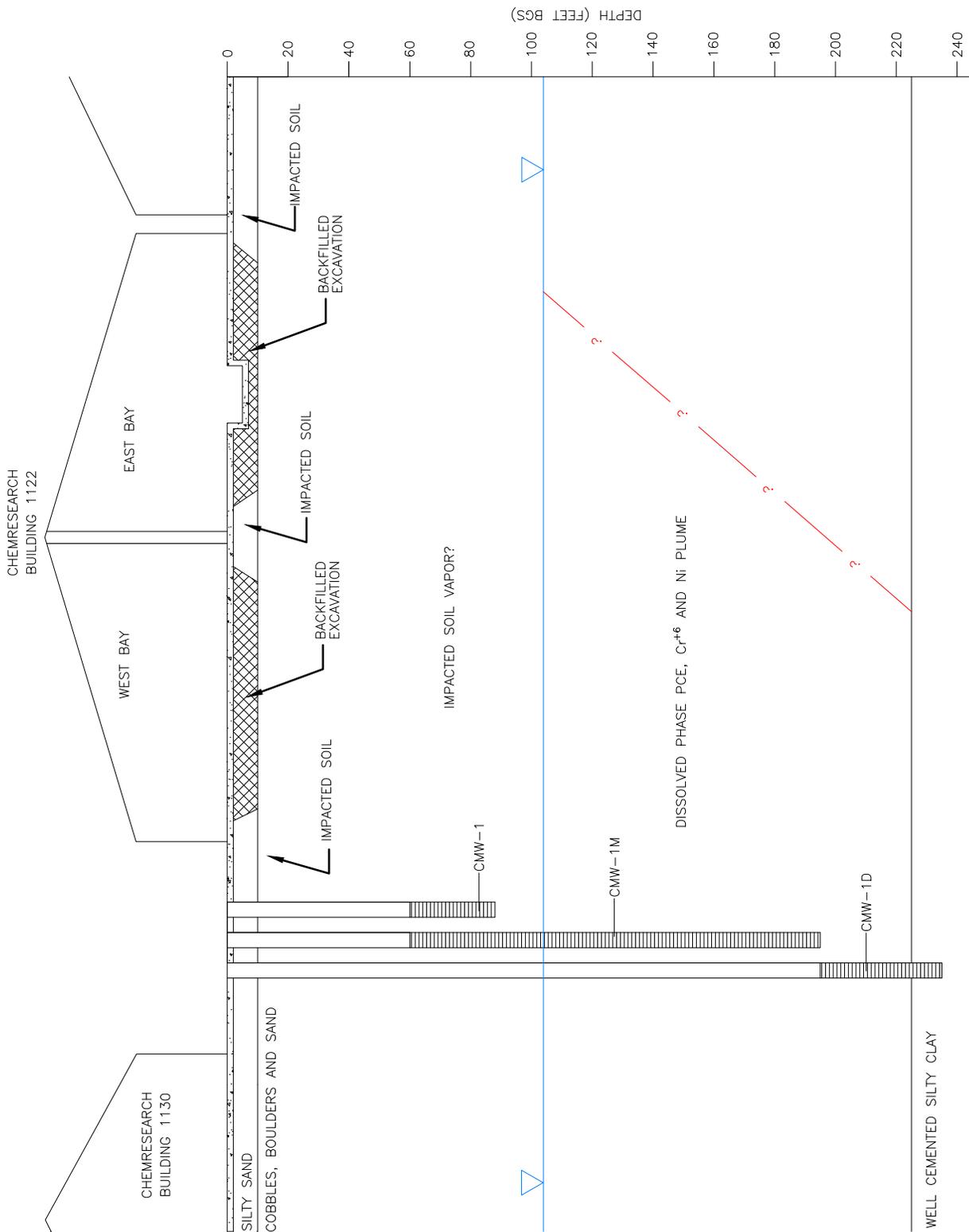
LEGEND

- A dashed line indicates an incomplete or broken exposure pathway.
- = Absent/insignificant exposure concern.
- = Potentially complete exposure pathway.
- FBG = Feet below grade.

PROJECT NUMBER: 1052000111
 APPROVED BY: GEM
 DATE: 4/16/19
 DRAWN BY: TV
FIGURE 12

PRELIMINARY SITE CONCEPTUAL MODEL
 CHEMRESEARCH COMPANY, INC.
 1122 W. HILTON AVENUE
 PHOENIX, ARIZONA 85007

ATC
 9185 S. Farmer Ave., Ste. #111
 Tempe, Arizona 85284-2912
 Ph: (480) 894-2056 *** Fax: (480) 894-2497



NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

SITE CONCEPTUAL MODEL

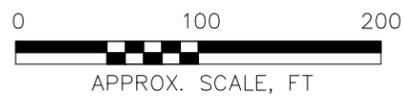
CHEMRESEARCH COMPANY, INC.
1122 WEST HILTON AVENUE
PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 4/2/19	FIGURE 13
APPROVED BY: GEM	DRAWN BY: TV	
		9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497



LEGEND

- BUILDING
- ROADWAY
- RAILROAD
- IW-12 (190-15') SOIL VAPOR SAMPLE LOCATION WITH TETRACHLOROETHYLENE CONCENTRATION IN µg/m³ AT 15 FEET BELOW GROUND SURFACE.
- NOT ANALYZED.
- PROPOSED SOIL VAPOR SAMPLE LOCATIONS.
- PROPOSED SOIL VAPOR AND SOIL SAMPLE LOCATIONS.



NOTES: DETECTIONS LISTED WITH ONE VALUE REPRESENT FIVE FOOT DEPTH RESULTS UNLESS OTHERWISE NOTED. SCALE AND LOCATIONS ARE APPROXIMATE.

PROPOSED SOIL VAPOR AND SOIL SAMPLE LOCATIONS MAP
 CHEMRESEARCH COMPANY, INC.
 1122 WEST HILTON AVENUE
 PHOENIX, ARIZONA 85007

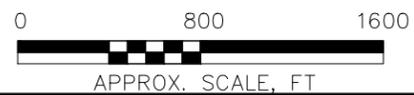
PROJECT NUMBER: 1052000111	DATE: 4/1/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	14
9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		



LEGEND

- + GROUNDWATER MONITOR WELL (INSTALLED BY ADEQ)
- + GROUNDWATER MONITOR WELL (INSTALLED BY CHEMRESEARCH CO. INC.)
- PROPOSED GROUNDWATER MONITOR WELL
- + ROOSEVELT IRRIGATION DISTRICT PRODUCTION WELL
- + 19TH AVENUE LANDFILL SUPERFUND SITE MONITOR WELL

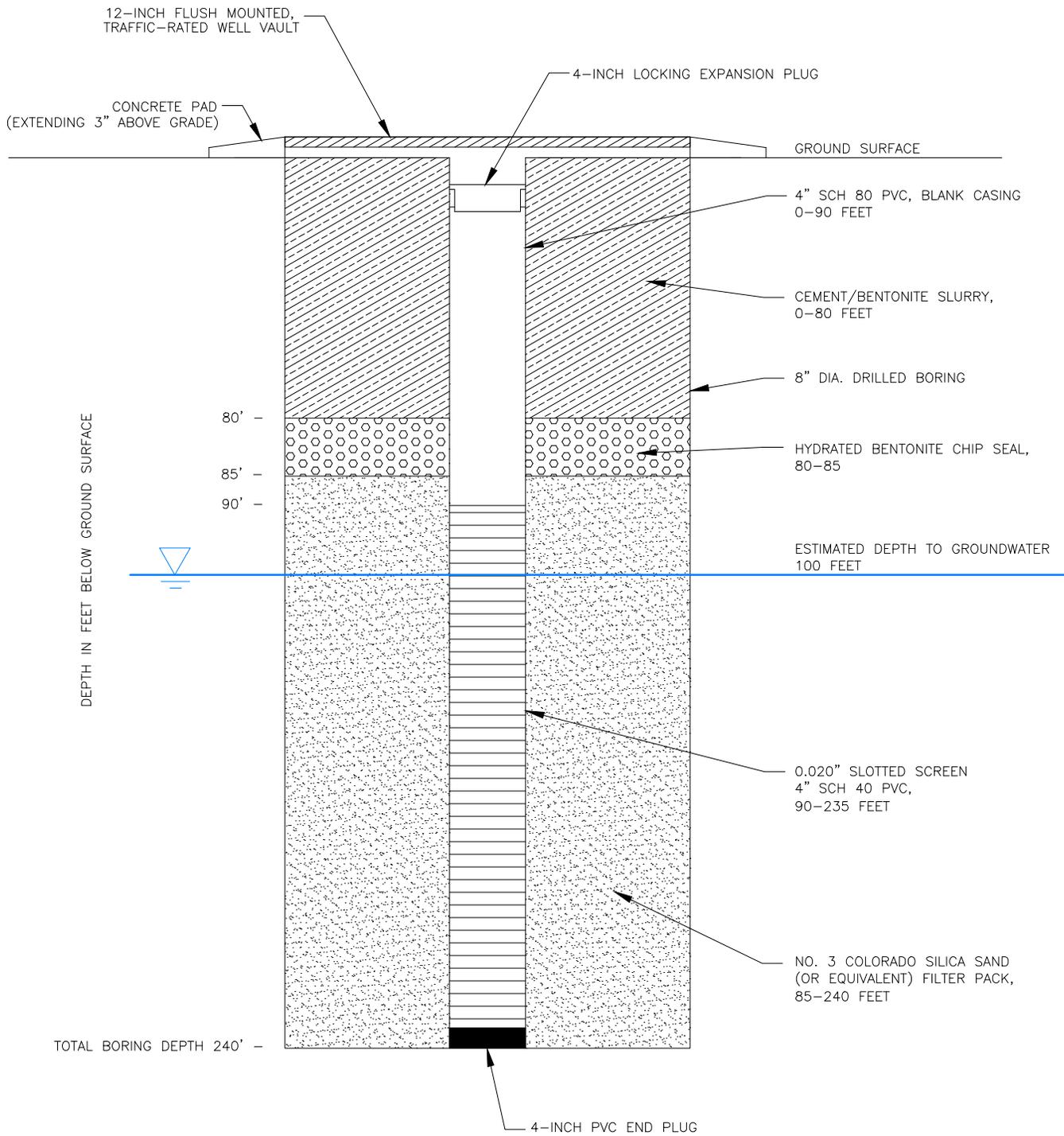
— A — A' CROSS-SECTION (SEE FIGURE 17)



NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

**PROPOSED NEW GROUNDWATER MONITOR
WELL LOCATIONS MAP**
CHEMRESEARCH COMPANY, INC.
1122 WEST HILTON AVENUE
PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 5/2/19	FIGURE 15
APPROVED BY: GEM	DRAWN BY: BK	
ATC 9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		



NOTE: NOT TO SCALE.

**PROPOSED MONITOR WELL CONSTRUCTION
 DIAGRAM: CMW-2R AND WVB-4R**
 CHEMRESEARCH COMPANY, INC.
 1122 WEST HILTON AVENUE
 PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 7/5/19	FIGURE 16
APPROVED BY: GEM	DRAWN BY: TV	
		9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497

NORTHWEST

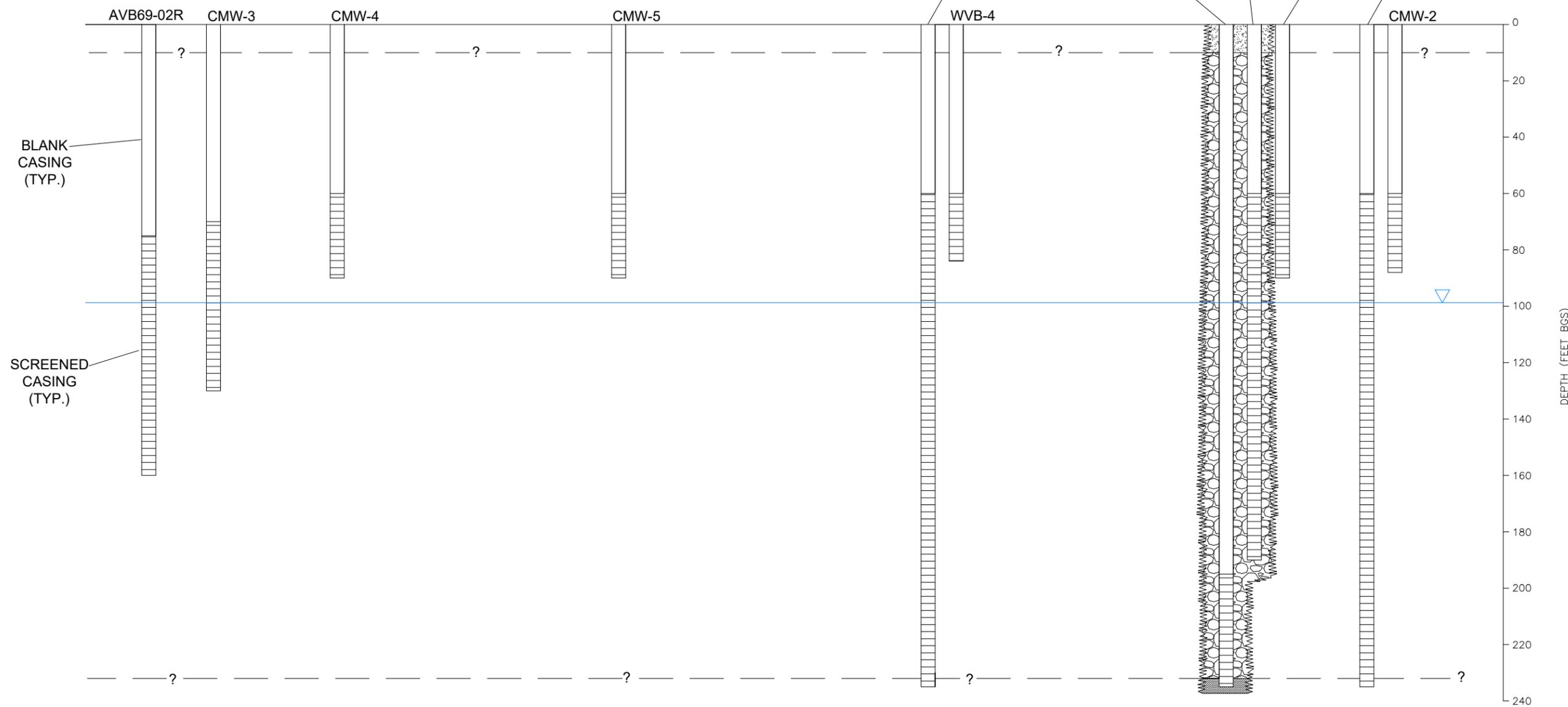
A

PROPOSED WELL
WVB-4R

PROPOSED WELL
CMW-2R

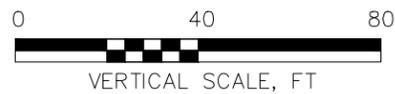
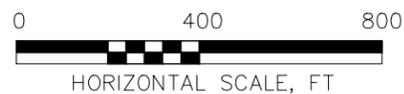
SOUTHEAST

A'



LEGEND

-  SILTY SAND
-  GRAVELS
-  WELL CEMENTED SILTY CLAY



NOTE: SCALES AND LOCATIONS ARE APPROXIMATE.

CROSS-SECTION A-A'

CHEMRESEARCH COMPANY, INC.
 1122 WEST HILTON AVENUE
 PHOENIX, ARIZONA 85007

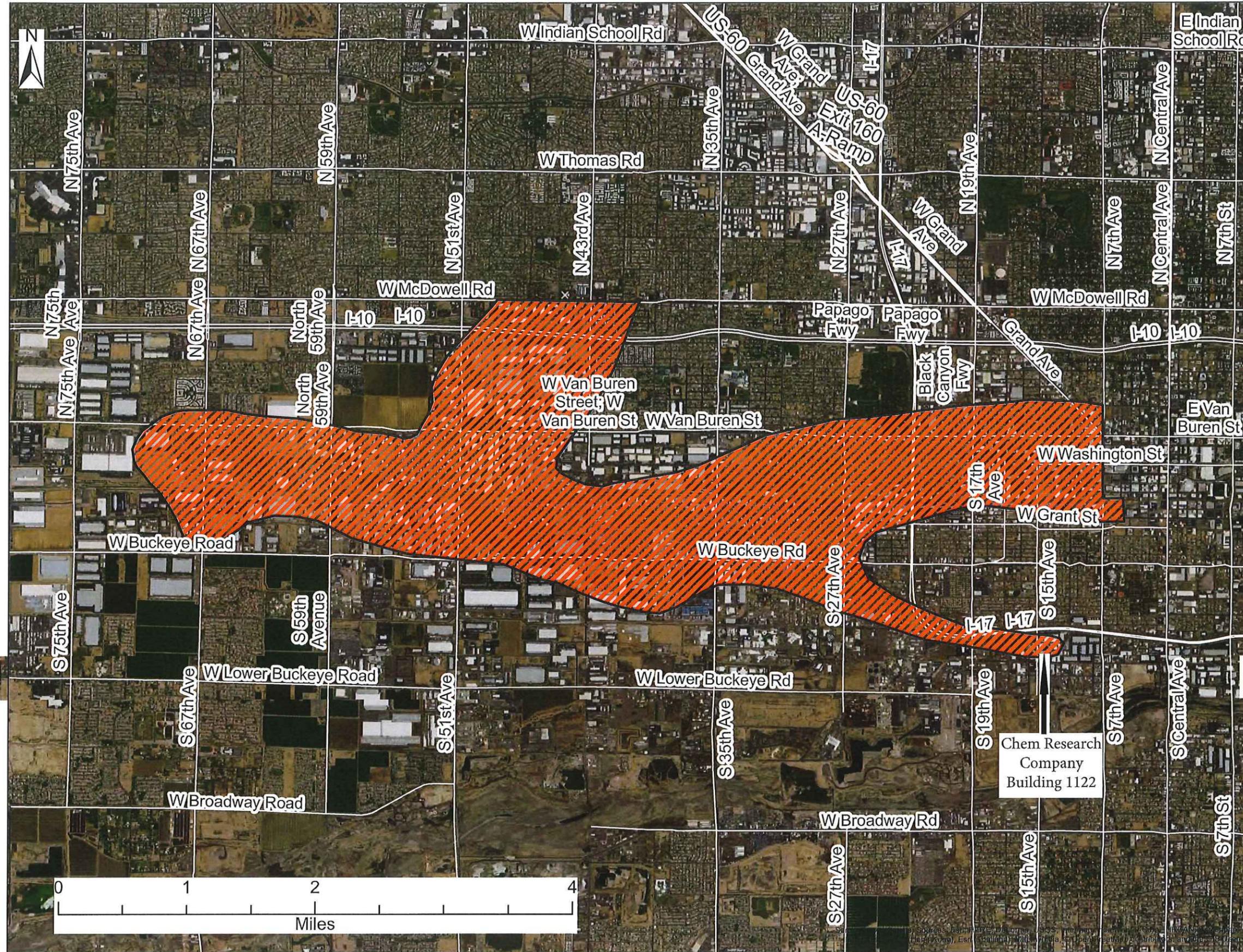
PROJECT NUMBER: 1052000111	DATE: 4/1/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	17
 9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		

APPENDICES

APPENDIX A

ADEQ WEST VAN BUREN WQARF SITE MAP

WEST VAN BUREN



- Superfund TYPE**
-  WQARF
 -  EPA NPL
 -  DOD

Plume Data Update: 2015-04-04

Plume boundaries depicted on the site map represent ADEQ's interpretation of data available at the time the map was constructed. The map is intended to provide the public with basic information as to the estimated geographic extent of known contamination as of the date of map production. The actual extent of contamination may be different. Therefore, the plume for this site may change in the future as new information becomes available.

Date Map Saved: 2016-08-03



Publication Number: M 16 -20

APPENDIX B
LIST OF CHEMICALS

Chemical Inventory (April 9, 2019)

ChemResearch Company, Inc.

1122 West Hilton Avenue

Phoenix, Arizona 85007

Chemical/Product Name	
Acetone	Nistrip-R 501-A
Aluminum Oxide	Nistrip-R 501-C (B)
Alumseal W-2000	Nitric Acid I
Black Dye HBL	Oxalic Acid
Calcium Fluoride	Potassium Cyanide
Chromic Acid	PureSun Culinary Salt
Colcad Cadmium Brightener	Rack Saver 2000
DTC Precipitant	RC Phos M
E-100 Electrocleaner	Rochelle Salt
Enova 192A	RON Phos HZN
Enova 583 BR	Rustripper
Enova 583 CMPR #2	Salt Tablets
Enova H15-CMP	Sealing Salt AS Powder
ENOVA STR-22	Sodium Acetate
Enstrip S	Sodium Cyanide
Glass Bead #10	Sodium Dichromate
Gold N Dye	Sodium Hydroxide Bulk
HCA 50C Conc. Catalyst	Sodium Metabisulfite
HCA 8.2 Fume Suppressant	Specialty Deep Red L
Hydrochloric Acid	Specialty Green AEN
I-PHOS 33	Sulfamic Acid
Isoprep 184	Sulfuric Acid
Maskant XP-2000	Sulfuric Acid Bulk
Methyl Ethyl Ketone	Supreme
Multiwax ML445	Toluene
Nickel Anode S-Rounds	Triwall Boxes

APPENDIX C

SELECT WELL COMPLETION LOGS

Project ChemResearch Mid-range Well

Location 1130A W Hilton Ave, Phoenix, AZ

LOG OF CMW-1M

SHEET 1 OF 1

Client ChemResearch Company

Drill Method ARCH

Elevation (ft amsl) 1064.50

Number 1052000005

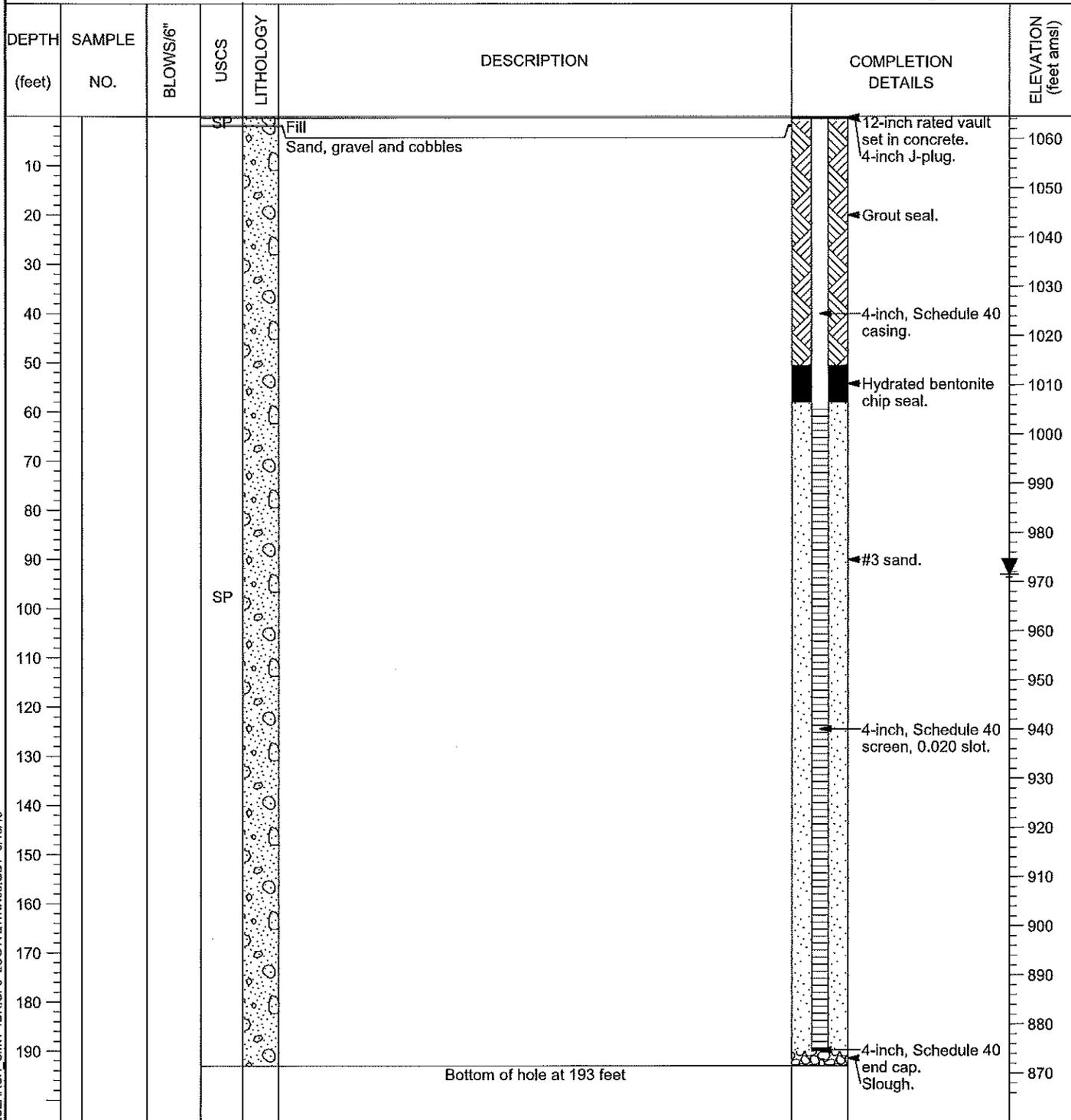
Drilling Started 3/11/15 Ended 3/17/15

Total Depth (ft) 193

Logged By DEN

Drill Contractor Yellow Jacket Drilling

Depth To Water (ft)  AD 93



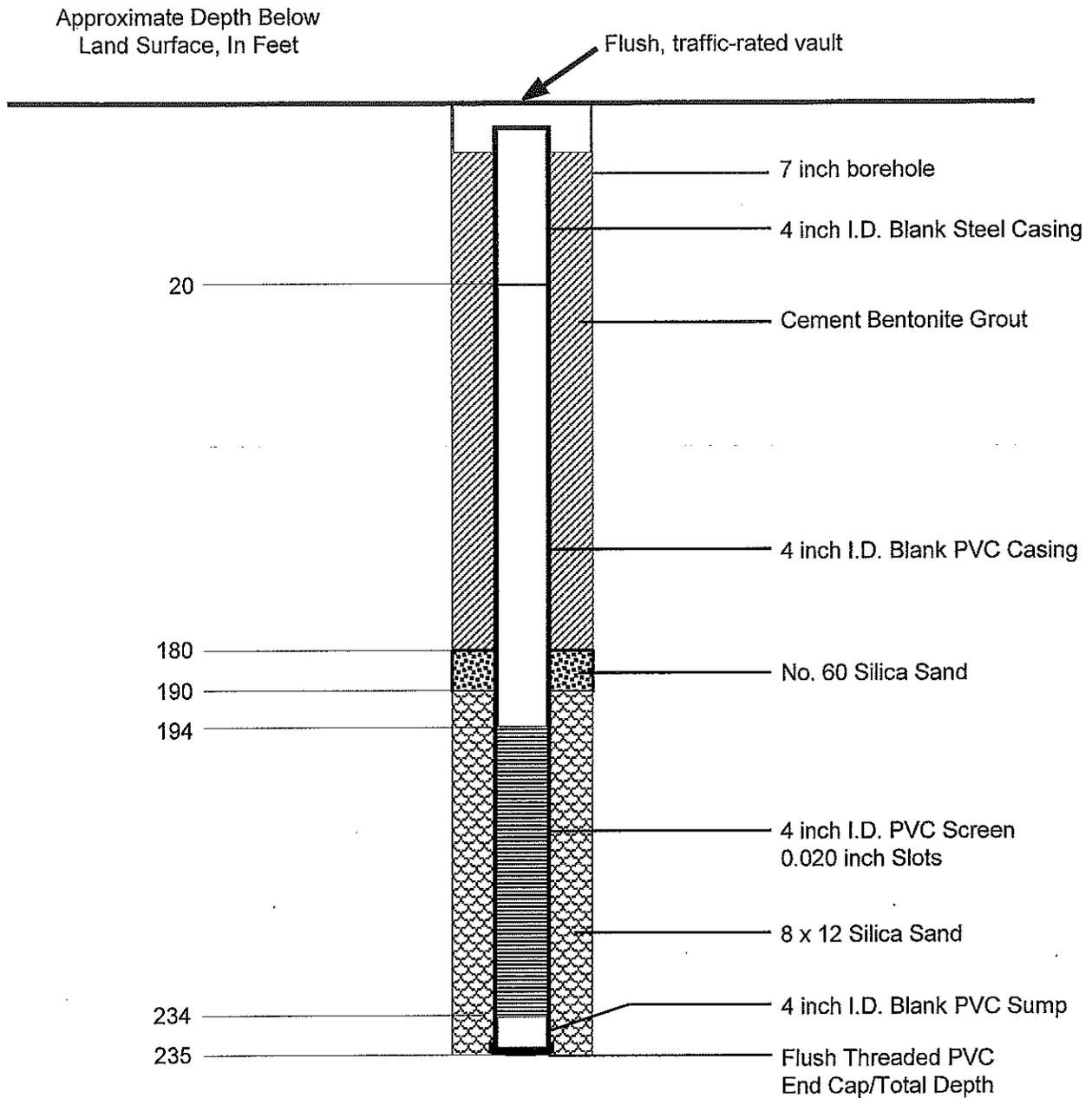
LOG A EWN05 CHEMRESEARCH_CMW-1DR.GPJ LOG A EWN05.GDT 9/15/15



9185 S. Farmer Ave., Ste. 111
Tempe, Arizona 85284
Phone: 480.894.2056
Fax: 480.894.2497

Remarks: ADWR Well # 55-224426. Elevation estimated from proximal wells CMW-1 and CMW-1D. Logged from hopper cuttings.
See key sheet for symbols and abbreviations used above.

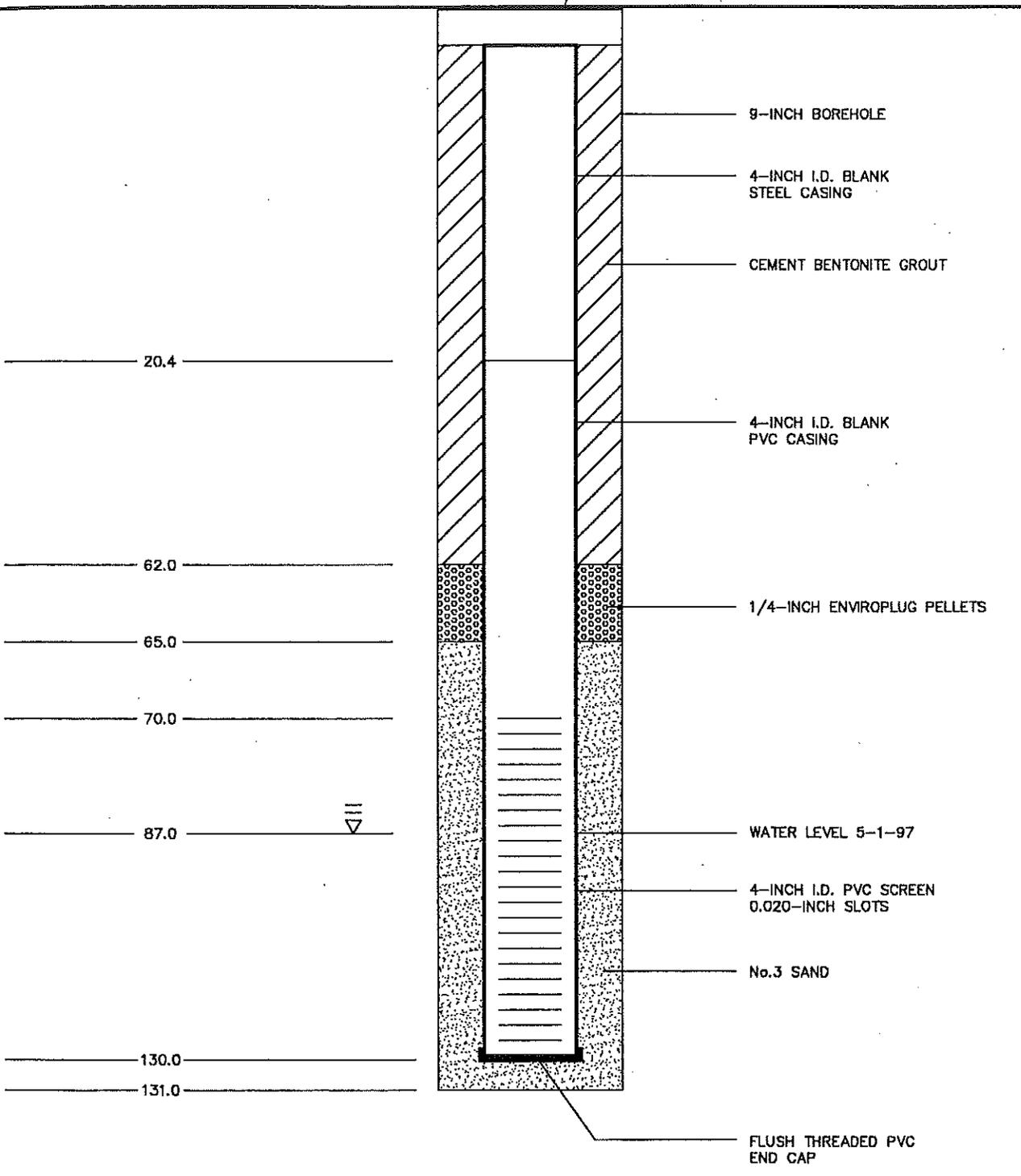
Drawing Not
To Scale



**FIGURE 4. SCHEMATIC WELL CONSTRUCTION DIAGRAM
FOR CHEMRESEARCH COMPANY INC.
MONITOR WELL CMW-1D**

APPROXIMATE
DEPTH BELOW LAND SURFACE
IN FEET

FLUSH, TRAFFIC-RATED VAULT

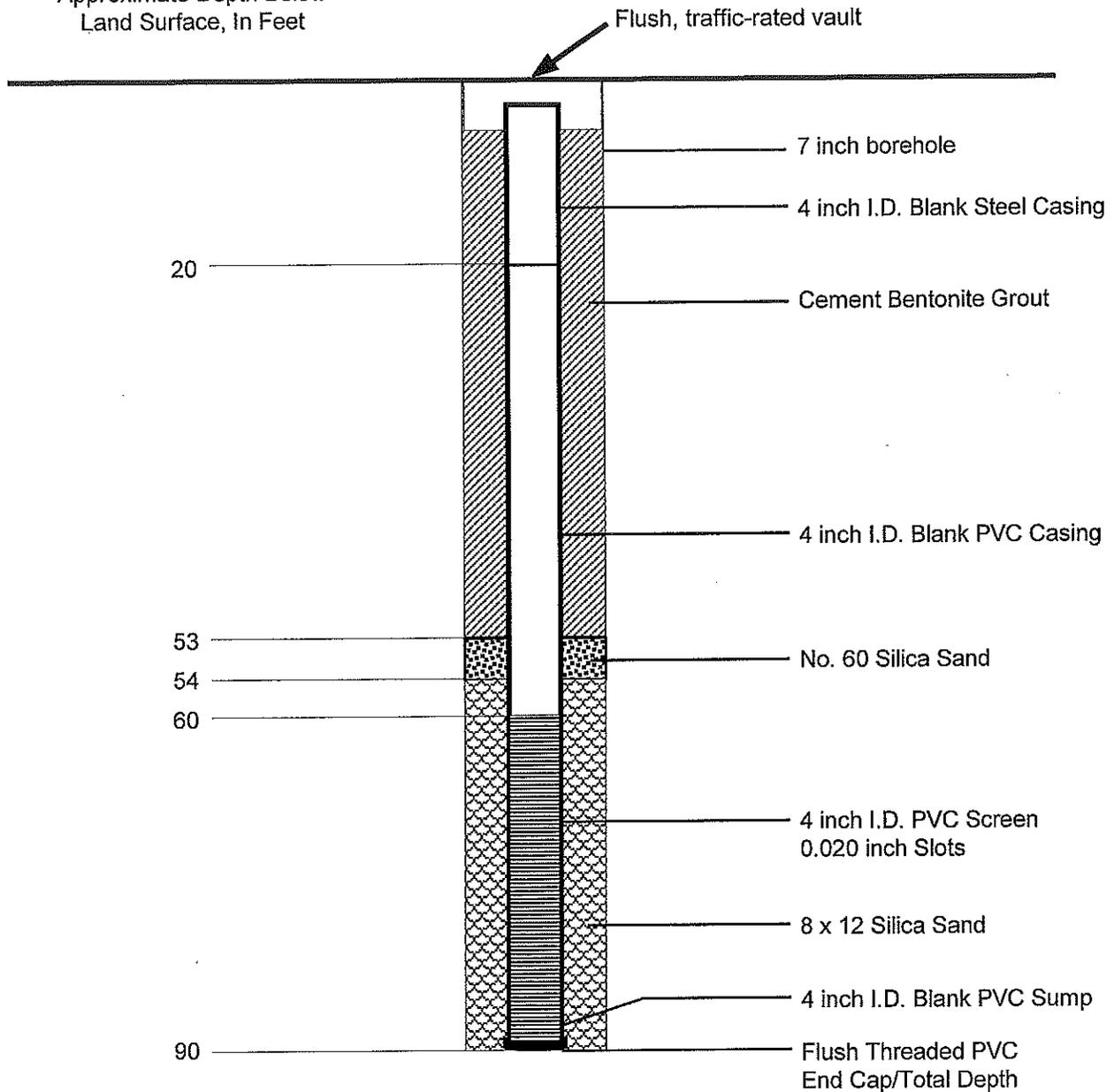


CR12F08

FIGURE 8. SCHEMATIC WELL CONSTRUCTION
DIAGRAM OF MONITOR WELL CMW-3

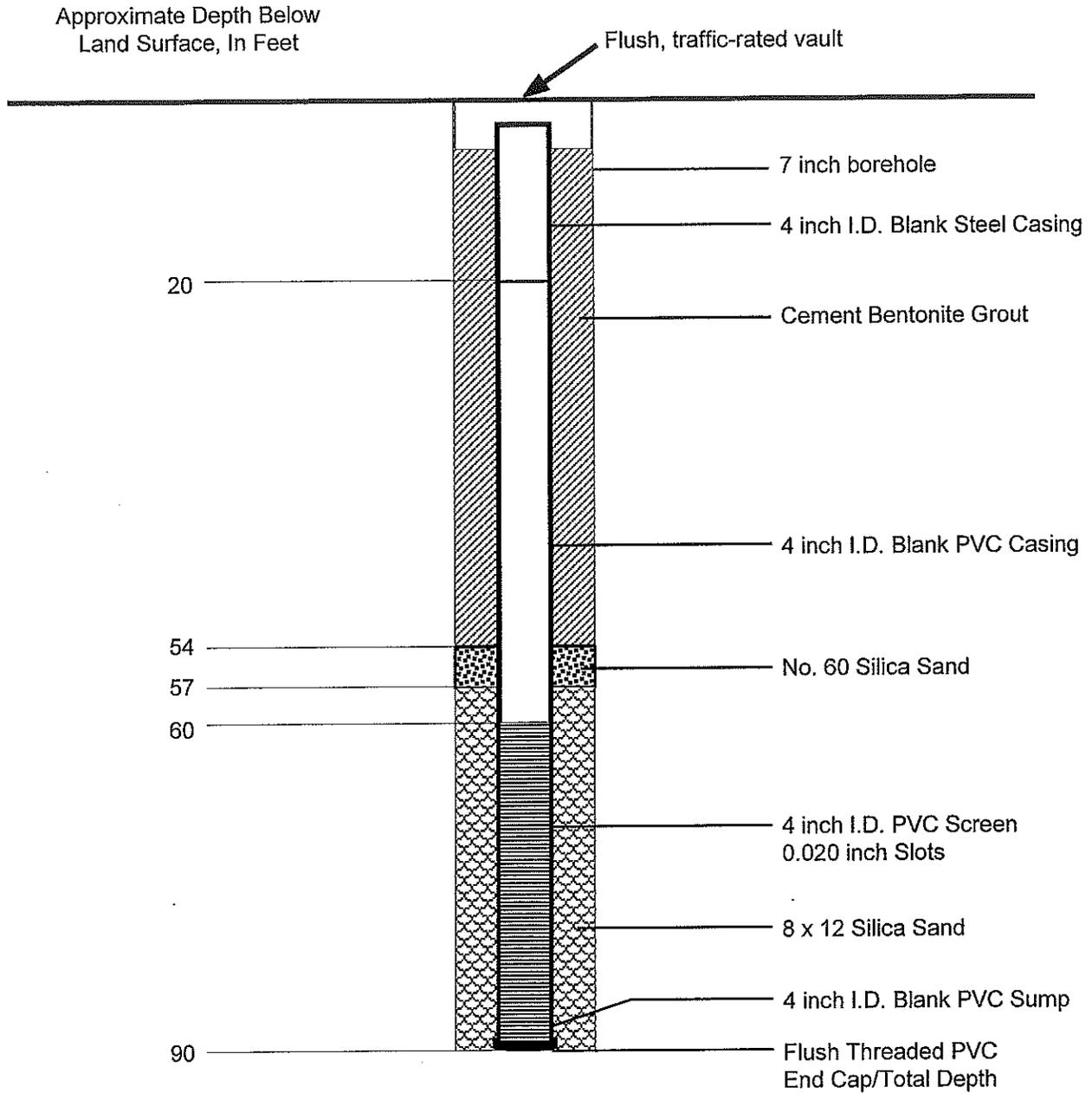
Drawing Not
To Scale

Approximate Depth Below
Land Surface, In Feet



**FIGURE 5. SCHEMATIC WELL CONSTRUCTION DIAGRAM
FOR CHEMRESEARCH COMPANY INC.
MONITOR WELL CMW-4**

*Drawing Not
To Scale*



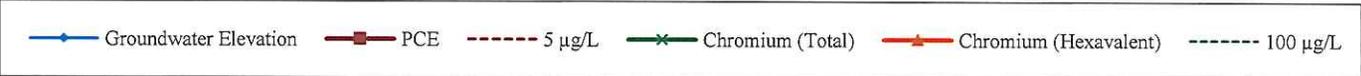
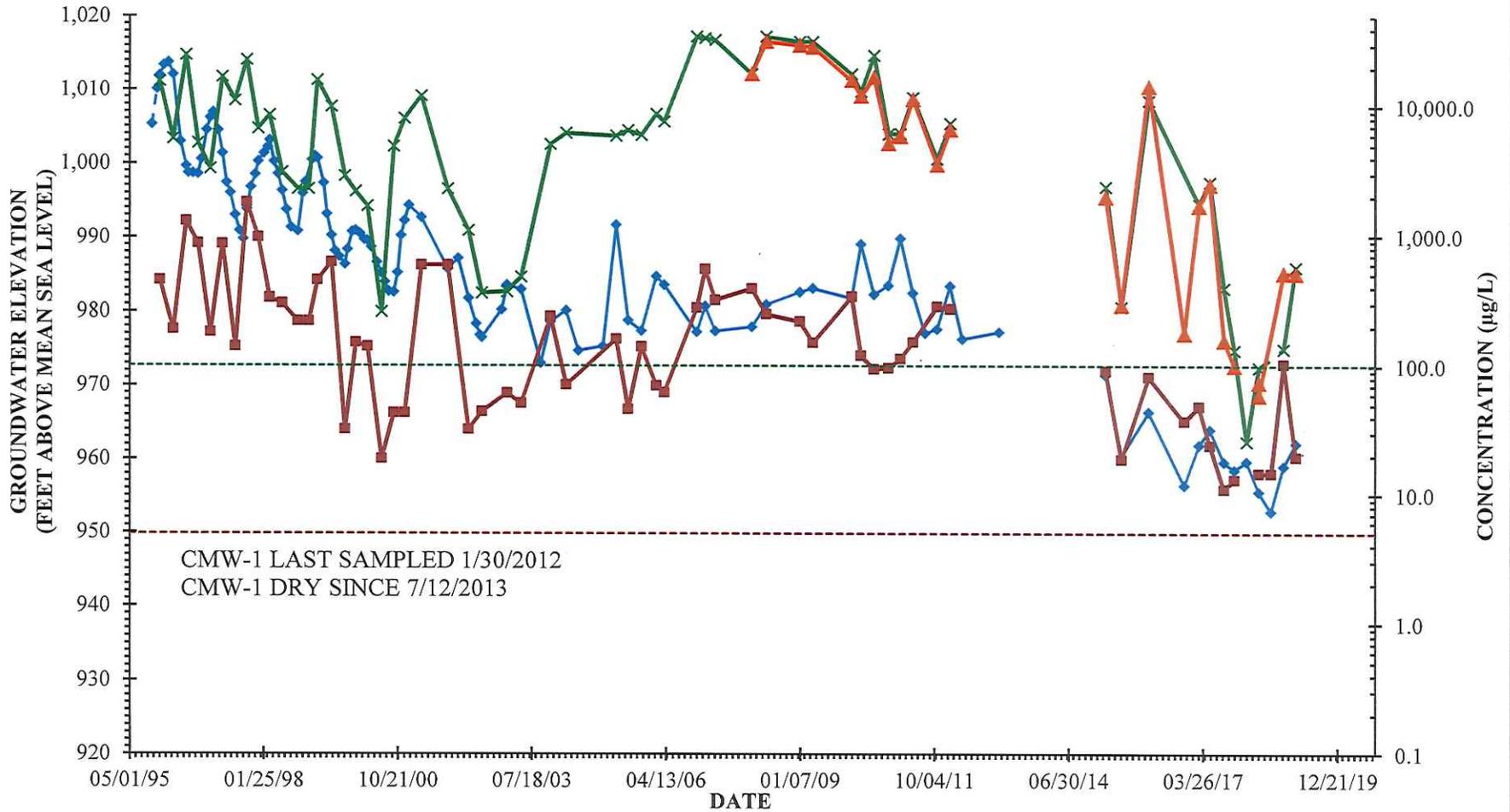
**FIGURE 6. SCHEMATIC WELL CONSTRUCTION DIAGRAM
FOR CHEMRESEARCH COMPANY INC.
MONITOR WELL CMW-5**

APPENDIX D

GROUNDWATER ELEVATION/CHEMICAL OF CONCERN VS. TIME GRAPHS

GROUNDWATER ELEVATION / COC ATTENUATION - CMW-1 AND CMW-1M AT 145 FEET

ChemResearch Company Inc.
1130 West Hilton Avenue
Phoenix, Arizona 85007

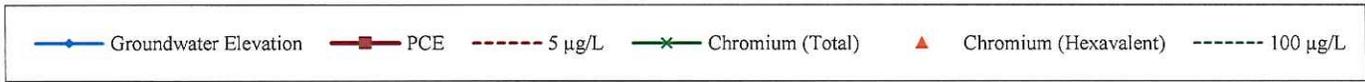
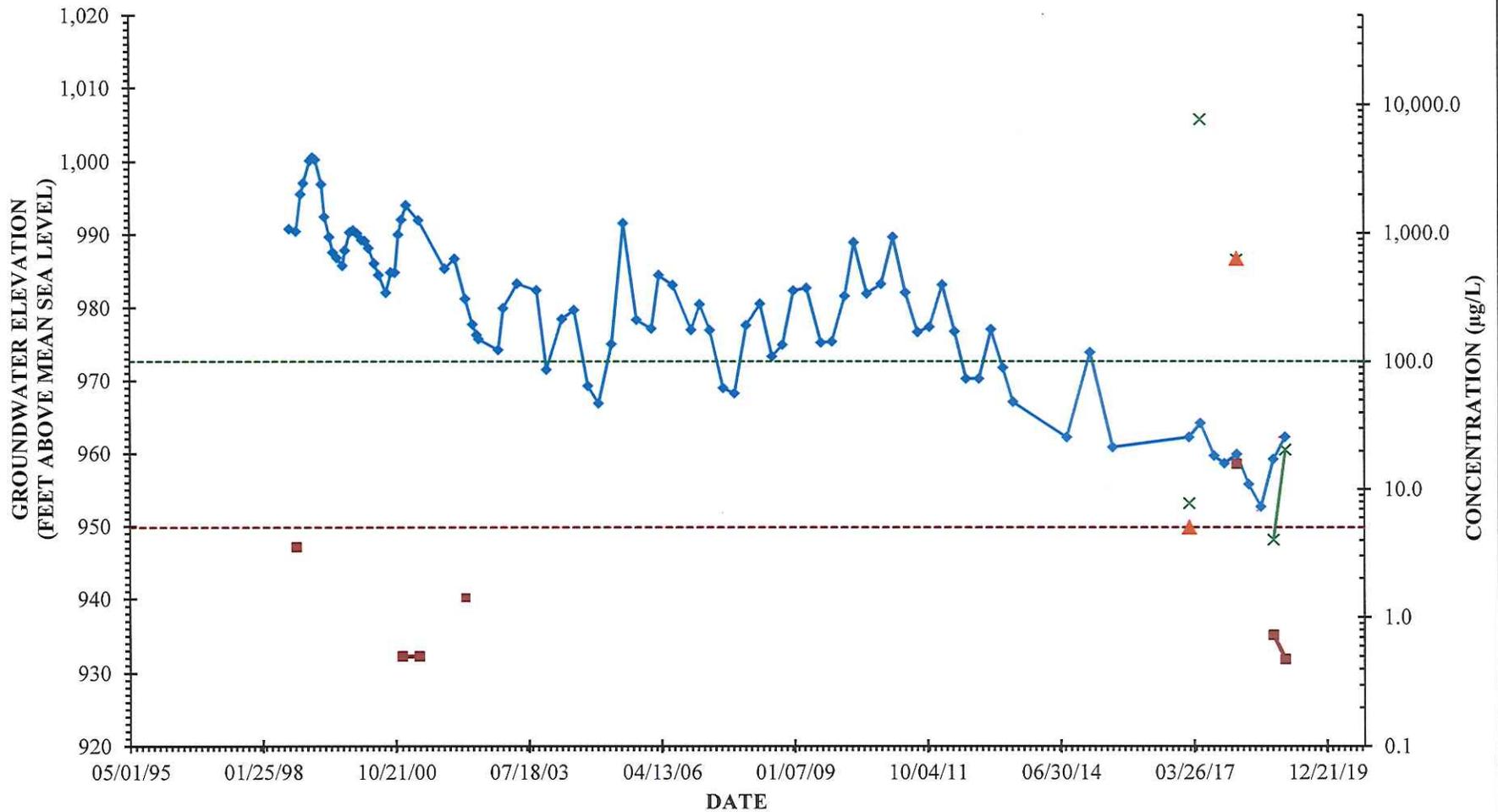


GROUNDWATER ELEVATION / COC ATTENUATION CMW-1D

ChemResearch Company Inc.

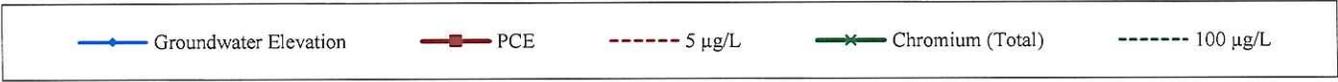
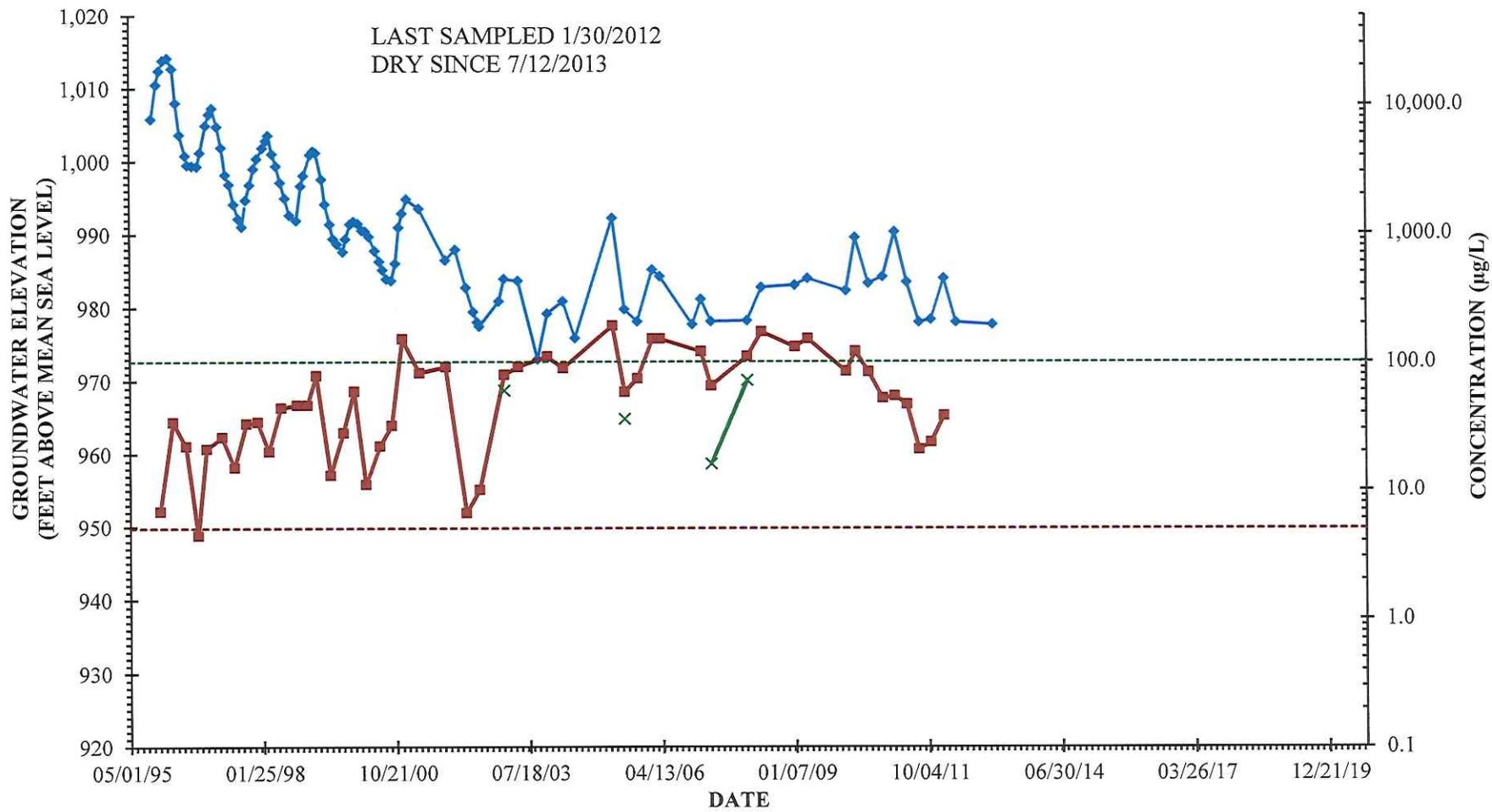
1130 West Hilton Avenue

Phoenix, Arizona 85007



GROUNDWATER ELEVATION / COC ATTENUATION - CMW-2

ChemResearch Company Inc.
1130 West Hilton Avenue
Phoenix, Arizona 85007

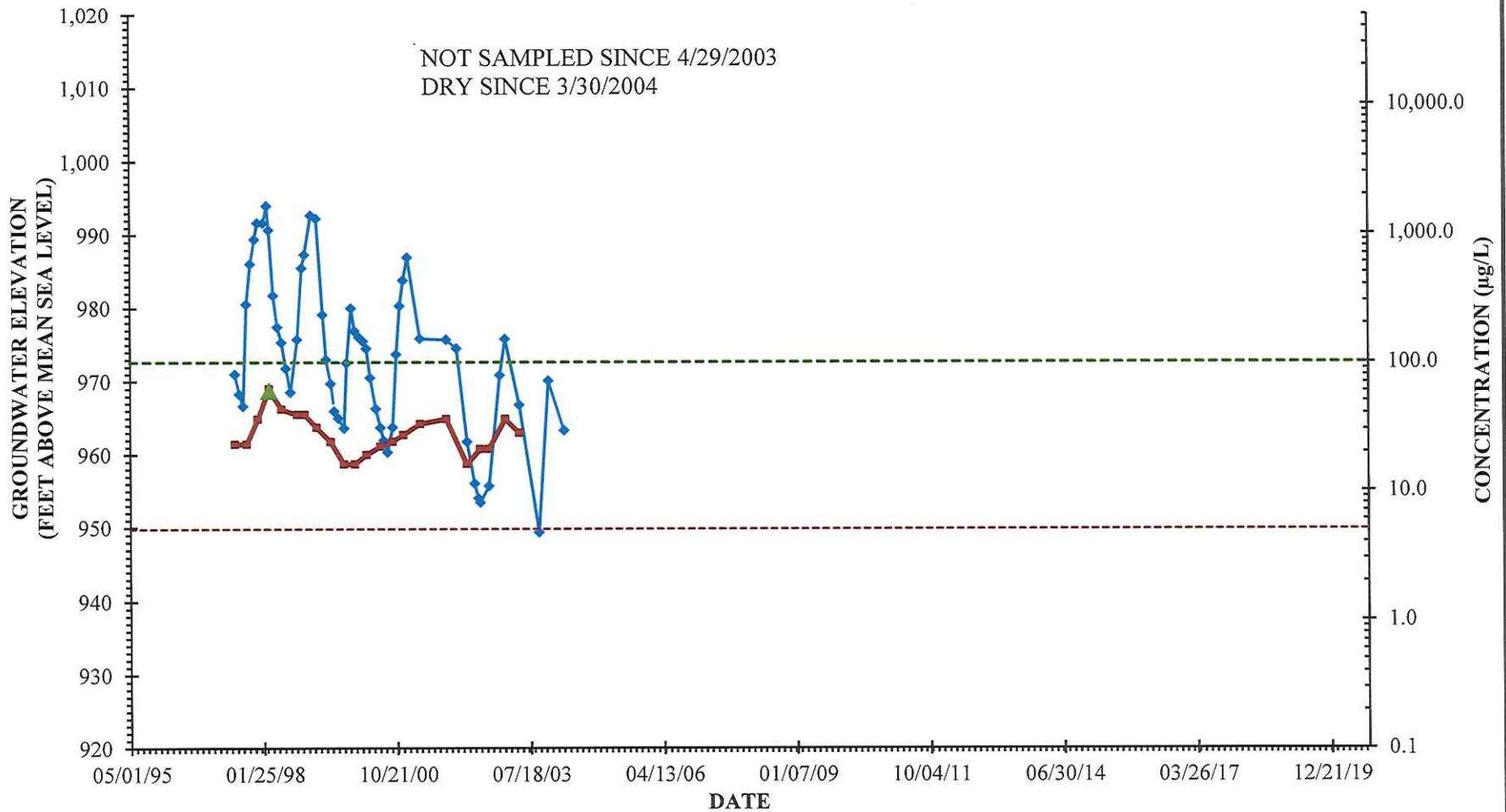


GROUNDWATER ELEVATION / COC ATTENUATION - CMW-3

ChemResearch Company Inc.

1130 West Hilton Avenue

Phoenix, Arizona 85007

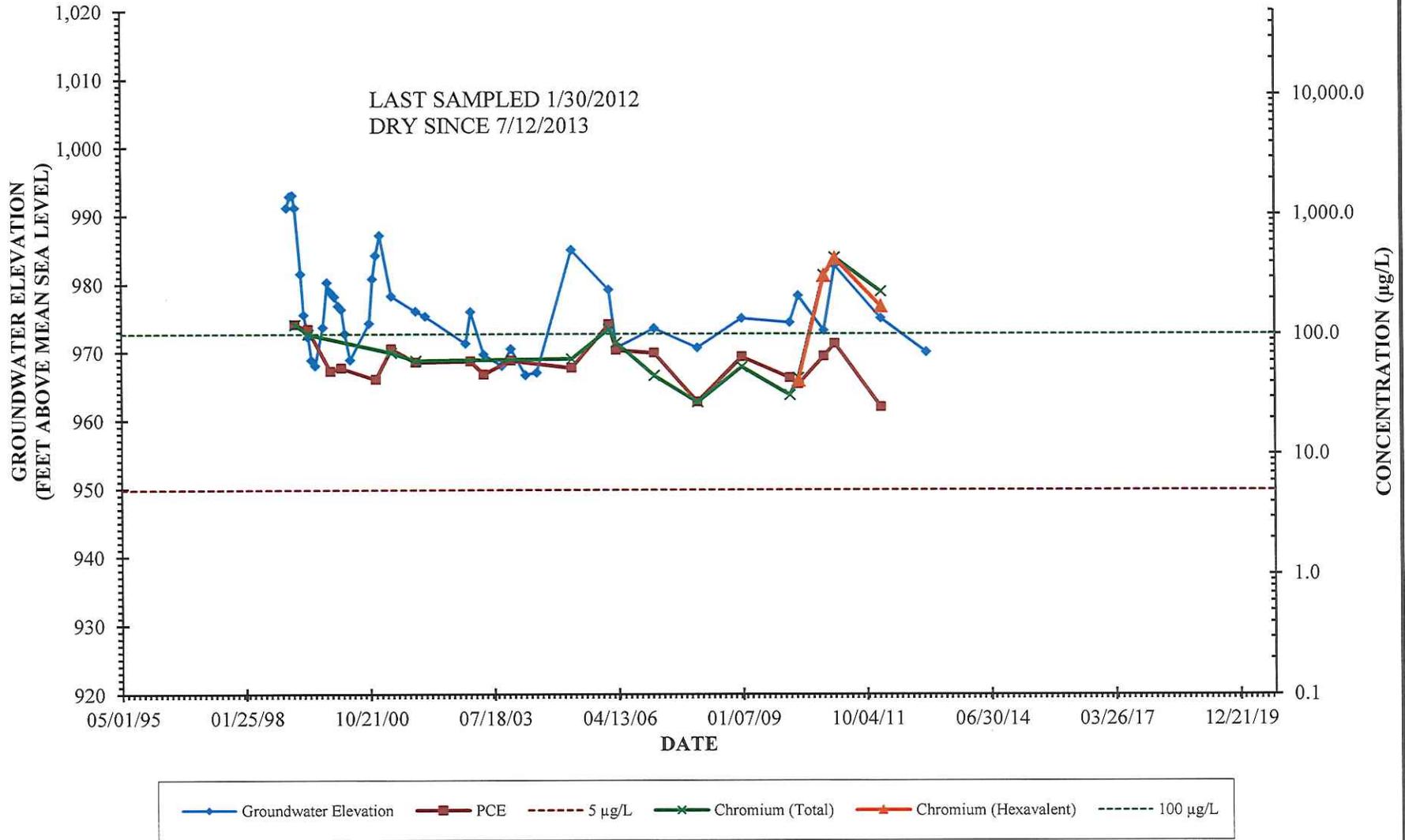


GROUNDWATER ELEVATION / COC ATTENUATION - CMW-4

ChemResearch Company Inc.

1130 West Hilton Avenue

Phoenix, Arizona 85007

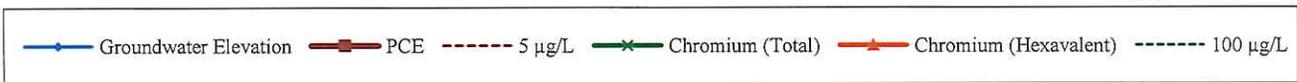
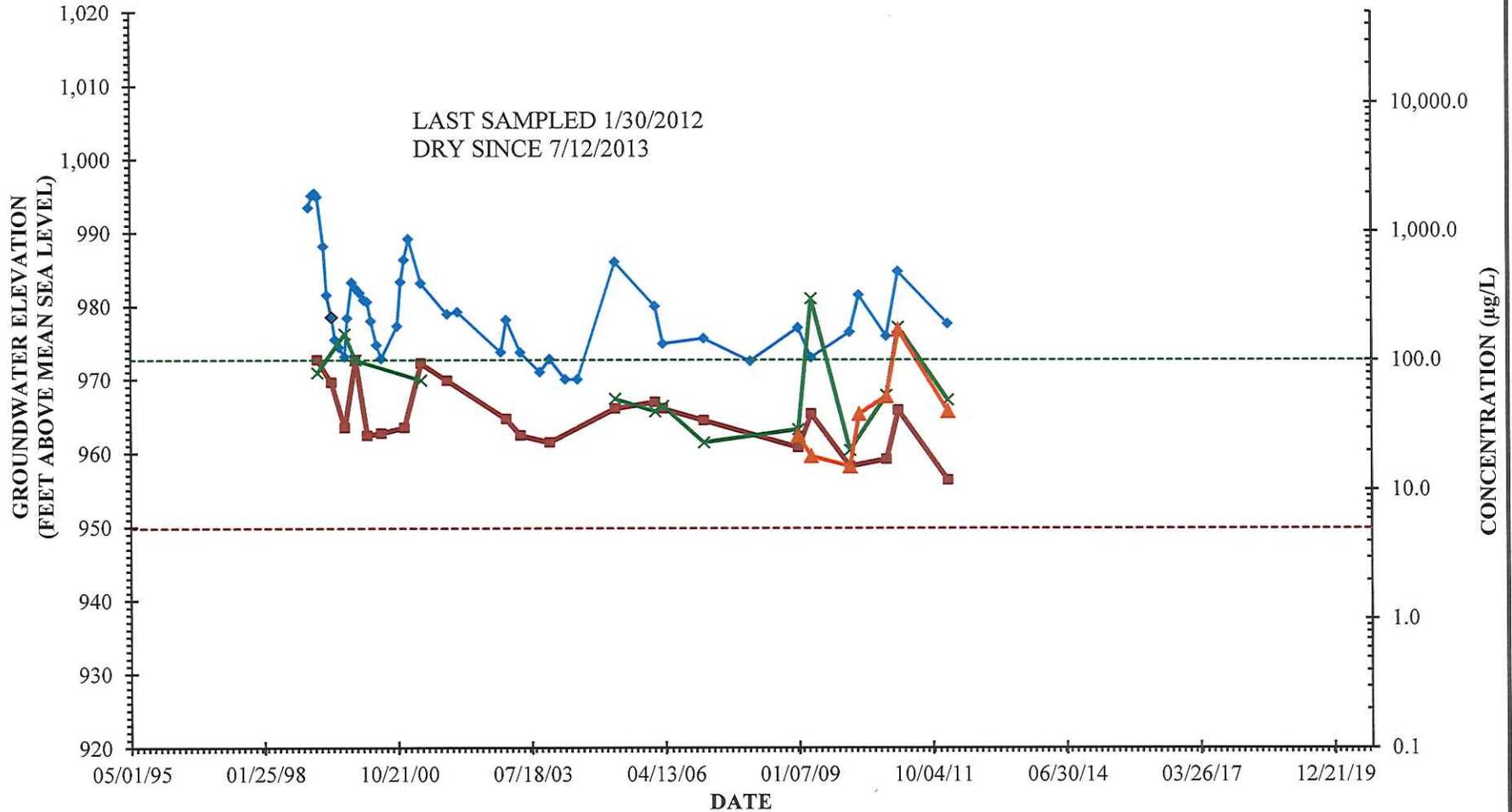


GROUNDWATER ELEVATION / COC ATTENUATION- CMW-5

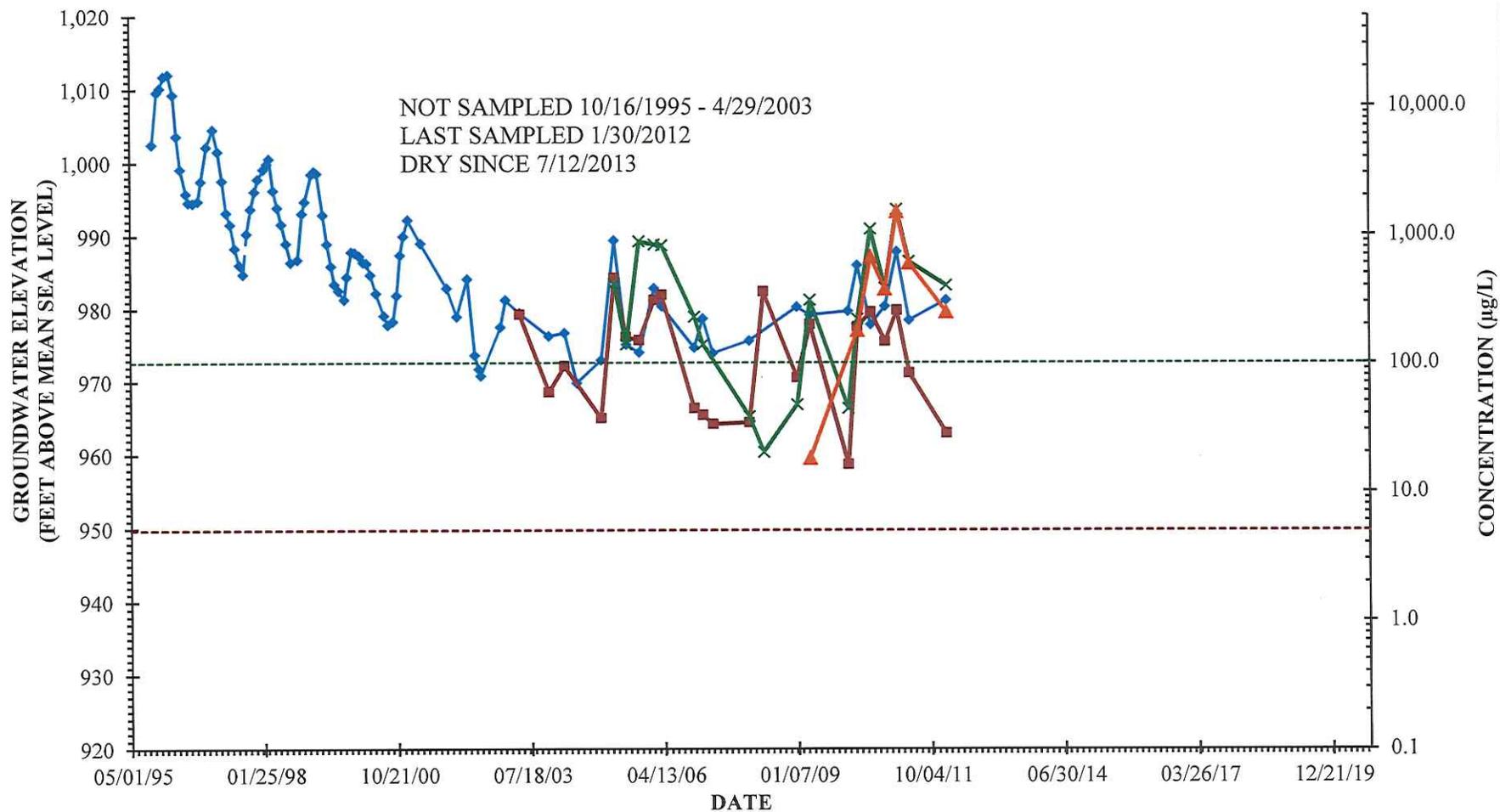
ChemResearch Company Inc.

1130 West Hilton Avenue

Phoenix, Arizona 85007



GROUNDWATER ELEVATION / COC ATTENUATION - WVB-4
ChemResearch Company Inc.
1130 West Hilton Avenue
Phoenix, Arizona 85007

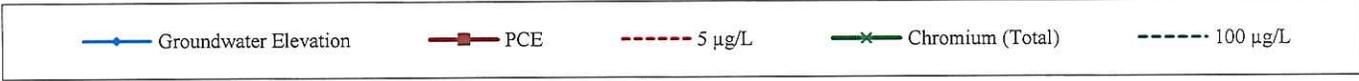
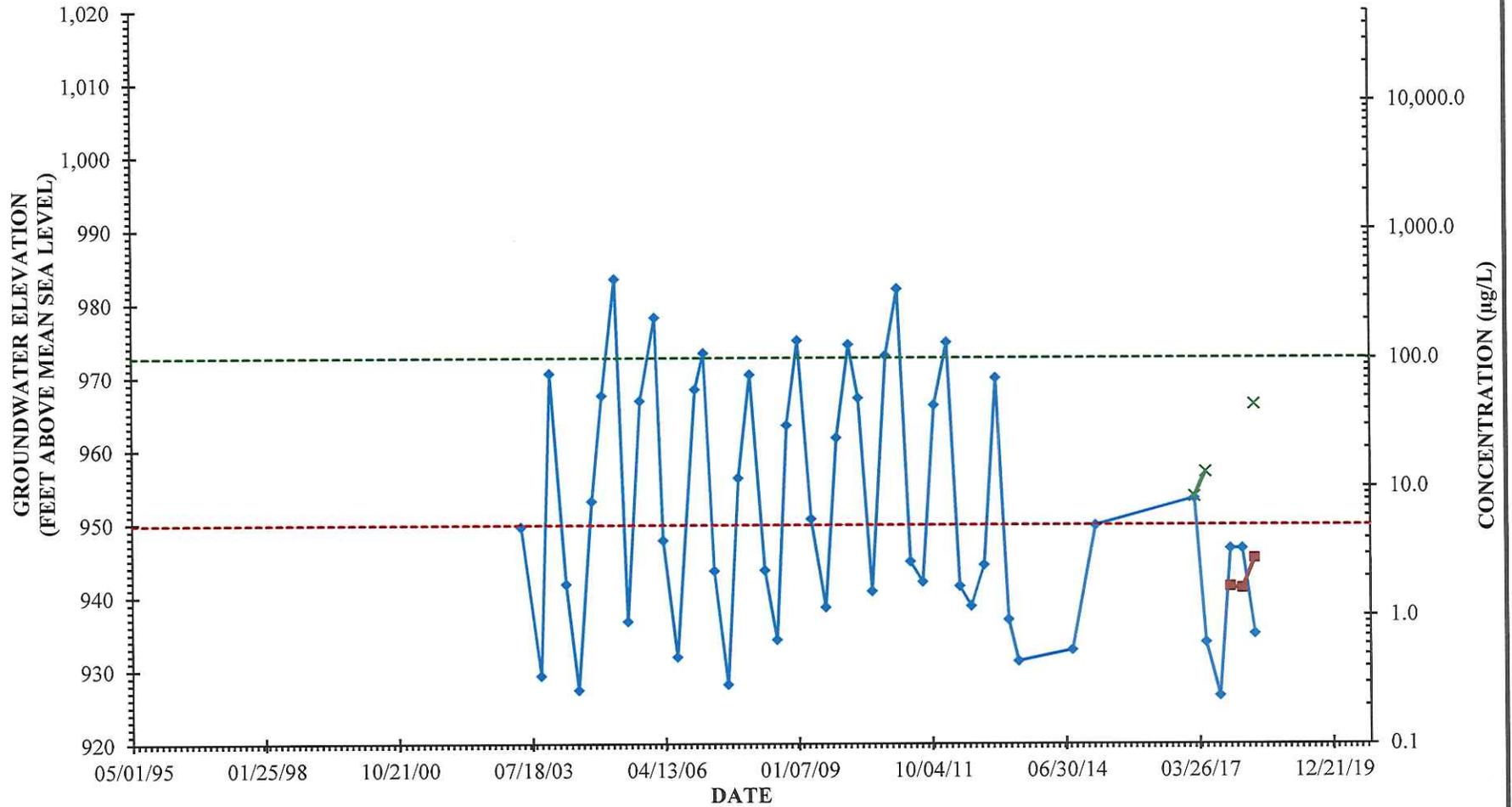


GROUNDWATER ELEVATION / COC ATTENUATION - AVB69-01

ChemResearch Company Inc.

1130 West Hilton Avenue

Phoenix, Arizona 85007

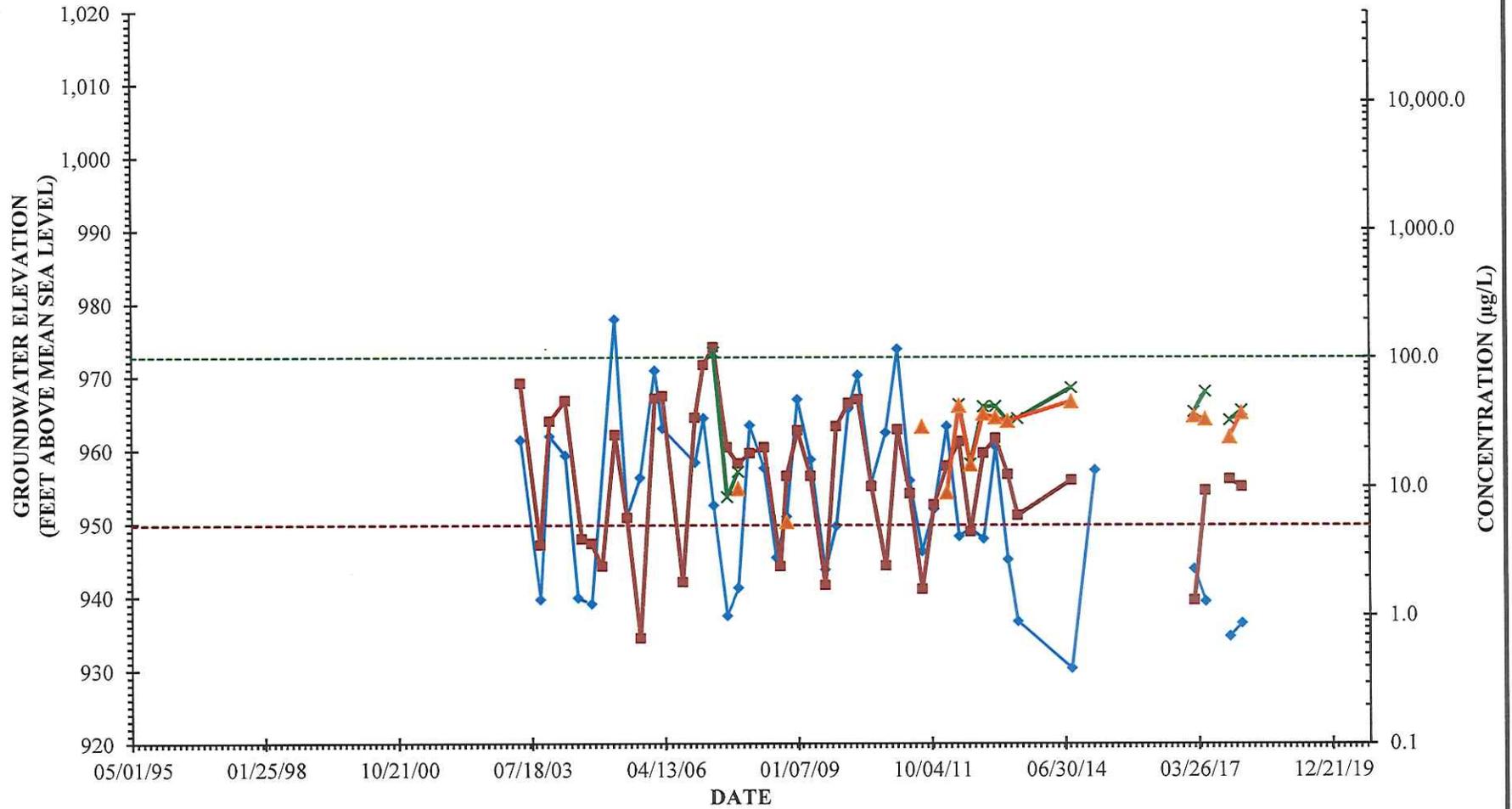


GROUNDWATER ELEVATION / COC ATTENUATION - AVB88-01

ChemResearch Company Inc.

1130 West Hilton Avenue

Phoenix, Arizona 85007



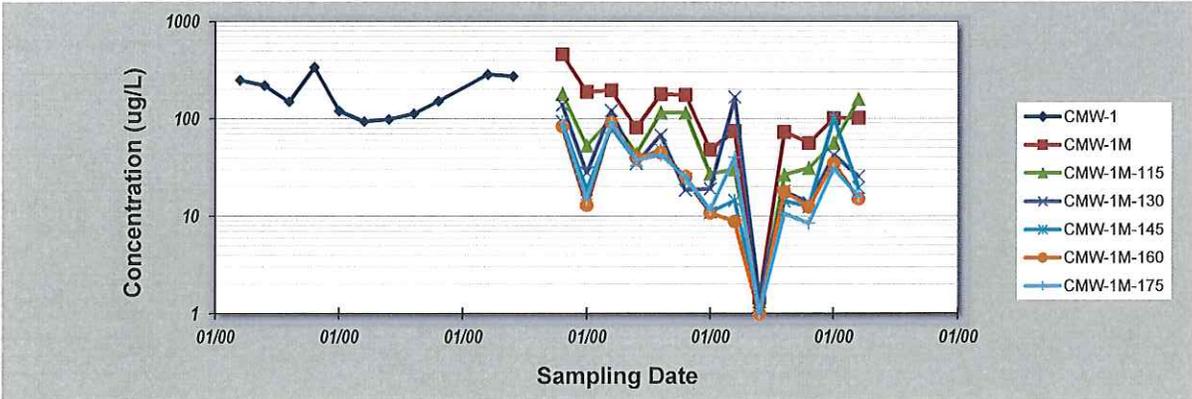
APPENDIX E

MANN-KENDALL CONSTITUENT TREND ANALYSIS WORKSHEETS

GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: **26-Feb-19** Job ID: **1052000122**
 Facility Name: **ChemResearch Company** Constituent: **PCE**
 Conducted By: **R. Morgan** Concentration Units: **ug/L**

Sampling Point ID:	CMW-1	CMW-1M	CMW-1M-115	CMW-1M-130	CMW-1M-145	CMW-1M-160	CMW-1M-175	
Sampling Event	PCE CONCENTRATION (ug/L)							
1	04/29/08	250						
2	01/06/09	220						
3	04/14/09	150						
4	01/27/10	340						
5	04/06/10	120						
6	07/13/10	94						
7	10/28/10	98.8						
8	01/25/11	113						
9	04/28/11	152						
10	07/28/11							
11	10/25/11	286						
12	01/30/12	274						
13	04/30/12							
14	04/01/15		460	180	140	94	84	90
15	07/28/15		189	53.2	28.0	18.8	13.0	14.9
16	02/16/16		196	101	122	81.9	91.4	91.3
17	11/07/16		81.2	43.9	34.8	37.2	39.9	37.4
18	02/22/17		179	115	68.0	48.5	44.9	42.6
19	5/1/17		175	115	18.5	24.1	25.4	25.2
20	08/29/17		48.2	27.2	19.1	11.0	10.8	11.6
21	11/15/17		75	30.2	167.0	14.5	8.83	40.4
22	02/14/18		1.45	1.33	1.54	1.18	1	1
23	05/15/18		72.9	26.5	18.1	14.3	17.9	10.6
24	08/15/18		56.3	31.1	13.7	12.5	12.4	8.48
25	11/15/18		101	56.6	42.3	103	35.0	30.7
26	02/14-15/19		102	159	25.6	19.6	15.1	15.9
27								
28								
29								
30								
Coefficient of Variation:	0.45	0.86	0.77	1.01	0.93	0.92	0.90	
Mann-Kendall Statistic (S):	-1	-36	-15	-26	-24	-28	-32	
Confidence Factor:	50.0%	98.5%	79.9%	93.6%	91.8%	95.0%	97.1%	
Concentration Trend:	Stable	Decreasing	Stable	Prob. Decreasing	Prob. Decreasing	Prob. Decreasing	Decreasing	



- Notes:**
- At least four independent sampling events per well are required for calculating the trend. Methodology is valid for 4 to 40 samples.
 - Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
 - Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, Ground Water, 41(3):355-367, 2003.

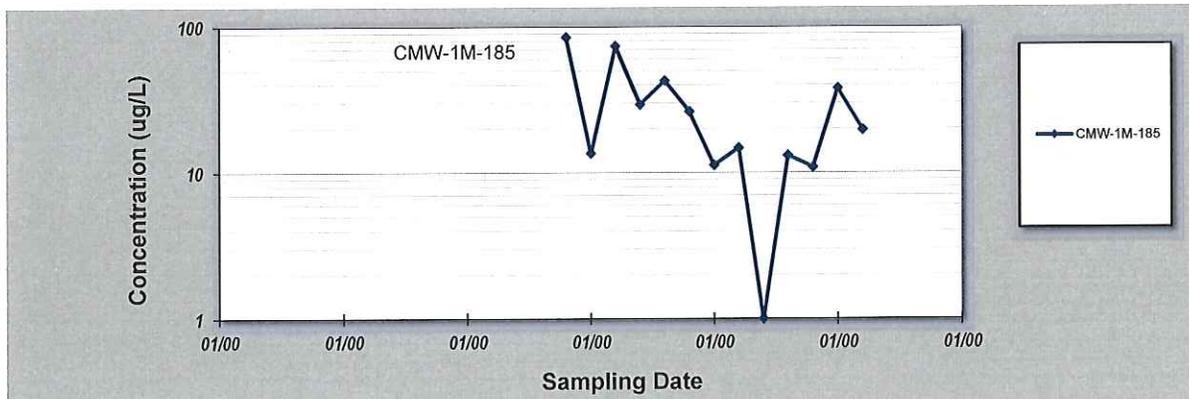
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GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: 26-Feb-19	Job ID: 1052000122
Facility Name: ChemResearch Company	Constituent: PCE
Conducted By: R. Morgan	Concentration Units: ug/L
Sampling Point ID: CMW-1M-185	

Sampling Event	Sampling Date	PCE CONCENTRATION (ug/L)					
1	04/29/08						
2	01/06/09						
3	04/14/09						
4	01/27/10						
5	04/06/10						
6	07/13/10						
7	10/28/10						
8	01/25/11						
9	04/28/11						
10	07/28/11						
11	10/25/11						
12	01/30/12						
13	04/30/12						
14	04/01/15	85					
15	07/28/15	13.6					
16	02/16/16	74.0					
17	11/07/16	29.4					
18	02/22/17	42.8					
19	5/1/17	26.2					
20	08/29/17	11.3					
21	11/15/17	14.8					
22	02/14/18	1					
23	05/15/18	13.1					
24	08/15/18	10.9					
25	11/15/18	37.9					
26	2/15/19	19.7					
27							
28							
29							
30							

Coefficient of Variation:	0.86
Mann-Kendall Statistic (S):	-30
Confidence Factor:	96.2%
Concentration Trend:	Decreasing



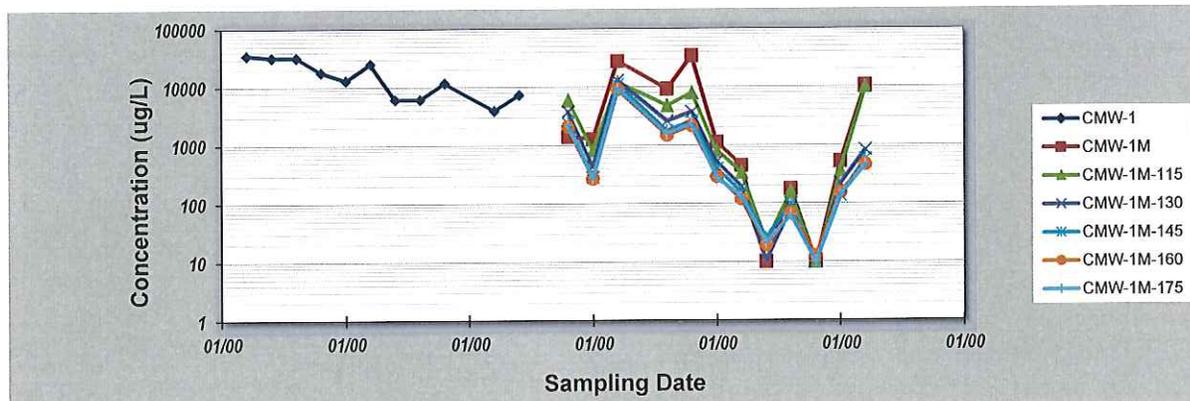
- Notes:**
- At least four independent sampling events per well are required for calculating the trend. Methodology is valid for 4 to 40 samples.
 - Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
 - Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: 26-Feb-19	Job ID: 1052000122
Facility Name: ChemResearch Company	Constituent: Total Chrome
Conducted By: R. Morgan	Concentration Units: ug/L

Sampling Point ID:	CMW-1	CMW-1M	CMW-1M-115	CMW-1M-130	CMW-1M-145	CMW-1M-160	CMW-1M-175	
Sampling Event	Sampling Date	TOTAL CHROME CONCENTRATION (ug/L)						
1	04/29/08	35,000						
2	04/06/09	32,000						
3	04/14/09	32,000						
4	1/2/10	18,000						
5	04/06/10	13,000						
6	07/13/10	25,000						
7	10/28/10	6,120.0						
8	01/25/11	6,160						
9	04/28/11	11,700						
10	07/28/11							
11	10/25/11	3,940						
12	01/30/12	7,360						
13	04/30/12							
14	04/01/15		1,400	5,900	3,800	2,400	2,100	2,200
15	07/28/15		1,280	817	431.0	285	270	269
16	02/16/16		27,700	12,200	12,900	11,100	8,970	9,320
17	11/07/16							
18	02/22/17		9,250	4,760	2,590	1,770	1,490	1,580
19	05/17/17		34,100	7,900	3,730	2,610	2,150	2,290
20	08/29/17		1,120	794	521	395	290	279
21	11/15/17		448	340	193	155	119	130
22	02/14/18		10	21.6	10.6	25.9	19.5	21.4
23	05/15/18		178	163	84	96.8	67.9	62.8
24	08/15/18		10	10	10	10	12.7	10
25	11/15/18		530	361	219	135	152	139
26	02/14-15/19		10,500	9,860	823	573	462	458
27								
28								
29								
30								
Coefficient of Variation:	0.68	1.62	1.22	1.75	1.92	1.89	1.89	
Mann-Kendall Statistic (S):	-38	-21	-24	-30	-30	-28	-28	
Confidence Factor:	99.9%	91.3%	94.2%	97.8%	97.8%	96.9%	96.9%	
Concentration Trend:	Decreasing	Prob. Decreasing	Prob. Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	



Notes:

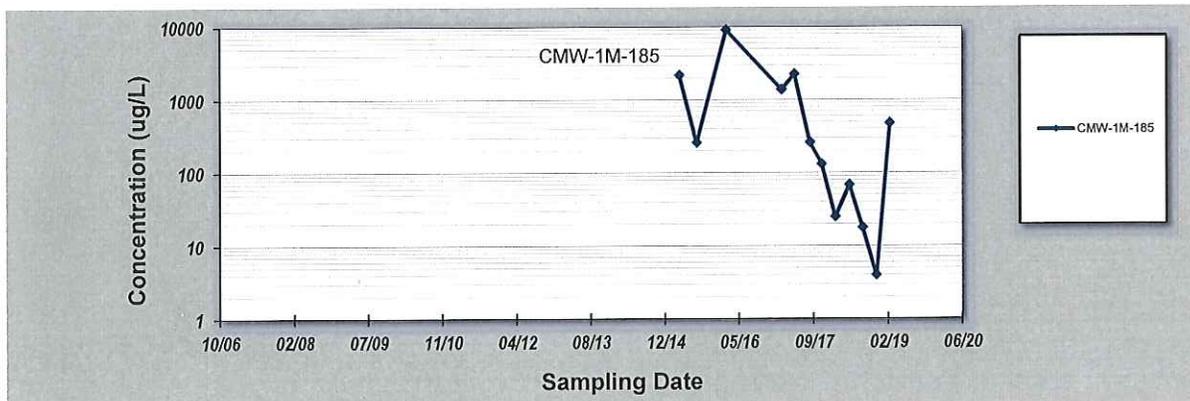
- At least four independent sampling events per well are required for calculating the trend. Methodology is valid for 4 to 40 samples.
- Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
- Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: 26-Feb-19	Job ID: 1052000122
Facility Name: ChemResearch Company	Constituent: Total Chrome
Conducted By: R. Morgan	Concentration Units: ug/L
Sampling Point ID: CMW-1M-185	

Sampling Event	Sampling Date	TOTAL CHROME CONCENTRATION (ug/L)					
1	04/29/08						
2	01/06/09						
3	04/14/09						
4	01/27/10						
5	04/06/10						
6	07/13/10						
7	10/28/10						
8	01/25/11						
9	04/28/11						
10	07/28/11						
11	10/25/11						
12	01/30/12						
13	04/30/12						
14	04/01/15	2,200					
15	07/28/15	261					
16	02/16/16	9,100					
17	11/07/16						
18	02/22/17	1,390					
19	05/17/17	2,250					
20	08/29/17	262					
21	11/15/17	132					
22	02/14/18	25.1					
23	05/18/18	68.4					
24	08/15/18	17.8					
25	11/15/18	4.01					
26	02/14/19	479					
27							
28							
29							
30							
Coefficient of Variation:		1.91					
Mann-Kendall Statistic (S):		-36					
Confidence Factor:		99.3%					
Concentration Trend:		Decreasing					



Notes:

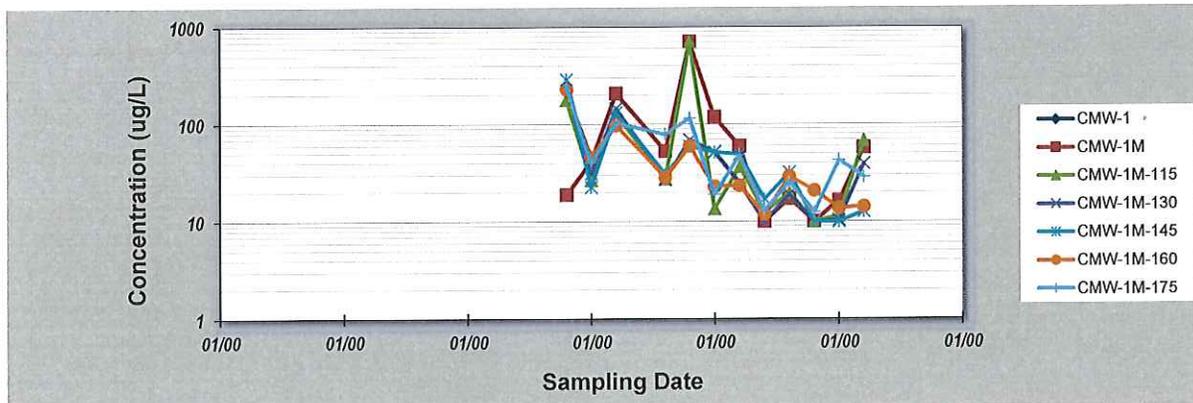
- At least four independent sampling events per well are required for calculating the trend. Methodology is valid for 4 to 40 samples.
- Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
- Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: **26-Feb-19** Job ID: **1052000122**
 Facility Name: **ChemResearch Company** Constituent: **Nickel**
 Conducted By: **R. Morgan** Concentration Units: **ug/L**

Sampling Point ID:		CMW-1	CMW-1M	CMW-1M-115	CMW-1M-130	CMW-1M-145	CMW-1M-160	CMW-1M-175
Sampling Event	Sampling Date	NICKEL CONCENTRATION (ug/L)						
1	04/29/08							
2	01/06/09							
3	04/14/09							
4	01/27/10							
5	04/06/10							
6	07/13/10							
7	10/28/10							
8	01/25/11							
9	04/28/11							
10	07/28/11							
11	10/25/11							
12	01/30/12							
13	04/30/12							
14	04/01/15	19	180	290	290	230	250	
15	07/28/15	41.4	27.1	31.4	22.6	45.9	40.6	
16	02/16/16	209	128	146	132	97.7	103	
17	11/07/16							
18	02/22/17	53.2	28	27.1	30.7	28.4	78.8	
19	5/1/17	706	706	69.2	59.3	59.7	116	
20	08/29/17	119	13.6	52.5	51.5	23.0	19.1	
21	11/15/17	59.5	36.6	24.8	49.1	23.4	48.1	
22	02/14/18	10	12.5	10	17	11.9	12.9	
23	05/15/18	17.2	19.6	19	31.8	29.1	25.5	
24	08/15/18	10	10	10	10	20.8	12.5	
25	11/15/18	16.5	11.5	10.4	9.95	13.8	42.8	
26	02/14-15/19	57.6	68.1	39.4	12.7	14.3	28.8	
27								
28								
29								
30								
Coefficient of Variation:		1.79	1.91	1.34	1.34	1.24	1.04	
Mann-Kendall Statistic (S):		-15	-26	-35	-40	-42	-30	
Confidence Factor:		82.8%	95.7%	99.2%	99.7%	99.8%	97.8%	
Concentration Trend:		No Trend	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	



- Notes:
- At least four independent sampling events per well are required for calculating the trend. Methodology is valid for 4 to 40 samples.
 - Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90% and S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
 - Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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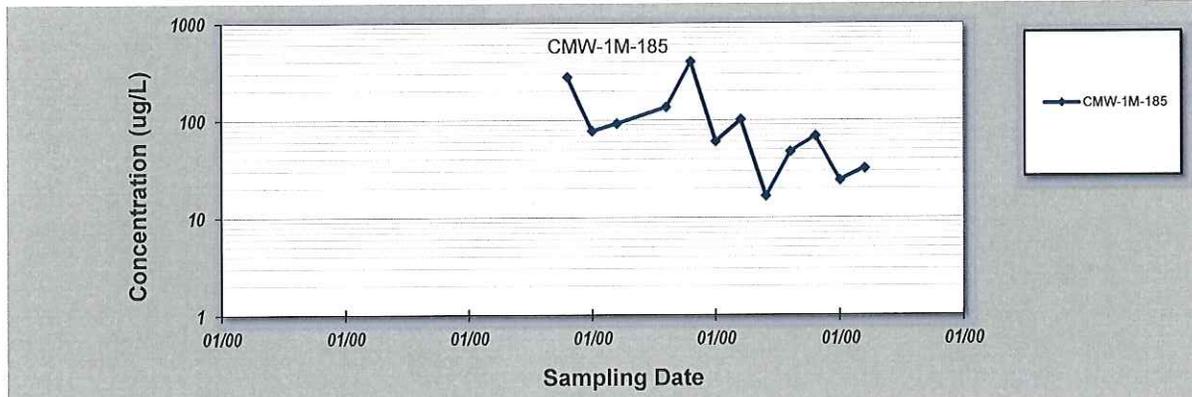
GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: **26-Feb-19** Job ID: **1052000122**
 Facility Name: **ChemResearch Company** Constituent: **Nickel**
 Conducted By: **R. Morgan** Concentration Units: **ug/L**

Sampling Point ID: **CMW-1M-185**

Sampling Event	Sampling Date	NICKEL CONCENTRATION (ug/L)					
1	04/29/08						
2	01/06/09						
3	04/14/09						
4	01/27/10						
5	04/06/10						
6	07/13/10						
7	10/28/10						
8	01/25/11						
9	04/28/11						
10	07/28/11						
11	10/25/11						
12	01/30/12						
13	04/30/12						
14	04/01/15	280					
15	07/28/15	77.9					
16	02/16/16	93.1					
17	11/07/16						
18	02/22/17	137					
19	5/1/17	402					
20	08/29/17	60.9					
21	11/15/17	102					
22	02/14/18	16.8					
23	05/15/18	47.8					
24	08/15/18	69.1					
25	11/15/18	24.3					
26	2/15/19	32.1					
27							
28							
29							
30							

Coefficient of Variation: **1.03**
 Mann-Kendall Statistic (S): **-32**
 Confidence Factor: **98.4%**
 Concentration Trend: **Decreasing**



Notes:

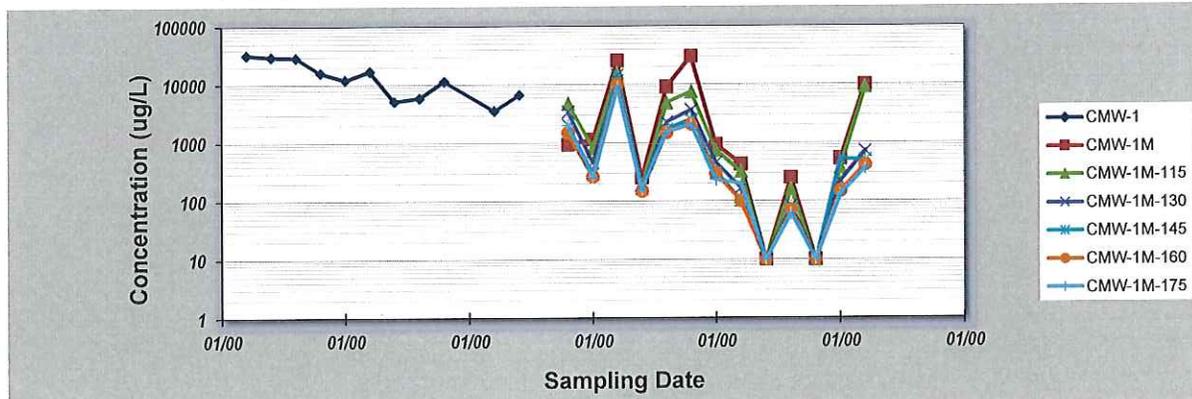
- At least four independent sampling events per well are required for calculating the trend. Methodology is valid for 4 to 40 samples.
- Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
- Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: **26-Feb-19** Job ID: **1052000122**
 Facility Name: **ChemResearch Company** Constituent: **Hexavalent Chrome**
 Conducted By: **R. Morgan** Concentration Units: **ug/L**

Sampling Point ID:		CMW-1	CMW-1M	CMW-1M-115	CMW-1M-130	CMW-1M-145	CMW-1M-160	CMW-1M-175
Sampling Event	Sampling Date	HEXAVALENT CHROME CONCENTRATION (ug/L)						
1	04/29/08	32,000						
2	01/06/09	30,000						
3	04/14/09	29,000						
4	01/27/10	16,000						
5	04/06/10	12,000						
6	07/13/10	17,000						
7	10/28/10	5,180						
8	01/25/11	5,880						
9	04/28/11	11,300						
10	07/28/11							
11	10/25/11	3,540						
12	01/30/12	6,620						
13	04/30/12							
14	04/01/15		940	4,700	3,400	2,000	1,500	2,000
15	07/28/15		1140	821	461	295	263	254
16	02/16/16		25600	15,800	11,600	14,300	9,900	9,120
17	11/07/16		254	181	164	177	149	154
18	02/22/17		9140	4,840	2,260	1,710	1,490	1,510
19	5/11/17		30200	7,440	3,660	2,490	2,080	2,070
20	08/29/17		933	728	457	310	296	231
21	11/15/17		427	320	167	101	100	199
22	02/14/18		10	10	10	10	10	10
23	05/15/18		251	160	84	74	70	61
24	08/15/18		10	10	10	10	10	10
25	11/15/18		536	371	223	512	149	129
26	02/14-15/19		9,900	8,970	723	510	419	361
27								
28								
29								
30								
Coefficient of Variation:		0.69	1.68	1.42	1.80	2.23	2.12	2.01
Mann-Kendall Statistic (S):		-39	-19	-21	-29	-27	-30	-33
Confidence Factor:		99.9%	86.1%	88.6%	95.6%	94.3%	96.2%	97.5%
Concentration Trend:		Decreasing	No Trend	No Trend	Decreasing	Prob. Decreasing	Decreasing	Decreasing



Notes:

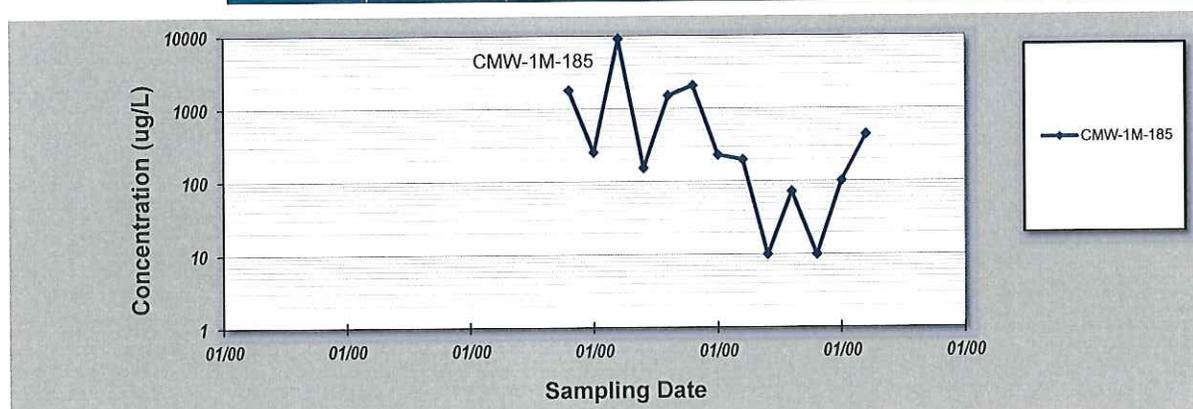
- At least four independent sampling events per well are required for calculating the trend. Methodology is valid for 4 to 40 samples.
- Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
- Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: 26-Feb-19	Job ID: 1052000122
Facility Name: ChemResearch Company	Constituent: Hexavalent Chrome
Conducted By: R. Morgan	Concentration Units: ug/L
Sampling Point ID: CMW-1M-185	

Sampling Event	Sampling Date	HEXAVALENT CHROME CONCENTRATION (ug/L)					
1	04/29/08						
2	01/06/09						
3	04/14/09						
4	01/27/10						
5	04/06/10						
6	07/13/10						
7	10/28/10						
8	01/25/11						
9	04/28/11						
10	07/28/11						
11	10/25/11						
12	01/30/12						
13	04/30/12						
14	04/01/15	1,800					
15	07/28/15	254					
16	02/16/16	9,120					
17	11/07/16	154					
18	02/22/17	1,510					
19	5/1/17	2,070					
20	08/29/17	231					
21	11/15/17	199					
22	02/15/18	10					
23	05/15/18	73					
24	08/15/18	10					
25	11/15/18	102					
26	2/15/2015	439					
27							
28							
29							
30							
Coefficient of Variation:		2,02					
Mann-Kendall Statistic (S):		-33					
Confidence Factor:		97.5%					
Concentration Trend:		Decreasing					



Notes:

1. At least four independent sampling events per well are required for calculating the trend. Methodology is valid for 4 to 40 samples.
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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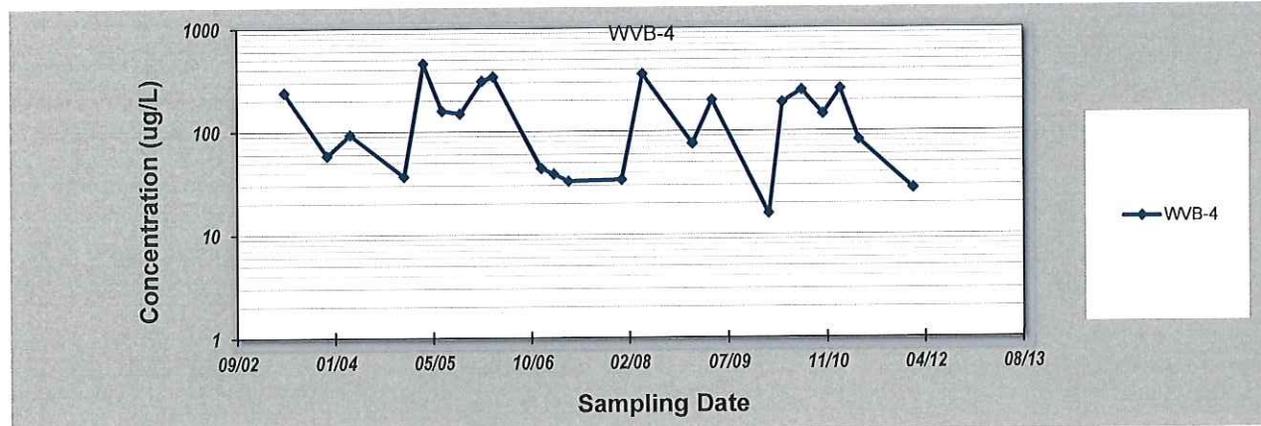
GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: **12-Apr-19**
 Facility Name: **ChemResearch Company**
 Conducted By: **R. Morgan**

Job ID: **1052000111**
 Constituent: **PCE**
 Concentration Units: **ug/L**

Sampling Point ID: **WVB-4**

Sampling Event	Sampling Date	PCE CONCENTRATION (ug/L)					
1	04/29/03	240					
2	12/04/03	59					
3	03/30/04	94					
4	12/28/04	37					
5	04/07/05	460					
6	07/11/05	160					
7	10/11/05	150					
8	01/31/06	310					
9	03/30/06	340					
10	11/28/06	44					
11	01/31/07	39					
12	04/16/07	33					
13	01/14/08	34					
14	04/29/08	360					
15	01/06/09	76					
16	04/14/09	200					
17	01/24/10	16					
18	04/06/10	190					
19	07/13/10	250					
20	10/28/10	147					
21	01/25/11	257					
22	04/28/11	82.7					
23	01/30/12	27.9					
24							
25							
Coefficient of Variation:	0.81						
Mann-Kendall Statistic (S):	-25						
Confidence Factor:	73.5%						
Concentration Trend:	Stable						



Notes:

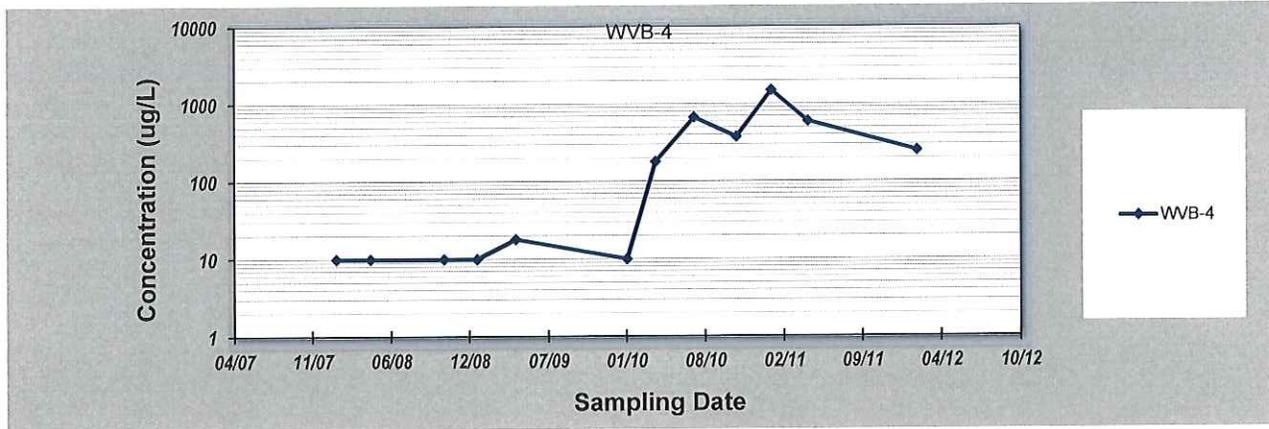
- At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
- Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
- Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: 12-Apr-19	Job ID: 1052000111
Facility Name: ChemResearch Company	Constituent: Hexavalent Chromium
Conducted By: R. Morgan	Concentration Units: ug/L
Sampling Point ID: WVB-4	

Sampling Event	Sampling Date	HEXAVALENT CHROMIUM CONCENTRATION (ug/L)					
1	01/14/08	10					
2	04/09/08	10					
3	10/14/08	10					
4	01/06/09	10					
5	04/14/09	18					
6	01/24/10	10					
7	04/06/10	180					
8	07/13/10	670					
9	10/28/10	378					
10	01/25/11	1500					
11	04/28/11	599					
12	01/30/12	251					
13							
14							
15							
16							
17							
18							
19							
20							
Coefficient of Variation:		1.47					
Mann-Kendall Statistic (S):		40					
Confidence Factor:		99.7%					
Concentration Trend:		Increasing					



Notes:

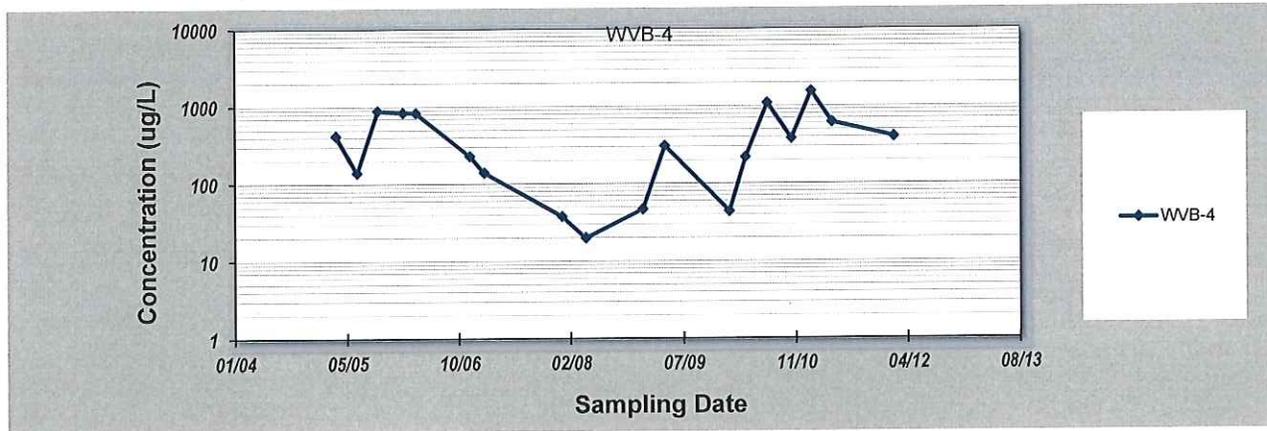
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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GSI MANN-KENDALL TOOLKIT for Constituent Trend Analysis

Evaluation Date: 12-Apr-19	Job ID: 1052000111
Facility Name: ChemResearch Company	Constituent: Total Chromium
Conducted By: R. Morgan	Concentration Units: ug/L
Sampling Point ID: WVB-4	

Sampling Event	Sampling Date	TOTAL CHROMIUM CONCENTRATION (ug/L)					
1	04/07/05	420					
2	07/11/05	140					
3	10/11/05	890					
4	01/31/06	840					
5	03/30/06	830					
6	11/28/06	230					
7	01/31/07	140					
8	01/14/08	38					
9	04/29/08	20					
10	01/06/09	47					
11	04/14/09	310					
12	01/24/10	44					
13	04/06/10	220					
14	07/13/10	1,100					
15	10/28/10	384					
16	01/25/11	1560					
17	04/28/11	618					
18	01/30/12	402					
19							
20							
Coefficient of Variation:		0.94					
Mann-Kendall Statistic (S):		10					
Confidence Factor:		63.2%					
Concentration Trend:		No Trend					



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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APPENDIX F

ATC STANDARD OPERATING PROCEDURES



ATC STANDARD OPERATING PROCEDURE INDOOR AIR QUALITY (IAQ) SAMPLE COLLECTION

Field personnel should refrain from wearing perfume, aftershave or any personal care products containing alcohol or other fragrances when using the SUMMA canister samplers as these products will impact the sample. Use only regular ink pens for note taking, not Sharpies or other markers.

The SUMMA canister is placed in the area of interest where there is moderate airflow around the canister and four to six feet above the floor surface. Do not place in a corner or against equipment. The regulator is then placed on the canister or opened if already placed. If the regulator must be screwed on and opened, ensure that the canister valve is closed and remains closed prior to attaching the regulator. The canister valve nut should be removed and the regulator should be delicately tightened into place using a wrench. Do not over-tighten. Once the regulator is securely attached, the canister valve may be opened. Some regulators attach using a quick-release. For these units, there is no valve on the canister. Once the regulator is attached using the quick release, sample collection has begun. For all samples, record the initial vacuum pressure displayed on the pressure gauge on the sampling form.

The regulator will be set by the analytical laboratory for the specified sample collection period. This period may range from eight to 24 hours on a normal basis and is dependent upon the sampling strategy. The container will be left in place throughout the sampling time period. Do not allow the canister to sit open for a prolonged period beyond the specified sampling time. Ideally, the canister is placed where it will not be impacted by human activity. Perfumes and other personal care products will bias the sample as will common office supplies such as dry-erase markers, Sharpie markers and cleaning fluids.

The sample is complete when the regulator reaches "0" or equilibrium with atmospheric pressure. At the conclusion of the sample period, the regulator is removed to stop sample collection if it is a quick release type. If it is a valve canister, the canister valve is closed BEFORE removing the regulator. The regulator is then removed and the canister valve nut is replaced. If the designated sample period has passed and the regulator does not read "0", record the final vacuum pressure on the sampling form.

The canister should be uniquely labeled and information regarding sample number, vacuum pressure readings and time of sample collection is entered on the chain of custody form. If directed to do so, field personnel will collect information on the temperature and relative humidity of the sample area and enter that information on the chain of custody. The sealed canister and regulator is then returned to the analytical laboratory for analysis.



ATC STANDARD OPERATING PROCEDURE SOIL VAPOR WELL INSTALLATION AND SAMPLING

Preliminary Activities

Prior to the onset of field activities at the site, ATC obtains the appropriate permit(s) from the governing agencies. Advance notification is made as required by the agencies prior to the start of work. ATC marks the borehole locations and contacts the local one call utility locating service at least 48 hours prior to the start of work to mark buried utilities. Borehole locations may also be checked for buried utilities by a private geophysical surveyor. Prior to drilling, the borehole location is cleared in accordance with the client's procedures. Fieldwork is conducted under the advisement of a registered professional geologist and in accordance with an updated site-specific safety plan prepared for the project, which is available at the job site during field activities.

Soil Vapor Well Construction

The borehole is advanced to the desired depth using either a direct-push rig, hand auger, or air vacuum rig. Lithologic conditions are recorded on a boring log during borehole advancement, and select soil matrix sampling may be conducted based on soil characteristics.

Each soil vapor sampling (SVS) well is constructed using inert screen material attached to 1/8- to 1/4-inch outer diameter inert tubing. A gas-tight vacuum fitting or valve is attached to the top of each length of tubing using a female compression fitting. Each screen is set within a minimum of a 12-inch thick appropriately sized sand pack, with a minimum of three inches of sand pack above the top of the screen. A minimum of four inches of dry granular bentonite is set above each screen and associated sand pack. In SVS wells with multiple and separate casings and screens, the annular space between the top of the dry granular bentonite above the deep screen and the bottom of the sand pack associated with the shallow screen is sealed with a minimum of 18 inches of hydrated bentonite. The remainder of the annular space of the well is sealed with hydrated bentonite to one foot below ground surface. Wellheads are finished with traffic-rated well boxes set in concrete flush with the surrounding grade. No glues, chemical cements, or solvents are used in well construction.

A boring log is completed with the construction details for each well, including the materials of construction, depth of the borehole, screen length, and annular seal thickness.

Soil Vapor Sampling

Samples are collected using a soil vapor purging and sampling manifold consisting of a flow regulator, vacuum gauges, vacuum pump, shroud, and laboratory-prepared, gas-tight, opaque containers such as Summa™ canisters. Samples may also be collected using a syringe and analyzed by a mobile laboratory. Prior to use, Summa™ canisters are checked to ensure they are under the laboratory induced vacuum between 31 and 25 inches of mercury (in. Hg). New inert tubing is used to purge and sample each well. Prior to purging and sampling each SVS well, the sampling manifold is connected to the gas-tight vacuum fitting or valve at the wellhead, and the downstream tubing and fittings are vacuum tested at approximately 24 to 28 in. Hg. Purging and sampling are conducted only on SVS wells when the tubing and fittings hold the applied vacuum for five minutes per vacuum gauge reading.

When required, ATC conducts a purge volume versus constituent concentration test on at least one SVS well prior to purging and sampling activities. The purge volume test well is selected based on the location of the anticipated source of chemical constituents at the site and on the location of anticipated maximum soil vapor concentrations based on lithologic conditions. If the SVS well has been in place for more than one week, it is assumed that soil vapor in the sand pack has equilibrated with the surrounding soil, and only the screen and tubing volumes are included in the purge volume calculation. If the SVS well has been in place for less than one week, the volume of the sand pack around the screen is included in the purge volume calculation. A photoionization detector (PID) or on-site mobile laboratory is used to evaluate concentrations of chemical constituents in the vapor stream after one, three, and 10 volumes of vapor have been purged from the SVS well.

CONTINUED ON NEXT PAGE



(Soil Vapor Well Installation and Sampling SOP – continued)

Purging is conducted at a rate of 100 to 200 milliliters per minute (ml/min). The purge volume exhibiting the highest concentration is the volume of vapor purged from each SVS well prior to sampling. If the three separate purge volumes produce equal concentrations a default of three purge volumes is extracted prior to sampling.

Prior to sampling, a leak test is performed at each SVS well, including a summa canister and its fittings, to check for leaks in the SVS annulus. Typically helium or 1,1-difluoroethane (DFA) are utilized as the leak check compound (LCC). To assess the potential for leaks in the SVS well annulus when using helium as the LCC, a shroud is placed over the SVS well and summa canister and the shroud is filled with a measured amount of helium. Helium screening is performed in the field by drawing soil gas into a Tedlar bag via a lung-box and screening the contents of the Tedlar bag with a helium meter. The concentration of helium in the sample divided by the concentration of helium in the shroud provides a measure of the proportion of the sample attributable to leakage. A leak that comprises less than 5% of the sample is insignificant. When DFA is utilized as the LCC, a rag infused with DFA is placed in near the sampling train during the sample intake period. Helium and DFA screening are performed using laboratory analysis of the contents of the summa canister. Sampling is conducted at approximately the same rate of purging, at 100 to 200 ml/min. Soil vapor samples are submitted under chain of custody protocol for the specified laboratory analyses.

At a minimum, weather conditions (temperature, barometric pressure and precipitation), the sampling flow rate, the purge volume, the helium leak detection percentage results, the sample canister identification number, the method of sample collection, and the vacuum of the sampling canister at the start and end of sample collection (if applicable) are recorded on a log for each SVS well purged and sampled.

Decontamination Procedures

If soil samples are collected, ATC or the contracted driller decontaminates the soil sampling equipment between each sampling interval using a non-phosphate solution, followed by a minimum of two tap water rinses. De-ionized water may be used for the final rinse. Downhole drilling equipment is steam-cleaned or triple-rinsed prior to advancing each borehole.

Waste Treatment and Disposal

Soil cuttings generated from the well installation are stored on site in labeled, Department of Transportation-approved, 55-gallon drums or other appropriate storage container. The soil is removed from the site and transported under manifest to a client- and regulatory-approved facility for recycling or disposal. Decontamination water is stored on site in labeled, regulatory-approved storage containers, and is subsequently transported under manifest to a client- and regulatory-approved facility for disposal or treated with a permitted mobile or fixed-base carbon treatment system.



ATC STANDARD OPERATING PROCEDURE HAND AUGER DRILLING AND SOIL SAMPLING

Soil borings are advanced utilizing a stainless steel hand-operated auger tool. The subsurface lithology will determine the type of auger bucket head used: a regular solid-body bucket is best for dry to slightly damp, light to medium density soils; a sand auger bucket is designed to retain soils comprised primarily of sand; and a mud auger bucket (windowed bucket) is best suited for wet silt and clays with high plasticity. Auger buckets are 3.25-inches in diameter, although 2.25-inch diameter and smaller, custom designs can be utilized depending on the lithology. ATC attempts to advance the hand auger by gently rotating the hand auger into the soil, allowing it to pull itself into the ground. Once the bucket is 3/4 full of cuttings, it is lifted out of the hole and emptied by shaking the bucket vertically. Using this technique, the boring is advanced to the desired sample depth. Extensions can be added to increase the length of the tool.

Sample collection is achieved by one of two methods. The soil extracted from the desired sample depth can be removed from the auger bucket head and placed directly in a laboratory supplied container appropriate for the proposed analysis. The collected sample container is appropriately sealed, marked for identification and stored in an ice chest cooled to approximately four degrees Celsius with wet ice for delivery to a State certified laboratory. Chain of custody records are maintained as samples are collected and accompany the samples to the laboratory.

The second method utilized for sample collection with hand-operated tools involves the use of a slide hammer and a two-inch diameter split core sampler (six-inches in length). The split core sampler is generally loaded with a decontaminated metal sleeve (brass or stainless steel), which is fitted with extensions to reach the bottom of the auger-advanced boring. At the surface, a hand-operated slide hammer is utilized to drive the split core sampler into the subsurface soils. After the sampler is driven, the tools are extracted from the boring and the split core sampler is disassembled to obtain the representative soil sample. The sample tube will be visually inspected to insure that the tube is completely filled with soil, and no headspace exists in samples submitted for laboratory analysis. The collected brass sample tube will be sealed at each end with Teflon® liner squares followed by aluminum foil liners, capped with plastic end-caps, sealed with Teflon® tape, marked for identification, and stored in an ice chest cooled to approximately four degrees Celsius with wet ice for delivery to a State certified laboratory. Alternatively, soil samples for volatile organic compound analysis are extracted in the field using laboratory-provided extraction kits. This sampling technique minimizes the sample exposure to the atmosphere (a potential for loss of volatile organic compounds). Chain of custody records are maintained as samples are collected and accompany the samples to the laboratory.

When utilizing hand auger for soil borings, selected cuttings are emptied into a sealable plastic bag for field soil vapor monitoring and soil classification purposes. Soil samples are logged by an ATC Field Scientist in general accordance with American Society of Testing and Materials (ASTM) Method D 2488 and boring logs maintained.

To minimize the potential for cross-contamination, a new pair of disposable gloves are worn when preparing a sample for laboratory analysis. Additionally, all downhole sampling equipment is washed in an Alconox® or Liquinox® and tap water solution, rinsed with tap water and rinsed again with distilled water prior to each sampling event. Decontamination water and soil boring cuttings are stored in separate, labeled 55-gallon drums which remain on-site pending disposal.



STANDARD OPERATING PROCEDURE FIELD SOIL VAPOR AND METALS MONITORING

Soil Vapor

The MiniRAE 2000 (or equivalent) photoionization detector (PID) is calibrated on-site at the commencement of each work day to zero and to 100-parts per million by volume (ppmV) using isobutylene-in-air span gas (equivalent to benzene). An appropriate PID lamp is selected based on the ionization potential of the primary chemical(s) of concern relevant to the investigation.

A representative soil sample is collected from each sample location and placed in a sealable plastic bag. The soil sample identifier is marked on the bag above the top of the bag seal. The bag is sealed and the soil disaggregated. At least ten minutes is allowed for the soil to be heated by direct sunlight and for any volatile organic compounds in the soil to accumulate in the headspace of the bag. In cool weather (e.g. below 60 degrees Fahrenheit) or darkness, the soil sample bag is warmed for at least ten minutes inside a heated vehicle.

Volatile gases are then monitored by inserting the probe of the PID into the bag. The PID is equipped with a lamp which is capable of detecting volatile organic compounds at concentrations of 0.1 to 9,999 ppmV. The PID probe remains inside the bag for a period of time sufficient to allow the reading to peak and stabilize. The peak reading is recorded on the soil boring log.

Metals

Soil samples subject to x-ray fluorescence (XRF) analyzer screening are retained in the sealable plastic bag which is wiped clean of debris. The contents of the bag are packed so that the soil in the bag is a minimum of one inch thick below the XRF analyzer window. The XRF analyzer is calibrated to known standards and programmed to measure target metals concentrations in soil. The XRF analyzer window is placed over the packed soil sample and the x-ray trigger engaged for 60 seconds. After 60 seconds, the analysis is terminated and the metals constituent concentrations of interest are recorded along with the unique sample identifier in the field notes (all data are also recorded in the XRF's data logger and are available for later download).



ATC STANDARD OPERATING PROCEDURE ROTONSONIC DRILLING AND SOIL SAMPLING

The rotonsonic drill rig employs the use of high-frequency, resonant energy to rotationally advance a 6-inch inside diameter (ID) by 7-inch outside diameter (OD) core barrel within a nominal 7-inch ID by 9-inch OD overshot casing to construct an approximate 9 $\frac{1}{8}$ -inch diameter borehole. This dual-string assembly allows advancement of the overshot casing with the inner core barrel used to collect samples. The core barrel is driven ahead of the overshot casing and is used to collect a representative continuous core sample in approximate 10-foot lengths. Once the core barrel is advanced to the required depth, the drill head (attached to the drill rig) is disconnected from the core barrel and reconnected to the overshot casing. The overshot casing is then driven down over the core barrel. The overshot casing prevents the hole from collapsing when the core barrel is extracted for sample retrieval. Attached to the tip of both the core barrel sampler and the overshot casing are hardened steel casing shoe-type bits. The drill bits have several carbide buttons around the tip and outer edge that cut through the formation as the drill string is vibrated and rotated.

Following core sample retrieval, the soil is emptied into plastic bags in approximate two-foot lengths and labeled for depth. Soil samples are logged by an ATC Field Scientist in general accordance with American Society for Testing and Materials Method D 2488 and field boring logs maintained.

Soil samples are collected by driving a laboratory-provided sample container into the core sample. The container is visually inspected to insure it is completely filled with soil, and no headspace exists in samples submitted for laboratory analysis. The sample container is sealed with a Teflon[®] lined cap, marked for identification and stored in an ice chest cooled to approximately four degrees Celsius with wet ice for delivery to a State-certified laboratory. Alternatively, soil samples for volatile organic compound analysis are extracted in the field using laboratory-provided extraction kits. Chain of custody records are maintained as samples are collected and accompany the samples to the laboratory.

To minimize the potential for chemical exposure, a new pair of disposable gloves are worn when logging. All downhole drilling and sampling equipment is washed in an Alconox[®] or Liquinox[®] and tap water solution, rinsed with tap water and rinsed again with distilled water prior to each drilling event. Excess drill cuttings are placed in 55-gallon drums or a rolloff-type container and remain on-site pending disposal. Alternatively, soil cuttings may be spread onsite depending on project-specific requirements. Borings are typically backfilled with grout (or other materials deemed acceptable by the permitting agency) if no well is installed.



ATC STANDARD OPERATING PROCEDURE IN-SITU SOIL VAPOR, SOIL AND GROUNDWATER SAMPLER

In-situ soil vapor, soil and groundwater sample collection can be accomplished utilizing a downhole sampling device (commonly referred to as a Simulprobe or Hydropunch) operated by a variety of drilling methods (direct-push, hollow-stem auger, rotosonic and air rotary). The downhole sampler tool (generally provided and operated by the drilling contractor) is designed to collect soil vapor, soil and/or groundwater (or other liquids) just ahead of the drill string. At the pre-selected depth, the sampler is set-up in the correct sampling mode (soil vapor, soil or groundwater) and lowered to the bottom of the boring. At the bottom of the boring the sampler is driven up to 21 inches into undisturbed soil using the down-hole hammer for soil sample collection. The sample is retrieved by recovering and disassembling the sampler device. In the soil vapor sample collection mode, the sampler is driven into undisturbed soil four- to six-inches and the external sheath is pulled back exposing a screen section to allow a soil vapor sample to be collected at the surface by applying a vacuum to the tubing line that was lowered with the sampler. To collect a groundwater sample, the sampler is assembled by the driller into the groundwater mode with an internal water canister and the sampler is lowered to the bottom of the boring and driven four- to six-inches into native soil. The protective sheath is then pulled back to expose the screen interval of the sampler allowing groundwater to enter into the water canister. A top and bottom check valve assembly prevent the loss of the sample as it is transported to the surface.

Samples are collected from the sample device and transferred directly into laboratory provided containers. The containers are then labeled, entered onto a chain of custody form and placed into an iced cooler for transport to the analytical laboratory.

Decontamination (typically conducted by the drilling contractor) is a non-phosphate soap and water wash with a two stage distilled water rinse.



ATC STANDARD OPERATING PROCEDURE GROUNDWATER MONITOR WELL INSTALLATION AND DEVELOPMENT

Prior to drilling, ATC completes an applicable permit from the regulating agency (varies by state and locality). Copies of the original permits are on-site during drilling operations.

Following completion of each well boring, wells are constructed using two- or four-inch nominal diameter, Schedule 40, 0.020-inch machine slotted, polyvinylchloride (PVC) well screen from the bottom of the borehole to 10 feet above the static depth to groundwater to account for seasonal water level fluctuations. The remaining well string is constructed of Schedule 40 blank PVC casing. Actual well construction specifications are determined on a site-specific basis.

The bottom of the perforated interval is capped with a flush-threaded PVC cap or riveted cap and the monitor well casing is assembled and lowered into the open end of the drill pipe. No PVC cement or other solvents or glues are used in construction of the monitor well. All well casing and screen material is delivered to the site in factory-sealed containers.

The annulus of the well is backfilled with clean #3 Monterey or 8/12 sand (or equivalent) filter pack to approximately three feet above the top of the well screen. In general, the sand filter pack extends to a height above the top of the well screen equivalent to approximately 10% of the well screen length. The top of the filter pack is direct measured with a weighted tape. A minimum 1.5-foot thick layer of bentonite pellets or chips is placed on top of the filter pack and hydrated to form an annular seal. The bentonite pellets are hydrated by adding approximately one gallon of water for each linear foot of bentonite. The remaining annular space to the surface is filled with cement grout. Well construction details are recorded in the boring logs. The well is completed at the ground surface with a watertight, flush-mounted, traffic rated vault.

The well vault lid or surface completion is typically marked with the permit registration number and unique well identifier. The geographic position and elevation of the well is recorded using a handheld global positioning system unit. A permanent mark is made on the north side of the well casing, and this point surveyed for location and elevation. All subsequent groundwater level measurements are recorded from this surveyed point.

A minimum of 24 hours after well completion, the groundwater monitor well is developed to remove sediment and to stabilize the filter pack by a combination of surging, bailing and/or pumping groundwater from the well. Bailing or purging continues until movement of the fine sediment stabilizes or ceases and turbidity stabilizes. Groundwater purged from the well is contained in 55-gallon drums and remains on-site pending the waste profile sample analytical results and subsequent disposal.



ATC STANDARD OPERATING PROCEDURE DEPTH-SPECIFIC PNEUMATIC SAMPLER

The pneumatic sampling device utilizes air pressure to keep fluid from entering the sample vessel until it is released. Prior to using a pneumatic sampling device, field personnel review the manufacturer's instructions regarding assembling, pressurizing, de-pressurizing, transferring the sample and decontaminating the sampling device.

Sample collection is achieved by slowly lowering the pressurized sampling vessel, hose and supporting cable to the proscribed depth and opening (de-pressurizing) the device to allow groundwater to enter the sample chamber. The sample is retained in the sample chamber with a check valve. The sampling vessel is then retrieved to the surface and the collected groundwater sample is then transferred to the appropriate laboratory glassware. As each sample is collected and transferred to a laboratory supplied container, the container is labeled, entered on to a chain of custody form and then stored in a hard-sided cooler with ice. Samples collected for volatile organic compounds analysis are transferred to the laboratory supplied glassware in a manner to avoid aerating the samples during the transfer process. At the direction of the ATC Project Manager or Technical Leader, the field crew will record temperature, conductivity, pH, dissolved phase oxygen and oxidation-reduction potential of the portion of the groundwater sample not prepared for laboratory analysis.

Subsequent to sample collection the pneumatic sampler is then dis-assembled, decontaminated and re-assembled in accordance with the manufacturer's instructions.



ATC STANDARD OPERATING PROCEDURE LOW-FLOW PURGING AND GROUNDWATER SAMPLING

EQUIPMENT

Pumps: Adjustable rate, positive displacement pumps (e.g., low flow-rate submersible centrifugal or bladder pumps constructed of stainless steel or Teflon). The pump should be easily adjustable and capable of operating reliably at lower flow rates. Adjustable rate peristaltic pumps may be used with caution. Bailers are inappropriate for use in this procedure.

Tubing: Tubing used in purging and sampling each well must be dedicated to that individual well. Once properly located, moving the pump in the well should be avoided. Consequently, the same tubing should be used for purging and sampling. Teflon or Teflon-lined polyethylene tubing must be used to collect samples for organic analysis. For samples collected for inorganic analysis, Teflon or Teflon lined polyethylene, PVC, Tygon or polyethylene tubing may be used. The tubing wall thickness should be maximized ($\frac{3}{8}$ to $\frac{1}{2}$ inch) and the tubing length should be minimized (i.e. do not have excess tubing outside of the well). Pharmaceutical grade (platinum-cured polyethylene, or equivalent) tubing should be used for the section around the rotor head of the peristaltic pump to minimize gaseous diffusion.

Water level measuring device, 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).

Flow measurement supplies (e.g., graduated cylinder and stop watch).

Power source (e.g., generator, located downwind; car battery; nitrogen tank; etc). The generator should not be oversized for the pump.

In-line flow-through cell containing purge criteria parameter monitoring instruments for pH, specific conductance, temperature, oxidation-reduction potential (ORP) and dissolved oxygen (DO). The in-line device should be bypassed or disconnected during sample collection.

Decontamination supplies: distilled water, scrub brushes, Liquinox® soap and three five-gallon buckets are required for three-stage decontamination (Liquinox®/water wash and two distilled water rinse cycles).

Sample Bottles: It is recommended that preservatives are added to sample bottles by the laboratory prior to field activities to reduce potential error or introduction of contaminants.

Sample tags or labels, chain of custody.

Well construction data, location map, field data from last sampling event.

PROCEDURE

1. Measure and record the depth to water (to 0.01 foot) in all wells to be sampled before installing the pump or tubing. Care should be taken to minimize disturbance to the water column and to any particulate matter attached to the sides or at the bottom of the well.
2. Attach and secure the tubing to the low-flow pump. Slowly lower the pump into the well and secure the safety drop cable, tubing, and electrical lines to each other using nylon stay-ties. For peristaltic pump operation, lower only the Teflon-lined tubing into the well and attach pharmaceutical-grade polyethylene tubing to the portion to be attached to the pump rotor.
3. Pump, safety cable, tubing and electrical lines should be lowered slowly into the well to a depth corresponding to the center of the saturated screen section of the well (by default), or at a location determined to either be a preferential flow path or zone where contaminants are present. The pump intake should be kept a minimum of two feet, if possible, above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well. Secure the pump and tubing to the well casing to prevent slippage of the tubing into the well during purging and sampling.
4. Measure the water level again with the pump in the well before starting the pump. Start the pump at the lowest rate possible (100 milliliters per minute [mL/min]) while measuring drawdown continuously. Avoid

CONTINUED ON NEXT PAGE



(Low-Flow Purging and Groundwater Sampling SOP – continued)

surging water from the well. Observe air bubbles displaced from discharge tube to assess progress of steady pumping until water arrives at the surface. Adjust the pumping rate such that there is little or no water level drawdown in the well (less than 0.3 foot) and the water level should stabilize. If the minimum drawdown that can be achieved exceeds 0.3 foot, but remains stable, continue purging until indicator parameters stabilize without dewatering the well screen, if possible. Water level measurements should be made continuously. Pumping rate changes (both time and rate) should be recorded on the field logs. Precautions should be taken to avoid pump suction loss or air entrainment. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to avoid pumping the well dry and ensure stabilization of indicator parameters. If the recharge rate of the well is very low, purging should be interrupted so as not to cause the drawdown within the well to advance below the pump intake but the operator should attempt to maintain a steady flow rate with the pump to the extent practicable. In these low-yielding wells, where 100 mL/min exceeds the entrance rate of groundwater into the well, it is important to avoid complete dewatering of the well screen interval. In these cases, the pump should remain in place and the water level should be allowed to recover repeatedly until three well volumes have been purged and there is sufficient volume in the well to permit collection of samples (up to four hours). Samples may then be collected even though the indicator field parameters have not stabilized.

5. While purging the well, monitoring of in-line water quality indicator parameters should include specific conductance, pH, DO, temperature and ORP, which must be collected every three to five minutes until all of the parameters have stabilized. Stabilization is achieved when three successive readings are within:
 - ± 0.1 for pH;
 - $\pm 3\%$ for conductivity and temperature;
 - ± 10 mV ORP; and,
 - $\pm 10\%$ for DO

A minimum subset of these parameters that can be used to determine stabilization during purging in this procedure is pH, specific conductivity and DO. DO is typically the last parameter to stabilize. Stabilization of indicator parameters is used to indicate that conditions are suitable for sampling to begin.

If, after one hour of purging, indicator field parameters have not stabilized, one of three optional courses of action may be taken:

- Continue purging until stabilization is achieved;
 - Discontinue purging, do not collect any samples, and record in the logbook that stabilization could not be achieved (the documentation must describe attempts to achieve stabilization); or
 - If three well volumes have been evacuated from the well and parameter stabilization has not been achieved, discontinue purging, collect samples, and provide a full explanation of attempts to achieve stabilization in the logbook.
6. Once stabilization has been documented, volatile organic compounds (VOC) and gas sensitive (e.g., Fe^{+2} , CH_4) parameter samples should be immediately collected directly into pre-preserved sample containers. All sample containers should be filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence. Samples requiring pH adjustment should have their pH checked to assure that the proper pH has been obtained. For VOC samples, this will require that a test sample be collected to determine the amount of preservative required to be added to the sample containers prior to sampling.
 7. Filtered metal samples are to be collected with an in-line filter. A high capacity, in-line 0.45-micron particulate filter must be pre-rinsed according to the manufacturer's recommendations, or with approximately one liter of groundwater following purging and prior to sampling. After the sample is filtered it must be preserved immediately.

As each sample is collected, the sample should be labeled and placed into a cooler with proper temperature control. After collection of the samples, the tubing from the pump should be properly discarded or dedicated to the well for re-sampling by hanging the tubing inside the well. When finished, secure the well (close and lock it up).

APPENDIX G

**ADEQ SOIL VAPOR SAMPLING GUIDANCE (JULY 10, 2008; REVISED MAY 19, 2011
AND APRIL 21, 2017)**

Notice Required by ARS § 41-1091(B):

"This substantive policy statement is advisory only. A substantive policy statement does not include internal procedural documents that only affect the internal procedures of the agency and does not impose additional requirements or penalties on regulated parties or include confidential information or rules made in accordance with the Arizona Administrative Procedure Act. If you believe that this substantive policy statement does impose additional requirements or penalties on regulated parties you may petition the agency under A.R.S. § 41-1033 for a review of the statement."

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

SOIL VAPOR SAMPLING GUIDANCE

**July 10, 2008
(Revised May 19, 2011)
(Revised April 21, 2017)**

Soil Vapor Sampling Guidance

1. Scope and Application

1.1 This guidance describes procedures for collection of active soil vapor samples and does not address procedures for collection of passive soil vapor samples.

1.2 This guidance details sampling procedures to ensure delivery of soil vapor samples to the laboratory that will yield reliable and consistent results that are representative of actual conditions.

1.3 This guidance provides a methodology to estimate the total contaminant concentration in soil using soil vapor samples.

2. Definitions

2.1 Dead Volume – volume of the sampling probe and the connected sampling tubing and equipment. The boring volume is not included in the calculation of dead volume, because the probe tip sand-pack space is assumed to have been allowed to equilibrate with surrounding soil formation before soil vapor sampling occurs.

2.2 Internal Volume – dead volume plus probe tip sand-pack volume.

2.3 Probe Driving System – hydraulic or hammer system used for installation of soil vapor sampling probes.

2.4 Soil Vapor Monitoring Well – a well constructed specifically to sample soil vapor from the vadose zone.

2.5 Soil Vapor Sample – a sample of soil vapor representative of the vadose zone at the sampled location.

2.6 Soil Vapor Sampling Port – any mechanical device (usually a ball valve with a hose barb) that allows a representative soil vapor sample to be collected from a soil vapor monitoring well.

2.7 Soil Vapor Sampling Probe – any mechanical device that allows collection of a representative soil vapor sample from a specified sampling depth.

2.8 Vapor Equilibration – the condition where vapor concentration entering a sampling probe is 95% or greater of vapor concentration in surrounding soil.

3. Considerations when Planning for Soil Vapor Sampling

The collection and analysis of soil vapor samples, along with any existing soil and groundwater data or any reasonably obtainable data (e.g., soil solids and groundwater data), is useful for the objectives of site characterization, determination of potential pathways of exposure for health risk, optimization of remedial or mitigation systems design, and confirmation of compliance with remedial goals.

3.1 Temporal Variations in Soil Vapor Concentrations

Variations in soil vapor concentrations due to temporal effects are principally due to temperature changes, precipitation, and activities within any overlying structure. Variations are greater for samples close to the surface and vary less with increasing depth. There are a number of available studies on the temporal variation in soil vapor concentrations and more are currently underway or planned in 2007 by the EPA and independent groups. The results of these studies have shown that short-term variations in soil vapor concentrations at depths four feet or deeper are less than a factor of two and seasonal variations in colder climates less than a factor of five.

Descriptions of expected variations in soil vapor concentrations due to temperature variation and periods of heavy precipitation follows:

3.1.1 Temperature: Effects on soil vapor concentrations due to actual changes in the vadose zone temperature will be minimal.

3.1.2 Precipitation: Infiltration from rainfall can potentially impact soil vapor concentrations by displacing the soil vapor, dissolving volatile organic compounds, and by creating a “cap” above the soil vapor. In most settings, infiltration from large storms only penetrates into the uppermost vadose zone. Soil vapor samples collected at depths greater than 3 to 5 feet below ground surface (bgs) under foundations or areas with surface cover are unlikely to be significantly affected. However, soil vapor samples collected closer to the surface (<3 feet) with no surface cover may be affected. It is preferred that sample collection not occur if any precipitation is falling or has fallen within 24 hours. Difficult collection of soil vapor samples is typical when the moisture has penetrated to the sampling zone. Consider measured values as minimum values when encountering high vacuum readings when collecting a sample or when drops of moisture are evident in the sampling system or sample. Measurement of percent moisture of the soil may also be useful if shallow sampling is performed during or shortly after significant rainfall (>1.0 inch).

3.1.3 Pressure: Barometric pressure variations are unlikely to have a significant effect on soil vapor concentrations at depths exceeding three to five feet bgs and only a minor effect (less than a factor of 2) at shallower depths unless a major storm front is passing through the area. A recent study in Wyoming (Luo et al., 2006) has shown little to no relationship between barometric pressure and soil vapor oxygen concentrations.

Human induced influences to pressure are likely to have a bigger effect upon soil vapor concentrations. For example, pressure changes resulting from the on-off

cycling of an overlying building's heating or HVAC system and the ventilation of the structure due to open doors and windows can greatly influence soil vapor concentrations at locations near the building. In colder climates, greater impacts are most likely in the winter season. Literature suggests that temporal variations in the radon concentrations are typically less than a factor of two and seasonal effects less than a factor of five. (Vapor Intrusion Pathway: A Practical Guideline, January 2007 Interstate Technology and Regulatory Council)

3.2 Conditions Unsuitable for Collection of Soil Vapor Samples

3.2.1 Collection of soil vapor samples is not desirable if:

- a. Groundwater is very close to the ground surface (i.e., < 3 feet);
- b. Chemical(s) of concern is/are not volatile; and
- c. Moisture or unknown material is in the sample stream or sample container. This is a field sampling quality concern, not a laboratory concern.

Please note that due to increased diffusivity, advective flow, and temperature fluctuations at near surface boundaries, the collection of a soil vapor sample in near surface soils is not useful for the purpose of calculating total soil solid VOC concentrations.

3.3 Tests to Determine if Soil Vapor Sampling is Practicable

Some soil types (i.e., clay or silty clays) may not be conducive for soil vapor collection. Tests to ascertain if soil vapor collection is possible from the soils are below.

3.3.1 Qualitative – connect a gas-tight syringe to the soil vapor sampling tubing to determine if a sample can be withdrawn. Please note that the soil vapor sampling tubing must have a volume of less than the gas-tight syringe for a meaningful result.

3.3.2 Qualitative – follow the instructions below:

- a. Install a T-connection at the end of the soil-vapor-sampling tubing;
- b. Connect a vacuum gauge to one branch of the T-connection;
- c. Connect a syringe fitting and a 60-mL or larger syringe to the remaining branch of the T-connector;
- d. With the syringe connected, pull the plunger back to the full-scale reading and hold in that position; and then

- e. Monitor the vacuum created at the full draw position and during relaxation

If the vacuum does not relax (i.e. less pressure over time) within a few minutes to an hour, it is unlikely that soil vapor sampling is practicable at that particular location and other locations in the subsurface with similar soil characteristics.

- A vacuum conversion table is provided in Attachment 1 for convenience.

3.4 Confirmation Sampling

Soil vapor samples used to verify completion of remedial actions must verify that residual contaminant concentrations are at or below the corrective action standard for each chemical of concern in the contaminated soil as determined under A.A.C. R18-7-201 *et seq* (please refer to Section 6). Collection of soil vapor samples must occur throughout all areas previously reporting soil solid concentrations for chemicals of concern above applicable corrective action standards.

Utilization of soil vapor data collected for the UST Program as part of assessing vapor intrusion issues for LUST case closure purposes occurs by demonstrating that soil contaminant concentrations above an applicable residential soil remediation level (rSRL), as determined by soil solids analysis, does not pose an unacceptable vapor intrusion risk.

4. **Installation Methods**

This section provides useful construction information and details for installation methods.

4.1 Sample Through Rods (also known as temporary probes)

This method is advantageous if only one sampling round is required. Also, minimal disturbance of the in-situ vapor occurs due to less material placed in the ground, which decreases the need for collection of blanks.

Consider the following construction details for the collection of a sample through rods:

4.1.1 Seal probes at the surface with bentonite before sampling;

4.1.2 Utilize small diameter tubing (e.g. nylon - preferred tubing when conducting risk assessments - polyethylene, copper or stainless steel) which will not react, absorb or interact with site contaminants. It is suggested to use new tubing for new field events or demonstrate that the tubing you are using is contaminant free; and

4.1.3 When using direct-push borings for the installation of soil-vapor-sampling probes, avoid lateral movement of the probes once they are in the ground to prevent atmospheric air from entering the sampling system.

4.2 Permanent Probes

4.2.1 Consider the following construction details for the installation of permanent probes:

- a. Use short discreet sampling intervals (e.g., 6 to 12 inches);
- b. Color code or tag tubing of probes at the surface to be sure that the sampling depth is easily identifiable for future sampling events;
- c. Complete and seal permanent probes at the ground surface (e.g., road boxes, locked caps, vapor-tight valves).

4.3 Types of Drilling

When using auger, air rotary, air knife, or roto sonic drilling methods for the installation of soil-vapor sampling probes, consider the following:

4.3.1 Install sampling probes with sand-pack intervals of approximately 1 foot;

4.3.2 Seal each sampling interval with bentonite or grout above and below the sand pack in the annulus of the boring. Take care to ensure that the seal material does not intrude into the sand pack;

4.3.3 If the boring contains dry bentonite, take care to fully hydrate the bentonite. Placing the bentonite in small increments (e.g., < 6 inches) followed by water is helpful. Alternatively, the bentonite can be added using a combination of dry and hydrated bentonite, or in slurry form if the boring is of sufficient diameter; and

4.3.4 For deeper probes, down-hole support rods may be necessary during probe installation, especially for tubing sized greater than 1/8-inch outside diameter (OD).

4.4 Equilibration Time

During probe installation, subsurface conditions are disturbed. For probes installed with auger, air rotary, air knife, or roto sonic drilling methods, purge volume test, leak test and soil vapor sampling should not be conducted for at least 48 hours (depending on site lithologic conditions and stage of investigation) following probe installation. When utilizing sample through rods, the recommended equilibration time is 20 to 30 minutes.

5. Sampling and Analysis

5.1 Sampling Containers

The sample containers chosen for a specific site will depend on the sampling equipment and analytical requirements. Select the final storage container prior to the initial sampling.

- 5.1.1 Examples of different sample containers include:
 - a. Tedlar™ bags;
 - b. 1.0 Liter (L) stainless steel canisters (e.g., Summa™ canisters). The lab is responsible for certifying the cleanliness of the canister and evacuating the canister before leaving the lab. It is strongly suggested that the lab be responsible for providing a record of the canister vacuum/pressure before and after sampling; and
 - c. Gas-tight syringes

All of the above listed sample containers are relatively simple to fill. Tedlar™ bags have a 72 hour holding time. Stainless steel canisters have a 30 day holding time. On-site analysis by a mobile lab typically utilize syringes for which the holding time should be as short as possible (less than 5 minutes for plastic syringes and less than 15 minutes for glass syringes). ADEQ does not recommend extending holding times by transferring samples to different container types.

ADEQ's UST Program recommends Tedlar™ bags for their soil vapor extraction (SVE) system influent or effluent sampling. Summa™ canisters certified as clean are the preferred sample container for soil vapor data used in risk assessments.

5.2 Shallow Samples

Observe care when collecting shallow soil gas samples to minimize atmospheric influence from the surface. If possible, avoid extensive purging or use of large volume sample containers (e.g. 6.0 L Summa™ canisters) for collection of near-surface samples.

5.3 Storage and Shipping Considerations

- 5.3.1 Do not put sample on ice;
- 5.3.2 Do not store sample exposed to light (keep sample in dark place);
- 5.3.3 Keep sample at standard temperature and pressure as much as practicable;
- 5.3.4 Do not ship Tedlar™ samples by airplane.

5.4 Sample Collection

ADEQ recommends use of the ADEQ QA/QC checklist for Soil Vapor Sampling when sampling (see Attachment 2).

- 5.4.1 Purging

Utilize purging to obtain a sample that represents equilibrated vapor concentrations of soil surrounding the sampling probe. Conduct the initial purge testing in an area where positive detections are most likely to occur.

The purged volume selected should be consistent for all sample locations across the site. Please consider the following procedure with respect to purging:

a. Remove three to five internal volumes of a sample system. This should ensure that vapor concentration entering a sampling container is 95% or greater representation of vapor concentration in surrounding soil; or

b. If vapor equilibration has occurred, remove one to five dead volumes;

Base the number of dead volumes requiring removal on procedures such as:

c. Analyzing the purged vapor with a field vapor analyzer (photoionization detector (PID) or flame ionization detector (FID)) until the concentrations stabilize and assess consistency across sequential purged volume samples; or

d. Conducting a purged volume test to determine the number of dead volumes to remove that corresponds to the highest recovered vapor concentrations.

5.4.2 Purging Equipment

a. A vacuum pump with a flow controller and flow meter can be used when sampling large (> than 200 milliliters (mL) probe volume) or middle size probe. Use another device (e.g. syringe) for small size probes (less than 3 mL probe volume).

b. To evaluate lithologic conditions adjacent to the soil gas probe (such as no flow conditions due to clayey lithology), a vacuum gauge or similar device should be used between the soil gas sample tubing and the soil gas extraction devices (e.g. vacuum pump).

The whole purging device should be used at the end of the sampling train (after the T-valve and canister) to avoid field cross contamination from the device.

5.4.3 Purging flow rate

a. 200 mL/min is the recommended default rate, unless a non-permeable cover is present.

b. Modify the purge rate based on conditions encountered in individual soil gas probes, such as:

- The probe vacuum reading > 5 inches Hg (full vacuum reading is 29.9 inch Hg)
- Condensation is present in the sampling train, or
- The internal volume of the sampling train is very large (i.e., the purging time would be over one hour at 200 mL/min flow rate). If the purge time is longer than 30 minutes, re-evaluate sampling conditions.

c. Document any modified rates.

5.4.4 Purging time

- a. Determine the dead volume - the internal volume of the probe plus the internal volume of the tubing used to connect the probe and the sampling train.
- b. The dead volume divided by 200 mL/min or the appropriate purging flow rate is the purging time.

Please take care to not collect a sample under non-equilibrium conditions generated by high purge rates. Overpurging is a common mistake of soil vapor sampling.

5.5. Leak Testing

Consider conducting a leak test where leakage may be a concern (i.e. at fitting junctures and anywhere leakage may occur).

The following are examples of procedures for checking below ground sampling equipment for leaks:

5.5.1 Use oxygen as a qualitative test for a high-end indicator of short circuiting. Elevated oxygen measurements in soil vapor analytical results may indicate significant short-circuiting. This, though, may not be true for shallow depths or in areas where there is only halogenated VOC contamination); and

5.5.2 Use tracer compounds (e.g., difluoroethane) to conduct leak tests. For example, apply the tracer at the surface where air could enter the soil vapor probes. When using helium as a tracer gas, use a shroud to keep the tracer gas in contact with the probe during the testing. Please note that helium is a common carrier gas during sample analysis, so it is not recommended for use as a tracer compound. If using difluoroethane, use it sparingly on a rag and do not use a shroud. Alternatively, use a shut in test to test for system leaks.

NOTE – Contact the lab with any specific questions regarding any further information on tracer compound and techniques.

5.5.3 Gently apply the tracer compound at the surface where air could enter the soil vapor probes (i.e. at the top of the probe) and at all the connections of the sampling train when the sampling starts. Never over apply. Over application of the tracer compound may cause cross contamination and failure to obtain usable results.

The Detection Limit for leak check compounds should be 10 parts per billion by volume (ppbv) or less in an undiluted sample. Analyze the soil vapor sample for the tracer compound using a method that can detect it as a calibrated analyte or as a Tentatively Identified Compound (TIC).

Take care that the tracer compound of interest and other co-existing volatile compounds in the tracer media are not target compounds of interest in soil vapors investigated at the site. Appendix D (pages D-9 and 10) of the January 2007 ITRC *Vapor Intrusion Pathway: A Practical Guideline* contains a discussion of advantages and disadvantages regarding different tracers.

5.6 Sample Collection Flow Rates

Maintain flow rates should not exceed approximately 200 mL/min and vacuums to below 10 inch Hg if practical. Also, consider the following:

5.6.1 Minimize the sample collection flow rate for near groundwater situations to prevent groundwater from entering the sample container;

5.6.2 Measure and record the vacuum for each sampling probe at sample collection;

5.6.3 Use a calibrated flow controller supplied by the lab to provide a consistent flow rate for each sample collected. Use one flow controller for each sample collected.

5.7 Sample Collection Procedure

The following are examples of sample collection procedures utilizing different types of sample containers:

5.7.1 Collection using Tedlar™ bags:

- a. Use a “T-coupling” to place the Tedlar™ bag in the sampling system ahead of the purging equipment used to purge vapor from the system. Appropriate compatible connecting threads will be required in order to use the Tedlar™ bag;

- b. Attach sample tubing to a vacuum box and pump;
- c. Open the valve on a clean dry Tedlar™ bag and attach it to the inside of the vacuum box;
- d. Close the vacuum box, close stopcock (3-way valve) between vacuum box and pump, then turn the pump on;
- e. Allow Tedlar™ bag to fill to 50 – 70% of capacity (do not overfill), shut off the pump, close the toggle switch (to prevent loss of sample), open the stopcock, and remove Tedlar™ bag from the vacuum box; and
- f. Label the bag accordingly and keep it in a dark area with the temperature as near as possible to the soil temperature at the time sampled (to avoid condensation) until analysis occurs. Analyze the sample collected in a Tedlar™ bag as soon as possible after collection.

5.7.2 Collection using stainless steel canisters (e.g., Summa™ canisters):

- a. The lab should provide a pre-cleaned, certified for cleanliness Flow Controller with every canister to control the sampling flow rate equivalent to 200 mL/min or appropriate rate.
- b. Use a “T-coupling” to place the stainless steel canister in the sampling system ahead of the purging equipment used to purge vapor from the system. Appropriate compatible connecting threads will be required in order to use the stainless steel canisters;
- c. If necessary, use a vacuum gauge to verify the pressure inside the stainless steel canister prior to sampling to ensure the canister has arrived from the laboratory with the proper vacuum. Please note, any kind of vacuum gauge may have potential field cross contamination risk if not used properly. ADEQ recommends to check the clean canister with vacuum gauge just prior to sampling in the field. Due to cross-contamination possibilities, do not use the same vacuum gauge while collecting samples at multiple locations.
- d. Empty stainless steel canisters may not be stored for more than 30 days prior to sample collection. Once filled, properly label and package the stainless steel canisters for transport to the off-site laboratory. (Note: Only stainless steel canisters can be shipped by air freight to an analytical laboratory for analysis and should be analyzed within 30 days after sample collection.);
- e. Connect all parts of the sampling train in the following order:
 - top of the probe
 - tubing

- “T-coupling”
- purging pump

Place the Flow controller on the site of “T-coupling”.

For permanently installed probes, check the tightness of the probe, the valve on the top of the probe, and the presence of glue applied at the probe junctures. Fix any problems if possible before purging, and record on the Soil Vapor QA/QC form which is included as an appendix.

5.7.3 Open all the valves; turn on the pump at the appropriate flow rate for the calculated purging time. During the purge, take action if any of the following conditions are noted:

- a. The probe vacuum is > 5 inches Hg, or
- b. Condensate is present in the sampling train

To address condition “a”, close the T-coupling valve, turn off the pump, and extend the sampling time (e.g. from 5 minutes to 10 or 15 minutes). To address condition “b”, raise the canister as high as possible until the water evacuates the line. Record all observations and actions.

If the probe vacuum is < 5 inches Hg, finish within the purging time, close the T-coupling valve, and turn off the pump.

Connect the canister to the Flow Controller, open the canister valve. If a canister with a bayonet style quick connector is used, simply push the canister fitting into the flow controller until it securely seats. Apply the leak test tracer compound (as described in 5.5) immediately after the canister is connected or opened.

Allow the canister to fill for the appropriate time.

5.7.4 Disconnect the canister from the sampling train, replace the canister valve cap and complete the sample label (Note: Label the tag attached to the canister), do not write on the outside of the stainless steel canister itself.

5.7.5 Use the **equipment blank** to monitor any cross contamination from the sampling train. Use the same setup as outlined above, using clean cylinder air or nitrogen (preferred) as source gas.

5.7.6 A **background blank** will monitor any cross contamination from the surrounding ambient air. To collect a background sample, place the canister upwind and as close as possible to the probe location.

5.7.7 A duplicate or split sample should be collected every 20 samples or field sampling event. Please note that it is very difficult to have reasonable precision for sample duplicates if a T-manifold splitter is not used, especially for medium or shallow depth probes.

5.8 Analysis

Analysis of vapor samples can occur in the field (mobile laboratory) or at a fixed laboratory setting. Use of a mobile laboratory for vapor analyses can be practical in terms of data collection when making field decisions, especially during the investigative process. The intention of analyses in the field is to ensure a good data set that provides results in real time that adequately represents conditions at the site. A good field data set should result in less time spent during the site investigation process.

The following analytical methods are acceptable for soil vapor analysis. Analytical methodology will depend on the project's objective(s), reporting limits needed, and sample container type:

For VOCs:

5.8.1 8260BAZ (Modified for Vapor)

5.8.2 8021B (Modified for Vapor)

5.8.3 TO-15 (Preferred method for risk assessments)

5.8.4 TO-14A

NOTE: Please contact the regulating program for the appropriate analytical method. All COCs may not be included in the method target compound list.

5.9 Data Quality Objectives (DQOs)

Data quality objectives (DQOs) will vary with both the stage of investigation and the intended use of the data collected from soil vapor sampling. During screening or the initial stages of investigation, DQOs will be less stringent than those for confirmation of remediation or risk assessment for indoor air vapor intrusion. DQOs will determine the sampling method, the type of sample collected, the frequency of sample collection, sampling location, the number of samples to be collected, and the specific quality assurance (QA) and quality control (QC) necessary, both in the field as well as in the laboratory. Following DQOs will ensure that the data is useable for the intended purpose.

The most important QA/QC activities and parameters include:

5.9.1 Sampling method

5.9.2. Sampling equipment maintenance and calibration

5.9.3 Control samples, i.e., trip blanks, field blanks, method blanks

5.9.4 Standard Operation Procedures (SOPs)

- 5.9.5 Analyses method appropriate for target compounds
- 5.9.6 Sample holding times and transportation conditions
- 5.9.7 Analyses method with required practical quantitation level
- 5.9.8 Laboratory QC samples

5.10 Quality Assurance/Quality Control

5.10.1 Sampling QA/QC

Solid quality assurance and quality control procedures start with organized planning. A well thought out work plan will help to ensure collection of soil vapor samples in a manner resulting in data of known quality. Stated data objectives and quality control techniques are essential to the work plan. There are several quality control procedures to ensure collection of representative samples. Listed are some of those quality control procedures to consider:

- a. Purging (see Section 5.4.1)
- b. Leak Testing (see Section 5.5)

5.10.2 Analysis QA/QC

All soil vapor samples require analysis by an Arizona Department of Health Services (ADHS) certified laboratory and maintains a Quality Assurance Plan. Quality Control Procedures for analysis performed with soil vapor sampling should follow good laboratory practices and criteria within the specified methods and at a minimum include the following quality control criteria:

- a. Detection Limit Study
- b. Method Blank
- c. Calibration
- d. Calibration Verification
- e. Surrogates
- f. Duplicate (1 per 20 sample/field sampling event)
- g. Proficiency Test (PT) Samples

When QC criteria fall outside specified control limits, the analysis should be qualified using Arizona data qualifiers. The final report includes a case narrative for any event not describable by data qualifiers. Using the Arizona data qualifiers does not automatically qualify the data as acceptable to ADEQ. ADEQ expects that data reported utilizing these qualifiers, unless stated otherwise, is useable, scientifically valid and defensible.

5.10.3 Other Soil Vapor Analytes

Chemicals of interest for soil vapor sampling are specific for the type of contaminant release and breakdown products. They include both volatile organic and inorganic compounds, as well as some semi-volatile organic compounds. The method selected for laboratory analysis should be consistent with the stage of investigation and remediation, the volume of sample that is practical to collect, and the DQO's. Analysis of all samples collected to demonstrate compliance with regulatory requirements requires a laboratory licensed by the ADHS using an ADHS approved method.

The following table lists the types of compounds, methods, and ADHS approval status. Consult the laboratory for specific target list compounds, as well as detection limits. If using a particular laboratory analytical method not currently approved by ADHS for compliance samples, please contact ADEQ to begin an approval process through A.A.C. R9-14-610(C).

Table 5.1 Analytical Methods

Compounds	Method	ADHS Certified
Chlorinated VOCs and Petroleum VOCs BTEX/MTBE	TO-14A	Yes
Chlorinated VOCs and Petroleum VOCs	TO-15	Yes
VOCs	8260BAZ	Yes
VOCs	8021B	Yes

6. Relating Soil Vapor Concentration to Total Soil Concentration

Calculation of total soil concentrations using the method outlined below will vary depending on the input choice of chemical and physical values, such as soil adsorption coefficients (K_{oc}) and soil organic carbon fractions (f_{oc}). In this section, ADEQ provides a list of default values and methods to derive alternative values to be utilized in the three-phase partitioning equation outlined in Section 6.1. The listed default values are appropriate for use throughout much of Arizona and are conservative values so as to be protective of public health and the environment.

6.1 Three-phase Partitioning Equation

ADEQ accepts the following three-phase partitioning equation for the calculation of total soil concentrations which may occur in situ for a chemical. The basis of this equation is a

standard soil partitioning equilibrium model that assumes non-aqueous phase liquid (NAPL) is not present. Therefore, at soil concentrations exceeding the 3-phase saturation limit, measured soil vapor concentrations are inapplicable for calculating total soil concentrations using this equation. For a better understanding of when the 3-phase partitioning equation is not applicable, please see Section 6.5 of this document. The equations used that govern the equilibrium partitioning between phases are the linear sorption partitioning equation normalized with respect to organic carbon (Karichoff et al., 1979) and Henry's Law:

$$C_t = \frac{C_g [K_{oc} f_{oc} \rho_b / H_o + \theta_w / H_o + (\theta - \theta_w)]}{\rho_b}$$

where:

C_t – Total concentration in soil (micrograms per kilogram ($\mu\text{g}/\text{kg}$))

C_g – Concentration in soil vapor (micrograms per liter ($\mu\text{g}/\text{L}$))

f_{oc} – Mass fraction of natural soil organic carbon content (grams (g)-organic carbon/g-soil)

K_{oc} – Soil organic carbon-water partitioning coefficient (milliliters per gram (ml/g))

ρ_b – Dry Bulk Density (kilograms per liter (kg/L))

H_o – Henry's Law Constant (dimensionless)

θ – Total soil porosity (volume of voids/volume total)

θ_w – Volumetric Water Content (volume of water/volume of soil)

6.2 List of Default Values for the Soil Matrix

6.2.1. **Fraction of Organic Carbon in Soil (f_{oc}).** 0.006 (0.6%) is the default value for fraction of organic carbon in soil for use in the equation.

6.2.2 **Soil Dry Bulk Density (ρ_b).** -1.5 kg/L is the default value for dry bulk soil density of 1.5 kg/L for use in the equation. Dry bulk-densities for basin-fill deposits typically range from 1.3 to 1.8 kg/L . The 1.5 kg/L value is within this range.

6.2.3 **Total Soil Porosity (θ).** **0.43 (43%) is the default value for** total soil porosity selected for use in the equation. Its' basis is the default soil particle density (ρ_s) of 2.65 kg/L [$\theta = 1 - \rho_b/\rho_s = 0.43$].

6.2.4 **Soil Volumetric Water Content (θ_w)**. 15% (0.15) is the default value selected for use in the equation. Volumetric water content in basin-fill deposits typically range from 5 to 25 percent. The 15% value is within this range.

6.3 Test Methods Required to Change Soil Matrix Default Values

This section specifies procedures and requirements to derive site-specific input parameters for use in the three-phase partitioning equation. Site-specific value substitutions for one or more of the following four input parameters are acceptable: soil dry bulk density, soil organic carbon content, total soil porosity, and soil volumetric water content.

6.3.1 **Deriving soil organic carbon fraction (f_{oc})**. ASTM Method D2974 or other methods approved by ADEQ to derive site-specific soil organic carbon fraction values are acceptable. Using uncontaminated soil samples from lithologic zones that are representative of where the soil-vapor contamination is present is necessary to measure site-specific soil organic carbon content. Laboratory methods cannot include inorganic carbon in laboratory measurements.

6.3.2 **Deriving soil dry bulk density (ρ_b)**. ASTM Method D2049 or D2937 or other methods approved by ADEQ to derive site-specific soil bulk density values are acceptable.

6.3.3 **Deriving total soil porosity (θ)**. ASTM Method D4404 or other methods approved by ADEQ to derive site-specific total soil porosity values are acceptable.

6.3.4 **Deriving soil volumetric water content (θ_w)**. ASTM Method D2216 or other methods approved by ADEQ to derive soil volumetric water content values are acceptable.

6.4 List of Chemical Default Values (K_{oc} and H_o) for Selected VOCs

The VOCs listed in the following table provide soil organic carbon-water partitioning coefficients (K_{oc}) and dimensionless Henry's Law constants (H_o). ADEQ accepts these values, taken from *Soil Screening Guidance* (US EPA, 1996), for use in the three-phase partitioning equation. The chemicals shown are not a complete list of all potential VOCs encountered in contaminant releases, but represent those commonly encountered, those with greater potential to exist in the vapor phase, or those with greater toxicity relative to other VOCs.

Alternative K_{oc} and H_o values listed on the following table are substitutions for the values listed in the table on the next page when those alternative values more accurately represent conditions encountered at a site. Sources for these values may be obtained from the *Superfund Chemical Data Matrix* (US EPA, most current editions) and the EPA's

most recent version of Estimation Programs Interface Suite™ available at <http://www.epa.gov/opptintr/exposure/pubs/episuite.htm>.

Alternative K_{oc} and H_o values based on scientific literature are subject to ADEQ approval.

Table 6.1. List of Chemical Default Values for Selected VOCs

Compound	K_{oc} (L/kg) ¹	H_o (dimensionless) ²
Benzene	5.89E+01	2.28E-01
Bromodichloromethane	5.50E+01	6.56E-02
Bromoform	8.71E+01	2.19E-02
Carbon disulfide	4.57E+01	1.24E+00
Carbon tetrachloride	1.74E+02	1.25E+00
Chlorobenzene	2.19E+02	1.52E-01
Chloroform	3.98E+01	1.50E-01
1,2-Dibromoethane (EDB)	2.81E+01	2.90E-02
1,1-Dichloroethane	3.16E+01	2.30E-01
1,2-Dichloroethane (DCA)	1.74E+01	4.01E-02
1,1-Dichloroethene	5.89E+01	1.07E+00
cis-1,2Dichloroethene	3.55E+01	1.67E-01
Trans-1,2-Dichloroethene	5.25E+01	3.85E-01
1,2-Dichloropropane	4.37E+01	1.15E-01
1,3-Dichloropropene	4.57E+01	7.26E-01
Ethyl benzene	3.63E+02	3.23E-01
Methyl bromide	1.05E+01	2.56E-01
Methylene chloride	1.17E+01	8.98E-02
Styrene	7.76E+02	1.13E-01
1,1,2,2-Tetrachloroethane	9.33E+01	1.41E-02
Tetrachloroethene (PCE)	1.55E+02	7.54E-01
Toluene	1.82E+02	2.72E-01
1,1,1-Trichloroethane	1.10E+02	7.05E-01
1,1,2-Trichloroethane	5.01E+01	3.74E-02
Trichloroethene (TCE)	1.66E+02	4.22E-01
1,2,4-Trimethylbenzene	3.72E+03	2.30E-01
1,3,5-Trimethylbenzene	8.19E+02	3.20E-01
Vinyl acetate	5.25E+00	2.10E-02
Vinyl chloride	1.86E+01	1.11E+00
Xylenes (total) ³	3.86E+02	2.76E-01

Ref. U.S. EPA Soil Screening Guidance: User's Guide, 2nd Edition (July 1996)

¹ - K_{oc} = organic carbon partition coefficient

² - H_o = Dimensionless Henry's Law Constant ($HLC[atm \cdot m] \cdot 41(25^\circ C)$)

³ - K_{oc} and F_{oc} values for total Xylenes represent average of values for *ortho*-, *meta*-, and *para*-Xylenes.

Supplied below are formula air unit conversions:

$$\text{ug/m}^3 = \text{ppbv} \times (\text{Molecular Weight}) / 24.45$$

$$\text{ppbv} = \text{ug/m}^3 \times 24.45 / (\text{Molecular Weight})$$

For example: 2.5 ppbv Benzene x 78.11 / 24.45 = 7.99 ug/m³

(Standard Condition: 1 atm, 25°C)

ppbv = parts per billion by volume
ppmv = parts per million by volume

$$1 \text{ ppmv} = 1,000 \text{ ppbv}$$

$$1 \text{ m}^3 = 1,000 \text{ Liters}$$

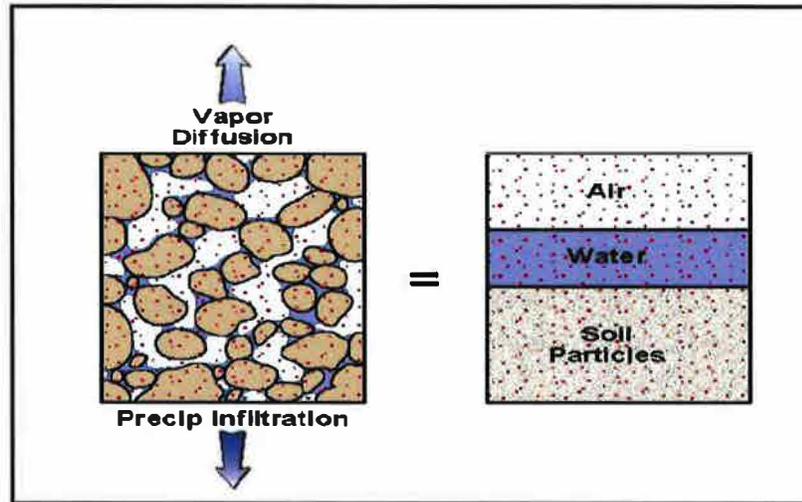
$$1 \text{ mg} = 1,000 \text{ ug}$$

$$1 \text{ mg/m}^3 = 1,000 \text{ ug/m}^3 = 1 \text{ ug/Liter}$$

6.5 Inappropriate Situations in which to apply the Three-Phase Partitioning Equation to calculate total contaminant concentrations in soil

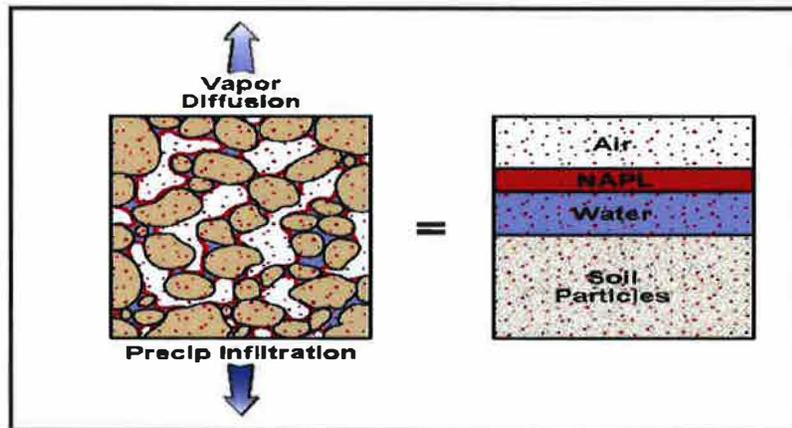
6.5.1 The Presence of NAPL

Section 6.1 indicates that the three-phase partitioning equation is not applicable when NAPL is present. The following diagrams illustrate this inapplicability:

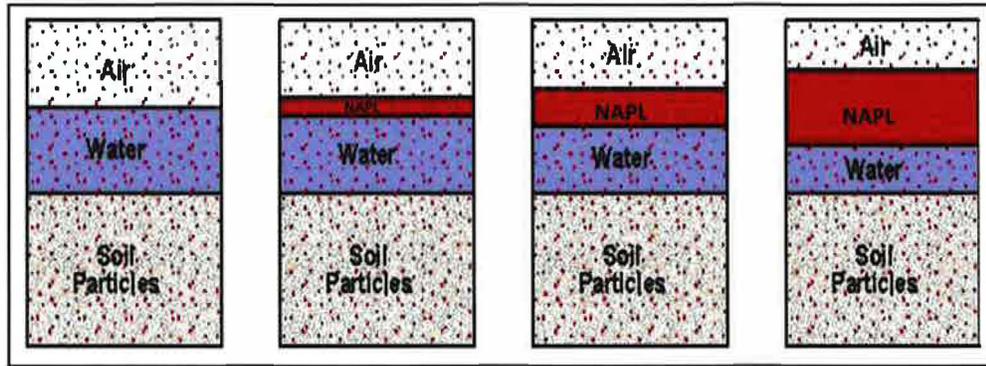


The red dots represent contamination. The red dots placed on the soil grains represent the sorbed phase contamination. The red dots placed on the soil moisture represent the dissolved phase contamination. The red dots placed in the open spaces represent the vapor phase contamination.

If a vapor sample was collected in this type of situation, where there are only 3 phases present, the 3-phase partitioning equation could be used to calculate a total contaminant concentration in the soil. The next diagram is the same as the previous with NAPL added.



The 3-phase partitioning equation is not applicable in this type of situation. This next diagram helps explain why this is so.



Vapor Conc 1 = Vapor Conc 2 = Vapor Conc 3 = Vapor Conc 4
Dissolved Conc 1 = Dissolved Conc 2 = Dissolved Conc 3 = Dissolved Conc 4
Adsorbed Conc 1 = Adsorbed Conc 2 = Adsorbed Conc 3 = Adsorbed Conc 4
Total Conc.1 < Total Conc 2 < Total Conc 3 < Total Conc 4

The key to understanding the above diagram is first understanding the concept of saturation with respect to contamination in a given volume of soil. Saturation is a comparison between the degree to which something is dissolved, absorbed, or volatilized and the maximum dissolution, adsorption, or volatilization, respectively, possible.

When adding a contaminant to a given volume of soil, that contaminant, over time, will separate and equilibrate into the vapor, dissolved and sorbed phases. Each phase, though, can only accept so much contamination. Once these three phases accept the maximum possible amount of contamination, they will not accept additional contamination and is in a state of saturation. When adding a contaminant to a given volume of soil already saturated with that contaminant, the additional contaminant will remain as Non-aqueous phase liquid contamination.

Example:

Please consider the four situations depicted in the diagram above. The saturation value for PCE in a typical Arizona soil is about 61 mg/kg. A PCE vapor concentration from the 1st volume of soil plugged into the 3-phase partitioning equation would result in a total contaminant concentration of 61 mg/kg – which is a true value for that volume of soil.

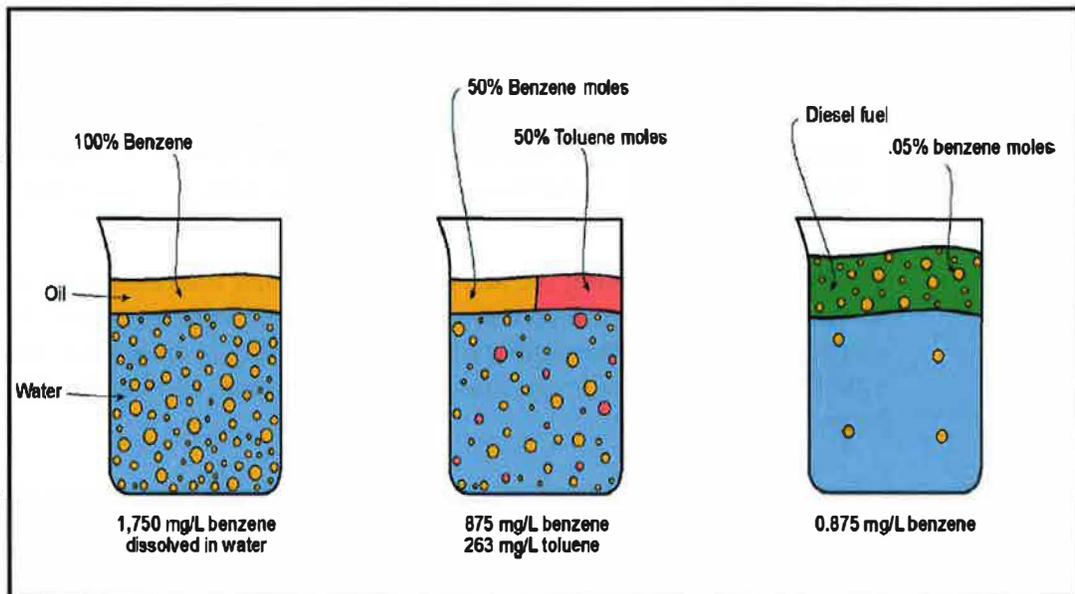
Now consider a vapor sample collected from soil volume #3. A PCE vapor concentration from the 3rd volume of soil plugged into the 3-phase partitioning equation would still result in a total contaminant concentration of 61 mg/kg - which is not a true value for that soil volume #3.

Vapor samples collected from each of the volumes of soil depicted here have the same concentrations because the volumes of soil are at or over their saturation

limit of 61 mg/kg PCE. The sorbed, dissolved and vapor phases in all of the volumes of soil cannot accept any more contamination. Calculating a total contaminant concentration for soil volumes 2, 3 and 4 using only vapor data will not yield an accurate result.

6.5.2 Single vs Multiple Chemical Contaminant Mix

The presence of NAPL is not the only factor to be aware of when using soil vapor data to calculate total contaminant values. Multiple chemical mixes are also a consideration. Saturation values for chemicals change when a contaminant mix has additional chemicals added.



Adding additional chemicals to the contaminant mix changes individual chemical saturation values.

To illustrate how saturation values change when multiple chemicals are in the contaminant mix, consider these three beakers with different combinations of chemicals in them.

The first beaker contains only one chemical in the contaminant mix - benzene. The water can only dissolve so much contamination before a state of saturation occurs. Since this beaker contains benzene as the sole contaminant, 1,750 mg/L of benzene dissolves into the water – this represents the benzene saturation value when no other chemical is present in the contaminant mix.

The second beaker contains two chemicals in the contaminant mix – benzene and toluene in equal molar amounts. No matter how many chemicals are in the contaminant mix, the water can still only dissolve the same amount of contamination as the first beaker before a state of saturation occurs. Since there are equal molar amounts of benzene and toluene in the contaminant mix, an equal amount of benzene and toluene moles dissolve in the water. This effectively cuts

the amount of dissolved benzene in half compared to the first beaker. The saturation value for benzene has changed compared to the first beaker.

The third beaker contains diesel fuel for the contaminant mix. Diesel fuel is composed of several dozen chemicals. In this example, the diesel fuel contains .05% benzene moles. This means that the water in this beaker will only contain a dissolved benzene concentration of 0.875 mg/L ($1,750 \text{ mg/L} \times .05\% = 0.875 \text{ mg/L}$). 0.875 mg/L represents its saturation value for this contaminant mix.

Although this illustration focuses on the dissolved phase, the same concept holds true for the vapor phase. This is an important concept with respect to using the 3-phase partitioning equation. One needs to know the contaminant mix concentration in order to derive saturation values for individual chemicals. If only vapor sample collection occurs in places of saturation value exceedances, calculated total contaminant concentrations will be inaccurate.

7. Procedure References

- 7.1 Karichoff, S.W., D.S. Brown, and T.A. Scott. 1979. Sorption of hydrophobic pollutants on natural sediments. *Water Resources Research* 13, no. 3: 241–248.
- 7.2 Luo, H., P. Dahlen, P. Johnson, T. Creamer, T. Peargin, P. Lundegard, B. Hartman, L. Abreau, and T. McAlary. 2006. “Spatial and Temporal Variability in Hydrocarbon and Oxygen Concentrations Beneath a Building Above a Shallow NAPL Source.” Presented at Remediation of Chlorinated and Recalcitrant Compounds, Monterey, Calif.
- 7.3 U.S. EPA Soil Screening Guidance: User’s Guide, 2nd Edition (July 1996)
- 7.4 Vapor Intrusion Pathway: A Practical Guideline, January 2007, Interstate Technology and Regulatory Council.

Other useful references

Atlantic RBCA Version 2.0 for Petroleum Impacted Sites in Atlantic Canada, User Guidance, Appendix 9 – Guidance for Soil Vapor and Indoor Air Monitoring Assessments

California Regional Water Quality Control Board, California Department of Toxic Substances Control. Advisory – Active Soil Gas Investigations January 28, 2003. Hartman, Blayne (2006). Part 4 – “How to Collect Reliable Soil-Gas Data for Risk-Based Applications, Specifically Vapor Intrusion: Updates on Soil-Gas Collection and Analytical Procedures.” LUSTLine Bulletin 53 September 2006

Wilson, L. H., P. C. Johnson, and J.R. Rocco (2005). Collecting and Interpreting Soil Gas Samples from the Vadose Zone: A Practical Strategy for Assessing the Subsurface-

Vapor-to-Indoor-Air Migration Pathway at Petroleum Hydrocarbon Sites. API Soil Gas Sampling May 2005 Pre-Publication Version.

Attachment 1

Vacuum Conversion Table

Vacuum	In Hg (rel)	ft H ₂ O (rel)	Torr (abs) mm Hg (abs)	mbar (abs)	psia (abs)
0%	0.00	0.00	760.0	1013.3	14.70
10%	2.99	3.39	684.0	911.7	13.23
20%	5.98	6.78	608.0	810.4	11.76
30%	8.98	10.17	532.0	709.1	10.29
40%	11.97	13.56	456.0	607.8	8.82
50%	14.96	16.95	380.0	506.5	7.35
60%	17.95	20.34	304.0	405.2	5.88
70%	20.94	23.73	228.0	303.9	4.41
80%	23.94	27.12	152.0	202.6	2.94
90%	26.93	30.51	76.0	101.3	1.47
91%	27.23	30.85	68.4	91.2	1.32
92%	27.53	31.19	60.8	81.0	1.18
93%	27.83	31.53	53.2	70.9	1.03
94%	28.13	31.87	45.6	60.8	0.88
95%	28.42	32.21	38.0	50.6	0.73
96%	28.72	32.54	30.4	40.5	0.59
97%	29.02	32.88	22.8	30.4	0.44
98%	29.32	33.22	15.2	20.3	0.29
99%	29.62	33.56	7.6	10.1	0.15
99.10%	29.65	33.59	6.8	9.1	0.13
99.20%	29.68	33.63	6.1	8.1	0.12
99.30%	29.71	33.66	5.3	7.1	0.10
99.40%	29.74	33.70	4.6	6.1	0.09
99.50%	29.77	33.73	3.8	5.1	0.07
99.60%	29.80	33.76	3.0	4.1	0.06
99.70%	29.83	33.80	2.3	3.0	0.04
99.80%	29.86	33.83	1.5	2.0	0.03
99.90%	29.89	33.87	0.8	1.0	0.01
<100%	29.92	33.90	0.0	0.0	0.00

Pressure measurement units:

In Hg - inches of mercury

ft H₂O – feet of water

mm Hg – millimeters of mercury

mbar – millibars

psia – pounds per square inch absolute

Attachment 2

Arizona Department of Environmental Quality QA/QC checklist for Soil Vapor Sampling

Sampling Company

- 1 Date: _____ Start time: _____
- 2 Company Name: _____ Sampler's Name: _____
- Consulting Firm:**
- 3 Company Name: _____ Project Name: _____
- 4 Project Manager: _____ Project Number: _____

Well's Information

- 5 Location: _____ Client ID: _____ Permanent Temporary
- 6 Address: _____
- 7 ADEQ File Identification #(s) _____
- 8 Describe the probe location: _____
- 9 Probe Depth: _____ inch Probe ID: _____ inch **Probe volume: 0 inch³ (0) mls**
- 10 Probe type: Tygon Teflon Vinyl PVC Metal Other: _____
- 11 Is probe tested in the lab before installed? Y N NA Don't know
- 12 Comments: _____

Weather Conditions

- 13 Temperature: _____ C° F°
- 14 Has there been significant rain or snow recent to the sampling event? Y N
- 15 If Yes to Question 14 Date _____ Amount of Precipitate _____ inches

Soil Conditions Information

- 16 Was a soil sample collected and analyzed for volumetric moisture content? Y N attach results if yes
If yes, attach results _____
If no, is the apparent moisture content dry moist saturated
- 17 What is soil type encountered at sample location? _____
- 18 Was sample collected beneath a surface cover (e.g. parking lot, sidewalk, road, building, other)? Y N
- 19 Describe the surface cover, if any _____
- 20 Was the sample collected near a subsurface conduit? Y N

Describe subsurface conduit, if any _____

Sampling Train

- 21 Sample container: Canister: 1.0 L 6.0 L Silanized: Y N
Other: _____
Tedlar bag: Y N Gas tight syringe Y N
- 22 Flow restrictor: On: 1000 mL/min 500 mL/min 200 mL/min Other: _____
One min = Taking one minute to fill one liter canister.
- 23 Tubing type: Tygon Teflon Vinyl PVC Other: _____
- 24 Tubing used from probe top to canister: Length: _____ inch ID _____ inch
- 25 **Tubing volume: 0 inch³ (0) mls**
- 26 Are all parts of Sampling Train tested in the lab before sampling? Y N

Probe Purging Before Sampling

- 27 Total volume: probe(v) + tubing(v) = Probe volume 0 + Tubing volume 0 = 0 ml
- 28 Total volume to be purged (ml): 1x 0 1.5x 0 2x 0 3x 0
- 29 Purging pump #: _____ Purging flow rate: _____ ml/min Purging time: _____ mins _____ seconds
- 30 Gauge reading: < 5 inHg Other: _____ Comments: _____
- 31 Syringe Purging: NA Dedicated Syringe Re-used Surlinge Volume _____
- 32 Is there condensation evident in the sampling train? Y N
- 33 Post sample collection - Is there condensation evident in the sampling container? Y N
- 34 **Leak Test** Y N If Yes, fill in the blanks blow: _____
- 35 Tracer compound: _____ Trade name: _____ Tested before use: Y N
- 36 Locations applied: Probe top Sampling train: Other: _____
- 37 **Field Duplicate** Y N If Yes, fill in the blanks blow: _____
- 38 Used the Duplicate Splitter? Y N If no, describe the procedure: _____

Other Information

- 39 Identify the equipment and method used to install probe and collect sample _____
- 40 What was the equilibration time between probe installation and withdrawal of any soil vapor? _____
- 41 Sample storage /shipping temperature _____
- 42 Sample storage /shipping container _____
- 43 Sample transportation mode(s) _____
- 44 Was an equipment blank taken? Y N Was Tank air or Nitrogen used? _____
Note: Ambient air should not be used
- 45 Was a field blank taken? Y N
- 46 Was a background (upwind ambient) sar Y N
- 47 Are there any potential VOC sources other than the identified release nearby?
Groundwater/active fueling station/ dry cleaners/ dry wells/ other - please describe _____

48 Well (Probe) Inspection Note:

Attachment 3

1.0 Directive Owner (Person Responsible for Implementing & Maintaining the Directive – Title/Unit/Section/Division)

WPD Environmental Associate Hydrogeologist

2.0 Audience

Stakeholders conducting Hazardous Waste, WQARF, UST and other remediation or corrective action

3.0 Communication & Training

The Waste Programs Division Environmental Associate Hydrogeologist will conduct a class within 45 days of the policy effective date and annually thereafter insure that employees that deal with soil vapor issues are familiar with the policy's content, including any procedures for internal compliance, audit and review. Concurrent with the 2nd class and annually thereafter, the Environmental Associate Hydrogeologist will review the policy for any needed changes or updates.

4.0 Compliance & Audit Plan

Prior to each annual review, the Environmental Associate Hydrogeologist will arrange for a records review or similar inquiry to estimate the number of corrective actions that have involved issues with soil vapor contained in the current policy. Each annual review shall evaluate whether applicable WPD personnel and external stakeholders are aware of the policy and explore methods to increase awareness if needed.

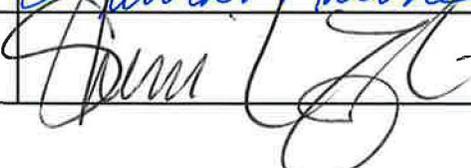
5.0 Review & Revision

This directive will be reviewed after the first year on an annual basis.

6.0 Additional Documentation

This policy complements the Site Investigation Guidance Manual.

7.0 Approved by:

Title	Name	Signature	Date
WPD Division Director	Laura Malone		3/31/17
Administrative Counsel (as to form)	Sherri Zendri		4/21/17

11.0 Historical Note

[Describes the changes or updates to a directive, which serves as a reference for the reader to understand any past changes.]

Date	Change	Ref. Section
July 10, 2008	Issued	
May 19, 2011	Revised	Grammatical changes and procedure clarifications
April 21, 2017	Revised	Grammatical changes and added Section 6.5

APPENDIX H

SOLINST DISCRETE INTERVAL SAMPLER

SOLINST TECHNICAL BULLETIN

Review of No-Purge Groundwater Sampling

Introduction

Changes in legislation, combined with improved and lower cost sampling instrumentation, have encouraged consultants, researchers, and government agencies to obtain higher quality groundwater samples. No-purge, also known as passive or grab sampling, is one method that is gaining acceptance by many regulatory agencies for obtaining representative groundwater samples.

The ITRC (Interstate Technology & Regulatory Council) define a "passive" sampler as one that is able to acquire a sample from a discrete location without the active media transport induced by pumping or purge technologies.

Methodology

Sampling methods are based on the principle that groundwater, which flows through a screen and into a well, is characteristic of the water outside the well at that depth. Studies have shown that sampling at the screened interval should result in a representative sample, without the need for purging. In order to get a sample representative of aquifer conditions, passive samplers must be submerged within the screened interval and remain in the well until groundwater conditions have re-equilibrated. Once equilibrium is reached, a sample can be taken. Samples can also be taken as soon as the target depth is reached to obtain a sample of current conditions in the well.

When compared to conventional sampling methods, no-purge samplers typically require less costs and time to retrieve a sample. Minimal labour is required as there is no purge water to manage, or dispose. Normally, no-purge samplers do not require power, a compressor or control unit, and there is little or no well water agitation when the samplers are deployed and operated.

Sampler Options

There are a variety of passive sampler types available, they include pressure sealed canisters, trigger released samplers and passive diffusion bag samplers. Many passive samplers can also be categorized as "grab" samplers. These devices retrieve a well water sample that is an instantaneous "snap shot" of that sampling point at the moment the sample was taken.

Traditionally bailers were used to obtain grab samples, now discrete interval samplers are another option. Discrete interval samplers differ from bailers in that water only passes over the body of the device and not through it as it is lowered through the water column. At depth and after re-equilibration has occurred, the device is "opened" allowing water to enter. Once filled, the device is resealed and retrieved to surface.



Solinst Canada Ltd. produces the **Model 425 Discrete Interval Sampler (DIS)**, which is a pressure sealed stainless steel sampler activated by a high pressure hand pump. The sampler is pressurized before being lowered into the well. Once the desired depth is reached, the pressure is vented and hydrostatic pressure fills the sampler with water directly from the sampling zone.

When the sampler is filled, it is repressurized and raised to surface. Check balls prevent water from entering the tubing. The sample is decanted using the sample release device, which regulates flow and minimizes degassing of the sample.

Issues and Considerations

Passive sampling relies on the natural horizontal flow of groundwater through a screened interval in a well. Other factors should also be considered when using passive samplers, including vertical flow in the well, contaminant stratification, hydraulic conductivity of the aquifer, mixing, etc. Other sampling options, such as low flow pumping, should also be compared and considered to determine the most appropriate sampling method for a site's conditions.

References

ITRC (Interstate Technology & Regulatory Council). 2007. *Protocol for Use of Five Passive Samplers to Sample for a Variety of Contaminants in Groundwater: DSP-5*. Washington, D.C.: Interstate Technology & Regulatory Council, Diffusion/Passive Sampler Team. www.itrcweb.org.

Parker, Louise V., Charles H. Clark. 2002. *Study of Five Discrete Interval-Type Groundwater Sampling Devices*. US Army Corps of Engineers® Engineer Research and Development Center, Technical Report: ERDC/CRREL TR-02-12.

Printed in Canada: July 17, 2012

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APPENDIX I

ADEQ REMEDIAL PROJECTS SECTION QUALITY ASSURANCE PROGRAM PLAN

REMEDIAL PROJECTS SECTION
QUALITY ASSURANCE PROGRAM PLAN



Douglas A. Ducey, Governor
Misael Cabrera, Director

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
Waste Programs Division

Date: February 2017
Revision A



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

February 1, 2017

MEMORANDUM

SUBJECT: Approval - Quality Assurance Program Plan for ADEQ's Remedial Projects Section [QA Office Document Control Number MISC0233PV2]

FROM: Marlon Mezquita, Document Reviewer
Quality Assurance Office (EMD-3-2)

Handwritten signature of Marlon Mezquita in black ink.

THROUGH: Eugenia McNaughton, Ph.D., Manager
Quality Assurance Office (EMD-3-2)

Handwritten signature of Eugenia McNaughton in black ink.

TO: Nadia Hollan-Burke, Project Officer
Superfund Division, SFD-8-1

The subject Quality Assurance Program Plan (QAPrP), prepared by the ADEQ Technical support Staff for the Remedial Projects Section of the Arizona Department of Environmental Quality (ADEQ) and dated February, 2017, has been reviewed. The review was based on "EPA Region 9 Guidance for Quality Assurance Program Plans" (R9QA/03.2, March, 2012), "EPA Requirements for Quality Management Plans" (EPA R-2, December, 2001), "EPA Requirements for Quality Assurance Project Plans" (EPA QA/R-5, March, 2001), "EPA Guidance for Quality Assurance Project Plans" (EPA QA/G-5, December, 2002), and "Guidance for the Data Quality Objectives Process" (EPA QA/G-4, August, 2000).

The QAPrP is approved by the QA Office, all January 25, 2017 Quality Assurance comments have been adequately addressed.

If you have any questions or need further information, please feel free to contact me by phone at 415-972-3808 or by email at <Mezquita.Marlon@epa.gov>.

cc: Wayne Pudney, ADEQ

A.1 TITLE AND APPROVAL PAGE

This QA Program Plan is hereby recommended for approval and commits the Department to follow the elements described within.

Arizona Department of Environmental Quality

Laura L. Malone, Director, Waste Programs Division

Signature: *Laura Malone*

Date: 1/30/17

Tina LePage, Manager, Remedial Projects Section

Signature: *Tina LePage*

Date: 1/30/17

Thomas Titus, Remedial Projects Section QA/QC Representative

Signature: *TTA*

Date: 1/30/17

EPA Region 9

Eugenia McNaughton, Quality Assurance Manager, EPA Region 9

Signature: *Eugenia McNaughton*

Date: 2/1/17

Nadia Hollan Burke, EPA Project Officer, EPA Region 9

Signature: _____

Date: _____

The Arizona Department of Environmental Quality (ADEQ) has prepared this Quality Assurance (QA) Program Plan titled **Remedial Projects Section Quality Assurance Program Plan** following the *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)* dated March 2001, the *EPA Guidance for Quality Assurance Project Plans (EPA QA/G-5)* dated December 2002, the *EPA Region 9 Requirements for Quality Assurance Program Plan (R9QA/03.2)* dated March 2012, and the *ADEQ Quality Management Plan* dated May 2016.

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ACRONYMS AND ABBREVIATIONS

AAC	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ADHS	Arizona Department of Health Services
ADQ	Audit of Data Quality
ARS	Arizona Revised Statutes
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CSM	Conceptual Site Model
CWA	Clean Water Act
DoD	Department of Defense
DQA	Data Quality Assessment
DQI	Data Quality Indicator
DQO	Data Quality Objective
EDD	Electronic data deliverable
EPA	Environmental Protection Agency
ERA	Early Response Action
FS	Feasibility Study
HASP	Health and Safety Plan
ICP	Inductively Coupled Plasma
IDW	Investigative Derived Waste
ITRC	Interstate Technical Regulatory Council
LCS	Laboratory Control Sample
MDL	Method Detection Limit
MQO	Measurement Quality Objective
MS/MSD	Matrix Spike and Matrix Spike Duplicate
MSR	Management System Review
MI	Multi-increment
MPC	Measurement Performance Criteria
NIST	National Institute of Standards and Testing
NOV	Notice of Violation
NPL	National Priorities List
O & M	Operations and Maintenance
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PE	Performance Evaluation
PID	Photo Ionization Detector
PPE	Personnel Protective Equipment
PQL	Practical Quantitation Limit

PRAP	Proposed Remedial Action Plan
PRQL	Project Required Quantitation Limit
QA	Quality Assurance
QAPjP	Quality Assurance Project Plan
QC	Quality Control
QCSR	Quality Control Summary Report
QMP	Quality Management Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SDG	Sample Delivery Group
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
TSA	Technical System Audit
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
VRP	Voluntary Remediation Program
WQARF	Water Quality Assurance Revolving Fund
WPD	Waste Programs Division

Distribution List

Remedial Projects Section Program Staff
ADEQ Technical Support Staff
Tina LePage, Remedial Projects Section Manager
QA/QC Manager and/or QA/QC Specialists

GROUP A: PROGRAM MANAGEMENT

Introduction

The United States Environmental Protection Agency (EPA) requires that all environmental monitoring and measurement efforts mandated or supported by EPA have in place a centrally managed Quality Assurance (QA) Program Plan. ADEQ provides this QA Program Plan for guidance on how quality assurance (QA) and quality control (QC) procedures are applied to produce data that are:

- Scientifically valid.
- Of documented quality.
- Legally defensible.

The format and elements of this QA Program Plan are in accordance with EPA Region 9 Guidance for Quality Assurance Programs Plans R9QA/03.2 (March 2012), EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations EPA QA/R-5 (March 2001), and EPA Guidance for Quality Assurance Project Plans EPA QA/G-5 (December 2002). Specific elements required in a QA Program Plan include: project management, measurement data acquisition, assessment and oversight, data review and verification, and usability.

ADEQ's Waste Programs Division Remedial Projects Section

Minimum procedures to ensure the precision, accuracy, completeness, comparability, and representativeness of data generated for programs operated under the Arizona Department of Environmental Quality (ADEQ) Waste Programs Division (WPD) Remedial Projects Section (Remedial Projects Section) are the responsibility of the party generating the data and must report them to ADEQ WPD Remedial Projects Section. The environmental programs operated under the Remedial Projects Section include the Water Quality Assurance Revolving Fund (WQARF) Program and the Voluntary Remediation Program (VRP). The Remedial Projects Section also provides oversight of federally managed sites such as Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and Department of Defense (DoD) sites. All QA/QC procedures must be in accordance with applicable professional technical standards, EPA requirements, government regulations and guidelines, and specific project goals and requirements. The QA Program Plan is a management tool. It helps guarantee data are of sufficient known quality to withstand scientific and legal challenge relative to its intended use.

ADEQ's Remedial Projects Section is composed of three units: 1) Remedial Projects Unit; 2) Federal Projects/VRP Unit; and 3) Remedial Projects Support Unit. Described below are the environmental programs these three units oversee. In this document, terminology hierarchy is as follows: Remedial Projects Section → Unit within the Remedial Projects Section → Environmental Program overseen by a specific unit.

The Remedial Projects Unit oversees the WQARF Program. The WQARF Program (see Arizona Revised Statute (ARS) Title 49, Chapter 2, Article 5), created under Arizona's Environmental Quality Act of 1986, has remedial action, abatement, and liability provisions. This revolving fund may be used for a variety of purposes, such as: 1) providing funds for costs incurred for remedial actions taken if a responsible party cannot be identified or refuses to undertake remedial actions relating to hazardous substances released into the environment; and 2) providing funds for the costs of conducting site investigations, feasibility studies, health-effects studies and risk assessments. The WQARF Program conducts these efforts throughout Arizona with support from state and federal funds. The WQARF Program also oversees privately-funded cleanup efforts.

The Voluntary Remediation Program (VRP) (see ARS § Title 49, Chapter 1, Article 5) was created in 2000 so property owners, prospective purchasers and other interested parties could investigate or clean up a contaminated site in cooperation with ADEQ. VRP provides a streamlined process for participants by having a single point of contact at ADEQ to address applicable cross-program remediation efforts. ADEQ reviews these voluntary remedial actions and provides closure documents for successful site remediation.

ADEQ's Federal Projects staff provides oversight of contaminated sites in Arizona that are governed and funded under CERCLA (1980), commonly known as Superfund. The National Priorities List (NPL) is a list of sites that pose the greatest potential threat to human health and the environment. The NPL is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL guides the EPA in determining which sites warrant further investigation. In addition to the CERCLA sites, the Federal Projects staff provides state review and oversight at DoD sites.

A4: Program Organization and Planning Documentation

ADEQ's Remedial Projects Section operates within the Waste Programs Division of the ADEQ. This Division functions as a consolidated source of environmental cleanup in the State of Arizona, with authorities and responsibilities arising from delegated authorities through the Resource Recovery Conservation and Recovery Act (RCRA), the Clean Water Act (CWA) and from cooperative work agreements through CERCLA. The Remedial Projects Section is one component of the WPD and consists of full-time employees and managers/supervisors.

ADEQ employs agency-wide QA/QC program management (AQPM) for QA/QC purposes. This approach decentralizes the role of QA/QC, whereby each Division of ADEQ is responsible for deciding how they will specifically implement the general policies and procedures of ADEQ's Quality Management Plan. The AQPM consists of either an agency-wide QA/QC manager and/or designated QA/QC representatives from each division to fulfill the roles and responsibilities stated in this QMP. The AQPM is independent of the Leadership Team, the policy making group for ADEQ, for reasons of autonomy.

The AQPM is independent of the Leadership Team who are the policy making group for ADEQ. With this separation of groups, Leadership Team, division specialists, and the AQPM autonomy is preserved in fact and appearance. The ultimate responsibility for Quality Assurance for ADEQ lies with the agency Director.

The QA/QC Manager or QA/QC Representatives are not routinely involved with the day-to-day activities of the Remedial Projects Section. The QA/QC Manager or QA/QC Representatives do not routinely participate in any of the planning phases of a project nor are involved in the review/approval of submitted planning documents (e.g. work plans) or reports. However, the QA/QC Manager or QA/QC Representatives can assist in the review of data when requested/necessary. Please see Section A4.1.2 under QA/QC Manager or QA/QC Representatives for a full description of the QA/QC Manager or QA/QC Representative's role.

A4.1 Program/Task Organization

The operation of the Remedial Projects Section involves a number of parties/organizations with specific responsibilities related to data quality. These parties/organizations have specific functions related to the operation of the Remedial Projects Section. The following paragraphs discuss these organizations and

their general responsibilities, followed by discussions of specific responsibilities held by various individuals within those organizations.

An organizational chart showing all the parties/organizations involved in the data quality system has been included as Figure A1: Components of the Quality System for ADEQ's Remedial Projects Section. Figure A1 identifies entities based on their applicable data roles: data quality management, data generators or data users. The defined Remedial Projects Section includes: 1) Section Manager; 2) Remedial Projects Unit Supervisor; 3) Federal Projects/VRP Unit Supervisor; 4) Remedial Projects Section Technical Support; and 4) staff level personnel. Figure A1 incorporates the EPA Region 9 Arizona Project Officer. The prospective data users include the facility owner/operator, property owner, and local and state government.

A4.1.1 Organizational Roles and Responsibilities

Environmental Protection Agency (EPA)

EPA works closely with Arizona in implementing the WQARF Program by providing grant funding, setting national goals and priorities, and conducting program oversight. Each year, EPA identifies the national priorities for implementing all of its programs, including the CERCLA programs. These priorities form the basis for EPA and ADEQ workload negotiations for the upcoming year as part of the establishment of grant funding. Also, EPA regional staff has oversight responsibilities to promote national consistency in CERCLA implementation, encourage coordination and agreement between EPA and ADEQ on technical and management issues, ensure proper enforcement by the ADEQ and ensure appropriate expenditure of federal grant funds.

Arizona Department of Environmental Quality (ADEQ)

ADEQ is responsible for the operation of the Remedial Projects Section. All Remedial Projects Section programmatic activities reside in the WPD of ADEQ. This section has one designated Section Manager and three Unit Supervisors. Two of the units are involved with collection of environmental data. The other unit is a support unit comprising of a legal team and a community involvement team. The legal team assists with the collection of historical environmental data. These three units within the Remedial Projects Section execute the programmatic activities.

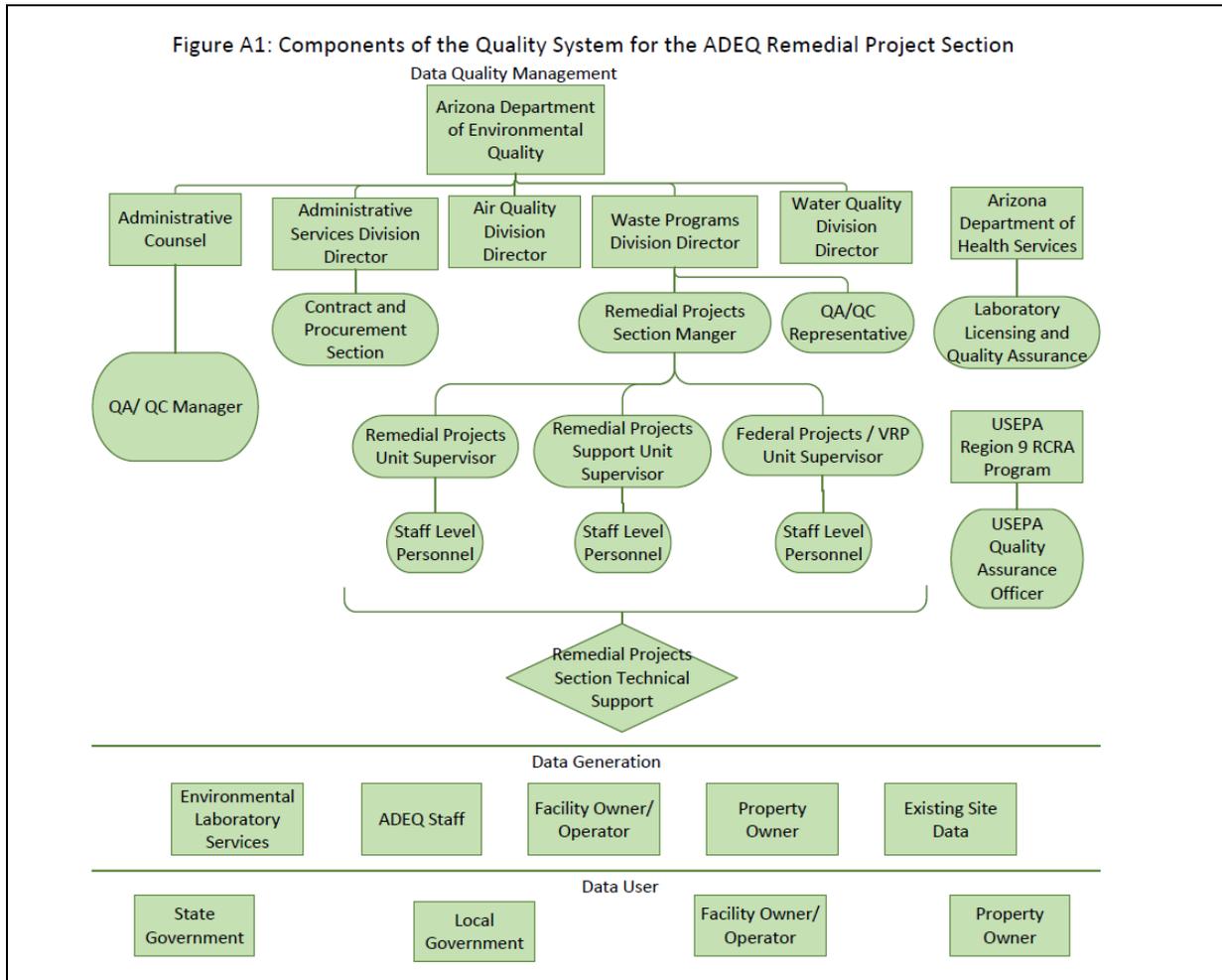
Environmental Laboratory Services

All parties and organizations submitting data generated for and submitted to ADEQ's Remedial Projects Section are required to use analytical laboratories licensed by the Arizona Department of Health Services (ADHS). The licensed analytical laboratories are required to follow all Arizona Administrative Code (AAC) applicable to ADHS laboratories (see Appendix A). The data produced from the analysis of environmental samples provide information to make informed decisions relating to the health and welfare of Arizona's citizens. These data must be of known quality, technically sound and legally defensible.

Upon application for an environmental laboratory license, ADHS shall issue the license if, after investigation, ADHS determines that the application conforms to the standards established by ADHS.

The ADHS Director shall prescribe rules providing for minimum standards of proficiency, methodology, quality assurance, operation, and safety for environmental laboratories and may prescribe standards for personnel education, training, and experience to meet Federal environmental statutes or regulation. The ADHS Director may also allow reciprocity with other states and prescribe reporting formats for compliance testing results. Development of the rules shall be in cooperation with the Director of ADEQ and shall be consistent with Title 49 (Section 49-101 et seq.).

Unless exempted by ARS § 36-495.02, no person may operate or maintain an environmental laboratory without a license issued by the ADHS pursuant to ARS §§ 36-495.03 through 36-495.14.



Facility Owners/Operators and Property Owners

As primary data generators, the Facility Owner/Operators and Property Owners – either directly or through their environmental contractors - are responsible for the implementation and documentation of specific QC elements, such as the collection and analysis of field blanks, field duplicates and rinsate samples, to satisfy the requirements of the QA Program Plan. Please note Section B.5 of this QA Program Plan discusses Quality Control in detail.

Please note: Facility Owner/Operators and Property Owners rarely employ staff that are qualified to satisfy the requirements of a QA Program Plan and, therefore, hire environmental contractors to generate environmental data. Also, reports requiring a certified [Arizona Board of Technical Registration](#) registrant’s seal must meet all of the Arizona Board of Technical Registration requirements under ARS Title 32, Chapter 1 and the rules made under that Chapter.

The documentation of all environmental data collection activities must meet the following minimum requirements:

- Documentation of data must be direct, prompt, and legible. All reported data must be uniquely traceable to the raw data. Documentation of all data reduction formulas must occur.
- All original data records include, as appropriate, a description of the data collected, units of measurement, unique sample identification, station or location identification (if applicable), name (signature or initials) of the person collecting the data, and date of data collection.
- Any changes to the original (raw data) entry must not obscure the original entry. The person making the change must document the rationale and initial and date the change.

In addition, development of standard operating procedures (SOPs) for data collection should follow EPA's April 2007 *Guidance for Preparation of Standard Operating Procedures for Quality-Related Operations* (EPA/600/B-07/0001). SOPs should be included as an appendix of all the planning documents and reports referenced in Figure A2. QA or QC reports (see Sections C2.2 and C2.3) should be included as an appendix to all planning documents and reports submitted to ADEQ's Remedial Projects Section. The field team should document rationale for any deviations from an SOP and include that documentation in all planning documents and reports submitted to ADEQ's Remedial Projects Section.

A.4.1.2 Individual Roles and Responsibilities

In addition to those general responsibilities maintained by the above organizations, individuals involved in Remedial Projects Section activities have specific QA responsibilities. These individuals are referred to herein by a given project title or position, since these assigned duties will be unaffected by staff changes within these positions. The listed individuals below correspond to the organization structure outlined above. They are described according to the level of direct oversight those individuals provide in the Remedial Projects Section's QA system.

EPA Region 9, Arizona Project Officer

The EPA Arizona Project Officer for grant funding has responsibility to:

- Monitor ADEQ's progress and activities required to meet grant commitments;
- Review progress reports to ensure ADEQ is performing the work as agreed and approved in the grant application;
- Serve as the focal point for programmatic and technical issues;
- Ensure completion of EPA's programmatic terms and conditions; and
- Maintain proper grant documentation.

Director, Arizona Department of Environmental Quality

The ADEQ Director has overall responsibility for ADEQ's QA Program as outlined in EPA Order CIO 2105.0 (formerly 5360.1 A2). More specifically, the ADEQ Director is responsible for ensuring that QA is an identifiable activity having adequate resources allocated for the accomplishment of the mission's goals for ADEQ's divisions and Southern Regional Office. These goals include providing the resources for the collection of the right type, quantity, and quality of data generated in-house and externally.

Environmental Laboratory Services

The Remedial Projects Section relies on the ADHS licensing program for the satisfaction of many of the QA elements associated with laboratory operation and reporting (see Appendix A of this QA Program Plan). ADHS maintains oversight of analytical laboratory QC procedures regarding all environmental samples submitted for meeting requirements of a federal or state regulatory program. QA plans, as required by AAC R9-14-615.B, describe licensed laboratory QA responsibilities. ADHS maintains a list of licensed laboratories and periodically inspects them to ensure compliance.

The Remedial Projects Section also has the option of having audits performed by ADEQ's QA/QC Manager or QA/QC Representatives on laboratories licensed by ADHS. All ADEQ laboratory audits must be performed in accordance with Section 2.3.2 of ADEQ's August 2010 Quality Management Plan.

Director, Waste Programs Division (WPD) of ADEQ

ADEQ, through its combined authorities from state-delegated environmental programs, oversees all site investigations and cleanups conducted in the State of Arizona. The Director of the Waste Programs Division (Division Director) is responsible for the administration of all these cleanup authorities. In addition, because site cleanup regulations play an integral part in the development of data quality guidelines, the Division Director plays an important function in determining data quality and sufficiency for the WPD which includes the Remedial Projects Section.

The regulations governing investigations and cleanups (ARS Title 49 – The Environment) in Arizona determine, on a general level, the type and amount of data necessary to make decisions regarding issuance of permits, Notice of Violations (NOVs), compliance orders, and the issuance of determination letters (e.g. "No Further Action" letters). The Division Director is responsible for ensuring a consistent application of these regulations across all WPD cleanup sites. All site information is available to the Division Director for review and consideration of site decisions. The Division Director also holds regular supervisor-level meetings to discuss ADEQ issues and WPD operations.

Section Manager, Remedial Projects Section of Waste Programs Division

The Manager of the Remedial Projects Section (Section Manager) is responsible for staff level participation in all the administrative and technical areas of the three units within the section. The Section Manager is responsible for ensuring that the three units perform their functions consistent with WPD policies and procedures. The Section Manager's level of review will routinely consist of ensuring that the proper staff members reviewed, commented and drafted an appropriate decision or comment letter. The Remedial Projects Section Manager ensures that the Remedial Projects Section meets program goals.

Unit Supervisor, Remedial Projects Unit

The Unit Supervisor of the Remedial Projects Unit is responsible for staff level participation in all the administrative and technical areas of the Remedial Projects Unit. The Unit Supervisor's level of supervision routinely consists of ensuring staff members perform inspections and review, comment on, and draft an appropriate response to submitted planning documents and reports. The Unit Supervisor will also edit, if necessary, decision/response letters. The Unit Supervisor is responsible for final approval of submitted planning documents and reports.

Unit Supervisor, Federal Projects/Voluntary Remediation Program (VRP) Unit

The Unit Supervisor of the Federal Projects/VRP Unit is responsible for staff level participation in all the administrative and technical areas of the Federal Projects/VRP Unit. The Unit Supervisor's level of review will routinely consist of ensuring staff members carry out document reviews and comment on and draft an appropriate response to submitted planning documents and reports. The Unit Supervisor will also edit, if necessary, comment or decision letter. The Unit Supervisor is responsible for final approval of submitted planning documents and reports.

Unit Supervisor, Remedial Projects Support Unit

The Unit Supervisor of the Remedial Projects Support Unit is responsible for staff level participation in ADEQ's Remedial Projects Section community involvement and responsible party identification. The Unit Supervisor's level of review routinely consists of ensuring that proper staff members carry out their assigned duties with respect to community involvement and responsible party identification. This unit is not responsible for any environmental data collection, analysis, quality assurance, or quality control.

Staff Level Personnel - Remedial Projects Unit

Staff level personnel consist of Environmental Hydrogeologists, Engineers and Scientists. Their responsibilities with QC may involve reviewing planning documents and reports (see Figure A2) submitted by the Facility Owner/Operators – either directly or through their contractors – or WQARF Program contractors assigned by ADEQ to investigate and remediate soil and groundwater contamination.

In addition, collection of soil, groundwater and soil gas samples occurs directly by staff during split sampling events at facilities being investigated for entry into the WQARF Program.

During the Preliminary Investigation phase (see Figure A1), available data are gathered and reviewed by WQARF Program staff level personnel. Part of this available data normally contains sampling results for soil, soil gas and/or groundwater.

Proposed investigations or remedial actions are typically detailed in a work plan or proposed remedial action plan (PRAP), which is reviewed, commented upon and approved by a Unit Supervisor after resolution of all issues and before the investigation or remedial actions begin. The following is a short list of some of the most common goals for sampling:

- a. To document a discharge;
- b. To determine the substance discharged;
- c. To document the source of discharge;
- d. To document the discharge meets certain parameters;
- e. To establish the amount/concentration of a substance in a discharge;
- f. To document the extent and degree of contamination; or
- g. To document that an area is below clean-up standards.

On the infrequent occasions when ADEQ staff collects samples and has them analyzed by an ADHS approved laboratory (i.e. during split sampling events), the Technical Support person is available to assist the various staff level personnel when necessary. The Technical Support person, upon request from the staff level personnel, Unit Supervisor or Section Manager, will review this data with regards to QA Program Plan requirements, sampling goals and data quality objectives (DQO's).

Staff Level Personnel - Federal Projects/VRP Unit

Staff level personnel consist of Environmental Hydrogeologists, Engineers and Scientists. Their responsibilities with QC may involve reviewing planning documents and reports (see Figure A2) submitted by the Property Owner – either directly or through their contractors.

Work plans typically detail proposed investigations or remedial actions. Approval of work plans occur after review, comment, and resolution of all issues and before the investigation or remedial actions begin. The following is a short list of some of the most common goals for sampling:

Voluntary Remediation Program:

- a. Site characterization;
- b. Determining effectiveness of remedial efforts; and
- c. Determining if a No Further Action request is appropriate

Federal Projects:

- a. To document a discharge;

- b. To determine the substance discharged;
- c. To document the source of discharge;
- d. To document that the discharge meets certain parameters;
- e. To establish the amount/concentration of a substance in a discharge;
- f. To document the extent and degree of contamination; or
- g. To document that an area is below clean-up standards.

On the infrequent occasions when ADEQ staff collects samples and has them analyzed by an ADHS approved laboratory (i.e. during split sampling events), the Technical Support person is available to assist the various staff level personnel when necessary. Technical Support, upon request from staff level personnel, Unit Supervisor or Section Manager, will review this data with regards to QA Program Plan requirements, sampling goals and DQO's.

Remedial Projects Section Technical Support

Technical Support is available to assist with site assessment and/or remediation issues to ensure the investigation and data collection efforts of the environmental consultant and facility meet QA objectives. Technical Support is technical staff placed in an "Associate", "Senior", or "Principal" position. Described below are three major activities for Technical Support:

1. Review of Planning Documents (see Figure A2) — Technical Support is available to assist staff members when necessary. Technical Support is available upon request from staff level personnel, Unit Supervisor or Section Manager, and will review and comment on the submitted planning documents with regards to QA Program Plan requirements, project goals and DQO's.
2. Development of DQOs — An initial scoping session may be held with all available stakeholders to outline project goals and DQOs prior to the preparation of planning documents by the Facility/Responsible Party/Property Owner or its contractor,. These initial meetings will roughly follow EPA's 2006 [Guidance on Systematic Planning using the Data Quality Objectives Planning Process](#) for guidance on the standard DQO process. The results of these initial meetings will guide the development of the project-specific planning documents.
3. Review of Data Reports (see Figure A2) — Technical Support will be available to assist the various staff level personnel when necessary. Technical Support is available upon request by staff level personnel, the Unit Supervisor, or the Section Manager. Technical Support will review submittals generated under planning documents with regards to QA Program Plan requirements, project goals, and DQO's.

On the infrequent occasions when ADEQ staff collects samples and has them analyzed by an ADHS approved laboratory (i.e. during split sampling events), the Technical Support person is available to assist the various staff level personnel when necessary. The Technical Support person, upon request from the staff level personnel, Unit Supervisor or Section Manager, will review this data with regards to QA Program Plan requirements, sampling goals and DQO's.

When requested by the staff level personnel, the Unit Supervisor, or the Section Manager, Technical Support will prepare comments for revision of the data reports.

QA/QC Manager or QA/QC Representatives:

The QA/QC Manager or QA/QC Representatives provides assessment of Remedial Projects Section activities through the processes listed below:

- Technical System Audits
- Performance Evaluations
- Audits of Data Quality
- Data Quality Assessments

Please see Section C1.2.2 – Assessment of Program Activities for specific details on these processes. The QA/QC Supervision also reviews and can revise the QA Program Plan. An update of the QA Program Plan can accommodate new developments in QA/QC. Revisions to the QA Program Plan may become necessary through several different routes, and the QA/QC Manager or QA/QC Representatives will be responsible for responding and making these revisions when appropriate. For example, the EPA QA Officer may make quality performance improvement suggestions that necessitate a change to the QA Program Plan. During a Technical System Audit (TSA), the QA/QC Manager or QA/QC Representatives will examine the QA Program Plan and the performance of the WQARF Program and may make suggestions for improved performance that result in revisions to the QA Program Plan.

The QA/QC Manager or QA/QC Representatives is not routinely involved with the day-to-day activities of the Remedial Projects Section. The QA/QC Manager or QA/QC Representatives does not routinely participate in any of the planning phases of a project, nor is the QA/QC Manager or QA/QC Representatives involved in the review/approval of submitted documents. The QA/QC Manager or QA/QC Representatives may assist in the review of data when requested.

Facility Owners/Operators and Property Owners

As primary data generators, the Facility Owner/Operators and Property Owners – either directly or through their contractors - are responsible for the implementation and documentation of a number of QC elements, such as collection and analysis of field blanks, field duplicates and rinsate samples, to satisfy the requirements of the QA Program Plan. Please note that Section B.5 of this QA Program Plan discusses Quality Control in detail.

Please note: Facility owner/operators and Property Owners rarely employ staff that are qualified to satisfy the requirements of a QA Program Plan and, therefore, hire contractors to generate environmental data. Also, reports requiring a certified [Arizona Board of Technical Registration](#) registrant's seal must meet all of the Arizona Board of Technical Registration requirements under ARS Title 32, Chapter 1 and the rules made under that Chapter.

A4.2 Planning and Reporting Documentation

Sampling activities conducted or overseen by the Remedial Projects Section will be associated with those planning document or reports identified in Figure A2. Those activities will occur within a framework that is well-defined by specific documentation requirements. Figure A2 describes a coordinated flow path for the submittal and review of documents that describe sampling activities. Therefore, each defined document will play a role in establishing QC elements to ensure the production of a usable, reliable final product.

Outlined below are descriptions of planning documents and reports associated with the Remedial Projects

Section. The descriptions are in an order that follows a projects life cycle. For instance, the typical WQARF Program environmental project life cycle is as follows: Preliminary Investigation → WQARF Registry Listing → Early Response Actions → Remedial Investigations → Feasibility Study → Proposed Remedial Action Plan → Record of Decision → Remedy Implementation → Operation and Maintenance → Removal from Registry. The reports listed below are those reports that are necessary for decision making at different phases of the life cycle.

Section B9: Non-direct Measurements of this QAPrP explains the documentation and use of previously generated data. Later sections will discuss other documentation issues, particularly the development of audits.

A4.2.1 Planning Documents and Reports

The following describes documents and reports for each unit within the Remedial Projects Section:

Remedial Projects Unit – Planning Documents

Figure A2 identifies six types of Remedial Projects Unit planning documents that describe sampling activities and/or analysis of historical data. A WQARF Program facility or its contractor or a Remedial Projects Unit contractor prepare these documents. Described below are the functions of the six different planning documents:

- a. The primary function of a **Preliminary Investigation Work Plan** (AAC R18-16-201(H)) is to provide a description of proposed work, a description of known site conditions, and a plan for conducting additional field work, if needed. A preliminary investigation will obtain additional information necessary to determine a sites potential risk to public health, welfare, and the environment in order to score the site and include it on the registry established under ARS § 49-287.01(D). *Please note: when planning to collect new environmental data, The PI Work Plan generally follow's EPA's May 2014 Sampling and Analysis Plan Guidance and Template (R9QA/009.1) construct. ADEQ has adopted this EPA document as a Substantive Policy Statement.
- b. The primary function of an Early Response Action (ERA) Work Plan (AAC R18-16-405(D)) is to provide a plan for conducting work to address a current risk to public health or the environment, to protect a source of water, or to provide a supply of water. Also, it provides a description of proposed work and a description of known site conditions. Initiation of an early response action can occur prior to the selection of a remedy if it meets the requirements of AAC R18-16-405(A). If immediate action is necessary to address a current risk to public health or the environment, to protect a source of water, or to provide a supply of water, the work plan and written rationale may be prepared after commencement of early response actions. Submittal of the ERA Work Plan to the Remedial Projects Section for review and approval is required per AAC R18-16-405(H). *Please note: The ERA Work Plan generally follow's EPA's May 2014 Sampling and Analysis Plan Guidance and Template (R9QA/009.1) construct. ADEQ has adopted this EPA document as a Substantive Policy Statement.
- c. The primary function of a **Remedial Investigation (RI) Work Plan** (AAC R18-16-406(B)) is to provide a plan designed to meet the requirements of AAC R18-16-406(C) and (D). The RI Work Plan provides a plan designed to be in accordance with guidance documents issued by the ADEQ, standards, and other guidance documents that are commonly accepted in the scientific community. Basically, the RI Work Plan is a plan designed to determine the nature and extent of contamination at a site. Also, it provides a description of proposed work and a description of

known site conditions. Submittal of the RI Work Plan to the Remedial Projects Section for review and approval is required per AAC R18-16-413. *Please note that a Quality Assurance Project Plan (QAPjP) is required component (see AAC R18-16-406(B)(2)) of the RI Work Plan. The QAPjPs generally follows EPA's December 2002 Guidance for Quality Assurance Project Plans (EPA QA/G5) construct.

- d. The primary function of a **Feasibility Study (FS) Work Plan** (AAC R18-16-407(B)) is to provide a plan to identify a reference remedy and alternative remedies that appear to be capable of achieving remedial objectives and to evaluate them based on the comparison criteria to select a remedy that complies with ARS § 49-282.06. Also, it provides a description of proposed work and a description of known site conditions. Submittal of the FS Work Plan to the Remedial Projects Section for review and approval is required per AAC R18-16-413. It also can be an avenue for further data collection for the purpose of assisting identification of reference and alternative remedies.
- d. The primary function of a **Proposed Remedial Action Plan (PRAP)** is to detail the description of the proposed remedy at a site and detail the measures for accomplishment of remedial objectives. Also, it provides a description of proposed work and a description of known site conditions. Submittal of the PRAP to the Remedial Projects Section for review and approval is required per AAC R18-16-413.
- e. A primary function of a **Record of Decision (ROD)** is to detail the description of the chosen remedy at a site and detail the measures for accomplishment of remedial objectives. The ROD is prepared after the PRAP public comment period. Also, it provides a description of proposed work and a description of known site conditions. Submittal of the PRAP to the Remedial Projects Section for review and approval is required per AAC R18-16-413.
- f. The primary function of an **ERA or Remedy Operations and Maintenance Plan** (R18-16-411(D)) is to provide a plan for implementing remedial actions designed to achieve remedial objectives. Included in the operations and maintenance plan are requirements for the following: 1) a schedule and plan for water quality monitoring; and, for a discharge to a water of the United States 2) operational, maintenance and management practices to assure achievement of water quality discharge standards established in 18 AAC 11 prior to the point of discharge for contaminants of concern at the site. Submittal of this plan to the Remedial Projects Section for review and approval is required per (R18-16-411(E)).

Remedial Projects Unit – Reports

A WQARF Program facility or its contractor or a WQARF Program contractor prepare reports that typically contain data collected from field efforts. Described below are those reports:

- a. A major function of a **Preliminary Investigation (PI) Report** (AAC R18-16-201(I)) is to describe all historical data collected for a site and its surrounding area, including any new information collected. The purpose is to determine the potential risk to public health, welfare, and the environment in order to score the site and include it on the registry established under ARS § 49-287.01(D). Please note that new data collection occurs infrequently for a PI report. A data quality review for all historical and new data are included in this report.
- c. A major function of a **Remedial Investigation Report** (AAC R18-16-406(H)) is to provide site characterization information, details on all new data collected - including information on the nature and extent of contamination and its risk with respect to human health and the environment.

This report also provides a current conceptual site model and a list of Remedial Objectives based on the current and reasonably foreseeable uses of the property.

- d. A major function of a **Feasibility Study Report** (AAC R18-16-407(C & D)) is to provide analysis of remedial alternatives, provide demonstrations that remedial objectives will be met using each alternative, and propose a remedy. Collection of new data assists in analysis of remedial alternatives and is included into the Feasibility Study Report.
- e. A major function of **Operation & Maintenance (O & M) Reports** (AAC R18-16-411 (E)) is to provide analysis of performance of a remedial system with respect to attaining the remedial objectives.
- f. A major function of a **No Further Action** request (AAC R18-16-414) is to provide the Remedial Projects Section the necessary information to assist in determining whether a facility has met its remedial objectives or that no remedial action is necessary..

Voluntary Remediation – Planning Documents

The planning document for a facility utilizing the Voluntary Remediation Program is the Work Plan (ARS § 49-175). The Work Plan can address either the characterization or remediation phase of a projects life cycle.

- a. The major functions of a **Voluntary Remediation Program Work Plan** are to: 1) provide a summary of existing information on site characterization; 2) to provide a plan for characterization for a site or portion of a site that has not been characterized; 3) provide a summary of any remedial work that has occurred at the site; and 4) provide a plan for remediation at the site or portion of a site, if needed, that ensures that there will be no unacceptable risk to human health and the environment after remediation is completed.

*Please note: the Voluntary Remediation Program Work Plan framework generally follows EPA's May 2014 Sampling and Analysis Plan Guidance and Template (R9QA/009.1) construct. ADEQ has adopted this EPA document as a Substantive Policy Statement.

Also, please note VRP follows the WQARF Program process if contamination extends offsite.

Voluntary Remediation – Reports

The Voluntary Remediation Program reports that typically contain data collected from field efforts are typically prepared by the property owner or their contractor. Below are descriptions of these reports:

- a. A major function of the **Progress Reports** is to report data collected so the Remedial Projects Section can determine the effectiveness of characterization and remediation efforts.
- b. The primary function of the **No Further Action Request Report** (ARS 49-181) is to provide the Remedial Projects Section with information to determine whether characterization and/or remedial efforts have been effective to ensure ensures that there will be no unacceptable risk to human health and the environment.

Federal Projects – Planning Documents

Figure A2 identifies four types of Federal Projects planning documents that describe sampling activities and/or analysis of historical data. Responsible parties under CERCLA or their contractors prepare planning documents. Below are descriptions of these reports:

- a. The major function of a **Preliminary Assessment (PA) Work Plan**, performed under CERCLA guidance for an investigation on a Comprehensive Environmental Response, Compensation and Liability Information System or Superfund Enterprise Management site, is to provide a description of proposed work that establishes known site conditions. Also, if needed, the PA Work Plan provides a description of additional field work. This limited-scope investigation includes a site and environs reconnaissance. A preliminary assessment will collect and describe readily available information. This information assists in determining a sites potential risk to public health, welfare, and the environment and distinguishes between sites that pose little risk and sites that require further investigation. These Work Plans are constructed to follow EPA’s September 1991 Guidance for Performing Preliminary Assessments Under CERCLA (EPA/540/G-91/013).
- b. The primary function of a **CERCLA Remedial Investigation Work Plan** is to provide a description of proposed work for determining the nature and extent of contamination at a site. A CERCLA Remedial Investigation Work Plan also provides a description of proposed work for determining if certain remedial technologies are technically feasible with respect to treating contaminants. These Work Plans are constructed to follow EPA’s September 1992 Guidance for Performing Site Inspections Under CERCLA (EPA/540-R-92-021).
- c. The primary function of a **CERCLA Feasibility Study Work Plan** is provide a plan to identify a reference remedy and alternative remedies that appear to be capable of achieving remedial objectives. The FS Work Plan also provides a plan to evaluate the cost and performance of potential technologies anticipated to assist in remediating a site.
- d. A primary function of a **CERCLA Record of Decision** is to detail the description of the chosen remedy at a site and provide the measures for accomplishment of remedial objectives. It contains descriptions of site history, site description, site characteristics, community participation, enforcement activities, past and present activities, contaminated media and contaminants present. It also includes considerations for potential future uses at the site.

Federal Projects – Reports

The Federal Projects reports typically contain data collected from field efforts. The responsible party or their contractor typically prepare the reports. Below are descriptions of these reports:

- a. The major function of a **CERCLA Preliminary Assessment (PA)** is to describe all historical data collected for a site and its surrounding area, including any new information collected. This information assists in determining a sites potential risk to public health, welfare, and the environment and distinguishes between sites that pose little risk and sites that require further investigation. The PA also identifies sites requiring assessment for possible emergency response actions, which the Federal Project Unit or their contractor typically performs. Please note that new data are usually collected only infrequently for a PA report. A data quality review for all historical and new data are included in this report.
- b. A major function of a **CERCLA Remedial Investigation Report** is to provide site characterization information and detail all new data collected - including information on the extent of contamination and its risk with respect to human health and the environment. This

report also provides a list of Remedial Objectives based on the current and reasonably foreseeable uses of the property.

- c. A major function of a **CERCLA Feasibility Study Report** is to provide the Remedial Projects Section an analysis of remedial alternatives and provide demonstrations that remedial objectives will be met using each alternative. Data collected for assisting in analysis of remedial alternatives is included in the Feasibility Study Report.
- d. A major function of **CERCLA Operation & Maintenance (O & M) Reports** is to provide analysis to the Remedial Projects Section of performance of a remedial system with respect to attaining the remedial objectives. These O & M Reports detail all new data collected subsequent to the previous O & M Report.
- e. A major function of **Progress Reports** is to provide details on all new collected data to the Remedial Projects Section for the purpose of determining the effectiveness of remedial efforts.
- f. A major function of **Remedial Action Completion Reports (RACR)** is to provide the Remedial Projects Section necessary information to assist in determining whether a facility has met its remedial objectives as specified in the ROD and all other applicable legal documents.

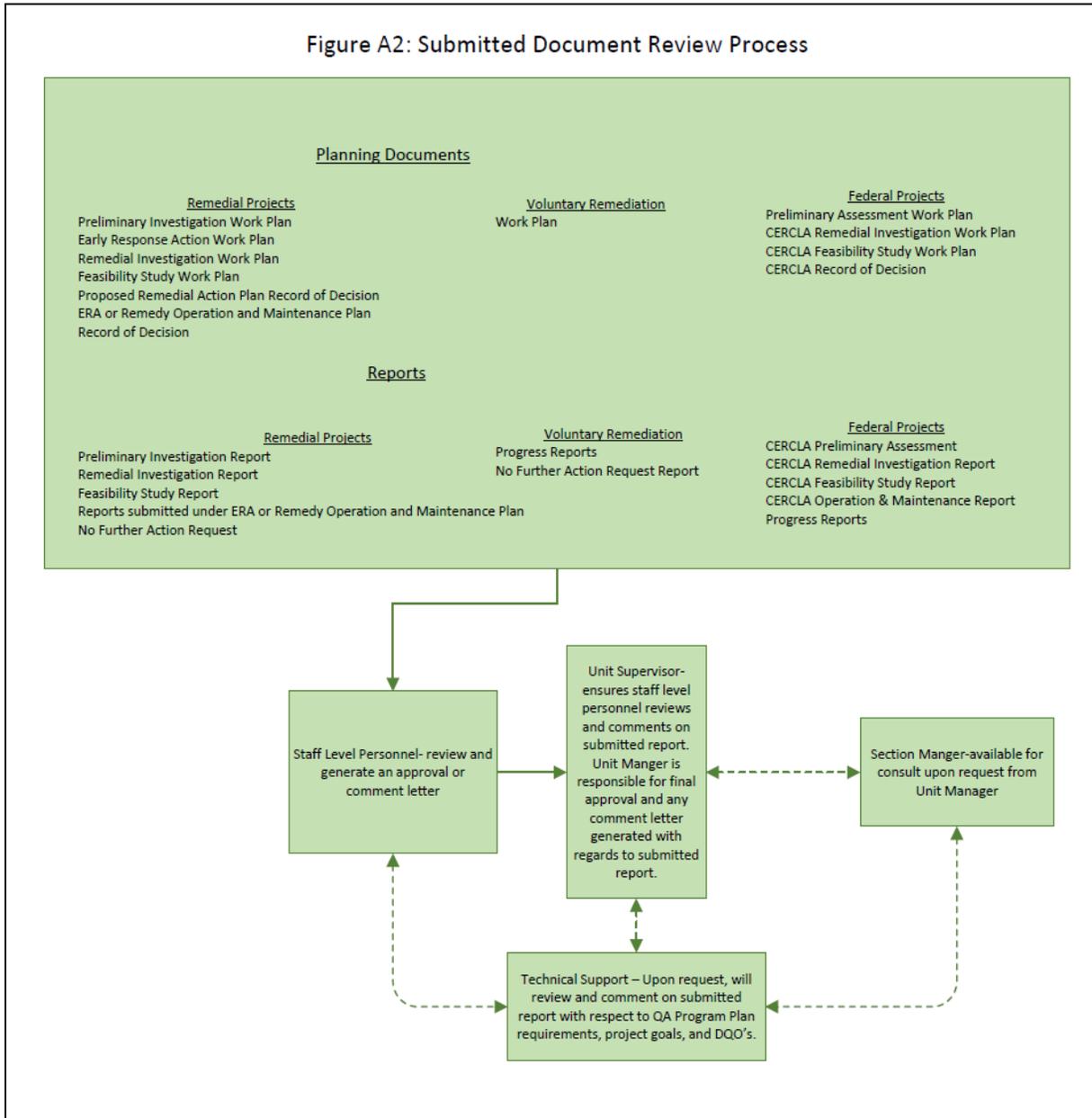
Supporting documentation relevant to data generation and data quality must be attached to the final report, either in a hard-copy or electronic format. Generally, the report has all field documentation attached in a hard-copy format. Also, the report has a copy of the laboratory data package attached in an electronic format - with the exception of the chain of custody forms and the actual laboratory analytical sheets, which should be included in hard-copy format.

The documentation of all environmental data collection activities must meet the following minimum requirements:

- Documentation of data must be direct, prompt, and legible. All reported data must be uniquely traceable to the raw data. Documentation of all data reduction formulas must occur.
- All original data records include, as appropriate, a description of the data collected, units of measurement, unique sample identification, station or location identification (if applicable), name (signature or initials) of the person collecting the data, and date of data collection.
- Any changes to the original (raw data) entry must not obscure the original entry. The person making the change must document the rationale and initial and date the change.

In addition, EPA's 2007 [*Guidance for Preparation of Standard Operating Procedures for Quality-Related Operations*](#) is a guidance for developing SOPs for data collection. SOPs should be included as an appendix of all planning documents and reports (see Figure A2) submitted to ADEQ's Remedial Project Section personnel. Any QA/QC reports (see Sections C2.2 and C2.3), if produced, should be included as an appendix of all planning documents and reports submitted to ADEQ's Remedial Project Section personnel. The field team – ADEQ staff, ADEQ contractors, or Owner/Operator contractors - should document the rationale for any deviations from an SOP and include that documentation in all planning documents and reports submitted to ADEQ's Remedial Project Section personnel.

Figure A2: Submitted Document Review Process



A4.2.2 Planning Documentation and Report Approval

After review of the planning document, report, and/or comments received during any required public comment period, the Remedial Projects Staff Level Personnel will take one of three actions through written correspondence to the party submitting the planning document or report. These actions are:

- a. If the planning document or report is fully satisfactory, Staff Level personnel will draft an approval letter for review. The Unit Supervisor is responsible for Final Approval of the letter.
- b. If the planning document or report has minor deficiencies, staff level personnel will: 1) comment and request a modified planning document or report; or 2) approve the planning document or report and require the next report to address the minor deficiencies. The Unit Supervisor is responsible for Final Approval of the letter. Technical Support is available at all stages of the process for consult.
- c. Where there are major deficiencies in a plan or report, Staff Level personnel and/or their contractor will review the document and draft a comment letter, indicating the deficiencies and clarifications needed. The Unit Supervisor will issue Final Approval to the comment letter. Technical Support is available at all stages of the process for consult.

Figure A2 details the review process for submitted Plans and required reports within the Remedial Projects Section.

The facility will provide a Responsiveness Summary to document their responses to the Remedial Projects Section's comment letter. If those responses are not satisfactory to the Remedial Projects Section, then a meeting with the facility and their contractor occurs to work out any remaining differences. During the entire review process, a facility is welcome to request a technical assistance meeting with the Remedial Projects Section personnel, and, if desired, the contractors involved with the project.

A4.2.3 Field Documentation

Though largely discussed elsewhere in this document, the environmental consultant is required to maintain certain levels of field documentation to help demonstrate compliance with approved methods and assist reviewers in making QA/QC conclusions. Examples of required field documentation can include field logs, monitoring well sampling logs and chain-of-custody forms for environmental samples. Requests for field documentation and the analytical laboratory data package are part of the independent data validation. Submittal of hard copy field documentation is part of the required report.

A4.2.4 Laboratory Analytical Package

A detailed data package produced by the analytical laboratory allows for review of analytical methods through data verification and validation processes and to determine appropriateness of data quality. Other sections of this QA Program Plan discuss the specific content requirements for laboratory data packages. The laboratory data package can be in an electronic format, with the exception of the chain of custody forms and the laboratory analytical sheets, which should be included in hard-copy format.

Typical data packages include the following information (also listed in Table D1 of this plan):

- Holding times
- Calibration● Blanks

- Surrogate recovery
- Matrix spike and matrix spike duplicate recovery
- Laboratory control sample or blank spike
- Internal standard performance
- Field duplicate sample analysis
- Temperature
- Overall assessment of data for an SDG

A5: Problem Definition/Background

ADEQ Remedial Projects Section administers investigative and remedial measures for hazardous substances through the Arizona Revised Statutes and Arizona Administrative Code. The regulations establish a system for identifying, investigating and remediating hazardous substances beginning with discovery of its release into the environment and ending in site closure. In practical terms, this means regulating a large number of facilities that handle hazardous substances. In administering the regulations, the Remedial Projects Section performs targeted education and outreach functions to facilities and the general public.

A6: Program/Task Description

Please see sections A.4.1.2 (Staff Level Personnel Remedial Projects Section), A4.2, and A5 for details on the Remedial Projects Section and Task Descriptions.

A7: Quality Objectives and Criteria for Measurement Data

This section is broken into two parts, consistent with EPA Region 9 guidance for QA Program Plans. The first section documents regulatory levels that are specific to the ADEQ; these regulatory levels serve as the driver for site assessments and cleanup. The second section discusses measurement quality objectives (MQOs) and data quality indicators (DQIs) under the Remedial Projects Section.

DQIs, as defined by EPA, involve precision, accuracy, representativeness, completeness, comparability, and sensitivity, also known as “PARCCS” parameters. Utilization of DQIs is part of the data evaluation processes. In general, project data quality needs (i.e. the MQOs) determine PARCCS parameters. The extent to which program or project QC results meets MQOs determines whether data are acceptable for the intended use.

MQOs are the acceptance thresholds or goals for project data, usually based on the individual DQIs for each matrix and analyte group or analyte. MQOs are project-or method-specific quality acceptance criteria established to support project-specific DQOs, as well as decisions made based on the quality of the data. MQOs define whether the data are usable and meet project needs. Like DQOs, MQOs can be quantitative or qualitative statements.

MQOs specify what the QC acceptance criteria are for each analysis. AAC R9-14-615 (see Appendix A) details QA requirements for ADHS licensed laboratories. Regardless of how the laboratory evaluates performance, the laboratory’s acceptance criteria must meet the needs of each project. This QA Program Plan provides general requirements, but individual planning documents (see A4.2 Planning and Reporting

Documentation) will provide project-or site-specific requirements. Tables A1 through A3 are examples of the QC data from laboratories ADEQ typically receives.

Table A1. Typical QC data from laboratories. This is an example for water samples using EPA Method 8260B.

Compound (Laboratory Method - EPA Method 8260B)	Matrix Spike (% Recovery Limits) Matrix Spike Duplicate (Relative % Difference)	Laboratory Control Sample (% Recovery Limits) Laboratory Control Sample Duplicate (Relative % Difference)	Method Blank Result (µg/l) Method Detection Limit (ug/l)	Surrogates (% Recovery Limits)	
Benzene	68-131	68-130	ND		
	32	20	2.0		
Carbon Tetrachloride	65-147	60-150	ND		
	35	25	5.0		
PCE	67-131	70-130	ND		
	31	20	2.0		
TCE	66-132	70-130	ND		
	29	20	2.0		
Dibromofluoromethane					70-130
Toluene					70-130
4-Bromofluorobenzene				70-130	

PCE: tetrachloroethylene

TCE: trichloroethylene

ND: non-detect

µg/L: micrograms per liter

%: percent

Table A2. Typical QC data from laboratories. This is an example for soil samples using EPA Method 8310.

Compound (Laboratory Method - EPA Method 8310)	Matrix Spike (% Recovery Limits)	Laboratory Control Sample (% Recovery Limits)	Method Blank Result (mg/l)
	Matrix Spike Duplicate (Relative % Difference)	Laboratory Control Sample Duplicate (Relative % Difference)	Reporting Limit (mg/l)
Naphthalene	10-143	38-126	ND
	50	18	0.20
Benzo[a]pyrene	18-134	48-137	ND
	50	32	0.010
Chrysene	23-136	69-128	ND
	50	31	0.020
Dibenz[a,h]anthracene	21-137	73-130	ND
	49	31	0.010
Surrogate % Recovery Limits	2-Chloroanthracene 18-128	2-Chloroanthracene 62-124	2-Chloroanthracene 18 -128

mg/L: milligrams per liter

%: percent

Table A3. Typical QC data from laboratories. This is an example for water samples using EPA Method 8081A.

Compound (Laboratory Method 8081AZ)	Matrix Spike (% Recovery Limits)	Laboratory Control Sample (% Recovery Limits)	Method Blank Result (µg/l)
	Matrix Spike Duplicate (Relative % Difference)	Laboratory Control Sample Duplicate (Relative % Difference)	Method Detection Limit (µg/l)
4,4-DDT	10-161	61-126	ND
	20%	35%	0.007
Aldrin	10-143	43-120	ND
	20%	33%	0.009
Endrin	10-147	67-122	ND
	20%	35%	0.007
Heptachlor	10-157	51-124	ND
	20%	33%	0.008
Surrogate % Recovery Limits		Decachlorobiphen 10 -103%	
Surrogate % Recovery Limits		TCMX(S) 10-132%	

µg/L: micrograms per liter

%: percent

A7.1 Regulatory Levels

ADEQ has authority to require owners and operators to conduct remedial/corrective actions at the site of a release. A remedial action is defined at ARS § 49-281 and a corrective action is defined at ARS § 49-1001 and cross-referenced to ARS § 49-1005. The terms are similar in that each refers to actions intended to stop, minimize and mitigate damage to the public health and the environment. Therefore, ADEQ has the authority to set regulatory levels for investigation and remediation of soil, groundwater and surface water.

Discussed below are two areas of Arizona's regulations. These two areas are (1) the release reporting regulations, which govern the initiation of remedial investigations, and (2) the establishment of regulatory levels specific to site media.

A7.1.1 ADEQ Release Reporting Regulations

The State of Arizona has adopted regulations that govern the reporting of releases of pollutants, contaminants, petroleum products and hazardous substances. These regulations are contained in the AAC Title 18. The enabling authority for these regulations is contained in several statutes adopted by the

Arizona Legislature. ARS – Title 49 contains provisions for the regulation of Water Quality, Air Quality, Solid Waste Management, Hazardous Waste Disposal and Underground Storage Tanks.

These enabling authorities allow Arizona to adopt reporting requirements that would be protective of state water resources and would also be consistent with federal hazardous waste requirements. The model for the State release reporting regulations comes from two federal sources: (1) reportable quantities of hazardous substance as contained in CERCLA and (2) reportable quantities of petroleum product described in RCRA Subchapter IX.

A7.1.2 Establishment of Media-Specific Regulatory Levels

ADEQ has authority to require owners and operators to conduct corrective/remedial actions at the site of a release. A remedial action is defined at ARS § 49-281 and a corrective action is defined at ARS § 49-1001 and cross-referenced to ARS § 49-1005. The terms are similar in that each refers to actions intended to stop, minimize and mitigate damage to the public health and the environment. Therefore, ADEQ has the authority to set regulatory levels for investigation and remediation of soil, groundwater and surface water.

Remediation Standards for Soils

AAC Title 18, Chapter 7 Article 2 (Soil Remediation Standards) establishes remediation standards for soils. ADEQ has three standards for soil: Background, Pre-determined and Site Specific. Appendix B contains the weblinks for Arizona's Soil Remediation Standards rule which details how each standard is established. The weblink for Soil Remediation Standards is http://www.azsos.gov/public_services/Title_18/18-07.htm. Appendix B also contains a table that list regulatory levels for chemicals found at typical ADEQ Remedial Project Section sites.

Water Quality Standards for Groundwater and Surface Water

AAC Title 18, Chapter 11 (Water Quality Standards) establishes remediation standards for groundwater and surface water. Articles 1 and 4 establish water quality standards for surface water and aquifer water, respectively. Appendix C contains the weblinks for Arizona's Water Quality Standards rule. The weblink for Water Quality Standards is http://www.azsos.gov/public_services/Title_18/18-11.htm. Appendix B also contains a table that list regulatory levels for chemicals found in common petroleum products.

Please note that for those chemicals that do not have an established Aquifer Water Quality Standard, the Narrative Aquifer Water Quality Standards (AAC R18-11-405) apply.

A7.2 Measurement Quality Objectives and Data Quality Indicators

Analysis involves the characterization of samples based on chemical and/or physical properties. Analyses result in generating raw data from instrumental analysis, chemical analysis, or physical testing. The analytical methods used will be specific, sensitive enough to answer the question posed by the Remedial Projects Section objectives and meet the data quality goals associated with those objectives.

MQOs are the project or program QC criteria defined for various DQIs. During the planning phase, these set pre-determined limits on the acceptability of the data in regards to accuracy/bias, and precision, completeness and sensitivity.

ADEQ Project Managers may consult with the ADEQ QA/QC Manager or QA/QC Representatives, or research a variety of published or written materials, to aid them in selecting or developing measurement technologies. The ADEQ QA/QC Manager or QA/QC Representatives shall maintain a file of in-house procedures and practices used in the measurement process. ADEQ's QA/QC Manager

or QA/QC Representatives use DQO's and professional knowledge to identify appropriate analytical procedures.

DQIs, as defined by EPA, involve precision, accuracy, representativeness, completeness, comparability, and sensitivity, also known as "PARCCS" parameters. Utilization of DQIs is part of the data evaluation processes. In general, project data quality needs (i.e. the MQOs) determine PARCCS parameters. The extent to which program or project QC results meets MQOs determines whether data are acceptable for the intended use.

Each DQI helps interpret and assess specific data quality needs for each sample medium/matrix and for each associated analytical operation. The following summaries contain a description of each DQI along with a brief summary of information, related to assessing each DQI:

Precision

Precision is the degree of agreement among repeated measurements of the same parameter under the same or similar conditions. Reporting precision as either relative percent difference (RPD) or relative standard deviation (RSD) depends on the end use of the data. Collection and analysis of field duplicate samples assists in assessing field precision. Laboratory matrix spike/matrix spike duplicate (MS/MSD) analyses is the basis for laboratory precision.

Accuracy

Accuracy is the extent of agreement between an observed or measured value and the accepted reference, or true, value of the parameter. For example, the objective for accuracy of the field sample collection procedures is to ensure that samples stay unaffected by sources external to the sample, such as sample contamination by ambient conditions or inadequate equipment decontamination procedures. Evaluating the results of equipment blank samples for contamination is an assessment of sampling accuracy. Pervasive contamination found in equipment blank results will prompt further investigation or reanalysis of samples. Laboratories assess accuracy by determining percent recoveries from the analysis of laboratory control samples (LCSs) or standard reference materials.

Representativeness

Representativeness is a qualitative term that describes the extent to which a sampling design adequately reflects the environmental conditions of the site. It also reflects the ability of the sample team to collect samples and laboratory personnel to analyze those samples in such manners that the data generated accurately and precisely reflect the conditions at the site.

Completeness

Completeness is the measure of the quantity of valid data obtained from a measurement system compared to the quantity expected under normal conditions. While a completeness goal of 100 percent (%) is desirable, achieving an overall completeness goal of 90% is more realistic under normal field sampling and laboratory analysis conditions.

Comparability

Comparability is a confidence measure of comparisons between data sets. The ability to compare data sets is particularly critical when comparing a set of data for a specific parameter to historical data for the purpose of determining trends. Ensuring adherence to property-specific Site Assessment Plans and properly handling and analyzing all samples will satisfy the comparability of field data.

Sensitivity

Sensitivity is the ability of a method or instrument to detect a parameter at a specific measured level of

interest. For example, the sensitivity measurements of the field instruments that measure temperature, pH, conductivity, and turbidity of groundwater occurs by analyzing calibration check solutions, where appropriate, that equate to the lower end of the expected concentration range.

Sensitivity relates to the reporting limit. In this context, sensitivity refers to the capability of a method or instrument to detect a given analyte at a given concentration and reliably quantitate the analyte at that concentration. The investigator should be concerned that the instrument or method can detect and provide an accurate analyte concentration that is not greater than an applicable standard and/or screening level. Analytical results for samples that are non-detect for a particular analyte that have reporting limits greater than the applicable cleanup standards and/or screening levels cannot be used to demonstrate compliance with the applicable cleanup standards and/or screening levels.

The issue of analytical sensitivity may be one of the most difficult to address as it pertains to data usability evaluations. Samples contaminated with sufficient quantity of material may require diluting prior to laboratory analysis. Dilution is a leading cause of reporting limits exceeding applicable criteria. However, there may be instances where such exceedances are insignificant relative to the site specific DQOs. As an example, the project may be on-going and/or other compounds are “driving” the cleanup such that not meeting applicable criteria for all compounds at that particular juncture is not an issue.

A8: Special Training/Certification

A8.1 Responsibilities

ADEQ’s Unit Supervisors are responsible for ensuring each staff member involved with collecting or analyzing environmental data has the necessary technical, quality assurance, and project management training required for his or her assigned tasks and functions. Section Managers are also responsible for ensuring that technical staff maintains the necessary level of proficiency to effectively meet ADEQ’s QA/QC responsibilities. ADEQ’s QA/QC Manager or QA/QC Representatives will serve as the Agency resource for arranging for, and assisting in, defining QA/QC training needs on a regular basis to update Program staff with developing QA/QC issues.

A8.2 Identification of Training Needs

Core training will be coordinated through the QA/QC Manager or QA/QC Representatives in conjunction with various Division supervisory personnel. Intermediate and advanced skill training will be arranged when the appropriate Agency staff identify the need. The QA/QC Manager or QA/QC Representatives, in conjunction with Program management, will identify continuing professional training requirements and address those requirements utilizing external resources for the latest technological advances and evolution in industry standards.

A8.3 Implementation of Training Requirements

ADEQ staff members are encouraged by their managers/supervisors to draw upon their educational background, experience, technical training, and on-the-job training to enhance their understanding and performance of QA-related procedures.

ADEQ’s training program will offer, or arrange for through a third-party vendor, courses on the following subject matter on a schedule and frequency suited to meet the needs of ADEQ’s staff with QA

responsibilities:

- An Orientation to Quality Assurance Management
- Establishing Data Quality Objectives
- Preparing Quality Assurance Project Plans
- How to Perform a Preliminary Data Review
- Public and Confidential Records Management

In addition, they will be encouraged to attend meetings and seminars, and to take formal training, in accordance with ADEQ's training policy, to enhance their understanding of Program specific QA requirements within the Programs they work. ADEQ's QA/QC Manager or QA/QC Representatives will maintain a record of all QA training taken by staff and managers responsible for environmental data generation. In addition, all planning documents and reports listed in Figure A2 are required (AAC R18-12-264) to have an Arizona Professional Registrant's signature and seal.

A9: Documents and Records

A9.1 QA Program Plan Revisions

Throughout the life of ADEQ's Remedial Projects Section, there may be changes to program requirements, or modifications to the way environmental data are collected, or changes to the definitions of enforcement activities. Therefore, this QA Program Plan is a dynamic document that is subject to revision, as needed. ADEQ Remedial Projects Section personnel, Technical Support and QA/QC personnel will examine and revise this QA Program Plan annually. Re-submittal of this plan to the EPA Region 9 QA manager for review, though, will occur once every five years or as otherwise needed. Dissemination of approved revisions include personnel on the Distribution List (page 6).

A9.2 Environmental Data Documentation

This QA Program Plan and referenced policy, guidance and SOPs include written procedures for all methods and procedures related to the collection, processing, analysis, reporting, and tracking of environmental data. All data generated for and submitted to ADEQ's Remedial Projects Section, including data from split sampling and inspections, must be of sufficient quality to withstand challenges to their validity, accuracy and legibility. To meet this objective, utilization of standardized formats and prescribed procedures occurs to record data. The documentation of all environmental data collection activities must meet the following minimum requirements:

- Document data directly, promptly, and legibly. All reported data must be uniquely traceable to the raw data. Document all data reduction formulas.
- All original data records include, as appropriate, a description of the data collected, units of measurement, unique sample identification, station or location identification (if applicable), name (signature or initials) of the person collecting the data, and date of data collection.
- Any changes to the original (raw data) entry must not obscure the original entry. Document the reason for the change. The person making the change initials and dates the change.

Discussions of other specific documentation requirements are throughout this QA Program Plan and referenced SOPs.

A9.2.1 Field Documentation and Forms

Completion of appropriate field documentation and forms for each sample is the responsibility of the field personnel. Field personnel accomplish the following: 1) maintain records for each field activity to ensure that samples and data are traceable and defensible; 2) document field records on field forms or in designated field logbooks to provide a secure record of field activities, observations and measurements during sampling; and 3) record field data and observations in real time on activity-specific data forms. Section “B5.1 – Quality Control in the Field” provides a more complete description of the types of recorded field information.

A9.2.2 Project Files

Remedial Projects Section personnel are responsible for the maintenance of the project file. The project file will consist of all site documents specifically listed in Section A4.2 of this QA Program Plan. Additionally, Remedial Projects Section personnel will collect and include in the project file all other relevant project documentation in the file. These additional documents may include any official correspondence that does not correspond to any of those previously listed documents. The project file will also include all information not related to data generation, including documentation of all public involvement or community notification efforts.

A9.3 Routine Records Management Quality Assurance

ADEQ Records Management Process addresses the system employed by the Agency for handling documents. This plan outlines the roles and responsibilities for management and staff concerning chain of custody procedures and records management.

ADEQ document control procedures require that documents generated, or obtained, by Agency personnel are accounted for when a project is completed. ADEQ’s Records Management System dictates the procedures for checking-in and checking-out files for ADEQ staff, external clients, and the public.

ADEQ managers/supervisors/directors will ensure achievement that the objectives of the Records Management Process. These objectives include the following:

- Prevent the creation of unnecessary records in any media;
- Promote the continuous development of filing systems and structures that allow for the efficient organization, maintenance, and retrieval of records;
- Ensure that records of continuing value are preserved, but that valueless or noncurrent information is disposed of or transferred to storage in a timely manner in accordance with ADEQ and/or ADHS records retention requirements;
- Ensure that the acquisition and use of all direct paper to microform systems and equipment, or electronic digital imaging, are technically feasible, cost-effective, and most importantly, satisfy Program needs;
- Preserve and protect information that is vital to the essential functions or mission of the organization. Preserve and protect information that is essential to the legal rights and interests of individual citizens and the government.

ADEQ maintains an internal electronic database to track project related documents. This database, **Arizona Unified Repository for Informational Tracking of the Environment** or AZURITE, maintains lists of project related documents. Electronic back-up of this database occurs on a nightly basis.

ADEQ currently maintains an internal electronic groundwater quality database to track groundwater sampling results collected from ADEQ Remedial Projects Section projects. Electronic back-up of this database occurs on a nightly basis.

GROUP B: DATA GENERATION AND ACQUISITION

B1: Sampling Design/Experimental Design

Remedial Projects Section conduct site investigations to determine if site media are contaminated. Further investigations follow to determine characteristics of the contamination if the initial phase of the investigation finds evidence of contamination. Characterization includes evaluating the threat posed by the contamination and determining potential solutions for cleanup of the contamination. This QA Program Plan documents the planning, implementation, and assessment procedures for data generated for and submitted to ADEQ's Remedial Projects Section. It describes specific applications of QA and QC activities throughout the course of investigations and cleanup.

A Remedial Projects Section site investigation routinely involves one or more of the following activities: a background investigation on the history of site use, a field investigation that includes sample collection and analysis, an evaluation of cleanup options and costs and an assessment of the usability of resulting data. Typically, the first step is to conduct an investigation of site history to identify past uses of the property, including types and amounts of chemicals that may have been used onsite and any disposal activities that may have contributed to contamination.

This QA Program Plan includes requirements for measurements collected for a typical facility. The conceptual site model (CSM) largely dictates the specific design and extent of a facility site investigation, resource needs, and the required level of data quality and QC. Planning documents outline and describe project-specific DQOs and sampling design.

The following sections describe sampling and analysis requirements in the Remedial Projects Section. Site-specific information required in project-specific planning documents includes the number and location of samples, types of samples to be collected, measurement parameters, sampling frequencies, design of sampling networks for monitoring and the time period over which sampling activities are to occur. Review and approval by Remedial Projects Section personnel is required for all project-specific planning documents.

Section B5.1 has additional discussion on sampling and equipment decontamination procedures.

B1.1 Sampling Design

A sampling design specifies the number and location of samples collected at a site. Study objectives guide sampling design strategies. Sampling design strategies should factor in the conditions unique to the site, including data gaps in the CSM, exposure potential, projected site reuse, and available resources. As noted above, identification of sampling design strategies occurs during the systematic planning process and the project-specific planning document contains descriptions of the sampling design strategy.

Typical designs for the collection of samples at Remedial Projects Section sites include biased sampling, statistically based sampling, one-time events, and ongoing (multi-phase) events. Biased sampling specifies sampling locations based on the judgment of the field team leader and sampling plan designer. Statistically based sampling designs use random or systematic sampling locations designed to avoid bias, as with investigation exposure area decision units at mining sites

A key distinction in sampling design is between judgmental sampling (also called authoritative or biased sampling), in which sample numbers and locations are selected based on expert knowledge of the

problem, and probability-based sampling, in which sample numbers and locations are selected based on randomization and each member of the target population has a known probability of being included in the sample. Judgmental sampling has advantages for source area decision unit investigations, such as investigations involving dry cleaners.

Probabilistic sampling typically takes more effort to implement than judgmental sampling. However, a probability-based sampling design has the advantage of allowing the use of statistical tests, which permit specification of confidence and uncertainty of the results. Probability-based designs do not preclude the use of expert knowledge or the use of existing data to establish the sampling design. An efficient sampling design is one that uses all available prior information to stratify the site (in order to improve the representativeness of the resulting samples) and set appropriate parameters. Common types of probabilistic sampling designs include simple random, stratified, systematic and grid, composite, and others. Section 2 of EPA's 2002 *Guidance on Choosing a Sampling Design for Environmental Data Collection* explains the difference between these types of probabilistic sampling designs.

Please note that a single sampling event may not provide an adequate characterization of the contamination onsite, especially when the CSM contains significant data gaps. In these situations, multi-event sampling may be helpful. The systematic planning process should help identify the need for this sort of investigation.

Additional information on the development of sampling strategies is available in ADEQ's 2014 *Site Investigation Guidance Manual*, EPA's 2002 *Guidance on Choosing a Sampling Design for Environmental Data Collection*, EPA's 2006 *Guidance on Systematic Planning Using the Data Quality Objectives Process*, and EPA's 2007 *Guidance for Developing Standard Operating Procedures*.

B1.1.1 Sample Types and Matrices

Sample types typically include surface soil, subsurface soil, groundwater and surface water. Some sites require sampling of sediment, pore water, sludge, air (soil gas or vapors) and other non-routine matrices such as building materials. Samples collected can be discrete (grab) or composite samples. Discrete samples are useful for identifying and quantifying chemicals in areas of a site where there is suspected contamination. The number of discrete samples should be determined during the systematic planning process. Composite samples are useful for identifying the average concentrations of contaminants across a site. Composite samples are composed of more than one discrete sample collected from different locations. Submittal to the analytical laboratory as a single sample occurs after mixture of the samples into a single homogeneous sample. Multi-increment (MI) samples represent a specific type of composite sample (see Incremental Sampling Methodology, Interstate Technical Regulatory Committee (ITRC) February 2012 <http://itrcweb.org/ism-1/>). The goals established during the systematic planning process determine the number of composite samples and the number of individual samples within a composite sample.

Background samples should be collected from the same media as site samples, from areas on or near the site that are unlikely to be contaminated by site-related chemicals. Analysis of background samples for the same parameters as the site samples assists in determining background concentrations of chemicals. Typically, collection of background data for naturally occurring inorganic chemicals, such as metals, occurs. The typical assumption for manmade organic chemicals background concentrations is 0%. It is the responsibility of the applicant to demonstrate if there is an "anthropogenic background" for organic chemicals that is unrelated to site activities.

B1.1.2 Sampling Locations and Frequencies

Identification of sampling locations and schedule for sampling occurs during the systematic planning process. The sampling duration and frequency or whether the work will be done in phases is also determined during the systematic planning process. For instance, if initial investigations indicate that contaminant levels in soils are below regulatory thresholds, no additional sampling would be required. If initial investigations indicate contaminant levels in soils are above cleanup standards, additional sampling would be required during remedial activities and/or post remedial activities.

B1.1.3 Parameters of Interest

The measurements to be collected at a site depend on the characteristics and history of the site. This QA Program Plan provides QA/QC information for parameters and media typically analyzed for Remedial Projects Section sites. Unusual parameters and matrices will necessitate preparation of a project-specific planning document. Section B2 of this QA Program Plan discusses this topic in more detail.

B1.1.4 Sampling Event Planning

Advance planning for field sampling events is required to ensure that the necessary arrangements are in place and that equipment is ready. Listed are considerations when planning a sampling event:

- 1) Sample Handling and Custody Procedures— Field personnel will make arrangements with the appropriate laboratory for proper sample containers and custody procedures (described further in Section B3).
- 2) Equipment— Prior to collection of any sample, field personnel will ensure that all sampling equipment has been properly assembled, decontaminated, calibrated and is functioning properly prior to use. Field personnel must use equipment according to manufacturer's instructions and decontaminate equipment according to the EPA SOP-Sampling Equipment Decontamination (see Appendix D of this QA Program Plan).
- 3) Field Forms— Prior to the sampling event, field personnel will assemble all necessary field forms, such field log books, soil and groundwater sampling forms, and boring logs. Site specific needs establish the need for developing site specific forms.
- 4) Health and Safety— Field personnel will ensure that all site-specific health and safety procedures are considered and that personal protective equipment (PPE) is gathered.
- 5) Investigation-Derived Waste— Field personnel will plan for the generation of investigation-derived waste (IDW), and should assemble the appropriate IDW containers prior to the sampling event.
- 6) Field Audits— Field personnel will plan to conduct periodic field system audits for ongoing sampling events.
- 7) Paperwork and Permits— Field personnel will also ensure prior to the sampling event that other applicable paperwork is in order, such as permits and access agreements.

B2: Sampling Methods

The systematic planning process and project-specific planning documents establish site-specific sampling methods as well as the numbers and types of samples collected. Details of sample collection methods will depend upon site conditions, equipment limitations, chemicals of concern, sample matrices, and cost. Collection methods will follow an ADEQ or EPA approved sampling protocol, unless unforeseen circumstances do not allow for an approved collection method. The following sections present general information on sampling methods for various media, including surface water, groundwater, drinking water, soil, soil vapor, sediment, pore water, sludge, air, and non-routine matrices such as building materials.

Additional methods proposed to use need approval of the Remedial Projects Section. General guidelines for field sampling are included in the EPA Standard Operating Procedure (SOP) on General Field Sampling Guidelines (see Appendix D). EPA SOPs for field sampling methods are available for download at https://clu-in.org/publications/db/db_search.cgi?title=1&submit_search=1&cat=18.

B2.1 Soil Samples

Soil samples collected at Remedial Projects Section sites may include surface and subsurface samples. Sample types may be discrete or composite samples. There are a variety of acceptable methods for collection of soil samples. Selection of an appropriate method will depend on site conditions and the sampling design. Methods commonly used to collect soil samples include drilling soil borings, digging test pits, sampling via hand auger, and digging with a shovel or trowel. Additional information on the collection of soil samples can be found in EPA's 1992 *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies* and in the referenced EPA SOP for soil sampling (see Appendix D of this QA Program Plan).

B2.2 Groundwater Samples

Groundwater sample collection is typical during Remedial Projects Section site investigations and cleanups. Collection of groundwater samples may be one-time or ongoing and periodic. Groundwater sample collection can occur from soil borings, temporary well points, monitoring wells, and existing wells (e.g., municipal or community supply wells, domestic water wells, irrigation wells, or industrial supply wells). Shallow, intermediate, deep, and perched aquifers contain groundwater.

Groundwater samples collected from soil borings at specific depth intervals assist in location selection for future monitoring wells. Collection of these one-time samples using a direct-push groundwater sampling method is typical. Appendix D of this QA Program Plan contains an SOP for direct-push groundwater sampling.

Groundwater sample collection from permanently installed monitoring wells is typical. Proper installation according to state regulations (see ARS Title 45, Chapter 2, Article 10) and proper development according to an Arizona Department of Water Resources (ADWR), ADEQ, or EPA-approved protocol of monitoring wells is required. Field logbooks and subsequent reports must note non-standard wells or problems encountered during well installation and sampling. EPA SOPs describe groundwater monitoring well sampling, monitoring well installation and monitoring well development (see Appendix D of this QA Program Plan).

The following is a procedures list to use when sampling residential water supplies or water-supply wells of any kind:

- Obtain permission to access property and obtain samples for analysis
- Inspect the water system to locate the tap nearest to the wellhead. Samples should be collected prior to any treatment units (e.g., ultra-violet light, reverse osmosis, etc.), if possible.
- Purge the water lines to flush the plumbing and holding tanks before collecting samples from drinking water, irrigation, or industrial wells so that the sample collected is as representative as possible. Remove any faucet aerators and reduce water flow before collecting samples.

B2.3 Surface Water Samples

Surface water sample collection is typical during Remedial Projects Section site investigations and cleanups when evaluating whether contaminants have migrated to nearby surface water bodies. Physical evidence such as odors, organic films on water surfaces, and soil discoloration in the vicinity of surface water are indicators of possible contamination. Surface water samples include representative liquid samples collected from streams, brooks, rivers, lakes, ponds, lagoons, seeps, estuaries, drainage ways, sewers, channels, wetlands, surface water impoundments, and other surface water bodies. Sample collection occurs at the surface or at depth within the water body. Surface water samples will be collected in general accordance with the EPA SOP for surface water sampling (see Appendix D of this QA Program Plan).

B2.4 Pore Water Samples

Pore water is water contained within the upper few centimeters of sediments just below the surface water/sediment interface. This interface is the hyporheic zone. Typical equipment utilized for sampling of this zone are seepage meters and push-point pore water samplers or lysimeters. Discharge of groundwater to surface water through the hyporheic zone is unlikely to be homogeneous; therefore, determining locations for pore water sampling can involve additional investigative steps.

B2.5 Sediment Samples

Sediment sample collection occurs for the analysis of biological, chemical, or physical parameters in sediments. There are many factors to consider when choosing sediment sampling equipment including, but not limited to, site access, sample volume requirements, sediment texture, target depth for sediment collection, and flowing versus standing water. In general, use of piston samplers are best for soft, fine-grained sediments where sediments at depth are required. Grab/dredge samplers are best for coarse, shallow sediments and where large volumes of sediment are required. EPA's SOP for sediment sampling (see Appendix D of this QA Program Plan) provides additional information on the collection of sediment samples.

B2.6 Sludge Samples

Sampling of sludge could involve a number of different situations and will likely depend upon site conditions. Therefore, project-specific planning document will detail collection of sludge samples. Catch basins and drywells are common settings where sludge sampling occurs.

B2.7 Air/Soil Vapor Samples

Collection of air sampling is typical at sites where vapor inhalation of contaminants is or may be an exposure issue. Collection of soil vapor samples is routine to investigate releases of VOCs. Air sampling and soil vapor sampling is more complex than soil or water sampling because of the reactivity of chemical compounds in the gas matrix and sample interaction with the sampling equipment and media. A number of factors, including site conditions, sampling objectives, chemicals of concern, analytical methods, and cost, forms the basis for selecting air and soil vapor sampling equipment. Methods to sample air at active facilities include, but are not limited to, soil gas sampling or sampling with flux chambers. Typical sampling containers include tedlar bags, stainless steel Summa canisters, gas tight syringes, and glass sorbent traps used with sampling pumps. Sources of information for air and soil vapor sampling and analysis are: <http://www.airtoxics.com> in EPA's SOP for general air sampling guidelines (Appendix D) and ADEQ's Soil Vapor Sampling Guidance (<http://www.azdeq.gov/environ/waste/download/svsg.pdf>).

B2.8 Building Materials Samples

Sampling at Remedial Projects Section sites can involve non-routine sampling of unusual sample matrices, such as building materials. These matrices include concrete slabs or other types of building materials. Development of site-specific sample collection procedures occurs, if needed, for sampling such non-routine matrices. Sampling personnel will coordinate with the analytical laboratory on the anticipated sample collection and handling methods to ensure that the sample data will meet all QA/QC requirements. Additional information on the collection of non-routine sample matrices is in EPA's SOP for chip, wipe and sweep sampling (see Appendix D of this QA Program Plan).

B3: Sample Handling and Custody

Chain of custody procedures differ among laboratories. Title 9, Chapter 14, Article 6 of the Arizona Administrative Code (R9-14-615) details the necessary documentation for sample control activities at an ADHS licensed laboratory. Identification of custody procedures of the analyzing laboratory occurs prior to field activities. Field personnel must make arrangements with the appropriate laboratory for proper sample containers, preservatives, holding times and chain of custody forms. The custody of a sample must be traceable from the time of sample collection to the reporting of results. Chain of custody procedures provide a mechanism for documenting information related to sample collection and handling. Completion of a chain-of-custody form must occur after sample collection and prior to sample shipment or release. Cross-checking of the chain-of-custody form, sample labels and field documentation is necessary to verify sample identification, date and time sample was collected, type of analyses, number of containers, sample volume, preservatives and type of containers. Additional information on sample handling and custody procedures is in EPA's SOPs for specific sample collection methods. Appendix D of this QA Program Plan references SOPs and forms for sample handling, custody (chain-of-custody forms), and transport.

B4: Analytical Methods

All analytical methods used to analyze samples must comply with relevant requirements of applicable federal or state programs for which they were collected, such as the CWA, SDWA, RCRA, Clean Air Act, or use other EPA-approved alternate methods. The most recently approved methods under the CWA and SDWA are located in the Code of Federal Regulations under 40 CFR Part 136. The EPA website at <https://www.epa.gov/hw-sw846/sw-846-compendium> contains the current approved methods under

RCRA SW-846. Exhibit 1 of Title 9, Chapter 14 of the Arizona Administrative Code details ADHS approved methods with corresponding analytes.

Table B1 lists the classes of analytes that typically are the greatest interest during Remedial Projects Section site investigations, as well as ADEQ's preferred analytical methods. This table provides a starting point for selecting analytical methods for Remedial Projects Section site investigations. Additional methods may be available and appropriate; consult with the Remedial Projects Section or Exhibit 1 of Title 9, Chapter 14, Article 6 (http://apps.azsos.gov/public_services/Title_09/9-14.pdf) of the Arizona Administrative Code for alternate methods. The project-specific planning document should identify analytical methods and equipment, decontamination procedures, waste disposal requirements, and performance requirements.

B5: Quality Control

QC requirements are integral to the success of a QA program. QC covers the overall system of technical activities that measure the performance of a process against defined standards to verify that they meet predefined requirements. Because errors can occur in the field, laboratory, or office, it is necessary for QC to be part of each of these functions. This QA Program Plan describes and defines the general quality objectives of the Remedial Projects Section. Project-specific planning documents define site-specific quality objectives. This approach to quality system management ensures conducting quality activities throughout the data generation process but allows for the flexibility to tailor quality-related activities to individual site specific data needs.

QA and QC parameters apply to the two primary types of data — definitive and non-definitive data — regardless of whether the data collection activity is associated with field measurements or laboratory measurements. Non-definitive data are frequently collected during the first stage of a multi-phase screening investigation, using rapid, less precise methods of analysis with less rigorous sample preparation. Non-definitive data can provide analyte identification and quantification, although both may be relatively imprecise. Typically, confirmation of 5 to 10 percent of non-definitive samples or all critical samples occurs using analytical methods, QA/QC procedures, and criteria associated with definitive data. Non-definitive data without associated confirmation data are of unknown quality. Qualitative, non-definitive data identify the presence of contaminants and classes of contaminants and can help focus the collection of definitive data, which is generally the more expensive of the two. Some data uses, such as risk assessments, require definitive data.

Use of EPA's 2007 *Guidance for Preparation of Standard Operating Procedures for Quality-Related Operations* is typical for developing SOPs. SOPs should be included as an appendix of all planning documents and reports (see Figure A2) generated for and submitted to ADEQ's Remedial Projects Section. The project field team should document reasoning for any deviations from an SOP and include that documentation in all planning documents and reports generated for and submitted to ADEQ's Remedial Projects Section. . Please note that, in Arizona, the Arizona Department of Health Services (ADHS) is responsible for reviewing the standard operating procedures developed by and used for environmental laboratories. ADHS is responsible for licensing of environmental laboratories (Title 9, Chapter 14, Article 6 – Licensing of Environmental Laboratories).

B5.1 Quality Control in the Field

Description of QC parameters in detail for each step of field work should also include specific corrective actions for difficulties encountered in the field. Evaluation of field sampling procedures requires the

collection and evaluation of field QC samples. To provide a means of assessing data quality resulting from the field sampling program, collection and submittal to the analytical laboratory includes trip blanks, rinsate blanks, field duplicates, and extra volume for matrix spikes and matrix spike duplicates.

Subsequent paragraphs contained in this section of this QA Program Plan note collection frequencies for field QC samples.

Field QC requirements and documentation of all field sampling and observations are critical for providing a historical record for analysis of the usability of the data produced. The official field log book will contain documentation of field activities that involve the collection and measurement of environmental data. Recording related field activities as explained below can require developing additional forms.

SOPs delineate the step-by-step approach that field personnel must follow in collecting samples, taking field measurements, decontaminating equipment, handling investigative derived waste (IDW), and calibrating instruments. Most qualified sampling contractors and State and Federal certified laboratories develop SOPs and analytical methods as part of their overall QA program. Use of EPA's 2007 *Guidance for Preparation of Standard Operating Procedures for Quality-Related Operations* is typical for developing SOPs. SOPs should be included as an appendix of all planning documents and reports (see Figure A2) generated for and submitted to ADEQ's Remedial Projects Section. The project field team should document reasoning for any deviations from an SOP and include that documentation in all planning documents and reports (see Figure A2) generated for and submitted to ADEQ's Remedial Projects Section.

Each sampling SOP documents specific procedures for cleaning non-disposable equipment. The group/person responsible for sampling prepares sampling SOPs. All sampling tools will be decontaminated before sampling begins and between sample locations. Soil and water sampling tools, including stainless-steel spoons, bowls, hand augers, split spoons, pumps and Hydropunch equipment, will be decontaminated by scrubbing in a solution of potable water and non-phosphate detergent (Alconox or Liquinox). *Manufacturer verification regarding phosphate content of Alconox is needed as not all Alconox detergents are phosphate free.* EPA SOPs call for use of a 10 percent nitric acid (for metal analytes) or a solvent such as acetone for organic compound analytes (see Appendix D). The tools are then double-rinsed with distilled water. Sampling tools are air dried and wrapped in aluminum foil if not used immediately after decontamination. Decontamination of larger equipment, such as the drilling rods and augers, typically occurs between boring locations. A temporary decontamination pad will be constructed near the site and a high-pressure steam cleaner will be used to clean the end of the rig and all augers, drill rods, and core samplers. The procedures outlined in the SOP for IDW prescribe containment and disposal procedures for decontamination fluids.

B5.1.1 Field Instrument/Equipment Inspection and Calibration

Sampling and analysis generally requires the use of different pieces of equipment and tools in the gathering of environmental data. A field preventive maintenance protocol involves ensuring that all field equipment has been properly calibrated, charged, and inspected prior to and at the end of each working day and that replacement parts are available.

Inspection of all field equipment is required to determine if it is adequate and appropriate for the media, parameters, and required testing. Data may be generated onsite through the use of real-time equipment, such as photoionization detectors (PIDs), organic vapor analyzers, and pH meters. A more detailed analysis may call for relevant, later assessments of the usability of data generated by a mobile laboratory.

For field-testing and mobile laboratories, examination of equipment occurs to ensure that it is in working condition and properly calibrated. The team is required to track the transfer of samples. Staff calibrate

field instruments according to the method and schedule specified in an SOP. The manufacturer's operating manual usually forms the basis for these types of SOPs. Calibration of field equipment occurs more often than specified in the SOP when using equipment under adverse or extreme field conditions.

B5.1.2 Field Documentation

The field team should record field activities in indelible ink, in a permanently bound notebook with pre-numbered pages or on a preprinted form. For each sampling event, the field team must provide the site name, physical location, date, sampling start and finish times, names of field personnel, level of protection, documentation of any deviation from protocol, and signatures of field personnel. For individual samples, field teams should ensure that field logbooks document the exact location and time the sample was taken, any measurement made (with real-time equipment), a physical description of the sample, sample ID number, sampling depth, sample volume, sample type, and the equipment used to collect the sample. This information can be critical to later evaluations of the resulting data's usability.

Complete and accurate documentation is necessary to demonstrate that field measurement and sampling procedures are in accordance with this QA Program Plan and any project specific planning document. Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook will list the contract name and number, the project name, the site name, and the names of subcontractors, the service client, and the project manager. At a minimum, the field logbook must document the following information:

- Name and affiliation of all on-site personnel or visitors
- Weather conditions during the field activity
- Summary of daily activities and significant events
- Notes of conversations with coordinating officials
- References to other field logbooks or forms that contain specific information
- Discussions of problems encountered and their resolution
- Discussions of deviations from the project-specific planning document or other governing documents
- Description of all photographs taken

The contractors performing field work should develop field forms to record field activities.

Labeling individual samples occurs in the field. Labels should include sample location, sample number, date and time of collection, sample type, sampler's name, and method used to preserve the sample, if applicable. Sample preservation involves the treatment of a sample usually through the addition of a compound that adjusts pH to retain the sample properties, including concentrations of substances, until analysis of the sample. The field team should create a table listing the total number of samples, types of sample matrices, all analyses planned for each sample differentiating critical measurements and other information that may be relevant to later assessments of the data usability. Typically, report submittals to ADEQ contain copies of field forms that contain field data.

B5.1.3 Trip Blanks

Trip blank samples help evaluate whether the shipping and handling procedures are introducing contaminants into the samples or if cross-contamination in the form of migration of VOCs between the collected samples. One trip blank submitted to the laboratory for analysis is necessary each day that samples are collected. Trip blanks for soil and water samples are volatile organic analysis (VOA) vials filled with purged deionized water that remain closed while transported to the field and then returned to the laboratory.

B5.1.4 Rinsate Blanks

Rinsate blanks help evaluate the potential for cross-contamination of samples during collection. Collection of rinsate blanks occurs at a rate of one per day per matrix when using non-dedicated and non-disposable sampling equipment in the field. Collection of equipment rinsate blanks occurs by passing organic-free water through or over the decontaminated sampling equipment and collecting the rinse water in appropriate sample containers.

Rinsate blank analysis is for the same parameters as the associated field samples. Rinsate blanks should not contain detectable concentrations of target analytes greater than the Project Required Quantitation Limit (PRQL) for the compound. Any detection of target analytes in a rinsate blank will result in an investigation to determine effect on overall data usability. Affected results will be qualified as estimates or as non-detects at an elevated PRQL as appropriate.

B5.1.5 Field Duplicate Samples

Collection of field duplicate water and air samples occurs simultaneously in separate containers. The purpose of field duplicates is to allow evaluation of the contribution of random error from sampling to the total error associated with the data. One set of field duplicates will be collected and submitted for every twenty field samples collected (and at least one per sampling day if less than twenty are collected) for water, soil, and air. The following sections describe field duplicate precision.

B5.1.6 Matrix Spike/Matrix Spike Duplicates (Field Requirements)

Double sample volume should be collected at a rate of one per twenty samples per matrix (minimum of once per sampling event) to ensure that the laboratory has sufficient volume to perform matrix spikes and matrix spike duplicates (MS/MSDs).

B5.1.7 Inter-laboratory Split Samples (Field Requirements)

Inter-laboratory split samples are field duplicates (liquid matrices) or split samples (solid matrices) submitted to both the primary laboratory and a secondary or QC laboratory. Collection of inter-laboratory split samples occurs simultaneously with a sample from the same source under identical conditions into separate containers. Results from the split samples help assess laboratory performance by comparison of qualitative and quantitative results from the two laboratories, including indications of matrix interferences such as elevated PRQLs. In order to provide useful information, however, the split sample must be directly associated with the original (primary) sample to evaluate laboratory performance. Field personnel determine the association and maintain the association during the data import process. Both ADEQ and Owner/Operator contractors may collect these samples as a way to check on laboratory performance.

B5.2 Quality Control in the Laboratory

Compliance monitoring on ADHS licensed laboratories is conducted by the Arizona Department of Health Services (ADHS) as described in Title 9, Chapter 14, Article 6 of the Arizona Administrative Code (AAC R9-14-605 – Compliance Monitoring). ADEQ also conducts Technical Systems Audits on ADHS licensed laboratories (ADEQ contract laboratories and contract laboratories of contractors who submit analytical data to ADEQ). The primary goals of TSAs will be to review the laboratory organization, operation, and capabilities; determine the reliability of data; and note corrective action for any apparent deficiencies. The ADEQ QA/QC Manager or QA/QC Representatives selects auditors for TSAs based on their technical proficiency in the subject area. The designated auditors will be responsible for planning and conducting the audit, and reporting the findings to the laboratory manager and to the ADEQ QA/QC Manager or QA/QC Representatives.

B5.3 Data Quality Indicators (DQIs)

Identifying DQIs and establishing Quality Control (QC) samples and Measurement Performance Criteria (MPC) to assess each DQI, as introduced in Section 1.7, are key components of project planning and development. These components demonstrate an understanding of how “good” the data need to be to support project decisions and help to ensure there is a well-defined system in place to assess that data quality once data collection/generation activities are complete.

When faced with addressing data quality needs in a project-specific planning document, one of the first terms you may come across is DQIs. DQIs (Precision, Accuracy/Bias, Representativeness, Comparability, Completeness, and Sensitivity) include both quantitative and qualitative terms. Each DQI helps interpret and assess specific data quality needs for each sample medium/matrix and for each associated analytical operation. Section A7.2 of this QA Program Plan explains the principles along with a brief summary of information related to assessing each DQI. In addition to Section A7.2 of this QA Program Plan, ADEQ has established the following policies, procedures, and/or guidance for sample collection and analytical techniques. These procedures, where relevant, apply to all analytical data generated for use by the Remedial Projects Section. These procedures apply unless approved for special exceptions and/or deviations outlined in a project-specific planning document. Appendix F contains the following documents in their entirety.

- ADEQ Temperature/Preservation Guidance;
- Substantive Policy 0154 - Addressing Spike And Surrogate Recovery As They Relate To Matrix Effects In Water, Air, Sludge And Soil Matrices Policy; and
- Substantive Policy 0170 - Implementation of EPA Method 5035 - Soil Preparation for EPA Method 8015B, 8021B and 8260B.

B6: Instrument/Equipment Testing, Inspection and Maintenance

All field and laboratory analytical instruments should be tested, inspected, and maintained according to the manufacturer’s guidelines and recommendations. Data collected from improperly functioning equipment will not be used. ADEQ contractors, Owner/Operator contractors, and property owner contractors typically are the ones that collect field data and are responsible for the correct operation of their equipment. ADEQ staff, on rare occasion, does collect field data. ADEQ staff should follow the equipment manufacturers operating manual for ensuring proper operation of any utilized equipment.

Maintenance of records for equipment testing, inspection, and maintenance occurs in a bound logbook for each piece of equipment. Recorded in the logbook are the date, time, name of inspector, equipment inspected, and the results of testing and inspection. Inspection occurs on all equipment or systems requiring periodic maintenance.

Preventive maintenance for most field equipment is carried out in accordance with procedures and schedules recommended in (1) the equipment manufacturer's literature or operating manual or (2) SOPs that describe equipment operation associated with particular applications of the instrument. However, critical measurements for field equipment may require more stringent testing, inspection, and maintenance procedures.

Segregation of an out of order field instrument occurs and is clearly marked and not used until completing repairs. Notification to the field team leader of equipment malfunctions occurs for the purpose of repair or equipment substitution. Unscheduled testing, inspection, and maintenance occurs on equipment whose condition is suspect. Reporting in the daily field QC report occurs for any significant problems with field equipment.

The Remedial Projects Section can request equipment testing, inspection, and maintenance logs for all contractor equipment.

B7: Instrument/Equipment Calibration and Frequency

Calibration of all analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the sensitivity that is required to meet project-specific DQOs. Calibration on each instrument occurs with standard solutions appropriate to the instrument and analytical method in accordance with the methodology specified and at the QC frequency specified in laboratory or field sampling SOPs.

B7.1 Field-Based Instruments

Calibration of field equipment, if used, occurs at the beginning of the field effort and at prescribed intervals. The calibration frequency depends on the type and stability of equipment, the intended use of the equipment, and the recommendation of the manufacturer. Detailed calibration procedures for field equipment are available from the specific manufacturers' instruction manuals. General guidelines are included in SOPs. Recording all calibration information occurs in a field logbook or on field forms. In addition, there is a label on the field equipment that specifies the scheduled date of the next calibration. If this type of identification is not feasible, equipment calibration records will be readily available for reference. Field-based analytical instruments, such as turbidometers and pH electrodes, must be calibrated following manufacturers' instructions and frequency recommendations (or following appropriate SOPs) before they may be used for collecting data.

ADEQ contractors, Owner/Operator contractors, and property owner contractors typically are the ones that collect field data and are responsible for the correct operation of their equipment. ADEQ staff, on rare occasion, does collect field data. ADEQ staff should follow the equipment manufacturers operating manual for ensuring proper operation of any utilized equipment.

B7.2 Laboratory Instruments

Conducting calibration and maintenance of analytical instruments is in accordance with the QC requirements identified in each laboratory SOP and in QA manuals, along with the manufacturers' instructions. Discussed below are general requirements.

The history of calibration and maintenance for instruments in the subcontract laboratory is an important aspect of the project's overall QA/QC program. As such, trained personnel implement all initial and continuing calibration procedures by following the manufacturer's instructions and in accordance with applicable EPA protocols. This ensures the equipment is functioning within the tolerances established by the manufacturer and the method-specific analytical requirements.

The laboratory will obtain calibration standards from commercial vendors for both inorganic and organic compounds and analytes. Stock solutions for surrogate standards and other inorganic mixes are from reagent-grade chemicals or as specified in the analytical method. Expiration dating, proper labeling, proper refrigeration, and freedom from contamination requires special attention. Recording documentation on receipt, mixing and use of standards occurs in the appropriate permanently bound laboratory logbook. Subcontractor laboratory QA plans may provide additional specific handling and documentation requirements for the use of standards.

After the instrument calibration to verify the preparation and concentration of the calibration standards, analysis of the verification standards for initial calibrations occurs. The verification standards for continuing calibrations should be analyzed (as per method requirements) to verify the calibration of the analytical system over time.

Calibration of analytical balances occurs annually according to manufacturer's instructions and have a calibration check before each use by laboratory personnel. Personnel hardbound logbooks with pre-numbered pages document the balance calibration checks.

Monitoring for proper temperature of all refrigerators and incubators occurs by measuring and recording internal temperatures on a daily basis. At a minimum, calibration according to manufacturers' instructions of thermometers used for these measurements occurs annually.

The subcontract laboratories will maintain an appropriate water supply system that is capable of furnishing American Society for Testing Materials (ASTM) Type II polished water to the various analytical areas.

ADEQ, Owner/Operators, and any hired contractors should ensure that their support laboratories properly calibrate their instruments. To do this, ADEQ and Owner/Operators typically perform partial data validation (see Table D1) on laboratory analytical reports submitted to them from subcontracted laboratories. Depending on the outcome of the partial data validation, the data may be used qualitatively or quantitatively.

B8: Inspection/Acceptance of Supplies and Consumables

The laboratory shall inspect supplies and consumables prior to their use in analysis. The provided materials description in the method establishes a guideline for the acceptance criteria for these materials. Monitoring for purity of reagents occurs by analysis of LCSs. An inventory and storage system for these materials shall assure use before manufacturers' expiration dates and storage under safe and chemically compatible conditions.

Analytical laboratories are required to provide certified clean containers for all analyses. These containers must meet EPA standards described in EPA's 1992 *Specifications and Guidance for Obtaining Contaminant-Free Sampling Containers*.

Procedures for receiving supplies and consumables in the field are similar. When receiving supplies, the project manager or field team leader will log the supplies into a supply logbook and then inspect all items against the acceptance criteria. Personnel note any deficiencies or problems in the field logbook and return deficient items for immediate replacement.

B9: Non-direct Measurements

Environmental data generation typically involves planning, sampling, analysis, investigation, and data review. In planning their investigations, project teams generally use existing data to develop sampling designs and to decide how much and what type of data to collect. The term existing data are synonymous with "secondary data" and "non-direct measurements". Existing data may come from a number of sources, including other studies, government databases, etc. The original purpose for collecting these secondary data may be very different from that of the current investigation. Also, these secondary data may have been collected using different sampling methods (composite vs. grab, random vs. hot spot sampling), and/or analytical methods than those selected for the current investigation.

Basing decisions on existing data may result in errors if secondary data were not generated for the same purpose or using the same methods as the current investigation. Biased data can impact final conclusions. Therefore, before using secondary data, project team members should evaluate the data to identify any limitations on their use. Also, to ensure transparency in decision making, project team members clearly document criteria and reasons for *including* and *excluding* certain data from use.. Failure to clearly document why data are included or excluded can result in the appearance of biased data selection and diminish the product's credibility.

Sources of secondary data include the following:

- Environmental indicator data obtained from federal/state/local databases and records
- Existing sampling and analytical data from a previous investigation of the area
- Computer model simulations and applications pertaining to other studies
- Historical data (e.g., from organization's/facility's corporate records and/or federal/state local records pertaining to previous monitoring events, site investigations, etc.)
- Background information/data from organization's/facility's corporate records and/or federal/state/local records pertaining to site-specific industrial processes, process by-products, past and current chemical uses, raw material and finished product testing, waste testing and disposal practices, and potential chemical breakdown products
- Data generated to verify innovative technologies and methods
- Data obtained from computer databases (such as manufacturers' process/product information, waste management or effluent information, and EPA or state data bases)
- Literature files/searches
- Publications
- Photographs
- Topographical maps
- Meteorological data

B10: Data Management

Field staff record field data generated for ADEQ's Remedial Projects Section, such as sample ID and latitude/longitude coordinates, on field data sheets or hand-held computers. If used, ADEQ or Owner/Operator contractor field staff report field data to the Project Manager through submission of field notebooks or field sampling data sheets. Inclusion of originals/copies of field data also accomplishes this reporting.

Laboratory analytical reports will include QC results and any other necessary analytical information that enable reviewers to determine data quality. Submittal of laboratory data to the ADEQ or Owner/Operator Project Manager occurs by both printed and electronic form. Reporting of rapid turnaround data from the laboratory to the Project Manager occurs if requested, but rapid turnaround is generally not required. For review, ADEQ or Owner/Operator keeps copies of field data sheets (Appendix E contains sample data sheets), a copy of chain-of-custody forms, original preliminary and final lab reports, and electronic media reports. The field crew must retain original field logs. The contract laboratory shall retain chain-of-custody forms. The contract laboratory will retain copies of the preliminary and final data reports.

Table B1. Common Contaminants at Remedial Projects Section Facilities and Recommended Methods for Analysis of Soil, Groundwater or Materials Samples

Laboratory Analytical Methods for Investigations			
Test Method →	EPA Method 8260B	EPA Method 8310 or 8270 SIM	See Footnote 3
Products			
VOCs ^{1,2}	X		
SVOCs		X	
Metals			X
Organochlorine Pesticides	EPA Method 8081A		

Footnotes:

1. Soil gas samples to be collected when analysis from soils are not expected to yield results that would be a satisfactory demonstration of whether or not a Product Type was released into the environment (e.g. soil has coarse lithology). The analytical method should be TO-15.
2. VOCs are to be analyzed using the current EPA Method 8260B (full list). For UST systems in place during 1996 or before, EPA Method 504.1 should be used to investigate for the presence of ethylene dibromide (EDB) (water only).
3. Metals to be analyzed are: arsenic, cadmium, chromium (total), lead and mercury. Use EPA methods 6000 and 7000 series for the analyses. Make a due diligent effort to obtain the background levels of the metals analyzed for comparison purposes.

Abbreviations: VOC = volatile organic compounds; SVOCs = semi-volatile organic compounds

Please inform the laboratory when requesting compound specific analyses and the sample is petroleum based.

Please note that Appendix 1 of Title 9 (Health Services), Chapter 14 (Department of Health Services Laboratory) in the Arizona Administrative Code contains a listing of ADHS approved methods for several analytes in different mediums (see Appendix A of this QA Program Plan).

GROUP C: ASSESSMENT AND OVERSIGHT

C1: Assessments and Response Actions

Assessment and response actions are part of the quality system for ensuring and documenting that procedures required by this QA Program Plan are being followed during the generation of data to be included in all planning documents and reports (see Figure A2) generated for and submitted to ADEQ's Remedial Projects Section.

C1.1 Purpose/Background

During the planning process, many options for sampling, sample handling, sample analysis and data reduction are evaluated. Selection of specific options depends on the nature of the corrective action or monitoring activity. This section of the QA Program Plan describes the internal and external checks necessary to ensure correct implementation of all elements. In addition, needed checks ensure adequate data quality and implementation of timely and effective corrective actions. Documenting all internal assessments is a critical component of the quality system.

C1.2 Assessment Activities and Program Planning

ADEQ employs several QA assessment tools designed to provide a better understanding of the components of, and the basis for improving, the ADEQ Quality Management System. Internal (Programmatic) and External QA audits are one of the principal tools for determining the effectiveness of the ADEQ QA/QC components. QA audit frequency and scheduling will vary with the type of review conducted.

C1.2.1 Assessment of Subsidiary Organizations

A. Management System Reviews (MSRs)

An MSR is an independent assessment of a Program's QA management practices and data collection procedures. Generally, the ADEQ QA/QC Manager or QA/QC Representatives performs the MSR. The EPA QA Office can also conduct MSRs. The MSR will qualitatively assess a program to determine if the ADEQ Quality Management System is adequate to ensure the quality of the Program's data. MSRs address the effectiveness of management controls in achieving and assuring data quality, the adequacy of resources and personnel devoted to QA functions, the effectiveness of training and assessments, and the applicability of data quality requirements. While MSRs can identify significant QA concerns and areas of needed improvement, they also point out noteworthy accomplishments.

Most MSRs will examine the following items:

- Assessment of the overall effectiveness of the QA management system, as measured by its adherence to the approved QMP
- Procedures for developing Data Quality Objectives (DQOs);
- Procedures for developing and approving QA Program Plans and Quality Assurance Project Plans (QAPjPs);
- Effectiveness of existing QA Program Plan guidance and QAPjPs;
- Procedures for developing and approving SOPs;

- Procedures, criteria, and schedules for conducting QA audits;
- Tracking systems for assuring that the QA Program is operating effectively, and that corrective actions disclosed by QA audits have been taken;
- Responsibilities and authorities of various line managers and QA personnel for implementing the QA program;
- Degree of management support;
- Level of financial and other resources committed to implementing the QA Program

The ADEQ QA/QC Manager or QA/QC Representatives utilizes EPA's 2003 *Guidance on Assessing Quality Systems (Management Systems Review Process)* for conducting MSRs.

The following lists the objectives of reviews for any ADEQ related Quality Assurance Programs:

- Identify any data quality problems;
- Identify benchmark practices for use in other Agency Programs;
- Propose recommendations for resolving quality problems;
- Confirm implementation and effectiveness of any recommended corrective actions.

C1.2.2 Assessment of Program Activities

Technical Systems Audits (TSAs)

The purpose of a Technical Systems Audit is to assess the sampling and analytical quality control procedures used to generate environmental data. TSAs entail a comprehensive, on-site evaluation of the field equipment; sampling and analyses procedures; documentation; data validation; and training procedures for collecting or processing environmental data.

TSAs occur for both laboratory and field activities:

Laboratory TSAs

TSAs occur on entities that submit analytical data to ADEQ. These entities are the ADEQ contract laboratories, and contract laboratories of Owner/Operator contractors. The primary goals of TSAs will be to review the laboratory organization, operation, and capabilities; determine the reliability of data; and note corrective action for any apparent deficiencies. ADHS, rather than ADEQ, is responsible for licensing environmental laboratories and can conduct audits and inspections at environmental laboratories. ADEQ's QA/QC staff can work with ADHS to identify laboratories to audit/inspect.

Field TSAs

Oversight of field operations is an important part of the quality assurance process. The ADEQ QA/QC Manager or QA/QC Representatives will conduct QA audits of field sampling activities, both for its own field operations, and on those contractors that collect samples for Remedial Projects Section Programs. ADEQ will specify frequency and procedures for conducting field TSAs within specific Program areas. When project-specific planning documents are reviewed, and also during any MSRs or other QA audits, ADEQ's QA/QC Manager or QA/QC Representatives will determine the necessity of field TSAs.

Specific items observed during the audit may include:

- Availability of approved project plans such as the project-specific planning document and Health and Safety Plan (HASp) to all project members

- Documentation of personnel qualifications and training
- Sample collection, identification, preservation, handling and shipping procedures
- Decontamination procedures used to clean sampling equipment
- Equipment calibration and maintenance
- Completeness of logbooks and other field records (including nonconformance documentation)

Performance Evaluations

Use of Performance Evaluation (PE) samples help assess the ability of a laboratory, or field measurement system, to provide reliable data. PE samples are for laboratories providing analytical services, directly or indirectly, for ADEQ and will be traceable, whenever possible, through the National Institute of Standards and Technology (NIST). The evaluation consists of providing a reference "blind" or "double blind" sample to the laboratory for analysis. A PE sample contains known concentrations of chemical constituents, or pollutants, of interest and will normally be in the appropriate media (e.g., soil, water, air). The analytical results obtained by the laboratory are compared to the known concentrations of the chemical constituents contained in the PE sample(s) as a means of determining if the laboratory demonstrated its ability to properly identify, and quantify, pollutants within established, or calculated, control limits.

The Remedial Projects Section schedules PE samples on an as-needed basis depending on the laboratory. All PE studies performed for ADEQ, whether required on a regular basis or performed on a one time basis, will be coordinated through or requested from the ADEQ QA/QC Manager or QA/QC Representatives or designee. For external projects requiring PEs, the Task/Work Assignment, Task/Delivery Order, or similar document needs to outline the specific details of the Performance Evaluation so the associated costs can be included in the contractor proposal. The results of PEs provide a means for assessing overall data integrity and used as criteria for selecting candidates for on-site evaluations.

Audits of Data Quality

EPA 2001 Guidance for Quality Assurance Project Plans defines an audit of data quality (ADQ) as "a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality." This assessment primarily involves an evaluation of the completeness of the documentation of field and analytical procedures and quality control results. Also, it usually involves tracing the paper trail accompanying the data from sample collection and custody to analytical results and entry into a database. This technique is the common verification process involved in entering data residing in large regulatory databases.

Results of both Data Quality Assessments (DQAs) and data quality audits can be used in at least two ways. One use is in making recommendations for changes in the design and performance of data collection efforts and in the use and documentation of QC procedures. A second use is as a guide for the planning and acquisition of supplemental data for the project and potentially for other related projects. Problems identified through DQAs may trigger the need for an MSR to determine management deficiencies or a TSA to identify technical problems.

Data Quality Assessments (DQAs)*

A DQA refers to the process used to determine whether the quality of a given data set is adequate for its intended use. DQAs may occur on selected projects and/or data generation processes. The purpose of

this type of evaluation is to determine whether the data collected are acceptable to the decision-maker or end user. Assessments generally take during the data generation process. As data accumulates, aspects of the project such as surveillance of field and laboratory operations, consistency of the data with MQOs, successfully completing performance evaluation sample studies, and so forth, helps assess whether the data are valid and acceptable. ADEQ disregards rejected or questionable data in its decision making, except in limited circumstances, such as a rough site screening.

Once data are of known and acceptable quality, then evaluation of the results in the context of the Data Quality Objectives for the project occurs. For most circumstances involving source area decision units, sample results involves a 1:1 sample comparison to regulatory standards or laboratory detection limits. For circumstances involving exposure area decision units, the ADEQ Remedial Project Section typically use statistics on sample results (e.g. metal contaminants in soils from windblown deposits emanated from tailings piles or smokestack plumes). EPA's 2006 *Data Quality Assessment - A Reviewers Guide* and EPA's 2006 *Data Quality Assessment - Statistical Methods for Practitioners* discusses the types and uses of statistical analyses. An assessment also occurs as to whether there is a sufficient quantity of data to support program or project decisions, and whether the original sampling design was appropriate. In some cases, the data may suggest that additional data are required to achieve a higher statistical confidence level. This could be because of overlooking too many invalidated data points, not collecting samples over a long enough time period, or missing a vital sampling area not previously considered important. In other cases, an assessment might show that data of a different type are required, or that the sensitivity of the instrument used in the measurement was not adequate to meet project objectives. If necessary, ADEQ's QA/QC Manager or QA/QC Representatives can review data generated by contract laboratories, for the ADEQ Remedial Projects Section Programs. These data review activities should use checklists, standard operating procedures, and standardized qualification codes to indicate data quality.

* Data generated for and submitted to ADEQ's Remedial Projects Section have DQA's performed on them on an on-going basis.

Peer Reviews

Peer reviews are not strictly an internal QA function; rather, they are technical scientific reviews that evaluate assumptions, calculations, methods, and conclusions. The ADEQ will use internal expertise to evaluate different technical aspects of the reports produced by contractors and Owner/Operators.

C1.3 Documentation of Investigations

This section identifies the organization and the person(s) that will perform the assessments, as well as the documentation of information collected during the audit.

C1.3.1 Number, Frequency and Types of Assessments

Once every four years every major Agency Program attempts an MSR. TSA's occur if specifically requested by ADEQ's Project/Case Manager, the findings of another audit or review necessitate another, or if the ADEQ QA/QC Manager or QA/QC Representatives plans one. Results will be reported to the audited organization in the form of a written report within 14 calendar days of the completion of the audit, or a mutually agreed upon alternative. Written comments by ADEQ's Project/Case Manager must be supplied to ADEQ's QA/QC Manager or QA/QC Representatives within 14 calendar days of receipt of the audit findings, or a mutually agreed upon alternative. Copies of the TSA Audit Final Report will be stored in the project file and also with ADEQ's QA/QC Manager or QA/QC Representatives. Distribution of additional copies occurs as appropriate.

C1.3.2 Assessment Personnel

ADEQ's QA/QC Manager or QA/QC Representatives normally conducts MSRs and TSAs and focuses on the Remedial Projects Section's adherence to the approved Agency QMP and its Quality Assurance Program Plan.

C1.3.3 Schedule of Assessment Activities

See Section C1.3.1 above.

C1.3.4 Reporting and Resolution of Issues

Addressing nonconformance to practices and procedures outlined in this QA Program Plan or a project-specific planning document submitted to ADEQ by an Owner/Operator should happen in a timely manner to ensure correction of nonconforming issues or deficiencies. The ultimate responsibility to ensure that all issues and deficiencies are satisfactorily resolved rests with the Unit Supervisors and Section Manager. Arizona Administrative Code allows Owner/Operators to satisfactorily correct deficiencies in a planning document.

The Remedial Projects Section will have 30 days to prepare a written response to the reviewer's assessment memorandum. If the evaluation report recommends corrective actions, the Remedial Projects Section should address these recommendations and include a schedule for making any appropriate changes in its quality assurance procedures. The ADEQ Leadership team uses these reviews to gauge the effectiveness of the Agency QMP and of the Remedial Projects Section approach to data quality management.

C2: Reports to Management

Effective management of environmental data collection requires (1) timely assessment and review of all activities and (2) open communication, interaction, and feedback among all project participants. This section outlines the reporting requirements for activities conducted under the Remedial Projects Section, including Owner/Operator led projects.

C2.1 Purpose/Background

Required reports provide a structure for evaluating the management of program schedules, assessing the effect of deviations from approved program or project-specific planning document on data quality, and determining the potential uncertainties in decisions made based on the data. Senior technical staff, case/project managers, and the QA/QC Representative review these reports and provide summaries on any identified data quality issue. Typically, these summaries are in memo form for specific projects or, for program concerns, presented orally at unit or section meetings where discussion occurs. Required reports keep managers and project members informed on the performance of QA/QC activities. Data quality summaries by ADEQ staff provide the results of project-specific audits, list any significant problems and discuss the solutions and corrective actions implemented or to be implemented to resolve QA/QC problems.

C2.2 Frequency, Content and Distribution of Reports

Field, technical, laboratory or QA personnel generate QA/QC reports and send them to the Remedial Projects Section, as required throughout the duration of the project. These QA/QC reports are in written memo or oral form, depending on the problems observed. A summary of the information included in these QA reports is normally included in ADEQ's required reporting (See Figures A2).

The contractor field team will record daily activities in a field log book to summarize activities throughout the field investigation. This daily log book will describe sampling and field measurements, equipment used, subcontractor personnel on site, QA/QC and health and safety activities, problems encountered, corrective actions taken, deviations from the QA Program Plan or project-specific planning document, and explanations for the deviations. The field team leader prepares the daily log book and submits it to the Remedial Projects Section, if requested. The final report for field investigations will summarize the content of the daily log book.

The required reports submitted for the project should include discussion of the following QA/QC report elements, if appropriate:

- Sampling and support equipment that were used, other than those specified in the approved QA Program or project-specific planning document.
- Preservation or holding-time requirements for any sample that were not met
- QC checks (field and laboratory) that were found to be unacceptable
- Analytical requirements for precision, accuracy, or method detection limit/practical quantitation limit (MDL/PQL) that were not met
- Sample collection protocols or analytical methods specified in the QA Program Plan that were not met
- Any activity or event that affected the quality of the data
- Any corrective actions that were initiated as a result of deficiencies
- Any internal or external systems or performance audits that were conducted

The QA/QC report contains an emphasis on evaluating whether project MQOs and data are of adequate quality to support the required decisions stated in the project DQOs.

The following example contains a list of recommended topics for use in developing a comprehensive QA/QC report, if necessary. The information listed below should be contained within a QA Report, if appropriate.

Title Page – The following is required information:

Time period of the report,
QA Project Plan Title and/or Plan number
Laboratory name, address and phone number; and
Preparer's name and signature

Table of Contents – Should be included if the report is more than ten pages long

Audits – in table form, summarize all project specific audits performed during the specified time

period

Performance audits must include the following

- Date of the audit
- System tested
- Person(s) administering the audit
- Parameters analyzed
- Reported results
- True values of the samples (if applicable)
- If any deficiencies or failures occurred, summarize the problem area and the corrective action

System audits must include the following:

- Date of the audit
- System tested
- Person(s) administering the audit
- Parameters analyzed
- Results of tests
- Parameters for which results were unacceptable (include the reported and true values, if applicable)
- Explanation of the unacceptable results. Include probable reasons and the corrective action.

Copies of documentation such as memos, reports, etc., shall be enclosed

Significant QA/QC Problems

- Identify the problem, and the date found
- Identify the individual who reported the problem
- Identify the source of the problem
- Discuss the solution and corrective actions taken to eliminate the problem

Corrective Actions Status

- Discuss the effectiveness of all corrective actions taken during the specified time frame as well as any initiated during the previous report period.
- Discuss any potential additional measures to implement as the result of any corrective action.

C2.3 Identify Responsible Organizations and Individuals

The facility owner, operator, property owner, or state or federal government – either directly or through its contractor - is responsible for preparing planning documents and reports and incorporating any comments received from ADEQ Remedial Projects Section personnel. These parties are responsible for ensuring that a complete environmental laboratory report is included in all planning documents and reports, if applicable, generated for and submitted to ADEQ's Remedial Projects Section. Section A4.1 of this QA Program Plan Organizational describes individual roles and responsibilities in detail. A list of planning documents and reports is included in Figure A2. Section A4.2.1 of this Program Plan describes expectations of ADEQ's required planning documents and reports.

GROUP D: DATA REVIEW

D1: Data Verification, Validation and Assessment

This section describes the planned procedures to review, verify and validate field and laboratory data. This section also discusses procedures for verifying that data are sufficient to meet DQOs and MQOs for the project.

D1.1 Purpose/Background

Data verification, validation, and assessment ensures that environmental programs and decisions are supported by the type and quality of data needed and expected for the intended use.

D1.2 Data Verification

Data verification is the process of evaluating the completeness, correctness, conformance, and compliance of a specific data set against the method, procedural or contractual requirements. Data verification evaluates adherence to data generation sampling protocols, SOPs, analytical methods, and project specific planning documents. Verification also involves examining the data for errors or omissions. Field and laboratory staff can verify that the work is producing appropriate outputs.

D1.3 Data Validation

Data validation is a systematic process for reviewing a body of data against a pre-established set of acceptance criteria defined in this QA Program Plan and in project-specific planning documents. Data validation is an analyte- and sample-specific process. It extends data evaluation beyond data verification and determines the analytical quality of a specific data set.

ADEQ's Remedial Projects Section performs a partial validation on selected analytical data routinely generated for and submitted to ADEQ's Remedial Projects Section. This partial validation involves examining the data package to determine if it meets MQOs for precision, accuracy and sensitivity. Discrepancies noted during the verification step is the basis for partial validation. For example, perhaps some, but not all, surrogates in a method requiring an organic extraction are outside method defined acceptance criteria, but other QC data such as precision of the measurements and blank data are acceptable. This might lead to a review that centered on surrogate recoveries. The intent of the partial validation is to qualify data and alert the user to the data limitations. Full data validation may occur for results used in court cases.

D1.4 Data Quality Assessment

A DQA refers to the process used to determine whether the quality of a given data set is adequate for its intended use. DQAs may occur on all or selected projects and/or data generation processes. The purpose of this type of evaluation is to determine whether the data collected are acceptable to the decision-maker or end user. Assessments generally take place during the data generation process. As data accumulates, aspects of the project such as surveillance of field and laboratory operations, consistency of the data with MQOs, successfully completing performance evaluation sample studies, and so forth, helps assess whether the data are valid and acceptable. ADEQ disregards rejected or questionable data in its decision making, except in limited circumstances, such as a rough site screening.

Once data are of known and acceptable quality, then evaluation of the results in the context of the Data Quality Objectives for the project occurs. For most circumstances involving source area decision units, sample results involves a 1:1 sample comparison to regulatory standards or laboratory detection limits. For circumstances involving exposure area decision units, the ADEQ Remedial Project Section typically use statistics on sample results (e.g. metal contaminants in soils from windblown deposits emanated from tailings piles or smokestack plumes). EPA's 2006 *Data Quality Assessment - A Reviewers Guide* and EPA's 2006 *Data Quality Assessment - Statistical Methods for Practitioners* discusses the types and uses of statistical analyses. An assessment also occurs as to whether there is a sufficient quantity of data to support program or project decisions, and whether the original sampling design was appropriate. In some cases, the data may suggest that additional data are required to achieve a higher statistical confidence level. This could be because of overlooking too many invalidated data points, not collecting samples over a long enough time period, or missing a vital sampling area not previously considered important. In other cases, an assessment might show that data of a different type are required, or that the sensitivity of the instrument used in the measurement was not adequate to meet project objectives.

If necessary, ADEQ's QA/QC Manager or QA/QC Representatives can review data generated by the contract laboratories, for the ADEQ UST Program. These data review activities should use checklists, standard operating procedures, and standardized qualification codes to indicate data quality.

* Data generated for and submitted to programs under ADEQ's Remedial Project Section have DQA's performed on them on an on-going basis.

D2: Approaches to Verification, Validation and Assessment

Data verification and validation confirms the integrity of the data generated over the life of the project. The process for determining if the data satisfy program-defined requirements involves evaluating and interpreting the data, in addition to verifying meeting QC requirements. The systematic planning approaches described in ADEQ's Waste Programs Division Site Investigation Guidance Manual – the DQO Process and the Triad Approach - should produce data that provide answers to critical study questions. ADEQ's Remedial Projects Section utilizes the Triad Approach which contains some elements of the DQO Process

EPA's 2002 *Guidance on Environmental Data Verification and Data Validation* presents the process for verifying and validating data. Section 5 of this EPA guidance provides tools and techniques for data verification and validation: <https://www.epa.gov/quality/agency-wide-quality-system-documents>.

D2.1 Approaches to Data Verification

Project team personnel, whether they are ADEQ contractors, ADEQ staff, or Owner/Operators, will verify field data through reviews of data sets to identify inconsistencies or anomalous values. Any inconsistencies discovered will be resolved as soon as possible by seeking clarification from field personnel responsible for data collection. To obtain defensible and justifiable data, all field personnel will be responsible for following the sampling and documentation procedures described in the project-specific planning document.

Laboratory personnel will verify analytical data at the time of analysis and reporting and through subsequent reviews of the raw data for any non-conformances to the requirements of the analytical method. Laboratory personnel will make a systematic effort to identify any outliers or errors before they report the data. Outliers are corrected if found to be the result of errors. The case narrative section of the

analytical data package clearly identifies outliers not attributed to errors in analysis, transcription, or calculation. The laboratory must verify all analytical data generated for and submitted to ADEQ's Remedial Projects Section.

Verified data are checked for a variety of topics including transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct usage of conversion factors, among others. Verified data may have laboratory qualifiers. Verified data are one output of this process.

A second output from the verification process is documentation, which may include a certification statement signed by the laboratory manager and included in the data package. Narratives on technical issues, non-compliance and any corrective action taken are included in the laboratory data package. Records from field activities are likely to be logbooks or handwritten notes, all of which require dates and signatures.

A laboratory QA manual use is to assist in accepting, rejecting, or qualifying the data generated by the laboratory. ADEQ, though, makes the decision on whether or not to use the data. The laboratory management is responsible for validating the data generated by the laboratory. The laboratory personnel must verify that the measurement process was "in control" (i.e., all specified MQOs for the DQIs were met, or acceptable deviations are explained) for each batch of samples before proceeding with analysis of a subsequent batch. In addition, each laboratory must establish a system for detecting and reducing transcription and/or calculation errors prior to reporting data. When deviations are noted, the laboratory shall submit data that have acceptable deviations explained. When there are unmet QA requirements, re-analysis of the sample occurs when possible. Only the results of the reanalysis will be submitted, provided these results are acceptable.

D2.2 Approaches to Data Validation

Data validation determines the analytical quality of data within a specific data set; it is an analyte- and sample-specific process based on achieving the MQOs set forth in the planning documents for the project. Validation assesses whether data quality goals specified in the planning phase have been achieved. Unlike data verification, a qualified person not affiliated with the laboratory performs data validation. The Unit Supervisor, staff level personnel or, upon request, Technical Support performs data validation of analytical data generated for and submitted to ADEQ's Remedial Projects Section.

The level of data validation depends on the size and complexity of the project and the project's decisions. Basically, data validation is the process of evaluating the available data against the project MQOs. ADEQ's Remedial Projects Section performs cursory validation on data generated for and submitted to them. The Remedial Projects Section notifies the QA/QC Manager or QA/QC Representatives if there is a need for full data validation, although full data validation would be a rare occurrence for programs operated within in ADEQ's Remedial Projects Section. Table D-1 summarizes criteria for data validation.

The personnel validating the data should be familiar with the project-specific MQOs. So, the validator should have access to the QA Program Plan, project-specific planning documents, SOPs, and approved analytical methods. The validator must identify these and other project records, obtain records produced during data verification, and validate the records by determining whether the data quality meets goals established in the planning documents.

Data validation generally includes the following steps:

Validation of Field Data

- 1 Evaluate field records for completeness and consistency
- 2 Review field QC information
- 3 Summarize deviations and determine effects on data quality
- 4 Summarize number and type of samples collected

Validation of Laboratory Data

- 1 Assemble planning documents and data for validation. Review data records to determine method, procedural and contractual QC compliance or noncompliance
- 2 Review verified, reported sample results collectively for the data set as a whole, including laboratory qualifiers
- 3 Summarize data and QC deficiencies and evaluate the impact on overall data quality

ADEQ uses the most up-to-date Arizona Data Qualifiers when applying qualifiers to data. These qualifiers are located on the ADHS and ADEQ websites or at the following weblink:
<http://www.azdeq.gov/function/programs/download/azdatqa.pdf>.

ADEQ, its contactors, and Owner/Operators typically perform partial data validation (see Table D1) on laboratory analytical reports submitted to them from subcontracted laboratories. Depending on the outcome of the partial data validation, qualitative or quantitative use of the data occurs.

If necessary, a decision letter to the party responsible for performing remedial investigations summarizes any field or laboratory data that did not meet the quality goals established in the planning documents.

D2.3 Approaches to Data Assessment

The purpose of a data assessment is to integrate all aspects of data generation to determine the usability of the data. The final step in the process is to compare the data obtained to the DQOs established by the program in its QA Program Plan or in project-specific planning documents. Aspects of the sampling program evaluated during the data assessment include sampling design, sample collection procedures, and sample handling. The process also includes a review of analytical procedures (both field and laboratory) and QC procedures. ADEQ and Owner/Operator contractors and environmental laboratories, respectively, maintains field and laboratory instrument calibration logbooks. Appropriate ADEQ personnel (Unit Supervisors, staff level personnel, Technical Support and/or QA/QC Manager or QA/QC Representatives) and Owner/Operators review the logbooks on an as needed basis. The following paragraphs provide criteria for evaluating all aspects.

D2.3.1 Sampling Design

Samples should conform to the type and location specified in the project-specific planning document. Staff must note any deviations from the sampling design and its likely effect on the usability of the data for its intended purpose. Section B1.1 of this QA Program Plan discusses an overview of sampling design. ADEQ's 2014 Waste Programs Division Site Investigation Guidance Manual provides further

information on sampling designs. EPA also provides guidance in its 2002 *Guidance on Choosing a Sampling Design for Environmental Data Collection*: <https://www.epa.gov/quality/agency-wide-quality-system-documents>.

D2.3.2 Sample Collection Procedures

The data reviewer (i.e. typically the field team leader from the contracted environmental consultant) should verify use of the appropriate specified methods during sampling. The reviewer should:

- 1 Evaluate the field records for consistency
- 2 Review QC information
- 3 Summarize deviations and determine their effect on data quality
- 4 Summarize the samples collected
- 5 Prepare a field data verification summary

Improper field practices can compromise the usability of a data set. Specific issues to look for include mislabeling of sample containers, problems with field instruments, improper documentation (such as failure to properly fill in the log book), improper collection of volatile organic compounds (VOC) samples (such as leaving a cap off a container or collecting VOC samples from a well-mixed composite sample), biasing sampling locations or forgetting to obtain location information for each sample, improper purging of monitoring wells, improper decontamination procedures, or intentionally cutting corners by collecting many samples from one location to save time.

For preparation of the field data verification summary, the field team leader evaluates field records and notebooks for consistency with field methods and procedures described in project-specific planning document. This assures proper following of procedures or that deviations from the procedures still yield data of acceptable quality. The verification summary should include observations on (1) the consistency and completeness of field records, (2) the adequacy of field QC information, (3) any deviations project-specific planning document procedures and the probable effect of the deviations on data quality and (4) the number and types of samples collected and how this compares with specifications in the project-specific planning document. The final deliverable to ADEQ Remedial Projects Section personnel for review typically incorporates the different parts of the data verification summary. ADEQ's Remedial Projects Section personnel can request from the facility Owner/Operator copies of field records and notebooks for their own review on an as needed basis.

Most qualified sampling contractors and State and Federal certified laboratories develop SOPs and analytical methods as part of their overall QA program. These entities typically develop SOPs following EPA's 2007 *Guidance for Preparation of Standard Operating Procedures for Quality-Related Operations*. The field team should document which SOPs they are using in the field and any deviations from an SOP. Appendix D lists references and weblinks to EPA generated SOPs.

D2.3.3 Sample Handling

QA personnel perform the following: 1) confirm handling of samples were in accordance with protocols required in the QA Program Plan and project-specific planning document; 2) confirm utilization of sample containers and preservation methods as appropriate for the nature of the sample and type of data generated from the sample; and 3) check chain-of-custody records and storage conditions to ensure the representativeness and integrity of the samples.

D2.3.4 Analytical Procedures

Section B4 of this QA Program Plan identified the requirements of analytical methods used to generate the data. Verification of each sample ensures implementation of specified procedures used to generate the data. Acceptance criteria for these data follow those used in data validation with suitable codes to characterize any deviations from the procedure.

D2.3.5 Quality Control

Section B5 of this QA Program Plan specifies performing the QC checks during sample collection, handling, and analysis. Here, the QA reviewer confirms evaluation of results for QC samples against acceptance criteria (i.e., MQOs) specified in Section B.

D2.3.6 Calibrations

Section B7 of this QA Program Plan addressed the calibration of instruments and equipment and the information required to ensure that the calibrations (1) were performed within an acceptable timeframe prior to generation of measurement data; (2) were performed in proper sequence and included the proper number of calibration points; (3) were performed using standards that bracketed the range of reported measurements (i.e., were within the linear working range of the instrument); and (4) had acceptable linearity checks to ensure the measurement system was stable when the calibration was performed. The environmental consultant performing the field work is responsible for the calibration of all field sampling equipment. Contracted environmental laboratories are responsible for the calibration of all laboratory equipment used to analyze samples associated with all samples collected for the data generated for and submitted to ADEQ's Remedial Projects Section. Personnel record all equipment and instrument calibrations into an appropriate logbook and ensure availability of the logbook to ADEQ Remedial Projects Section personnel upon request.

D2.3.7 Data Reduction and Processing

Internal checks by laboratory staff should verify the integrity of the raw data generated by the analyses. Electronic data deliverables (EDDs) automatically produced by the laboratory should help minimize data entry errors. The steps in data reduction need clear documentation for properly assessing the validity of the analysis.

Data should be cross-checked to confirm consistency or comparability in analytical methods and detection limits, units of measurement, compatibility of file types or software, and other critical factors that affect data interpretation and its influence on conclusions and recommendations.

D3: Reconciliation with Data Quality Objectives

After the verification and validation of data, evaluation of the data against project DQOs occurs. Implementation of the DQA process completes the data life cycle by providing the assessment needed to determine achievement of project objectives.

Two 2006 EPA guidance documents on DQA are available from EPA at <https://www.epa.gov/quality/agency-wide-quality-system-documents>. DQA is the scientific and statistical evaluation of environmental data to determine if they meet the planning objectives of the project, and thus are of the right type, quality, and quantity to support their intended use. The document *Data Quality Assessment - A Reviewers Guide* broadly describes the statistical aspects of DQA in evaluating

environmental data sets. *Data Quality Assessment - Statistical Methods for Practitioners*, the companion guidance document on statistical methods for practitioners, provides a more detailed discussion on implementation of graphical and statistical tools. These EPA guidance documents discuss the use of DQA to support environmental decision-making (e.g., compliance determinations).

The DQA process has a fundamental premise: data quality is meaningful only when it relates to the intended use of the data. Data quality does not exist in a vacuum; a reviewer needs to know the context and use of a data set in order to establish a relevant yardstick for judging whether or not the data are acceptable. By applying the DQA process, a reviewer can answer four important questions:

- 1 Can someone make a decision (or estimate) with the desired level of certainty, given the quality of the data?
- 2 How well did the sampling design perform?
- 3 Is data expected to support the same intended use with the desired level of certainty for a similar study using the same sampling design strategy?
- 4 Is it likely that sufficient samples were taken to enable the reviewer to see an effect if there really were an effect? That is, is the quantity of data sufficient?

D3.1 Purpose/Background

This section outlines methods for evaluating the results obtained from the sampling and analysis. Use of scientific and statistical evaluations of the data determine if the data collected are of the right type, quantity, and quality to support their intended use and to adequately address the primary study questions.

Please note that ADEQ's Remedial Projects Section mainly employs statistical evaluations of data generated for and submitted to them for their use when considering exposure area decision units. ADEQ's Remedial Projects Section utilizes 1:1 evaluations (i.e. sample result compared to regulatory threshold) when considering source area decision units. When a project needs a statistical evaluation, confidence intervals (step 3 of the "Five Steps of Statistical DQA" in Section D3.2 below) is the statistic that would most likely best fit the project. If needed, a contractor can perform a statistical evaluation other than confidence intervals in accordance with the DQA process outlined in this QA Program Plan.

D3.2 Reconciling Results with Program Objectives or DQOs

For those scenarios when statistics are used for comparing sample results against a value (e.g. regulatory threshold), EPA guidance documents for data evaluation (EPA 2006) describes an iterative five-step process called the "Five Steps of Statistical DQA". These five steps are:

- 1 Review the DQOs and sampling design described in the project planning documents.
- 2 Conduct a preliminary data review or exploratory data analysis to understand the character and structure of the data set and to evaluate whether there are any previously unseen anomalies in the data not noticed during data verification and validation. Should further investigation of outliers or other anomalies occur prior to continuing with statistical testing?
- 3 Select a statistical test. Choose appropriate statistical tests based on the characteristics of the data and the questions that the investigation was intended to address.

4. Verify the assumptions of the statistical tests and assess the effect that violations of test assumptions may have on the result (i.e., is the test sufficiently robust to provide a valid result at a reasonable level of confidence?) and consider other factors (i.e., Are there effects of seasonality that must be considered? Would alternative statistical tests be better suited to the data than the tests proposed in the planning documents?).
5. Draw conclusions from the data. Using multiple lines of evidence, the results of statistical tests and professional judgment, the data analyst should be able to provide conclusions and recommendations for the site. The conclusion, in some cases, can detail a need for more data for the purpose of better answering the primary study questions.

For inadequately defined DQOs, the analyst may need to review the planning documents and sampling design, and then define the statistical hypotheses to be tested and establish tolerable limits on decision errors.

Judgmental sampling occurs when the DQOs are qualitative and ADEQ will still systematically assess data quality and data usability. This DQA – Four Steps of DQA for Qualitative DQOs - include the following:

1. A review of the sampling design and sampling methods to verify that these were implemented as planned and are adequate to support project objectives;
2. A review of project-specific MQOs for precision, accuracy, representativeness, completeness, comparability and quantitation limits to evaluate whether acceptance criteria have been met;
3. A review of project-specific DQOs to assess whether they have been achieved by the data collected; and
4. An evaluation of any limitations associated with decisions based on the data collected. For example, if data completeness is only 90 percent compared to a project-specific completeness objective of 95 percent, the data may still be usable to support a decision, but at a lower level of confidence.

D3.2.1 Review DQOs and Sampling Design

The DQA process should (1) document or define the project specific DQOs, (2) verify that the hypothesis is consistent with project objectives, and (3) identify any deviations from the sampling plan and assess the potential effect of the deviations.

A review of the objectives of the study occurs in order to provide a context for analyzing the data. If implementation of a systematic planning process occurs before the data are collected, this step reviews the study objectives and evaluates for completion of project goals and adequacy of answers to study questions. If there was no clear planning process prior to collecting the data, the reviewer should develop a concise definition of the problem (Step 1) and of the methodology of how the data were collected (Step 2). These two steps should provide the fundamental reason for collecting the environmental data and identify all potential actions that could result from the data analysis.

The project-specific planning document should clearly detail the design and sampling strategy. The overall type of sampling design and the manner in which data collection occurs typically constrains data use and interpretation. The data analyst should assess whether features of the design support or contradict the stated objectives of the study. Were there deviations from the planned design? What might be the effect of these deviations? Are data adequate to address the primary study questions? How do these

objectives translate into statistical hypotheses (null and alternative hypotheses)? * Section B1.1 of this document discusses sampling designs in greater detail.

Regardless of the type of sampling scheme, the reviewer should review the description of the sampling design and look for design features that support the project objectives. For example, if the goal of the study is to make a decision about the average (defined here as the arithmetic mean) concentration of a contaminant in a stockpiled soil, then composite samples may be an appropriate sampling design. On the other hand, if the goal of the study is to find contaminant source areas at a hazardous waste site, one needs caution when compositing samples to avoid "averaging away" hot spots.

The reviewer should also look for potential problems in the implementation of the sampling design. For example, if data collection involved simple random sampling, can the reviewer be confident that the sampling locations or data point were truly random? Careful assessment of significant or substantial deviations needs to occur. Small deviations from a sampling plan, though, probably have minimal effect on the conclusions drawn from the data set. Finally, the reviewer should verify that the data are consistent with the project-specific planning document and the overall objectives of the study.

D3.2.2 Conduct Preliminary Data Review

Step 2 of the DQA process reviews graphical representations of the data and calculates some basic statistical quantities. By reviewing the data both numerically and graphically, the reviewer can understand the structure of the data, and thereby identify appropriate use of the data.

Statistical quantities numerically describe the data. The quantities that are typically calculated include the arithmetic or geometric mean, the median and other percentiles, and the standard deviation. These quantities provide estimates of characteristics for the sample population and allow one to make inferences about the population from which the data were drawn. Graphical representations permit the reviewer to identify patterns and relationships within the data, confirm or disprove assumptions and identify potential problems.

The preliminary data review allows the reviewer to understand the structure and characteristics of the data set and the population from which these data were drawn. Graphical depictions of the data permit the analyst to identify anomalies that may require further investigation or perhaps even reanalysis by the laboratory. Output from DQA Step 2 typically includes (1) tables of summary statistics and (2) graphs and/or statistical plots of the data.

D3.2.3 Select Statistical Test

Under Step 3 of the DQA process, the data analyst selects the most appropriate statistical test or method for evaluating the data. The basis for selection of the statistical method are the sampling plan used to collect the data, the type of data distribution, and the assumptions (and any deviations from these assumptions) made in setting the DQOs. The results of this evaluation assist in formulating conclusions about other aspects of the data set or the stated null hypothesis. EPA DQA guidance provides a discussion (with mathematical formulas and examples for conducting statistical tests) of the process for statistically evaluating environmental data. Chapter 3 of EPA's 2006 *Data Quality Assessment: Statistical Methods for Practitioners* details technical information that reviewers can use to select appropriate procedures.

For the occasion when a Remedial Projects Section project needs a statistical evaluation, confidence intervals (step 3 of the "Five Steps of Statistical DQA" in Section D3.2 above) is the statistic that would most likely best fit the project. For example, the project's objective may be to estimate the average level

of pollution for a particular contaminant. A reviewer can describe the desired (or achieved) degree of uncertainty in the estimate by establishing confidence limits within which one can be reasonably certain that the true value will lie. When interpreting a confidence interval statement such as “The 95% confidence interval for the mean is 19.1 to 26.3”, the implication is that the best estimate for the unknown population mean is 22.7 (halfway between 19.1 and 26.3), and that we are 95% certain that the interval 19.1 to 26.3 captures the unknown population mean.

If the project-specific planning document specified a particular statistical procedure, the reviewer should use the results of the preliminary data review to determine if the procedure is appropriate for the data collected. If not, then the reviewer should document why the procedure is inappropriate and then select a different method. Chapter 3 of EPA’s 2006 *Data Quality Assessment: Statistical Methods for Practitioners* provides alternatives for several statistical procedures. If there is not a particular procedure specified, then the reviewer should select a statistical test or method based on the study objectives, results of the preliminary data review, and key assumptions necessary for the method.

All statistical tests make assumptions about the data. For instance, the t-test, which is a parametric test used to compare two data sets, assumes that each data set approximates a normal distribution and that the two data sets have approximately equal variance. In contrast to parametric tests like the t-test, nonparametric tests make much weaker assumptions about the distributional form of the data. However, both parametric and nonparametric tests assume that the data are derived from statistically independent samples. Common assumptions of statistical tests include distributional form of the data, independence, dispersion characteristics, approximate homogeneity, and the basis for randomization in the sampling design. For example, the one-sample t-test assumes random and independent samples, an approximately normal distribution, no outliers, and no more than a small percentage of non-detections.

Statistical methods are “robust” if they are insensitive to small or moderate departures from the assumptions. However, some tests rely on the data meeting certain key assumptions in order for the test results to be valid. The reviewer should note any sensitive assumptions where relatively small deviations could jeopardize the validity of the test results.

After completing Step 3 of the DQA process, the data analyst or reviewer should have selected appropriate statistical tests and noted the critical assumptions of the statistical tests.

D3.2.4 Verify Assumptions of Statistical Tests

The validity of a statistical test or method depends on the key assumptions underlying the test and whether the data violate these assumptions. Minor deviations from assumptions are usually not critical if the statistical technique is sufficiently robust to compensate for such deviations.

If the data do not show serious deviations from the key assumptions of the statistical method, then the DQA process continues to Step 5, ‘Draw Conclusions from the Data.’ However, it is possible that if there is one or more questionable assumptions, the chosen most appropriate test for the data could require re-evaluation. It is true that some deviations do not invalidate the results of a statistical test, but confirmation takes place in Step 4 of the DQA process. For example, deviation from normality may not be seriously important for a large sample size, but could be critically important for a small sample size.

This step in the DQA process is an important check on the validity and reliability of the conclusions that are drawn. Outputs from this step include documentation of the method used to verify assumptions and verification that the test results are valid. Additionally, the reviewer should provide a description of any corrective actions taken.

D3.2.5 Draw Conclusions from Data

Step 5 of the DQA process represents the culmination of the planning, implementation and investigation phases of the project operations. In this step, the data analyst draws conclusions that address the project objectives. All of the analysis and review conducted in Steps 1 through 4 should ensure that the conclusions drawn in Step 5 adequately address project objectives in a scientifically defensible manner.

Step 1 is a review (or retrospective development) of project objectives and sampling design evaluation. Step 2 is a review of the sampling scheme implementation and development of the preliminary picture with respect to the data set. Step 3 is a selection of appropriate statistical tests. Finally, Step 4 verifies the underlying assumptions of the statistical test.

Conclusions drawn in the final step of the DQA process allow the reviewer or data analyst to present valid statistical results with a specified level of significance. This step plainly states the confidence and power of the tests, along with the study conclusions. Finally, the data analyst provides an assessment of the overall performance of the sampling design and identifies any needed additional data (i.e. data gaps are identified).

Application of professional judgment to draw conclusions without relying on formal statistical testing occurs when judgmental sampling is the selection method for sample collection or when few samples are collected. Or, there can be application of statistical tests but with the recognition that the results may present a biased “worst-case scenario”. For example, if the data from biased samples (e.g., selective sampling of visibly stained soils) are used in a one-sample statistical test to compare concentrations against a regulatory threshold, and test results show that concentrations do not exceed the threshold, then a conclusion can be drawn. If test results show that concentrations do exceed a regulatory threshold, then, in formulating conclusions, the reviewer should balance the test results against the knowledge that the use of biased data toward the sampling of “hot spots.”

D4: Revisions to the QA Program Plan

Throughout the life of ADEQ’s Remedial Projects Section, there may be changes to program requirements, or modifications to the way environmental data are collected, or changes to the definitions of enforcement activities. Therefore, this QA Program Plan is a dynamic document that is subject to revision, as needed. ADEQ Remedial Projects Section personnel, Technical Support and QA/QC personnel will examine and revise this QA Program Plan annually. Re-submittal of this plan to the EPA Region 9 QA manager for review, though, will occur once every five years or as otherwise needed. Dissemination of approved revisions include personnel on the Distribution List (page 6).

Table D1 – Criteria for Partial and Full Data Validation

Analytical Group	Criteria for Partial Data Validation	Criteria for Full Data Validation
Organic Analyses	<ul style="list-style-type: none"> ● Holding times ● Calibration ● Blanks ● Surrogate recovery ● Matrix spike and matrix spike duplicate recovery ● Laboratory control sample or blank spike ● Internal standard performance ● Field duplicate sample analysis ● Temperature ● Overall assessment of data for an SDG 	<ul style="list-style-type: none"> ● Holding times ● Gas Chromatography/Mass Spectroscopy tuning ● Calibration ● Blanks ● Surrogate recovery ● Matrix spike and matrix spike duplicate recovery ● Laboratory control sample or blank spike ● Internal standard performance ● Field duplicate sample analysis ● Compound identification ● Target compound list identification ● Compound quantitation and reported detection limits ● Tentatively identified compounds ● System performance ● Temperature ● Overall assessment of data for an SDG
Inorganic Analyses	<ul style="list-style-type: none"> ● Holding times ● Calibration ● Blanks ● Matrix spike recovery ● Matrix duplicate sample analysis ● Laboratory control sample or blank spike ● Field duplicate sample analysis ● Temperature ● ICP serial dilution ● Overall assessment of data for an SDG 	<ul style="list-style-type: none"> ● Holding times ● Calibration ● Blanks ● ICP interference check sample ● Matrix spike recovery ● Matrix duplicate sample analysis ● Laboratory control sample ● Field duplicate sample analysis ● Graphite furnace atomic absorption QC ● Sample result verification ● Temperature ● ICP serial dilution ● Detection limits ● Overall assessment of data for an SDG

Notes:

- ICP Inductively coupled plasma (emission spectroscopy)
- SDG Sample delivery group
- QC Quality Control

APPENDICES

Appendix A	Arizona Administrative Code for Department of Health Services Laboratories
Appendix B	Arizona Administrative Code for Soil Remediation Standards and Water Quality Standards
Appendix C	Arizona Agencies Guidance Documents and Updates
Appendix D	Standard Operating Procedures
Appendix E	Field Forms
Appendix F	ADEQ Specific Quality Assurance Guidance and Policies

Appendix A **Arizona Administrative Code for Department of Health Services
Laboratories**

Below is the hyperlink to the Arizona Administrative Code for Title 9 (Health Services) Chapter 14 (Department of Health Services Laboratories):

http://apps.azsos.gov/public_services/Title_09/9-14.pdf

Appendix B **Arizona Administrative Code for Soil Remediation Standards and Water Quality Standards**

Below is the hyperlink to the Arizona Administrative Code for Title 18 (Environmental Quality) Chapter 7 (Department of Environmental Quality Remedial Action) Article 2 (Soil Remediation Standards):

http://apps.azsos.gov/public_services/Title_18/18-07.pdf

Below is the hyperlink to the Arizona Administrative Code for Title 18 (Environmental Quality) Chapter 11 (Department of Environmental Quality Water Quality Standards):

http://apps.azsos.gov/public_services/Title_18/18-11.pdf

Appendix C Arizona Agencies Guidance Documents and Updates

ADEQ's Waste Programs Division Site Investigation Guidance is available at the following link:

http://legacy.azdeq.gov/enviro/waste/download/SI_Guidance_Manual_Final.pdf

ADEQ's Soil Vapor Sampling Guidance dated May 2011 is available at the following link:

<http://legacy.azdeq.gov/enviro/waste/download/svsg.pdf>

The Arizona Department of Health Services (ADHS) issued information Update #119 (VOCs in 8260B) on May 15, 2014 and is available at the following link:

<http://www.azdhs.gov/documents/preparedness/state-laboratory/lab-licensure-certification/technical-resources/information-updates/information-update-119.pdf>

ADHS issued an update in November 2011 for VOCs to be added to the EPA Method TO-15 (the original list was dated July 1999). The information update is available at the following link:

<http://www.azdhs.gov/documents/preparedness/state-laboratory/lab-licensure-certification/technical-resources/information-updates/2011.pdf>

Appendix D Standard Operating Procedures

This appendix contains references and web addresses for numerous standard operating procedures (SOPs) from the U.S. Environmental Protection Agency (EPA). General sampling guidelines are included in the EPA SOP on General Field Sampling Guidelines. SOPs delineate the step-by-step approach that field personnel must follow in collecting samples, taking field measurements, decontaminating equipment, handling IDW and calibrating instruments. Most qualified sampling contractors and State and Federally certified laboratories develop SOPs and analytical methods as part of their overall QA program. EPA's April 2007 *Guidance for Preparation of Standard Operating Procedures for Quality-Related Operations* (EPA/600/B-07/0001) is a guide for developing SOPs. The field team should document which SOPs they are using in the field and any deviations from an SOP.

EPA SOPs for field sampling methods are available for download at:

https://clu-in.org/publications/db/db_search.cgi?title=1&submit_search=1&cat=18

Field personnel will ensure that all sampling equipment has been properly assembled, decontaminated and calibrated, and is functioning properly prior to use. Equipment use and decontamination is in accordance to manufacturer's instructions and in accordance to the EPA SOP for Sampling Equipment Decontamination.

The following list provides references and web addresses for a variety of SOPs provided by the EPA:

[Analysis of Polynuclear Aromatic Hydrocarbons \(PAHs\) in Air by GC/MS](#)

**Published
03/13/2002**

The objective of this Standard Operating Procedure (SOP) is to provide guidance on the requirements for the analysis of Polynuclear Aromatic Hydrocarbons (PAH) compounds in air samples using gas chromatography/mass spectrometry (GC/MS).

[Download \(667KB/29pp/PDF\)](#)

[Analysis of Polynuclear Aromatic Hydrocarbons \(PAHs\) in Dust by GC/MS-SIM](#)

**Published
03/14/2005**

This Standard Operating Procedure (SOP) outlines the preparation and analysis of polynuclear aromatic hydrocarbons (PAHs) in dust matrices using gas chromatography/mass spectrometry (GC/MS) in the select ion monitoring (SIM) mode.

[Download \(467KB/29pp/PDF\)](#)

[Data Validation Procedures for Routine Volatile Organic Analysis](#)

**Published
01/13/2004**

To establish a protocol for evaluation and validation of the volatile organic compound data generated by the Response Engineering and Analytical Contract laboratory as well as VOC data generated by subcontracted labs.

[Download \(1KB/53pp/PDF\)](#)

[Description and Identification of Soils](#)

**Published
02/23/2004**

The intent of this SOP is to establish a consistent method for describing soils that are to be sampled and analyzed in the course of a site investigation. Soil descriptions and identifications provide key information when investigating HW sites.

[Download \(187KB/18pp/PDF\)](#)

Determination of Granular Soil Permeability (Constant Head)

**Published
06/27/2003**

Outlines the procedure for the determination of the coefficient of permeability by a constant-head method for granular soils.

[Download \(572KB/14pp/PDF\)](#)

Drum Sampling

**Published
11/16/1994**

Provide technical guidance on implementing safe and cost-effective response actions at hazardous waste sites containing drums with unknown contents.

[Download \(806KB/32pp/PDF\)](#)

Field Analysis of Volatile Organic Compounds in Tedlar Bag AIR Samples by GC/MS (Triad GC/MS - Based on EPA TO-15A)

**Published
01/19/2006**

Describes the field gas GC/MS analysis of air sample collected in Tedlar bags. This procedure generates field screening data in ppbv and is based on EPA Compendium Method TO-15.

[Download \(360KB/17pp/PDF\)](#)

GC/MS Analysis of Sorbent Tubes and Canisters (EPA TO-15 and TO-17)

**Published
03/24/2006**

The purpose of this Standard Operating Procedure (SOP) is to outline the steps for the analysis of air samples collected on either sorbent tubes or in SUMMA® canisters by Gas Chromatography/Mass Spectrometry (GC/MS).

[Download \(2KB/34pp/PDF\)](#)

General Air Sampling Guidelines

**Published
11/16/1994**

Provides guidance in developing and implementing sampling plans to assess the impact of hazardous waste sites on ambient air.

[Download \(219KB/27pp/PDF\)](#)

Groundwater Well Sampling

**Published
04/16/2001**

Provides general information on sampling groundwater wells and ensures that the sample is representative of the particular groundwater zone being sampled.

[Download \(464KB/21pp/PDF\)](#)

Handling Potentially High Hazard Environmental Samples

**Published
10/24/1994**

To describe safe lab practices for the preparation and analysis of samples which may contain unknown concentrations of hazardous materials. It will focus on the practices for a mobile High Hazard lab.

[Download \(271KB/11pp/PDF\)](#)

[Indoor Air Analysis of Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry](#) **Published 06/03/2002**

The objective of this Standard Operating Procedure (SOP) is to provide guidance on the requirements needed to analyze Volatile Organic Compounds (VOCs) in air samples using gas chromatography/mass spectrometry (GC/MS).

[Download \(606KB/25pp/PDF\)](#)

[Investigation-Derived Waste Management](#) **Published 10/21/1994**

IDW includes soil cuttings, drilling muds, purged groundwater, decontamination fluids (water and other fluids), disposable sampling equipment, and disposable personal protective equipment (PPE).

[Download \(104KB/9pp/PDF\)](#)

[Low Level Methane Analysis for Summa Canister Gas Samples](#) **Published 12/16/1994**

Intended for use when analyzing Summa canister gas samples for low parts per million volume levels of methane.

[Download \(166KB/5pp/PDF\)](#)

[Manual Water Level Measurements](#) **Published 12/10/2002**

Set guidelines for the determination of the depth to water measurements in an open borehole, a cased borehole, a monitor well, or a piezometer.

[Download \(106KB/8pp/PDF\)](#)

[Mobile Laboratory VOC GC/MS Analysis of WTC Tedlar Bag Air Samples](#) **Published 11/19/2001**

Describe the Gas Chromatography/Mass Spectrometry (GC/MS) analysis of air samples collected using Tedlar bags. The methods are applicable to the analysis of Volatile Organic Compounds (VOCs).

[Download \(333KB/13pp/PDF\)](#)

[Monitor Well Development](#) **Published 09/06/2001**

The purpose of monitor well development is to ensure removal of fine grained sediments (fines) from the vicinity of the well screen. The most common well development methods are: surging, jetting, overpumping, and bailing.

[Download \(214KB/7pp/PDF\)](#)

[Monitor Well Installation](#)**Published
07/12/2001**

Methods used for the installation of the wells. Monitor well installation creates a permanent access for the collection of samples to assess groundwater quality and the hydrogeologic properties of the aquifer, in which contaminants may exist.

[Download \(313KB/16pp/PDF\)](#)

[Operation of the Hapsite Field Portable Gas Chromatograph/Mass Spectrometer \(GC/MS\) \(Triad GC/MS - Based on EPA/TO-15A\)](#)**Published
01/26/2006**

Describe the operation of the Inficon HAPSITE field-portable gas chromatograph/mass spectrometer (GC/MS).

[Download \(1KB/47pp/PDF\)](#)

[Procedures for Automated Summa Canister Cleaning](#)**Published
12/31/2008**

Intended for use when cleaning polished stainless steel SUMMA type or glass-lined Silco type canisters.

[Download \(497KB/14pp/PDF\)](#)

[Processing Air Samples with the Portable Sample Concentrator](#)**Published
12/22/1994**

Define the means of processing air samples with a portable sample concentrator. The sample concentrator is a field portable sorption tube concentration device used to concentrate dilute air samples prior to chromatographic analysis.

[Download \(277KB/13pp/PDF\)](#)

[Quality Assurance/Quality Control Samples](#)**Published
08/11/1994**

Describe typical Quality Assurance/Quality Control (QA/QC) samples that are collected in the field, or prepared for or by the laboratory. The QA/QC samples identified in this SOP are representative for soil, water and air matrices.

[Download \(198KB/12pp/PDF\)](#)

[Retrieving Meteorological Information](#)**Published
12/04/1994**

The objective of this Standard Operating Procedure (SOP) is to define the protocol for retrieving meteorological information to be used as inputs to categorize on-site field conditions in 'real-time.'

[Download \(64KB/5pp/PDF\)](#)

[Routine Analysis of Semivolatiles in Soil/Sediment by GC/MS \(EPA/SW-846 Methods 3500B/3541/8000B/8270C\) \(EPA/SW-846 Methods 3600C/3640A - Optional\)](#)**Published
01/23/2006**

Outlines the preparation and analysis of base/neutral/acid extractable (BNA) compounds in soil/sediment matrices using a gas chromatograph/mass spectrometer (GC/MS).

[Download \(574KB/34pp/PDF\)](#)

[Routine Analysis of Semivolatiles in Water by GC/MS \(EPA/SW-846 Methods 3500B/3510C/8000B/8270C\)](#)**Published
01/23/2006**

Outlines the preparation and analysis of base/neutral/acid (BNA) compounds in water matrices using a gas chromatograph/mass spectrometer (GC/MS).

[Download \(671KB/32pp/PDF\)](#)

[Sample Documentation](#)**Published
09/14/2002**

Define the procedures for preparing and maintaining documentation which provides the details of field sampling activities.

[Download \(596KB/19pp/PDF\)](#)

[Sample Packing and Shipment](#)**Published
11/30/2000**

Summarize requirements for the packaging, marking/labeling, and shipping of environmental and hazardous materials samples.

[Download \(429KB/16pp/PDF\)](#)

[Sample Storage, Preservation and Handling](#)**Published
08/11/1994**

Provide general guidelines for the storage and preservation of water and soil/sediment samples.

[Download \(214KB/7pp/PDF\)](#)

[Sampling Equipment Decontamination](#)**Published
08/11/1994**

Provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination.

[Download \(427KB/22pp/PDF\)](#)

The following list provides references and web addresses for a variety of SOPs provided by ASTM:

[ASTM D 5088- 02\(2008\) Standards Practice for Decontamination of Field Equipment Used at Waste Sites](#)

[ASTM D 5679-95a. 1995. Standard Practice for Sampling Consolidated Solids in Drums or Similar Containers](#)

[ASTM D 5680-95a. 1995. Standard Practice for Sampling Unconsolidated Solids in Drums or Similar Containers.](#)

[ASTM D 5743-97. 1997. Standard Practice for Sampling Single or Multilayered Liquids, With or Without Solids, in Drums or Similar Containers](#)

[ASTM D 6063-96. 1996. Standard Guide for Sampling of Drums and Similar Containers by Field Personnel](#)

[ASTM D6232 - 2008 Standard Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities](#)

Appendix E Field Forms

Contractors working on projects associated with the Remedial Projects Section are expected provide their own field log sheets and field forms for common tasks, such as drilling and logging borings, drilling and installing monitoring wells, and sampling environmental media. Daily field logbook entries also constitute part of the record and should be included as an appendix to site assessment reports prepared for the WQARF Program.

Include chain-of-custody form copies along with the analytical data from the laboratory in a separate appendix in the investigation report. Sampling sheets filled out during sample collection should correlate with the information reported on the chain-of-custody forms.

Samples of field forms are provided on the following pages. The list of these forms is as follows:

1. ADEQ QA/QC checklist for Soil Vapor Sampling
2. RBCA Tier 3 Submittal Checklist
3. Groundwater Sampling Field Form

Arizona Department of Environmental Quality QA/QC checklist for Soil Vapor Sampling

Sampling Company

1 Date: _____ Start time: _____
 2 Company Name: _____ Sampler's Name: _____

Consulting Firm:

3 Company Name: _____ Project Name: _____
 4 Project Manager: _____ Project Number: _____

Well's Information

5 Location: _____ Client ID: _____ Permanent Temporary
 6 Address: _____
 7 ADEQ File Identification #(s) _____
 8 Describe the probe location: _____
 9 Probe Depth: _____ inch Probe ID: _____ inch **Probe volume: 0 inch³ (0) ml**
 10 Probe type: Tygon Teflon Vinyl PVC Metal Other: _____
 11 Is probe tested in the lab before installed? Y N NA Don't know
 12 Comments: _____

Weather Conditions

13 Temperature: _____ C° F°
 14 Has there been significant rain or snow recent to the sampling event? Y N
 15 If Yes to Question 14 Date _____ Amount of Precipitate _____ inches

Soil Conditions Information

16 Was a soil sample collected and analyzed for volumetric moisture content? Y N attach results if yes
 If yes, attach results
 If no, is the apparent moisture content dry moist saturated
 17 What is soil type encountered at sample location? _____
 18 Was sample collected beneath a surface cover (e.g. parking lot, sidewalk, road, building, other)? Y N
 19 Describe the surface cover, if any _____
 20 Was the sample collected near a subsurface conduit? Y N
 Describe subsurface conduit, if any _____

Sampling Train

21 Sample container: Canister : 1.0 L 6.0 L Silanized: Y N
 Other: _____
 Tedlar bag: Y N Gas tight syringe Y N
 22 Flow restrictor: On 1000 mL/min 500 mL/min 200 mL/min Other: _____
 One min = Taking one minute to fill one liter canister.
 23 Tubing type: Tygon Teflon Vinyl PVC Other: _____
 24 Tubing used from probe top to canister: Length: _____ inch ID _____ inch
 25 **Tubing volume: 0 inch³ (0) ml**
 26 Are all parts of Sampling Train tested in the lab before sampling? Y N

Probe Purging Before Sampling

27 Total volume: probe(v) + tubing(v) = Probe volume 0 + Tubing volume 0 = 0 ml

28 Total volume to be purged (ml): 1x 0 1.5x 0 2x 0 3x 0

29 Purging pump #: _____ Purging flow rate: _____ ml/min Purging time: _____ mins _____ seconds

30 Gauge reading: < 5 inHg Other: _____ Comments: _____

31 Syringe Purging: NA Dedicated Syringe Re-used Syringe Volume _____

32 Is there condensation evident in the sampling train? Y N

33 Post sample collection - Is there condensation evident in the sampling container? Y N

34 **Leak Test** Y N If Yes, fill in the blanks blow:

35 Tracer compound: _____ Trade name: _____ Tested before use: Y N

36 Locations applied: Probe top Sampling train: Other: _____

37 **Field Duplicate** Y N If Yes, fill in the blanks blow:

38 Used the Duplicate Splitter? Y N If no, describe the procedure: _____

Other Information

39 Identify the equipment and method used to install probe and collect sample _____

40 What was the equilibration time between probe installation and withdrawal of any soil vapor? _____

41 Sample storage /shipping temperature _____

42 Sample storage /shipping container _____

43 Sample transportation mode(s) _____

44 Was an equipment blank taken? Y N Was Tank air or Nitrogen used? _____
Note: Ambient air should not be used

45 Was a field blank taken? Y N

46 Was a background (upwind ambient) sar Y N

47 Are there any potential VOC sources other than the identified release nearby?
Groundwater/active fueling station/ dry cleaners/ dry wells/ other - please describe _____

48 **Well (Probe) Inspection Note:** _____

	<h2 style="margin: 0;">UST Corrective Action Program Checklist</h2>
<h3 style="margin: 0;">RBCA Tier 3 Submittal Checklist</h3> <h4 style="margin: 0;">Soil Vapor Surveys</h4> <p style="margin: 0; font-size: small;">In accordance with A.A.C. R18-12-263.01</p>	
UST Facility Name _____ Assigned UST Facility ID 0-0 _____ Assigned LUST Release ID _____ Regulated substance released: <input type="checkbox"/> E10 <input type="checkbox"/> Gasoline (with MTBE) <input type="checkbox"/> Gasoline (Leaded) <input type="checkbox"/> Diesel <input type="checkbox"/> Used Oil <input type="checkbox"/> Jet Fuel <input type="checkbox"/> Other _____	
ADEQ Soil Vapor Sampling Guidance Document (revised May 2011) http://azdeq.gov/environ/waste/download/svsg.pdf	
Yes No	<h4 style="text-align: center; margin: 0;">Report Submittal</h4> <ul style="list-style-type: none"> <input type="checkbox"/> <input type="checkbox"/> Report/letter summarizing field activities <input type="checkbox"/> <input type="checkbox"/> Field notes <input type="checkbox"/> <input type="checkbox"/> QA/QC Soil Vapor Survey Checklist includes each vapor sampling point <input type="checkbox"/> <input type="checkbox"/> Laboratory analytical data including QA/QC data for EPA Method TO-15 including all 31 AZ compounds http://azdeq.gov/environ/waste/ust/download/Program_Analytical_Data_July_2014.pdf <input type="checkbox"/> <input type="checkbox"/> Sample location map <input type="checkbox"/> <input type="checkbox"/> Detection Summary Table with soil vapor results reported in µg/m³ and leak detection compound reported in ppbv <input type="checkbox"/> <input type="checkbox"/> Screening Level Johnson & Ettinger Model [forward calculation] indoor air simulation results* http://www3.epa.gov/ceampubl/eam2model/part-two/onsite/InE_ite_forward.html
Yes No	<h4 style="text-align: center; margin: 0;">Field Procedures</h4> <ul style="list-style-type: none"> <input type="checkbox"/> <input type="checkbox"/> Sample depth no greater than 5 feet bgs, no shallower than 3 feet bgs Note: Deeper sampling depth may be necessary due to site specific issues - check with UST program Note: Geotechnical data can be collected and used in the model instead of default values <input type="checkbox"/> <input type="checkbox"/> Field duplicate(s) collected at a rate of 1 per 20 samples <input type="checkbox"/> <input type="checkbox"/> Ambient air (background sample collected upwind at the site) <input type="checkbox"/> <input type="checkbox"/> Equipment blank(s) or field blank(s) collected daily (use Nitrogen or clean tank air only in the field; The equipment blank may also be provided by the laboratory) <input type="checkbox"/> <input type="checkbox"/> Purge and sample rate ≤200 ml/min Note: Over purging can happen under concrete so the rate can be reduced to 100 ml/min <input type="checkbox"/> <input type="checkbox"/> Temporary probes (correct internal volume purged) <input type="checkbox"/> <input type="checkbox"/> Permanent probes (correct number of internal purge volumes) <input type="checkbox"/> <input type="checkbox"/> Summa canisters certified clean
<h4 style="text-align: center; margin: 0;">Screening Level Johnson & Ettinger Model</h4> <p style="font-size: small; margin: 0;">*Chemical of concern to be modeled are the maximum concentration of each chemical that exceeds 1/10th of EPA Regional Screening Level Resident Air Supporting Table (lowest value reported). This is done to evaluate cumulative risk of all chemicals of concern. [Use the resident air table with Target Risk = 10⁻⁶ and THQ = 1.0]. Toxicity information (reference concentration and unit risk factor) must be updated in the model using information found in the most current EPA Regional Screening Level resident air table. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm</p> <p style="font-size: small; margin: 0;">Use High Indoor Air Prediction for determining cumulative cancer risk and cumulative hazard risk for petroleum related chemicals of concern, and non-petroleum related chemicals of concern for a conservative approach. The Best and Low Indoor Air Prediction may be used depending upon site specific conditions.</p> <p style="font-size: small; margin: 0;">The User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, revised February 22, 2004 prepared by Environmental Quality Management, Inc. for the US EPA provides information on what parameters can be updated in the model for site specific conditions.</p>	

	Monitor Well Purging and Sampling Log		FLD-103					
			Revision 1.0					
			Mar-13					
Branch: #10105 - Tempe, Arizona		Date: 12/29/15	Page of					
Representative(s): JM/JMC		Project: Speedy's						
Contact Information:		Location: 856 Navajo Boulevard, Holbrook, Arizona						
Well ID: MW-1L		Project No: ZB3400008	Phase No: 01					
		Contractor: None	Weather: Clear					
		Temperature: 30						
Purging & Sampling Instrumentation & Method								
Water Level Meter (Model#):		Interface Probe (Model#): Kock						
Water Quality Meter (Model#): YSI/askon/Hanna		Decontamination Method: Alconox						
Purging Method: <input type="checkbox"/> PVC Bailor <input type="checkbox"/> Vacuum Truck <input checked="" type="checkbox"/> Submersible Pump <input type="checkbox"/> Peristaltic Pump Other: Bladder								
3 Well Volumes <input checked="" type="checkbox"/> Low Flow <input type="checkbox"/> Micro Purge Intake Depth (feet below TOC): 19								
Sampling Method: <input type="checkbox"/> Teflon Bailor <input type="checkbox"/> Disposable Bailor <input checked="" type="checkbox"/> Dedicated Tubing Other: _____								
Casing Volume Information			Purging Calculations					
Casing Diameter: 2"			Casing Volumes (CV)					
Casing Multiplier (CM) _(gal/foot) : 0.16 (mL/ft) 695			WC _____ x CM _____ = _____ (CV) _(gal) x 3.0 CV _(gal) = _____ PV					
Monitoring Measurements								
Depth to LNAPL (feet): _____		Total Well Depth / Screened Interval (feet bTOC) 21.7 / 16.7-21.7						
Depth to Water (DTW)(feet): 13.44		Water Column (WC)(feet):						
LNAPL Thickness (ft): _____		Purging Start Time: 1510		End Time: 1525				
Purging Data								
Time (24 Hours)	DTW (Feet)	Cum. Vol. Purged (ml)	Temp (°C) (±3°)	Specific Cond. _(µS/cm) (±3%)	Dissolved Oxygen (mg/L) (±10%)	pH (±0.1)	ORP (mV) (±10 mV)	Other
1513	13.44	300	18.8	6.30	5.28	7.55	-12	
1516	13.60	600	20.6	6.47	4.58	7.20	38	
1519	13.60	900	20.6	6.40	5.00	7.19	61	
1522	13.60	1200	20.5	6.40	6.03	7.19	67	
1525	13.60	1500	20.5	6.42	5.01	7.19	64	
Sample Data								
Sample ID: MW-1L		Time of Sample: 1525		Filtered (yes/no)	Preservatives	Analytical Parameters		
Container Types, Volumes, & Quantities:								
3x 40mL VOA				No	HCl	VOC EPA 8260B		
3x 40mL VOC				No	HCl	Methanol EPA 8015MEETA		
Well Recovery Data								
Maximum Drawdown (DTWm)(feet):		Approximate Flow Rate (GPM): 100 m/min						
Recovery Type: <input checked="" type="checkbox"/> Fast <input type="checkbox"/> Slow		% Recovery =						
Purge Water Disposition (Attach Drum Inventory Log - FLD 106): Purge water returned to well following sample collection.								
Comments:								

Appendix F **ADEQ Specific Quality Assurance Guidance and Policies**

- ADEQ Temperature/Preservation Guidance (see next page);
- [Substantive Policy 0154 - Addressing Spike And Surrogate Recovery As They Relate To Matrix Effects In Water, Air, Sludge And Soil Matrices Policy](#); and
- [Substantive Policy 0170 - Implementation of EPA Method 5035 - Soil Preparation for EPA Method 8015B, 8021B and 8260B.](#)

**ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY**

DATE: January 24, 2002

ADEQ TEMPERATURE/PRESERVATION GUIDANCE POLICY

To help assure the validity and documentation of data generated for use by ADEQ, the QA Unit requires that the elements listed below be fulfilled. If the requirements listed below are not fulfilled, the data *may* be considered unacceptable for compliance or enforcement purposes.

Temperature Documentation Requirements

The documentation of the presence of "wet" ice with samples is not a substitute for measuring temperature. At a minimum, the temperature of a temperature blank must be recorded for each cooler upon sample receipt. The preferred procedure for documenting sample temperature is to record the temperature on the chain of custody.

It is, however, *recommended* that the temperature of each sample be recorded upon sample receipt. The measurement of a temperature blank is not required if each sample temperature is documented.

The sole use of "blue" ice is strongly discouraged for use by laboratories generating data that will be submitted to ADEQ. "If 'blue' ice is used, it should be frozen at the time of sampling, the sample should be chilled before packing, and special notice must be taken at sample receipt to be certain the required temperature (4C) has been maintained." *Manual for the Certification of Laboratories Analyzing Drinking Water*, page IV-3, section 6.2. There must be documentation substantiating that the "blue" ice was frozen at the time of sampling and that the sample was chilled before packing.

The QA Unit acknowledges that all samples may not have time to equilibrate to $\pm 2^{\circ}\text{C}$ due to an insufficient time between sample collection and sample submittal to the laboratory. The rejection of data in these situations will not be automatic. Each of these occurrences will be evaluated on an individual basis to determine if a good faith effort has been made to maintain the samples at the required temperatures.

Chemical Preservation Requirements

All pH adjustments performed by the laboratory must be recorded.

The pH of a sample must be recorded by the laboratory either upon receipt or before analysis, as appropriate to the specific method. Recording the pH of a sample may be documented on the chain of custody or some other appropriate form.

In lieu of a laboratory verifying that a sample has been preserved to the appropriate pH in the field, written documentation such as a laboratory copy of a sampler's field notes also provides adequate documentation of proper preservation.

APPENDIX J

TENTATIVE TABLE OF CONTENTS FOR FINAL RI REPORT

**FINAL REMEDIAL INVESTIGATION REPORT
Building 1122**

ChemResearch Company, Inc.
1101 West Hilton Avenue
Phoenix, Arizona 85007

TENTATIVE TABLE OF CONTENTS

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- 1.2 Report Organization
- 1.3 Site History
- 1.4 Contaminants of Concern

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- 2.2 Climate
- 2.3 Surface Water
- 2.4 Geologic Setting
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- 2.5 Hydrogeologic Setting
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 - 2.5.2 Site Hydrogeology
- 2.6 Ecologic Setting

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 - 3.7.4.1 Groundwater Monitor Well Installation and Development
 - 3.7.4.2 Groundwater Monitoring and Sampling
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FINAL REMEDIAL INVESTIGATION REPORT
Building 1122

ChemResearch Company, Inc.
1101 West Hilton Avenue
Phoenix, Arizona 85007

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- 9.0 LIMITATIONS AND CERTIFICATION
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FINAL REMEDIAL INVESTIGATION REPORT
Building 1122

ChemResearch Company, Inc.
1101 West Hilton Avenue
Phoenix, Arizona 85007

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FINAL REMEDIAL INVESTIGATION REPORT

Building 1122

ChemResearch Company, Inc.

1101 West Hilton Avenue

Phoenix, Arizona 85007

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PROJECT SCHEDULE

ChemResearch Company, Inc.: Remedial Investigation and Report

ID	Task Name	Duration	Start	Finish	3rd Quarter July 2019	4th Quarter August 2019 September 2019 October 2019 November 2019 December 2019	1st Quarter January 2020 February 2020 March 2020	2nd Quarter April 2020 May 2020 June 2020	3rd Quarter July 2020 August 2020 September 2020 October 2020 November 2020 December 2020	4th Quarter January 2021 February 2021 March 2021 April 2021 May 2021 June 2021	1st Quarter July 2021 August 2021 September 2021 October 2021 November 2021 December 2021	2nd Quarter January 2022 February 2022 March 2022 April 2022 May 2022 June 2022	3rd Quarter July 2022 August 2022 September 2022 October 2022 November 2022 December 2022	4th Quarter January 2023 February 2023 March 2023 April 2023 May 2023 June 2023				
1	1. Modification to R I Work Plan Submittal	1 day	Tue 7/16/19	Tue 7/16/19	[Task bar]													
2	2. Modified R I Work Plan Review and Approval	30 days	Mon 8/19/19	Fri 9/27/19	[Task bar]													
3	3. Project Updates	531 days	Mon 9/30/19	Mon 10/11/21	[Task bar]													
4	3a. Monthly Project Updates	149 days	Mon 9/30/19	Fri 7/16/21	[Task bar]													
5	3b. Quarterly Updates	80 days	Tue 12/31/19	Mon 10/11/21	[Task bar]													
6	4. Indoor Air Quality, Soil Vapor and Soil Sampling Investigations/Tech, Memos	48 days	Tue 8/20/19	Thu 10/24/19	[Task bar]													
7	4a. Indoor Air Quality Survey	24 days	Mon 9/23/19	Thu 10/24/19	[Task bar]													
8	4b. Soil Vapor and Surficial Soil Investigation	22 days	Tue 8/20/19	Wed 9/18/19	[Task bar]													
9	4c. Subsurface Soil Investigation	24 days	Tue 8/20/19	Fri 9/20/19	[Task bar]													
10	5. Groundwater Monitor Well Installation and Development/Tech. Memos	87 days	Tue 8/20/19	Wed 12/18/19	[Task bar]													
11	5a. Secure Access Agreements	21 days	Tue 10/1/19	Tue 10/29/19	[Task bar]													
12	5b. Drill/Construct/Develop Well WVB-4R/Tech Memo	9 days	Mon 10/14/19	Thu 10/24/19	[Task bar]													
13	5c. Drill/Construct/Develop Well CMW-2R/Tech Memo	8 days	Mon 12/9/19	Wed 12/18/19	[Task bar]													
14	6. Quarterly Groundwater Monitoring and Sampling/Tech. Memos	349 days	Mon 10/28/19	Thu 2/25/21	[Task bar]													
15	6a. Groundwater Monitoring and Sampling Event/Tech Memo	23 days	Mon 10/28/19	Wed 11/27/19	[Task bar]													
16	6b. Groundwater Monitoring and Sampling Event/Tech Memo	22 days	Mon 1/27/20	Tue 2/25/20	[Task bar]													
17	6c. Groundwater Monitoring and Sampling Event/Tech Memo	22 days	Mon 4/20/20	Tue 5/19/20	[Task bar]													
18	6d. Groundwater Monitoring and Sampling Event/Tech Memo	22 days	Mon 7/20/20	Tue 8/18/20	[Task bar]													
19	6e. Groundwater Monitoring and Sampling Event/Tech Memo	24 days	Wed 10/14/20	Mon 11/16/20	[Task bar]													
20	6f. Groundwater Monitoring and Sampling Event/Tech Memo	24 days	Mon 1/25/21	Thu 2/25/21	[Task bar]													
21	7. Prepare Draft and Final R I Report	533 days	Mon 8/19/19	Wed 9/1/21	[Task bar]													
22	7a. Land and Water Use Study	387 days	Mon 8/19/19	Tue 2/9/21	[Task bar]													
23	7b. Revise Conceptual Site Model	23 days	Mon 3/29/21	Wed 4/28/21	[Task bar]													
24	7c. QA/QC of Draft R.I. Report	23 days	Mon 4/5/21	Wed 5/5/21	[Task bar]													
25	7e. Finalize Draft R.I. Report and Submit to ADEQ Project Manager	23 days	Mon 4/19/21	Wed 5/19/21	[Task bar]													
26	7f. Address ADEQ and Public Comments to Draft R.I. Report	20 days	Mon 6/21/21	Fri 7/16/21	[Task bar]													
27	8f. Prepare Final R.I. Report	43 days	Mon 7/5/21	Wed 9/1/21	[Task bar]													

Project: Project Schedule Appen

Task Split	Milestone Summary	Project Summary	Inactive Task	Inactive Milestone	Inactive Summary	Manual Task	Manual Summary Rollup	Manual Summary	Start-only	Finish-only	External Tasks	External Milestone	Deadline	Progress	Manual Progress
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APPENDIX L
HEALTH AND SAFETY PLAN

Health and Safety Plan

Prepared For:

ChemResearch Company, INC.

1122 West Hilton Avenue

Phoenix, Arizona 85007

ATC Project #: 1052000111

Prepared By:

ATC Group Services LLC

9185 S. Farmer Avenue, Suite 111

Tempe, Arizona 85284



REVIEW AND APPROVAL

CLIENT: ChemResearch Company, Inc.

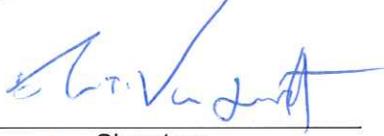
PROJECT NUMBER: 1052000111

SITE NAME: ChemResearch

SITE LOCATION: 1122 W. Hilton Avenue, Phoenix AZ.

PROJECT DESCRIPTION: Hand-augering to depth to install soil vapor probes and take soil samples.

PREPARED BY: Terence Vomocil TITLE: Staff Scientist DATE: July 1, 2019

Edwin T. Vandegrift		July 5, 2019
Project Manager	Signature	Date
Girard E. Morgan		7/5/2019
Reviewer's Name	Signature	Date

This Health and Safety Plan (HASP) has been written for the use of ATC and its employees. It may also be used as a guidance document by properly trained and experienced ATC subcontractors. However, ATC does not guarantee the health or safety of any person working on this project site.

Due to the potential hazardous nature of this site and the activity occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards which may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury at this site. The health and safety guidelines in this Plan were prepared specifically for this site and should not be used on any other site without prior research by trained health and safety specialists. All site personnel have the authority to "Stop Work" if unsafe conditions are present or discovered during site activities.

ATC claims no responsibility for use of this plan by others. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if these conditions change.

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EMERGENCY INFORMATION

Site Emergency Numbers	
Police, Fire and Ambulance Emergencies	911
CORE Health Networks <i>(24 hour Injury/Illness Case Management)</i>	(855) 282-6331
Poison Control Center	(800) 222-1222
Nationwide Call Before You Dig	811
National Response Center	(800)-424-8802
EPA Region 9 Main Office	(800) 300-2193
State Environmental Agency	(602)-390-7894

HOSPITAL AND ROUTE INFORMATION

Banner – University Medical Center Phoenix

1111 E McDowell Road, Phoenix, AZ 85006

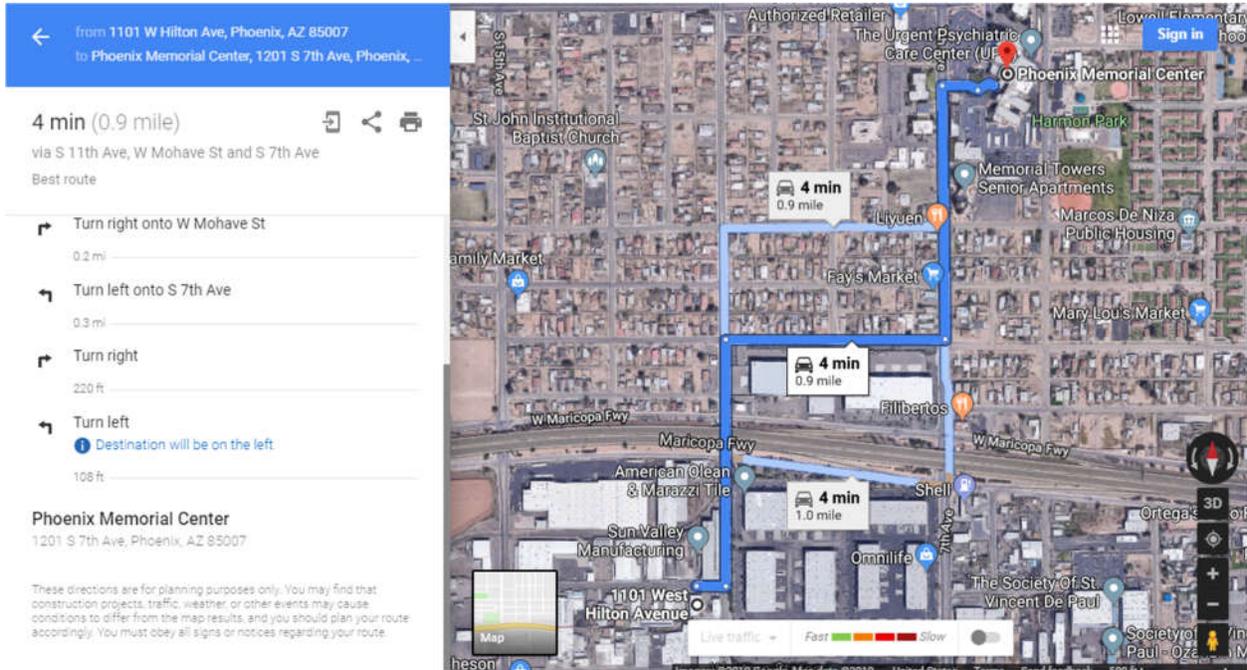
Approximate travel time is 10-15 minutes.

Directions from 1122 W. Hilton Avenue

1. Head East on W Hilton Ave toward S 11th Avenue.
2. Turn left onto S 11th Avenue.
3. Turn Right onto W Maricopa Fwy.
4. Use the left lane to take the ramp onto I-17S/US 60E
5. Merge onto I-17
6. Take Exit 194 to merge onto I-10 W toward Sky Harbor
7. Use the right two lanes to take exit 147A-B for AZ-51 N
8. Keep right to continue on Exit 1, Follow signs for McDowell Rd.
9. Keep left at the fork to continue toward E McDowell Rd.
10. Use any lane to turn slightly left onto McDowell Road.
11. Turn left onto N 12th street.
12. Turn right onto Brill St.
13. Turn left.

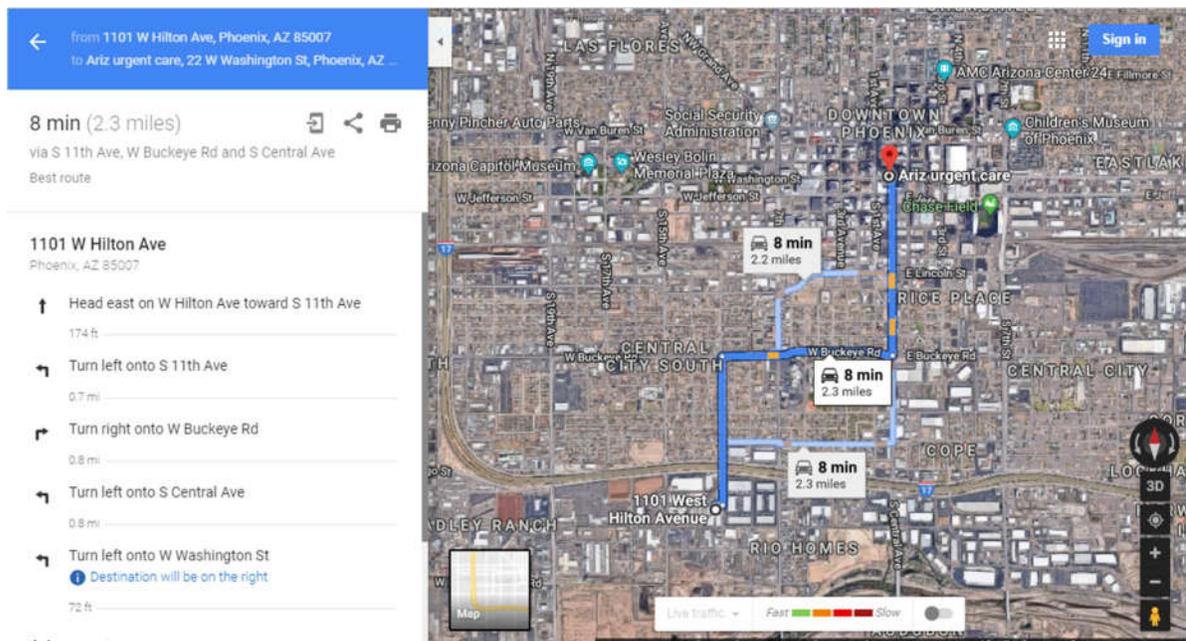
EMERGENCY MEDICAL ROUTE TO HOSPITAL

Phoenix Memorial Hospital



ROUTE TO OCCUPATIONAL CLINIC

Arizona Urgent Car



EMERGENCY ASSEMBLY LOCATION

Meet on the northside of ChemResearch Building 1101. Dependent on the site's hazards and work location, the exact location of the emergency assembly location will be communicated during the daily tailgate safety meeting.

FIRST-AID MEASURES

In the event that an employee exhibits symptoms of exposure contact **CORE Health Networks** immediately for phone assessment of injury/illness. The following procedures will be used:

Class of contaminant: Heavy Metals and dissolved chlorinated solvents

Eye Contact: Flush eye immediately with copious amount of water for a minimum of 15 minutes. Repeat until irritation is eliminated and seek medical attention.

Skin Contact: Wash exposed area with soap and water for at least 15 minutes. If dermatitis or severe reddening occurs, seek medical attention.

Inhalation: Move the person into fresh air. If symptoms persist, seek medical attention.

Ingestion: Do not induce vomiting. Seek immediate medical attention.

IMPORTANT NUMBERS:

Title	Name	Phone Number
Project Manager:	Ed Vandegrift	480-355-4672
Site Safety and Health Officer:	Stephen Sobansky	520-609-6799
Site Supervisor:	Dan Pike	541-829-1655
Regional Safety Coordinator:	Maria Rysavy	480-469-8851
Client Contact:	Tim Putnam	602 288 0393
State Utility Locate Service:	National Call Before You Dig	811

1.0 INTRODUCTION

All personnel and visitors who may enter work areas on this site must comply with the requirements of this Health and Safety Plan (HASP). All site personnel have the authority to “Stop Work” if unsafe conditions are present.

1.1. Scope and Applicability of the Site Health and Safety Plan

This HASP has been prepared by ATC for the activities associated with the sampling of soil and soil to identify extent of contamination associated with ChemResearch.

The principal hazardous chemical contaminants in the soil and soil vapor at the site are expected to be hex chrome, nickel, tetrachloroethylene, trichloroethylene. Appendix B contains Safety Data Sheets (SDS) for the potential onsite contaminants.

The health and safety protocols established in this HASP are based on the ATC Health and Safety Policy Manual, the Occupational Safety and Health Administration (OSHA) Regulations, past field experiences, specific site conditions, and chemical hazards known or anticipated to be present from available site data. The following HASP is intended solely for use during the proposed activities described in the project documents and technical specifications. Specifications herein are subject to review and revision based on actual conditions encountered in the field during site characterization activities. Such changes must be listed on the HASP List of Approved Amendments and/or Changes (see Appendix C).

Before site operations begin, all employees, including subcontractors for ATC working on this project site will have read this HASP and all revisions. Before work begins, all affected workers will sign the HASP Acknowledgement Form (see Appendix C). By signing this form, all individuals recognize the requirements of the HASP, known or suspected hazards, and will adhere to the protocols required for the project site.

1.2. Historical Overview

The facility was developed in an existing industrial area of south Phoenix between 1953 and 1955 by Hezzie and Helen Longwood. The site was originally occupied by the Francis Plating Company. Francis Plating Company’s primary operation was hard chrome plating. CRC took over the hard chrome plating business in 1959 and is the current occupant of the Facility (Hargis + Associates, Inc. [H+A], 2006). Prior to the excavation of impacted soil in the vicinity of the East Bay in June of 1995 and West Bay in July of 2017, the process lines operated over trenches and pits the bottom of which was composed of bare soil. Plating operations were relocated to the North Bay subsequent to the excavation of the East Bay in 1995. The North Bay has always operated over a system of concrete and high density polyethylene liner (HDPL) trenches and pits. The East Bay area concrete lined floor and trenches also employ an HDPL system. The West Bay plating operation was relocated to the East Bay in the spring of 2017. In July 2017, impacted soil beneath the West Bay was excavated, refilled with aggregate base material and covered with six-inches of reinforced concrete to match the existing floor of the Facility (ATC, 2017).

1.3. Visitors

All visitors to the site must participate in a site H&S discussion that informs them of the hazards at the site and the potential activities that ATC or its subcontractors are performing. All visitors must sign the ATC Visitors Log (see Appendix C).

Visitors are not allowed in the work area while work is being performed unless properly trained and are wearing the required PPE.

2.0 PROJECT ORGANIZATION

The following are specific roles and responsibilities for key site personnel.

2.1. Project Manager (PM)

The Project Manager (PM) has the primary responsibility for the fulfillment of the terms of the contract and overseeing operations for the purpose that includes meeting legal and safety requirements. It is the PM's responsibility to manage the scope of the project, provide for the H&S of all employees working and communicate with the Client regarding the progress toward project goals. The PM will inform the Regional Safety Coordinator (RSC) of all HASP modifications, violations and incidents. The PM responsibilities include:

- Provide personnel time to read and understand the HASP and complete any training required to work on the project site.
- Conduct project start-up health and safety briefing for onsite personnel and subcontractors.
- Check that each subcontractor is approved in ATC's subcontractor system and that each subcontractor's site workers have appropriate training.
- Verify ATC employees are medically cleared and have completed all necessary training.
- That hazards identified during any site audits or while working are corrected. If necessary for immediate hazards, shut down field operations if hazards cannot be corrected or the hazards present an immediate threat to life and health.
- Develop HASP.
- Determine and provide all necessary safety systems and PPE.

2.2. Site Supervisor

The site Supervisor is responsible for field operations and reports to the Project Manager. The site Supervisor is the onsite coordinator and overseer of operations. It is the site Supervisor's duty to supervise the personnel on the site, coordinate the activities of the subcontractor personnel and check that the scope of work is followed and modified when necessary. The site Supervisor's specific responsibilities include:

- Executing the work plan and schedule as detailed by the Project Manager
- Coordination with the SSHO on health and safety issues
- Ensuring site work compliance with the requirements of the HASP

2.3. Site Safety and Health Officer (SSHO)

The site Safety and Health Officer (SSHO) has the responsibility and authority to implement this HASP and to verify compliance. The SSHO reports to the Project Manager. The SSHO is on-site during all work operations and has the responsibility to halt site work if unsafe conditions are detected or if deviations in the work plan occur. The responsibilities of the SSHO at the site include the following:

- Managing the H&S functions on the site;
- Ensuring compliance with the HASP and use of PPE;

- Conducting daily Tailgate Safety Meetings for site personnel and subcontractors. The following topics should be covered:
 - Hazard Communication (i.e., SDS location, proper PPE to be used, chemical hazards of non-routine tasks).
 - Work zone setup and equipment movement
 - Review of all applicable JSA(s).
 - Discuss tasks to be performed, associated hazards and procedures to protect employees from those hazards.
 - Review site safety requirements.
 - Review site emergency procedures
- Conducting daily safety inspections of the site looking for unsafe acts or conditions and providing corrective action as appropriate.

2.4. Regional Safety Coordinator (RSC)

The Regional Safety Coordinator (RSC) is responsible for providing professional health and safety advice to the project. The RSC will review and provide support for concerns regarding the health and safety of field personnel assigned to this project, including:

- If requested by the Project Manager, review and approval of HASP;
- Review of incident reports, inspections and air monitoring results;
- When required, the RSC will conduct a field audit of the site to evaluate the adequacy of the protective measures and work with the PM to implement any necessary changes.

2.5. Field Personnel

The field personnel include technicians, engineers, scientists, geologists and subcontractors who perform work on this site. Each individual team member will be responsible for understanding and personally complying with the requirements of this HASP. Field personnel will report health and safety violations to either the site Supervisor or the SSHO. H&S responsibilities, as discussed in this HASP that are shared by all site personnel include:

- Complying with the requirements of the HASP
- Reporting unsafe acts or conditions
- Wearing correct PPE for the task
- Stopping any unsafe work
- Following the JSA and/or correct steps for a task.
- Assist other field personnel with being safe and meeting the requirements of this HASP.

3.0 TASK/OPERATION HEALTH AND SAFETY RISK ANALYSIS SUMMARY

This chapter of the HASP describes the identified and anticipated hazards associated with this project site based on the anticipated tasks to be performed and the environmental conditions of the project site and the control measures necessary to protect workers from these identified hazards. The assessment looked at the general, chemical, physical and biological hazards that may be encountered while working on this site. Using this information, appropriate control methods are selected to eliminate the identified risks or effectively control them.

Job Safety Analysis (JSA)

The purpose of the JSA is to identify the routine health and safety hazards associated with the routine site tasks and operations. JSAs for the anticipated tasks that will be performed onsite are maintained in Appendix A. A single JSA may be used for a task/operation performed in multiple locations if the hazards, potential exposures and controls are the same at each location. Field personnel are expected to modify JSAs for the site as new hazards are identified and create JSAs if one is not available for a task that will be performed.

3.1. Chemical Exposure Assessment

Hazardous chemicals may be used on the site to support site operations. The ATC H&S Policy No. 21 – Hazard Communication Program requires ATC to provide employees, contractors, subcontractors and visitors with information on the health effects of these chemicals and necessary actions to protect against exposure. This information is transmitted through Safety Data Sheets (SDS), container labels, training and a written Hazard Communication Program (Program).

Site activities will adhere to the Program as described in the ATC Policy. All site personnel, including subcontractors, will be briefed on this Program as part of the site orientation training before starting work. In accordance with this Program, the PM and/or SSHO will check that each chemical brought to the site is accompanied by its SDS. A copy of each SDS will be maintained and be made available to each site personnel who may be potentially exposed to the chemical. In addition, the SSHO will check that all subcontractors bring at least one copy of SDS for each chemical they bring onto the site. The SSHO will also check that all chemical containers brought to the site are labeled as to its contents and appropriate hazard warnings according to the Program. The location of all SDSs will be identified during the daily tailgate safety meeting and may be included in Appendix B of this HASP or maintained in a separate area.

3.2. Potential Chemical Hazards Associated with the Project Site

The following chemical hazard evaluation for the project site is based on historical and previous investigations of the site. The evaluation has been conducted to identify hazardous substances that potentially may be present at the site and to ensure that work activities, PPE and emergency response are consistent with the specific contaminants that could be encountered.

Chemical impacted material has been identified on the site. The potential contaminants that might be encountered during the field activities and exposure limits are listed below.

Table 3-1
Chemical Time Weighted Averages, PEL's and STEL's (if applicable).

Name (Constituent)	PEL	TWA (8hr)	STEL
Metals			
Hexavalent Chromium (dissolved Phase)	1 mg/ m ³	1 mg/ m ³	**N/E
Nickel (dissolved phase)	1 mg/ m ³	1 mg/ m ³	**N/E
Lead	0.050 mg/ m ³	0.050 mg/ m ³	**N/E
Cadmium	0.005 mg/ m ³	0.005 mg/ m ³	**N/E
Cyanide	10 ppm	11 mg/ m ³	**N/E
Commonly Used Chemicals			
Alconox (cleaning/detergent)	**N/E	5 mg/m ³	**N/E
Tetrachloroethylene (dry cleaning components)	25 ppm 170 mg/ m ³	25 ppm 170 mg/ m ³	100 ppm
Perchloroethylene (dry cleaning components)	100 ppm	200 ppm	100 ppm

**N/E – Not Established by OSHA or NIOSH.

3.3. Chemical Hazard Exposure Routes

Exposure routes for chemical impacted material:

- Inhalation of dust, vapor, particulates due to the presence of hazardous materials from soil or ground water.
- Ingestion of soil/water via hand to mouth contact.
- Absorption through the skin from contact with contaminated soil/water.

To protect field personnel, the following procedures will be used as needed:

- Establishment of work zones
- Use of PPE
- Decontamination procedures
- Atmospheric monitoring

3.4. Noise Hazards and Controls

Exposure to high levels of noise may occur when working near heavy equipment, tools and remediation systems. Depending upon the environment surrounding the project site airports, factory machines, etc. may produce high levels of noise. Employees exposed to noise levels in excess of the action level of 85 decibels (A-weighted, Slow Response) will be included in a Hearing Conservation Program according to ATC H&S Policy No. 34 – Hearing Conservation. The SSHO may evaluate employee noise exposures using a noise survey meter or a noise dosimeter. The RSC may conduct additional noise monitoring to determine the appropriate response to be taken. Employees will be provided with ear plugs and/or earmuffs when exposed to noise levels in excess of the 8-hour Permissible Exposure Limit (PEL) of 90 decibel (A-weighted, Slow Response). This hearing protection must have a Noise Reduction Rating (NRR) to protect hearing in accordance with Policy No. 34 and reduce the exposure level to below 90 dba.

3.5. Biological Hazards

Site activities may expose workers to other hazards such as poisonous plants, insects, animals, and indigenous pathogens. Protective clothing and respiratory protection equipment and training on how to identify poisonous plants, animals and insects, can greatly reduce the chances of exposure. Thoroughly washing any exposed body parts, clothing, and equipment will also protect against infections. If working in wooded/grassy areas, use appropriate insect repellants (containing DEET and/or Permethrin) and apply per the manufacturers' directions.

3.5.1. Poison Oak, Poison Sumac, Poison Ivy

- Avoid contact with plants.
- Use barrier products such as IvyX Pre-contact, IvyBlock, or other products on exposed skin where potential direct contact or contact through clothing is possible. Re-apply periodically throughout the day to exposed skin.
- Cover as much skin as practical; wear long sleeves, long pants, socks, boots, gloves, neckerchiefs, hats and other clothing articles. Wear impermeable gloves over cotton/leather gloves.
- Remove gloves before eating or taking bathroom breaks. Clean hands thoroughly with Tecnu, IvyX post-contact, or other product before eating or bathroom breaks. Ensure you do not touch your face or hands with a contaminated glove or other article of clothing.
- Separate contaminated field clothing and wash in hot water. Heavy contaminations may not be able to be removed and the clothing will need to be discarded.
- Clean all objects that may have urushiol on its surface. Besides clothing, urushiol can stick to many surfaces, including tools and equipment.
- Protect your vehicle interior by placing a large towel or bedsheet over the seats. Wash hands with Tecnu before and after removing contaminated clothes.
- Wash contaminated skin with Tecnu, IvyX Post-contact, or other product immediately. Do not delay since urushiol takes only a few minutes to affect your skin.
- Shower (do not take a bath) and thoroughly wash your entire body with warm, soapy water as soon as possible.
- Dermatitis can present in many forms which include itchy skin, redness or streaks, hives, swelling, small or large blisters or scabs after bursting after urushiol exposure.

3.5.2. Ants

- Look at your surroundings during site setup. If present in large numbers move the work area. If unable to move the work area stop work and contact the PM.
- Workers should take the following steps to prevent fire ant stings and bites:
 - Do not disturb or stand on or near ant mounds.
 - Be careful when lifting items (including animal carcasses) off the ground, as they may be covered in ants.
 - Fire ants may also be found on trees or in water, so always look over the area before starting to work.

3.5.3. Bee/Hornets/Wasp

- Look at your surroundings during site setup. If present in large numbers move the work area. If unable to move the work area stop work and contact the PM.
- Bees, wasps, and hornets are most abundant in the warmer months. Nests and hives may be found in trees, under roof eaves, in attics or on equipment such as ladders.
- Avoid perfumed soaps, shampoos, and deodorants.
- Wear clothing to cover as much of the body as possible.
- Remain calm and still if a single stinging insect is flying around. (Swatting at an insect may cause it to sting.)
- If you are attacked by several stinging insects at once, run to get away from them. (Bees release a chemical when they sting, which may attract other bees.)
- If a bee comes inside your vehicle, stop the car slowly, and open all the windows.
- Workers with a history of severe allergic reactions to insect bites or stings should consider carrying an epinephrine auto injector (EpiPen) and should wear a medical identification bracelet or necklace stating their allergy.

3.5.4. Ticks

- Avoid vegetation when possible. Stay to the center on trails where the vegetation is the shortest.
- Be especially vigilant if vegetation contacts your body above your knee. Remember that ticks find a place on vegetation to lie in wait until a host comes along and brushes across them.
- Apply CDC-recommended insect repellents: DEET or permethrin according to label directions up to, and above, parts of body and clothing where contact with vegetation occurs.
- DEET is most effective in higher concentrations from 20-30% (Deep Woods OFF! & Cutter Backwoods). Spray directly onto your exposed skin. Apply to face by spraying hands and then wiping on skin avoiding eyes and mouth.
- Reapplication throughout the day is needed since it only works while volatilizing.
- Do not apply DEET to skin underneath clothing.
- Permethrin is more effective at repelling ticks than DEET and is applied to clothing only.
- Re-application each day is not needed since it is effective on clothes for several consecutive days and after laundering. Launder separately from other clothes. Do not apply permethrin to your skin.

- For best protection apply permethrin to clothing, including footwear, socks and hats, and DEET to exposed skin.
- Always tuck shirt into pants and tuck pants into tightly woven socks. Small ticks can crawl through the fabric of some socks. Wear a hat to cover your exposed head.
- Check for ticks on clothing during field work and at every rest break.
- At the end of the day, before entering your vehicle, do a thorough tick check with your field partner.
- Reapply permethrin to clothing to knock down ticks and prevent them from entering the vehicle with you.
- As soon as possible after field work, remove clothing and check yourself before conducting office work. Check again while bathing and changing. Be sure to look closely and feel carefully for small, nymph “seed” ticks on waistline, neck, hairline, behind ears, under arms, and groin.
- Keep field gear and clothing out of living spaces and bag soiled field clothes until washing (separately in hot water).
- If you discover an embedded tick, call Core Health. Nurses there can help you with first aid and remind you of the symptoms to be alert for afterward.

3.5.5. Snakes

- Walk only as fast as you can watch the path ahead. If you see a snake, back away slowly. Most snakes avoid people if possible and bite only when threatened or surprised.
- When working in known snake habitats, snake gaiters must be worn by all site employees.
- Do not place your hands or feet in locations where you cannot see the surrounding area.
- When possible, avoid areas of tall vegetation.
- Tap or poke the ground ahead of you with a walking stick before entering an area where you can't see your feet. Snakes will try to avoid you if given enough warning.
- When in an area known to have snakes, wear long pants and boots. If work must be conducted in areas with tall grass or other cover where snakes may be present, also wear snake gaiters.
- Never handle a snake. Even non-venomous snakes can bite and cause serious injury.

3.6. Dogs

If an unsecured dog is seen on or near the project site, stop work and all employees are to take shelter in a building or vehicle until the dog leaves the area or the dog is secured by authorities or its owner. Contact animal control if the dog does not leave on its own.

3.7. Lightning

Weather conditions can change quickly when working. In the event, lightning is seen all outdoor work must stop and all onsite employees are to take shelter inside a building or vehicle. Work can resume 30 minutes after last seeing lightning.

3.8. General Public

When working in unsecured locations onsite employees must setup a work zone that keeps the general public away from or provides a barrier to any hazards created by the work performed onsite.

All employees are expected to treat the general public respectfully and to limit our engagement and interaction. In the event, that an employee feels threatened by the general public, work must stop and the employee should seek protection in a building, leave the area and/or contact local authorities. Work should only resume when the threat has been eliminated.

3.9. Hand and Power Tools

In order to complete the various tasks for the project, personnel will utilize hand and power tools. The use of hand and power tools introduce a variety of hazards including injury from being struck by flying objects, cut or struck by the tool, fire and electrocution. Proper PPE must be worn while using these tools. Ground Fault Circuit Interrupters (GFCIs) are required for all portable corded electric tools.

For specific PPE and procedures associated with a tool see the JSA for the task in which the tool is being used and the manufacturer's instruction manual.

3.10. Slips, Trips and Falls

Working in and around the project site will pose slip, trip and fall hazards due to equipment, tools/supplies and slippery surfaces from weather and from activities performed onsite. Good housekeeping must be maintained at all times. Tools and equipment no longer in use must be removed from the work area and secured. Traction control devices must be worn when working on slippery surfaces. A general site walk should be conducted prior to the start of work to identify trip hazards. These identified trip hazards should be correct or visibly marked to warn onsite employees.

3.11. Material Handling

Proper manual lifting of material will be required by site personnel and if not done correctly could result in injury. No one is to lift any object greater than 50 pounds or any object that is large or awkward by themselves. If possible, the use of equipment and tools to help lift and move the material is required.

Employees must be trained on proper lifting techniques prior to arriving at the project site.

3.12. Fire and Explosion

All equipment used to transfer flammable material, including contaminated soil or water must be grounded and bonded to prevent static buildup. An appropriately rated fire extinguisher must be maintained and available for use on site.

3.13. Moving Equipment

Field personnel working in the immediate vicinity of heavy equipment may encounter injuries from contact from the equipment.

Spotters must be used when heavy equipment is used onsite or moving from one location to another and the route and designation discussed with all site personnel prior to movement. Equipment must be equipped with back up alarms.

All site employees must wear at least an ANSI class 2 reflective vest or shirt.

3.14. Vehicular Traffic

Work zones will be established out of local traffic patterns whenever possible and clearly marked. All site personnel must wear high visibility PPE based on the amount and speed of the traffic.

3.15. Heat Stress

All employees and visitors, must adhere to the following procedures when heat stress conditions exist.

The SSHO will have training in first-aid and Cardiopulmonary Resuscitation (CPR), including training in heat-related illnesses. The SSHO shall also be trained on the requirements of the ATC Policy for Industrial Hygiene (Policy No. 23), which contains the requirement for heat stress monitoring. All workers should be capable of recognizing and treating the signs and symptoms of heat stress conditions. During potential heat stress conditions, ice should be readily available to rapidly cool victims.

Water will be made available at the site for employee fluid replacement. When heat stress is a hazard, employees will be provided with balanced, electrolyte solutions to replace fluid and electrolyte loss. Employees will be provided with replacement fluids at a minimum rate of 8 ounces every 15 to 20 minutes per person.

Acclimatization is a gradual physiological adaptation that improves an individual's ability to tolerate heat stress. Full-heat acclimatization requires up to 3 weeks of continued physical activity under heat-stress conditions similar to those anticipated for the work. Acclimatization loss begins when the work activity in heat stress conditions is discontinued. A noticeable loss usually occurs within 3 – 4 days.

3.16. Rest Breaks

All rest breaks will be taken out of the zone of exclusion in a cooler, shaded, rest area. The frequency of rest breaks will be based on the level of physical activity, temperature and humidity and will be discussed during the daily tailgate meeting. At any time, the frequency of rest breaks can be increased if the SSHO or other site employees determine it to be necessary.

Heat stress and heat strain are conditions resulting from environmental factors including temperature, relative humidity, radiant heat transfer, and air movement, as they are affected by clothing. The primary objective of the heat stress management program is to prevent heat stroke which is life threatening and the most serious of the heat-induced disabilities. Extra caution should be taken for workers who are not acclimated to working in the heat.

The following Heat Stress Index should be used as a guide to evaluate heat stress situations.

Table 3-2: Heat Stress Index

Heat Stress Index									
Temp. °F	Relative Humidity								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
105°	98°	104°	110°	120°	132°				
102°	97°	101°	108°	117°	125°				
100°	95°	99°	105°	110°	120°	132°			
98°	93°	97°	101°	106°	110°	125°			
96°	91°	95°	98°	104°	108°	120°	128°		
94°	89°	93°	95°	100°	105°	111°	122°		
92°	87°	90°	92°	96°	100°	106°	114°	122°	
90°	85°	88°	90°	92°	96°	100°	106°	114°	122°
88°	82°	86°	87°	89°	93°	95°	100°	106°	115°
86°	80°	84°	85°	87°	90°	92°	96°	100°	109°
84°	78°	81°	83°	85°	86°	89°	91°	95°	99°
82°	77°	79°	80°	81°	84°	86°	89°	91°	95°
80°	75°	77°	78°	79°	81°	83°	85°	86°	89°
78°	72°	75°	77°	78°	79°	80°	81°	83°	85°
76°	70°	72°	75°	76°	77°	77°	77°	78°	79°
74°	68°	70°	73°	74°	75°	75°	75°	76°	77°

NOTES: Add 10° F when protective clothing (use of a respirator and/or chemical protective clothing such as Tyvek, arch flash or flame resistant) is being used; Add 10° F when in direct sunlight.

HSI Temp	Category	Injury Threat
> 130° F	Extreme Danger	No work unless emergency exists. Contact ATC RSC and Corporate Risk Management Department prior to proceeding. Heat cramps or exhaustion likely, heat stroke possible if exposure is prolonged and there is physical activity.
105°-130° F	Danger	Contact RSC prior to proceeding. Requires strict adherence to ACGIH Heat Stress Guidelines, including use of on-site WBGT equipment. Heat cramps or exhaustion likely, heat stroke possible if exposure is prolonged and there is physical activity.
90°-105° F	Extreme Caution	Heat cramps or exhaustion likely, heat stroke possible if exposure is prolonged and there is physical activity.
80°-90° F	Caution	Heat cramps or exhaustion likely, heat stroke possible if exposure is prolonged and there is physical activity.
< 80° F	Normal Range	Typical conditions for time of year. Little or no danger under normal circumstances. As always, anticipate problems and work safely.

3.17. Cold Stress

This procedure applies to all employees who perform field work in cold environments at risk of cold stress injury and intended to protect workers from the most severe effects of cold stress.

ATC site employees have been trained in cold stress as part of their HAZWOPER 40-hour initial training, site workers will receive refresher training by the SSHO in cold stress safety and health procedures. The training program will include, as a minimum, instruction in the following areas:

- Proper first-aid treatment
- Proper clothing practices
- Proper eating and drinking habits
- Recognition of impending frostbite
- Recognition of the signs and symptoms of impending hypothermia or excessive cooling of the body when shivering does not occur
- Safe working practices

The SSHO will be trained in first aid, CPR and cold stress conditions.

Frostbite and hypothermia are two types of cold injury that personnel must be protected against during the performance of field duties. The objective is to prevent the deep body temperature from falling below 96.8° F and to prevent cold injury to body extremities. Two factors influence the development of a cold injury the ambient temperature, and wind velocity.

The SSHO will monitor environmental conditions by recording ambient temperature and estimated wind-speed. Information contained in Tables 3-3 be used to evaluate the possibility of hypothermia among workers on-site. No work shall be conducted when the temperature and wind speed combine for a temperature of less than -20° F.

Use appropriate cold weather clothing when temperatures are at or below 40°F as exposed skin surfaces must be protected. These protective items can include facemask, hand wear, and foot wear. Workers handling evaporative solvents during cold stress conditions will take special precautions to avoid soaking gloves and clothing because of the added danger of prolonged skin contact and evaporative cooling. Personnel will wear protective clothing appropriate for the level of cold and planned physical activity. The objective is to protect all parts of the body, with emphasis on the hands and feet. Eye protection against glare and ultraviolet light should be worn in snowy and icy conditions.

The work rate should not be so great as to cause heavy sweating that could result in wet clothing. If heavy work must be done, opportunities for rest breaks will be provided where workers have the opportunity to change into dry clothing. Conversely, plan work activities to minimize time spent sitting or standing still. Rest breaks should be taken in a warm, dry area. Windbreaks can also be used to shield the work area from the cooling effects of wind.

When frostbite, hypothermia, or other cold stress symptoms are suspected, treat the patient to relieve symptoms or transport them to the medical facility identified in this HASP.

Table 3-3: Hypothermia Evaluation

Estimated Wind Speed (mph)	Actual Temperature Reading (°F)											
	50°	40°	30°	20°	10°	0°	-10°	-20°	-30°	-40°	-50°	-60°
	Equivalent chill Temperature (°F)											
Calm	50°	40°	30°	20°	10°	0°	-10°	-20°	-30°	-40°	-50°	-60°
5 mph	48°	37°	27°	16°	6°	-5°	-15°	-26°	-36°	-47°	-57°	-68°
10 mph	40°	28°	16°	4°	-9°	-24°	-33°	-46°	-58°	-70°	-83°	-95°
15 mph	36°	22°	9°	-5°	-18°	-32°	-45°	-58°	-72°	-85°	-99°	-112°
20 mph	32°	18°	4°	-10°	-25°	-39°	-53°	-67°	-82°	-96°	-110°	-121°
25 mph	30°	16°	0°	-15°	-29°	-44°	-59°	-74°	-88°	-104°	-118°	-133°
30 mph	28°	13°	-2°	-18°	-33°	-48°	-63°	-79°	-94°	-109°	-125°	-140°
35 mph	27°	11°	-4°	-20°	-35°	-51°	-67°	-82°	-98°	-113°	-129°	-145°
40 mph	26°	10°	-6°	-21°	-37°	-53°	-69°	-85°	-100°	-116°	-132°	-148°
(Wind speeds > 40 mph have little additional effect)	LITTLE DANGER If < hour with dry skin. Maximum danger of false sense of security				INCREASING DANGER Danger from freezing of exposed flesh within one minute.				GREAT DANGER Flesh may freeze within 30 seconds.			
	Trench foot and immersion foot may occur at any point on this chart.											

* Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA

4.0 AIR MONITORING AND PERSONAL PROTECTIVE EQUIPMENT

4.1. Site Air Monitoring Requirements

To prevent exposure to hazardous atmospheres and aid in the selection of respiratory protection, monitoring for the presence of airborne contaminants will occur when knowledge of the site indicates their potential presence. One or more of the following direct-reading instruments may be used to aid in this determination;

- Photoionization Detectors (PID) and
- Flame Ionization Detectors (FID) will measure non-specific organic gases and vapors.
- Combustible Gas Indicators (CGI) will detect explosive atmospheres.
- Oxygen (O₂) meters will detect fluctuations in oxygen concentrations.

These instruments should be calibrated or bump tested daily and whenever the readings may be erratic. All readings should be recorded in the field log books according to the monitoring program. All employees responsible for using these devices must be shown how to properly calibrate and configure the equipment. A manual on how to use the equipment must always be maintained with the equipment.

All direct-reading instruments or equipment that are needed to monitor for hazardous atmospheres on this project site are listed in Tables 4-1, 4-2 and 4-3.

The breathing zone of the employee(s) anticipated to have the highest potential for exposure for each task will be monitored using an appropriate combination of some or all of these direct-reading instruments. Air monitoring will occur every 15 minutes during non-intrusive activities, or every 5 feet of penetration during intrusive activities. Site tasks and air monitoring requirements are shown in Table 4-1. Additional site monitoring may occur at the discretion of the SSHO, site supervisor, or RSC.

All air monitoring equipment must be calibrated as per manufacturer's instructions.

If any of the action levels listed in Tables 4-2 or 4-3 are met, work must immediately stop. No employee is authorized to work in conditions that require respiratory protection without first contacting your RSC. If any of the action levels listed in Table 4-2 or 4-3 are met, work must immediately stop. Contact must be made with the PM informing them that the Respiratory Protection Plan, Appendix H will be followed.

4.2. Action Levels for Respiratory Protection

The first and foremost means of protecting employees from injuries or exposures is to eliminate the exposure. The general hierarchy for controlling potential exposures is: (1) engineering controls; (2) administrative controls; and (3) the use of PPE. PPE is a means of preventing injury or exposure when exposure elimination and/or other control means are not feasible.

The initial level of protection and the upgrading to respiratory protection action levels at which the PPE will be upgraded are determined based on the identification of specific chemicals expected to be present at a site and the established OSHA Permissible Exposure Levels (PEL) or ACGIH Threshold Limit Values (TLVs), whichever is lower. In the event more than one chemical is

expected or exists at a site, the most hazardous chemical will dictate the level of personal protection required.

Air monitoring equipment used on the site should be calibrated according to the following:

Types	Frequency	Gas Standard
PID	Daily	100 ppm isobutylene in air
CGI	Daily	Pentane/Methane
Universal Test Pump-Sensidyne (refer to mfg. for other pumps)	Daily	Leak Test: Insert unbroken detector tube into orifice, pull and lock handle in sampling position, wait 15-30 sec. Slowly and carefully release the handle. If handle does not return to 1/8", pump leaks.

Field personnel, in conjunction with the SSHO and RSC, may choose to allow ventilation of vapors before resuming work in respirators. If ventilation is conducted, additional air monitoring will be performed prior to the resumption of work.

4.3. Levels of Protection

The protection levels may include all or some of the following, based on work scope.

Level D:

- See Section 8.0 of this HASP for minimum PPE requirements.

Level C:

- Half-face or full-face, air purifying respirator (NIOSH approved) with organic vapor cartridge. See Respiratory Protection Plan
- Disposable, chemical-resistant outer gloves
- Disposable, inner nitrile gloves (8 mil minimum)
- Chemical-resistant boots with steel toe
- Disposable boot covers*
- Hard hat*
- Goggles
- Face Shield*
- Coveralls*
- Hearing protection*

4.4. Respiratory Protection

Respiratory protection requirements for employees are described in detail within Appendix H - Respiratory Protection Plan. Basic rules of respiratory usage are listed below:

- Facial hair that contacts or interferes with the seal of the mask-to-face is not allowed on personnel required to wear respirators.
- Respirator cartridges should be replaced after approximately 8-hours of continuous or intermittent usage, unless otherwise noted. Cartridges should also be replaced if they become damaged, after the expiration date is exceeded, if breakthrough (smell and/or taste) occurs or if filters become clogged causing resistance to breathing.
- Contact lenses may be worn when respiratory protection is required, in conjunction with additional eye protection to protect against particles or splashes, provided there is no interference with the respirator seal and the chemical in the atmosphere does not prevent their use.
- Respirators shall be cleaned and disinfected after each day's use or more often, if necessary.
- Prior to donning, respirators will be inspected for worn or deteriorated parts. Emergency respirators or self-contained devices will be inspected at least once a month and after each use.
- After donning, personnel should perform a positive and negative user fit-check to determine if a good seal has been achieved.
- Any employee assigned a respirator or required to wear a respirator shall receive an annual medical evaluation, annual respirator fit test and receive respiratory protection training.

5.0 HEALTH SURVEILLANCE PROGRAM

5.1. Employee Medical Examinations

All ATC employees involved in work at this site will participate in ATC's Medical Surveillance Program administered by ATC's medical management provider. ATC has worked with its medical provider to develop a medical exam that evaluates employees for potential chemical exposure. The medical examinations provided to ATC employees meet the requirements in 29 CFR 1910.120(f).

Any subcontractors or visitors that will work in an area where there is potential for exposure to onsite contaminants must also undergo a medical exam that meets 29 CFR 1910.120(f) and be cleared by a physician to work.

When respirators are required as determined by section 4.0 of this HASP, each employee will also have current respirator clearance.

The PM for this project site is responsible for checking on the medical clearance for any ATC employee working on this site.

A post-project, follow-up exam may be required if an exposure incident is reported or an employee shows specific symptoms associated with the known or suspected hazardous chemicals. The RSC and the Project Manager will determine when post-project exams are required.

6.0 SITE SECURITY AND CONTROL

6.1. Work Zones

Restricted site areas will include, but not necessarily be limited to, the following zones:

- Exclusion Zone or Hot Zone - any area where contamination is either known or likely to be present in concentrations that could pose a threat to human health and safety or that potential for harm to personnel exists because of the type of work activities being conducted. Appropriate PPE and warning signs should be utilized in this area.
- Contamination Reduction Zone - any area where workers conduct personal and equipment decontamination.
- Support Zone - areas where access is controlled, but the chance to encounter hazardous materials or conditions are minimal.

Access to the work zones will be controlled by work zone delineators (e.g. traffic cones, flags, vehicles, DOT approved devices, temporary or permanent fencing, and/or safety barrier tape). Additionally, ATC employees should follow the requirements of ATC Policy No. 36, Work Zones in Traffic Areas for additional information. Setup of and delineation of the work zone will be discussed during the tailgate safety meeting.

In the event on-site personnel must upgrade their personal protective equipment, the work zones may require substantial modification in order to provide for the safety of nearby personnel not associated with this work. Any upgrade level will be communicated by the site supervisor to the PM. The PM will then inform the RSC of this occurrence.

6.2. Buddy System The buddy system is preferred when working on this project site. The Buddy System means that personnel work in pairs and stay in close visual contact to be able to observe one another and summon rapid assistance in case of emergency.

6.3. Lone Worker

When working alone, no worker should be left without means of summoning help quickly. All lone workers at a minimum must have a phone with service coverage and carry identification with them. The minimum expectation for lone workers:

- Call the PM or BSO on arrival and departure.
- Provide an anticipated length of time on site and tasks to be performed.

The PM should attempt to contact the lone worker if they fail to check in at the designated time.

6.4. Site Communication

Site communication may be in the form of hand signals, voice, or other communication devices. All forms of communication should be understood by all workers and discussed during the daily tailgate meeting prior to starting work.

6.4 Roadway Work Zones

When work is conducted in a city street or public right-of-way, the work zone and traffic control must be setup according to the Traffic Control Plan in Appendix I.

Check with the state or local government to determine if a permit for work in a traffic area is necessary. Regardless of length of time or type of activity a traffic control plan is required. Traffic Control Plans will include Transition Areas, Activity Areas, and Termination Areas.

7.0 DECONTAMINATION PROCEDURES

All personnel and equipment must undergo appropriate decontamination prior to leaving the project site. The decontamination of personnel and equipment will be performed within the exclusion and contamination reduction zones. The SSHO will visually watch the decontamination process and verify it is completed. The decontamination solution to be used onsite:

- Alconox/Liquinox and water for removal of low-molecular weight hydrocarbons, inorganic compounds (metals), salts, some organic acids, and other polar compounds.

The hands and face of each employee must be thoroughly washed upon leaving the work area. Trash receptacles will be provided for all disposable PPE.

Field equipment will be decontaminated according to the work plan. This may include manual removal of gross contamination with shovels or other tools, followed by a high-pressure, hot water sprayer. Decontamination with high-pressure and hot water poses the possibility of a splash and/or mist inhalation hazard, the task should be performed using Level D personal protective equipment with a face shield at a minimum.

Field tool including split-barrel soil samplers, brass liners, and sample knives and trowels will be decontaminated. The field tools may be scrubbed visually clean using the decontamination solution with a stiff, long-bristled scrub brush. Following scrubbing with the decontamination solution, the tools may be rinsed with distilled water or isopropyl alcohol.

All materials and equipment used for decontamination should be disposed of in accordance with local, State, and/or Federal Regulations. Clothing, tools, buckets, brushes, and all other equipment that is contaminated must be properly packaged and stored on the site until disposal arrangements are finalized. Clothing not completely decontaminated on-site should be secured in plastic bags before being removed from the site and taken to an appropriate cleaning facility.

8.0 STANDARD OPERATING PROCEDURES (SOPS)

As tasks are performed, the JSA must be reviewed by all onsite workers to identify additional precautions that must be taken. Any changes to the SOPs must be approved by the PM and RSC.

At a minimum the following PPE shall be worn at all times by all workers and visitors to this project site:

- Hard hat
- Long pants
- Shirt with sleeves
- Safety glasses
- Safety toed boots with ankle support
- Work gloves – the type of gloves worn may change based on task being performed.
- ANSI Class 2 safety vest (other garments jackets and shirts that meet the class 2 requirement may be worn in place of the safety vest).
- See JSA for task to be performed for specifics on type of PPE and any additional PPE.

The following SOPs will apply when working on this project site:

- Eating, drinking, chewing gum, tobacco products or any item that could facilitate hand-to-mouth transfer of contaminants are prohibited in the exclusion and contamination reduction zone or in any area known to be contaminated. Personnel must wash their hands and face and remove any contaminated PPE before handling these items.
- When decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.
- Contact with contaminated or suspected contaminated surfaces should be avoided. When possible, do not walk through puddles, leachate, or discolored surfaces; kneel on the ground; or lean, sit, or place equipment on drums, containers, or the ground.
- All personnel and visitors must be familiar with SOPs and any additional instructions and information contained in this HASP. All employees, visitors and subcontractors will read and sign an acknowledgement of the HASP before entering the site.
- All personnel must be or will be made aware of symptoms for heat or cold related illnesses.
- All personnel will be made aware of the location of the SDSs for the chemicals on-site.
- All loose clothing, jewelry, hair, or other items that could be caught in moving parts or snagged on equipment must be secured.
- All personnel going to the site must be trained on all tasks they are expected to perform and thoroughly briefed on anticipated hazards, equipment, safety practices, emergency procedures, and communications needed for this project site.
- Personnel on the site must use the buddy system when engaged in Level C, B or A work tasks. The purpose of the buddy system is to provide rapid assistance to employees in the event of an emergency.
- Personnel unfamiliar with a task must stop work and verify how to perform the task safely.
- All personnel have the responsibility to stop anyone from performing an unsafe act or stop work if they see a safety hazard.
- Warning signals for site evacuation must be established by the SSHO and discussed during the tailgate safety meeting. A clear unobstructed entrance and exit must be maintained.
- Personnel and equipment in any contaminated area should be minimized.
- Work areas for various operational activities will be established, defined and discussed during the tailgate safety meeting.
- Procedures for leaving a contaminated area will be planned and implemented during the daily tailgate safety meeting. Work areas and decontamination procedures will be established based on expected tasks to be performed.
- Daily and ongoing inspections of site operations will be conducted by the SSHO to check compliance with this HASP. If changes in operations are necessary, the HASP must be modified to reflect these changes.
- All hand and power tools will be inspected prior to use and removed from the work area when no longer needed.
- Fire prevention and protection (appropriate signs for flammable liquids, smoking areas, storage areas of combustible or flammable materials, etc.) will be according to ATC H&S Policy No. 18 – Fire Protection.

- Site tailgate safety meetings will be held daily to discuss anticipated site conditions and daily activities. This meeting will be summarized on the Tailgate Safety Meeting Form, see Appendix C.
- A GFCI will be used on any extension cord or plugged in item.

9.0 CONTINGENCY PLAN

There are numerous potential emergency situations that may occur while working on this project site. If an emergency does occur, it is important that employees stop work and as soon as reasonably possible contact the PM. All emergency procedures including location of stop switches, emergency equipment and muster location must be discussed during the tailgate safety meeting and with all visitors.

9.1. Medical Emergencies

The name, address, telephone number, travel distance, and travel time to the nearest medical treatment facility are found in the Emergency Information section of this HASP. A map and direction for locating the facility is also available in the Emergency Information section.

An emergency first-aid kit will be readily accessible and identified on the site, and personnel will have CPR and first-aid training. Location of the first aid kit will be identified and discussed during the daily tailgate meeting. The first-aid kit will contain equipment necessary to protect employees against exposure to bloodborne pathogens. All employees must receive bloodborne pathogens training and if requested could receive Hepatitis B vaccinations according to the ATC H&S Policy No. 09 – Bloodborne Pathogens if exposed to bodily fluids.

Any person who becomes ill or injured in the exclusion zone must be decontaminated as well as possible with consideration to which risk will be greater, the spread of contamination or the health of the individual. If the injury or illness is minor, full decontamination should be completed and first-aid administered before transport. If the patient's condition is serious, at least partial decontamination should be completed.

The following steps should be followed if an injury or illness case occurs regardless of severity of the injury:

- Check the area to make sure the scene is safe.
- Assess the employee's condition and if life threatening or if your training dictates call 911.
 - If 911 is called, Core Health should be contacted after talking with 911.
 - Emergency personnel must be informed if potential chemical contamination is suspected. If possible, initiate decontamination procedures to prevent contamination of responding personnel.
- Call Core Health, if the injury is not life threatening for first aid guidance.
 - A fellow employee may call for the injured employee.
 - Provide your name, Branch and phone number.
 - If provided with first aid advice from Core Health, employees are authorized to secure (go to Walgreens, CVS, etc.) the items recommended by the nurse to treat the injury.
 - It is important for the injured employee to follow the advice of the nurse even when not at work (evenings, weekends).

- Begin providing first-aid using universal precautions while using proper PPE.
- If Core Health directs the injured employee to an occupational clinic for evaluation have a fellow employee drive them.
 - If someone is not available to transport the injured employee to the clinic, please let Core Health know. Based on the injury the injured employee may be able to drive themselves, but only after speaking with Core Health.
- Contact the PM as soon as it can be done safely or once the situation is stable.
 - If you cannot reach your manager, call the Branch Manager or Branch Safety Officer.
 - Provide a detailed description of what and how the injury occurred. A fellow employee may make this call also.
- Complete and submit a written account of the injury within 24 hours to the ATC incident reporting system.

9.2. Emergency Equipment

1. Eyewash containers or equipment shall be available onsite.
2. First Aid Kit
3. An emergency spill cleanup kit will be available at the site at all times. Unplanned releases will be reported to the SSHO and/or site Supervisor as soon as possible.
4. A multipurpose dry chemical (Class A, B, and C) fire extinguisher, rated not less than 2A:10B:C, will be maintained on the site. ATC employees are not trained in firefighting techniques and use of a fire extinguisher should be used in cases of small or beginning fires. Always ensure you have an exit before attempting to fight a fire, personnel safety is more important than equipment or tools.

9.3. Site Evacuation Conditions

The following conditions will necessitate the cessation of field work in the area of concern, withdrawal from the work area and revisions to this HASP:

- Fires and/or explosions
- The atmospheric conditions listed in Table 4-2 of this HASP are met.
- Flammable atmosphere readings above 10 percent LEL
- Oxygen readings above 23.5 percent oxygen concentration
- Oxygen readings at or below 19.5 percent oxygen concentration
- PID readings over 50 ppm sustained for more than 5 minutes

9.4. Gas Line, Electrical Line or Chemical Line Strike

In the event of a strike or potential strike all operations must stop and equipment turned off if safe to do so.

Onsite employees must immediately contact 911 or onsite emergency response and begin evacuation of the surrounding areas if there is no area alarm.

Once emergency services have been notified and all site personnel evacuated including the surround areas, contact the PM.

9.5. Non-ATC Emergencies

In the event that an emergency occurs onsite that was not caused by project work, but may affect the safety of onsite staff all work must stop. If safe to do so, the site should be secured and employees moved to a safe location.

These events may include but are not limited to:

- General public medical emergency
- Vehicle incident
- Police activity – violence/theft

9.6. Emergency Communication System

Emergency contacts and telephone numbers are provided at the beginning of this HASP. Employees will be provided with a communication device for onsite and offsite communications. These devices may include radios or mobile telephones. If an emergency occurs on-site, the site supervisor is responsible for checking that the appropriate emergency contact has been notified. At the time of the emergency response, the site supervisor or designee will brief the emergency personnel on the status of the emergency, including site conditions.

Field personnel may need to use hand signals if there are noisy working conditions on the site. Any use of hand signals should be discussed during the tailgate safety meeting.

9.7. Emergency Response Follow-Up

If there is an incident or emergency response, the SSHO will notify the PM and RSC. The PM or BSO will complete a Supervisor's Investigation Report (SIR) and submit it to the internal ATC distribution list. Prior to resuming work, a site safety meeting will be held to discuss

10.0 Training

It is the responsibility of the PM and each subcontractor's supervising manager to determine if ATC and subcontractor employees meet these training requirements.

10.1. General Training Requirements

All ATC and subcontractor employees working on this project site will have received, at a minimum, the following training prior to arrival.

- PPE use
- All tools and equipment to be used by the employee
- Hazard Communication
- Proper housekeeping
- Slip, trip and fall prevention
- Fire extinguisher training
- Temperature – Heat and Cold injuries/illnesses
- Safe lifting
- Noise
- CPR/First Aid

10.2. Hazwoper

All ATC and subcontractor employees that work in the project exclusion zone, decontamination area or may be exposed to onsite contaminants must have completed the 40-hour training requirement of 29 CFR 1910.120(e) (Hazwoper) and maintain that training by completing an annual 8 hour Hazwoper refresher training.

10.3. Site Supervisor's Training

Onsite supervisors on this project who are directly responsible for or who supervise workers shall complete, in addition to the initial 40-hour Hazwoper training, 8 additional hours of specialized supervisory training in compliance with the OSHA regulations.

10.4. Site Safety Training and Briefing Topics

The SSHO will conduct site-specific health and safety briefing (tailgate safety meeting) for field personnel before the start of all field work. All site workers including the site supervisor, ATC employees and subcontractor personnel must attend. At the conclusion of the meeting, personnel are to sign the HASP Agreement and Acknowledgement Form and Tailgate Safety Meeting Form found in Appendix C.

As additional people are assigned to the site, it is the responsibility of the SSHO to ensure that new personnel are briefed on health and safety protocols and ensure that they have reviewed and signed the HASP Agreement and Acknowledgement Form.

The Tailgate Safety Meeting shall cover:

- Site-specific health and safety procedures
- Client-specific health and safety policies and procedures
- Incidents and reporting
- JSA for tasks to be performed
- Health effects of various chemicals used on the site
- Emergency response actions pertaining to operations on-site
- Contents of this HASP

Additionally, daily site tailgate safety meetings will review past activities, plan the day's tasks, understand any near-miss and "lessons learned", establish safe working procedures for anticipated hazards and provide pertinent safety and health training and motivation.

10.5. Visitors

All visitors entering the designated work zones will be subject to all applicable health and safety requirements during field operations at this site. All visitors to a work site will be given the opportunity to review the HASP, will be escorted at all times, and will be required to stay a safe distance from site activities. The site supervisor and/or the SSHO will be responsible for briefing all visitors on the site hazards, site safety precautions, and the site emergency response plan.

APPENDIX A

Job Safety Analyses (JSA)

JOB SAFETY ANALYSIS (JSA)

DESCRIPTION OF JOB: Driving	REVISION DATE: 02-07-18	JSA CREATED ON: 12/6/07	PAGE: 1 of 3
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MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT			
<input type="checkbox"/> REFLECTIVE VEST	<input checked="" type="checkbox"/> LONG PANTS	<input type="checkbox"/> AIR PURIFYING RESPIRATOR	<input type="checkbox"/> OTHER:
<input type="checkbox"/> HARD HAT	<input type="checkbox"/> COTTON, LEATHER, OR CRAFTSMAN GLOVES	<input type="checkbox"/> SUPPLIED AIR RESPIRATOR	<input type="checkbox"/> OTHER:
<input type="checkbox"/> SAFETY TOED BOOTS	<input type="checkbox"/> CHEMICAL RESISTANT GLOVE:	<input type="checkbox"/> CHEMICAL RESISTANT CLOTHING:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> SAFETY GLASSES	<input type="checkbox"/> HEARING PROTECTION	<input type="checkbox"/> GOGGLES	<input type="checkbox"/> OTHER:
<input type="checkbox"/> FACE SHIELD			

REQUIRED TOOLS/EQUIPMENT/SUPPLIES			
<input type="checkbox"/> DRINKING WATER	<input type="checkbox"/> RATCHET WITH EXTENSION	<input checked="" type="checkbox"/> OTHER: FIRST AID KIT	<input type="checkbox"/> OTHER:
<input type="checkbox"/> BUG REPELLENT	<input type="checkbox"/> WELL MAGNET	<input checked="" type="checkbox"/> OTHER: FIRE EXTINGUISHER	<input type="checkbox"/> OTHER:
<input type="checkbox"/> TRAFFIC CONTROL DEVICES	<input type="checkbox"/> AIR MONITORING SELECT FROM LIST	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> LADDER	<input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:

STOP WORK

ATC and Subcontractor employees must stop work and contact off-site senior personnel when a change in condition, process, or job phase develops on the project site that is not addressed by this JSA or within the project specific HASP. The JSA should be modified with new steps, hazards, and safe procedures agreed upon by all ATC and Subcontractor employees at the project site and approved by off-site senior personnel. Documentation of the modification and review by all affected personnel must take place.

1) JOB STEPS	2) POTENTIAL HAZARDOUS CONDITIONS / UNSAFE PRACTICES	3) SAFE PROCEDURES and PREVENTATIVE MEASURES
Entering and Exiting Vehicle	Striking Pedestrians or Objects	<ul style="list-style-type: none"> Be sure to walk around your vehicle to inspect the area for objects and pedestrian hazards.
	Hand Injuries – Cuts and Pinches	<ul style="list-style-type: none"> Make sure keys are in your pocket before shutting door. Only lock the vehicle once the door is closed. Do not try to stop the door. Do not place your hand between the door and the frame of the vehicle.
	Crime/Assault	<ul style="list-style-type: none"> Beware of your surroundings. Use buddy system and let your supervisor know if you are working in high crime areas or at night. Ask for someone to walk to your vehicle with you if a hazard is present.
Driving to and from a Site	Vehicles	<ul style="list-style-type: none"> Use defensive driving techniques.
	Pedestrians	<ul style="list-style-type: none"> Yield to all pedestrians. Use defensive driving techniques.
	Distractions	<ul style="list-style-type: none"> Do not use cell phones or other portable electronic devices while driving. Do not eat or engage in other distracting activities while driving.

JOB SAFETY ANALYSIS (JSA)

DESCRIPTION OF JOB: Driving	REVISION DATE: 02-07-18	JSA CREATED ON: 12/6/07	PAGE: 2 of 3
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1) JOB STEPS	2) POTENTIAL HAZARDOUS CONDITIONS / UNSAFE PRACTICES	3) SAFE PROCEDURES and PREVENTATIVE MEASURES
	Load Shifting/Moving	<ul style="list-style-type: none"> • All tools, equipment and supplies must be properly secured in the bed of the truck at all times. • Check strapping prior to driving. • Wear work glove (cotton, leather or craftsman) or an impact resistant glove with slip resistance anytime you are adjusting equipment, tools and supplies in the back of the truck.
	Road Conditions	<ul style="list-style-type: none"> • Obey posted signage and speed limits. • Use caution while traveling in construction zones. • Follow ATC's Winter Driving Tips. • If driving more than 4 hours create a travel plan and provide to your Project Manager along with anticipated arrival time. • Driver must have a cell phone in case of emergency. • Drive defensively maintaining distance from the vehicle in front so that you can see road debris or other road conditions with enough time to stop or avoid.
	Weather	<ul style="list-style-type: none"> • Prior to leaving check weather forecast. • If snowy or heavy rains are expected delay trip. • If weather develops unexpectedly, pull over and wait for it to move on or diminish

JOB SAFETY ANALYSIS (JSA)

DESCRIPTION OF JOB: Driving	REVISION DATE: 02-07-18	JSA CREATED ON: 12/6/07	PAGE: 3 of 3
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STOP WORK

ATC and Subcontractor employees must stop work and contact off-site senior personnel when a change in condition, process, or job phase develops on the project site that is not addressed by this JSA or within the project specific HASP. The JSA should be modified with new steps, hazards, and safe procedures agreed upon by all ATC and Subcontractor employees at the project site and approved by off-site senior personnel. Documentation of the modification and review by all affected personnel must take place.

Please explain additional steps, changes or amendments to this JSA in the provided space below. Prior to starting work ensure that all employees understand and agree with the changes in this JSA.

By signing this JSA form, you are acknowledging that you have read, reviewed and understand the job steps, potential hazardous conditions and unsafe conditions and the safe procedures, preventative measures required to perform the task safely and the requirement to Stop Work when a change in condition, process, or job phase develops on the project site that is not addressed by this JSA or within the project specific HASP.

Print Name	Signature	Company	Date



JSA

JOB SAFETY ANALYSIS

For CMT Department Use
 JSA NO: CMT-001(b)
 Primary Job Category: CMT

DESCRIPTION OF JOB: Site Setup		REVISION DATE: 02/10/2016	JSA CREATED ON: 10/10/07
PREPARED BY: Christine Anderson	REVIEWED BY: Maria Rysavy	APPROVED BY: Dan Mickelsen	PAGE: 1 of 4

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

<input checked="" type="checkbox"/> REFLECTIVE VEST	<input checked="" type="checkbox"/> LONG PANTS	<input type="checkbox"/> AIR PURIFYING RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> HARD HAT	<input checked="" type="checkbox"/> COTTON, LEATHER, OR CRAFTSMAN GLOVES	<input type="checkbox"/> SUPPLIED AIR RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY TOED BOOTS	<input type="checkbox"/> CHEMICAL RESISTANT GLOVE:	<input type="checkbox"/> CHEMICAL RESISTANT CLOTHING:	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY GLASSES	<input type="checkbox"/> HEARING PROTECTION	<input type="checkbox"/> GOGGLES	<input type="checkbox"/> OTHER:
<input type="checkbox"/> FACE SHIELD			<input type="checkbox"/> OTHER:

REQUIRED TOOLS/EQUIPMENT/SUPPLIES

<input type="checkbox"/> DRINKING WATER	<input type="checkbox"/> RATCHET WITH EXTENSION	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> BUG REPELLENT	<input type="checkbox"/> WELL MAGNET	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> TRAFFIC CONTROL DEVICES	<input type="checkbox"/> AIR MONITORING SELECT FROM LIST	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> LADDER	<input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:

STOP WORK

ATC and Subcontractor employees must stop work and contact off-site senior personnel when a change in condition, process, or job phase develops on the project site that is not addressed by this JSA or within the project specific HASP. The JSA should be modified with new steps, hazards, and safe procedures agreed upon by all ATC and Subcontractor employees at the project site and approved by off-site senior personnel. Documentation of the modification and review by all affected personnel must take place.

1 JOB STEPS	2 POTENTIAL HAZARDOUS CONDITIONS or UNSAFE PRACTICES	3 SAFE PROCEDURES and PREVENTATIVE MEASURES
Drive around site	<ul style="list-style-type: none"> Traffic Pedestrians 	<ul style="list-style-type: none"> Use defensive driving techniques Yield to all pedestrians. Use defensive driving techniques
Load/Unload equipment and supplies	<ul style="list-style-type: none"> Vehicles 	<ul style="list-style-type: none"> When backing the drill rig, vehicles with trailers, or other large vehicles a spotter must be used. Use barrier controls with a height of at least 36 inches. Wear traffic reflective vest. Caution tape or snow fence should be used to surround the work site.
	<ul style="list-style-type: none"> Pedestrians 	<ul style="list-style-type: none"> Use barrier controls with a height of at least 36 inches. Place signs indicating authorized personnel only at entrance to site. When backing the drill rig, vehicles with trailers, or other large vehicles a spotter must be used. Caution tape or snow fence should be used to surround the work site.
	<ul style="list-style-type: none"> Weather 	<ul style="list-style-type: none"> Prevent heat and cold illnesses by: drinking water frequently and moderately; rest frequently; wear light colored clothing; eat light meals. Adjust work schedule to avoid temperature extremes. Sunscreen Layer clothing to adjust to changing environmental temperatures Avoid drinks with caffeine (coffee, tea, or soda) or alcohol. Use the buddy system (work in pairs).
	<ul style="list-style-type: none"> Slips, trips and falls 	<ul style="list-style-type: none"> Maintain housekeeping. Set up work zone with enough room for staging of equipment and supplies such that there are aisle ways for walking and working.



JSA

JOB SAFETY ANALYSIS

For CMT Department Use
 JSA NO: CMT-001(b)
 Primary Job Category: CMT

DESCRIPTION OF JOB:

Site Setup

REVISION DATE:

02/10/2016

JSA CREATED ON:

10/10/07

PREPARED BY: Christine Anderson

REVIEWED BY: Maria Rysavy

APPROVED BY: Dan Mickelsen

PAGE: 2 of 4

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

<input checked="" type="checkbox"/> REFLECTIVE VEST	<input checked="" type="checkbox"/> LONG PANTS	<input type="checkbox"/> AIR PURIFYING RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> HARD HAT	<input checked="" type="checkbox"/> COTTON, LEATHER, OR CRAFTSMAN GLOVES	<input type="checkbox"/> SUPPLIED AIR RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY TOED BOOTS	<input type="checkbox"/> CHEMICAL RESISTANT GLOVE:	<input type="checkbox"/> CHEMICAL RESISTANT CLOTHING:	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY GLASSES	<input type="checkbox"/> HEARING PROTECTION	<input type="checkbox"/> GOGGLES	<input type="checkbox"/> OTHER:
<input type="checkbox"/> FACE SHIELD			<input type="checkbox"/> OTHER:

REQUIRED TOOLS/EQUIPMENT/SUPPLIES

<input type="checkbox"/> DRINKING WATER	<input type="checkbox"/> RATCHET WITH EXTENSION	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> BUG REPELLENT	<input type="checkbox"/> WELL MAGNET	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> TRAFFIC CONTROL DEVICES	<input type="checkbox"/> AIR MONITORING SELECT FROM LIST	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> LADDER	<input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:

STOP WORK

ATC and Subcontractor employees must stop work and contact off-site senior personnel when a change in condition, process, or job phase develops on the project site that is not addressed by this JSA or within the project specific HASP. The JSA should be modified with new steps, hazards, and safe procedures agreed upon by all ATC and Subcontractor employees at the project site and approved by off-site senior personnel. Documentation of the modification and review by all affected personnel must take place.

1 JOB STEPS	2 POTENTIAL HAZARDOUS CONDITIONS or UNSAFE PRACTICES	3 SAFE PROCEDURES and PREVENTATIVE MEASURES
		<ul style="list-style-type: none"> • If on pavement or concrete sweep up loose sand, dirt or rock • Wear slip resistant steel toed boots. • Keep foot wear clean of mud and other debris. • Setup areas away from snow and ice. • If ice is present wear yak-traks on boots.
	<ul style="list-style-type: none"> • Insects and animals 	<ul style="list-style-type: none"> • Look around area before setting up for the presence of bee nests and cob webs. • Do not disturb – leave them alone. • If stray dogs are present go indoors or the cab of the truck and wait for it to leave. Call animal control. • If you encounter bees or poisonous spiders leave the area and call the Project Manager. • Keep hands and feet out of areas you can not see.
	<ul style="list-style-type: none"> • Back Injuries 	<ul style="list-style-type: none"> • Use proper lifting procedures – avoid lifting with the back and twisting. • Do not lift over 50 pounds without assistance.
	<ul style="list-style-type: none"> • Hand Injuries 	<ul style="list-style-type: none"> • Wear work gloves – leather or craftsman while setting up. • Watch hand placement – always know where your hands are at. • Do not place your hand in direct path of a tool or between two objects.
	<ul style="list-style-type: none"> • Heavy Equipment 	<ul style="list-style-type: none"> • Spotters must be used at all times when heavy equipment is being operated. • All onsite personnel must wear safety reflective vest. • Operator must follow spotters hand signals and remove hands from controls when not working. • Site personnel should only approach the spotter • Backup alarm is required on heavy equipment.



JSA

JOB SAFETY ANALYSIS

For CMT Department Use
 JSA NO: CMT-001(b)
 Primary Job Category: CMT

DESCRIPTION OF JOB: Site Setup		REVISION DATE: 02/10/2016	JSA CREATED ON: 10/10/07
PREPARED BY: Christine Anderson	REVIEWED BY: Maria Rysavy	APPROVED BY: Dan Mickelsen	PAGE: 3 of 4

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

<input checked="" type="checkbox"/> REFLECTIVE VEST	<input checked="" type="checkbox"/> LONG PANTS	<input type="checkbox"/> AIR PURIFYING RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> HARD HAT	<input checked="" type="checkbox"/> COTTON, LEATHER, OR CRAFTSMAN GLOVES	<input type="checkbox"/> SUPPLIED AIR RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY TOED BOOTS	<input type="checkbox"/> CHEMICAL RESISTANT GLOVE:	<input type="checkbox"/> CHEMICAL RESISTANT CLOTHING:	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY GLASSES	<input type="checkbox"/> HEARING PROTECTION	<input type="checkbox"/> GOGGLES	<input type="checkbox"/> OTHER:
<input type="checkbox"/> FACE SHIELD			

REQUIRED TOOLS/EQUIPMENT/SUPPLIES

<input type="checkbox"/> DRINKING WATER	<input type="checkbox"/> RATCHET WITH EXTENSION	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> BUG REPELLENT	<input type="checkbox"/> WELL MAGNET	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> TRAFFIC CONTROL DEVICES	<input type="checkbox"/> AIR MONITORING SELECT FROM LIST	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> LADDER	<input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:

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1 JOB STEPS	2 POTENTIAL HAZARDOUS CONDITIONS or UNSAFE PRACTICES	3 SAFE PROCEDURES and PREVENTATIVE MEASURES
Underground Utility Locate	<ul style="list-style-type: none"> Vehicles 	<ul style="list-style-type: none"> Wear traffic reflective vest. A spotter should walk with the utility locator looking for hazards whenever the locator is looking down.
	<ul style="list-style-type: none"> Weather 	<ul style="list-style-type: none"> Prevent heat and cold illnesses by: drinking water frequently and moderately; rest frequently; wear light colored clothing; eat light meals. Adjust work schedule to avoid temperature extremes. Sunscreen Layer clothing to adjust to changing environmental temperatures Avoid drinks with caffeine (coffee, tea, or soda) or alcohol. Use the buddy system (work in pairs).
	<ul style="list-style-type: none"> Slips, trips and falls 	<ul style="list-style-type: none"> Wear slip resistant steel toed boots with ankle support. Keep foot wear clean of mud and other debris. If ice is present wear yak-traks on boots.
	<ul style="list-style-type: none"> Insects and animals 	<ul style="list-style-type: none"> Look around area before setting up for the presence of bee nests and cob webs. Do not disturb – leave them alone. If stray dogs are present go indoors or the cab of the truck and wait for it to leave. Call animal control. If you encounter bees or poisonous spiders leave the area and call the Project Manager. Keep hands and feet out of areas you can not see.

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT



JSA

JOB SAFETY ANALYSIS

For CMT Department Use
JSA NO: CMT-001(b)
Primary Job Category: CMT

DESCRIPTION OF JOB:

Site Setup

REVISION DATE:

02/10/2016

JSA CREATED ON:

10/10/07

PREPARED BY: Christine Anderson

REVIEWED BY: Maria Rysavy

APPROVED BY: Dan Mickelsen

PAGE: 4 of 4

<input type="checkbox"/> REFLECTIVE VEST	<input type="checkbox"/> LONG PANTS	<input type="checkbox"/> AIR PURIFYING RESPIRATOR	<input type="checkbox"/> OTHER:
<input type="checkbox"/> HARD HAT	<input type="checkbox"/> COTTON, LEATHER, OR CRAFTSMAN GLOVES	<input type="checkbox"/> SUPPLIED AIR RESPIRATOR	<input type="checkbox"/> OTHER:
<input type="checkbox"/> SAFETY TOED BOOTS	<input type="checkbox"/> CHEMICAL RESISTANT GLOVE:	<input type="checkbox"/> CHEMICAL RESISTANT CLOTHING:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> SAFETY GLASSES	<input type="checkbox"/> HEARING PROTECTION	<input type="checkbox"/> GOGGLES	<input type="checkbox"/> OTHER:
<input type="checkbox"/> FACE SHIELD			<input type="checkbox"/> OTHER:
REQUIRED TOOLS/EQUIPMENT/SUPPLIES			
<input type="checkbox"/> DRINKING WATER	<input type="checkbox"/> RATCHET WITH EXTENSION	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> BUG REPELLENT	<input type="checkbox"/> WELL MAGNET	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> TRAFFIC CONTROL DEVICES	<input type="checkbox"/> AIR MONITORING SELECT FROM LIST	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> LADDER	<input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:

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Please explain additional steps, changes or amendments to this JSA in the provided space below. Prior to starting work ensure that all employees understand and agree with the changes in this JSA.



JSA

JOB SAFETY ANALYSIS

For RM Department Use
 JSA NO: Em-007(b)
 Primary Job Category: Environmental Management

DESCRIPTION OF JOB: Unloading of Supplies		REVISION DATE: 02/10/16	JSA CREATED ON: 2/10/05
PREPARED BY: Christine Anderson	REVIEWED BY: Maria Rysavy	APPROVED BY: Dan Mickelsen	PAGE: 1 of 1

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

<input checked="" type="checkbox"/> REFLECTIVE VEST	<input checked="" type="checkbox"/> LONG PANTS	<input type="checkbox"/> AIR PURIFYING RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> HARD HAT	<input checked="" type="checkbox"/> COTTON, LEATHER, OR CRAFTSMAN GLOVES	<input type="checkbox"/> SUPPLIED AIR RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY TOED BOOTS	<input type="checkbox"/> CHEMICAL RESISTANT GLOVE:	<input type="checkbox"/> CHEMICAL RESISTANT CLOTHING:	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY GLASSES	<input type="checkbox"/> HEARING PROTECTION	<input type="checkbox"/> GOGGLES	<input type="checkbox"/> OTHER:
<input type="checkbox"/> FACE SHIELD			<input type="checkbox"/> OTHER:

REQUIRED TOOLS/EQUIPMENT/SUPPLIES

<input type="checkbox"/> DRINKING WATER	<input type="checkbox"/> RATCHET WITH EXTENSION	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> BUG REPELLENT	<input type="checkbox"/> WELL MAGNET	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> TRAFFIC CONTROL DEVICES	<input type="checkbox"/> AIR MONITORING SELECT FROM LIST	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> LADDER	<input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:

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1 JOB STEPS	2 POTENTIAL HAZARDOUS CONDITIONS or UNSAFE PRACTICES	3 SAFE PROCEDURES and PREVENTATIVE MEASURES
Pickup/Set down supplies/tools	Back injuries	<ul style="list-style-type: none"> Follow proper lifting procedures – lift with your legs. Do not lift more than 50 pounds without assistance.
	Cuts to the hands	<ul style="list-style-type: none"> Wear leather, cotton, or craftsman work gloves. Watch hand placement. Check object for sharp edges.
Carry supplies/tools	Back injuries	<ul style="list-style-type: none"> If carrying material over a long distance, use a cart or hand dolly to assist.
	Slips, trips and falls	<ul style="list-style-type: none"> Use designated paths whenever possible. Wear safety toed boots with ankle support. Limit the amount of material you are carrying so that you can see the path while walking. Do not jump from the back of pickup trucks. Always step down, facing the truck and maintaining three (3) points of contact. Set down all supplies and tools while climbing into and out of the back of the pickup.



JSA

JOB SAFETY ANALYSIS

For RM Department Use
 JSA NO: Em-007(b)
 Primary Job Category: Environmental Management

DESCRIPTION OF JOB:

Unloading of Supplies

REVISION DATE:

02/10/16

JSA CREATED ON:

2/10/05

PREPARED BY: Christine Anderson

REVIEWED BY: Maria Rysavy

APPROVED BY: Dan Mickelsen

PAGE: 2 of 1

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

<input type="checkbox"/> REFLECTIVE VEST	<input type="checkbox"/> LONG PANTS	<input type="checkbox"/> AIR PURIFYING RESPIRATOR	<input type="checkbox"/> OTHER:
<input type="checkbox"/> HARD HAT	<input type="checkbox"/> COTTON, LEATHER, OR CRAFTSMAN GLOVES	<input type="checkbox"/> SUPPLIED AIR RESPIRATOR	<input type="checkbox"/> OTHER:
<input type="checkbox"/> SAFETY TOED BOOTS	<input type="checkbox"/> CHEMICAL RESISTANT GLOVE:	<input type="checkbox"/> CHEMICAL RESISTANT CLOTHING:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> SAFETY GLASSES	<input type="checkbox"/> HEARING PROTECTION	<input type="checkbox"/> GOGGLES	<input type="checkbox"/> OTHER:
<input type="checkbox"/> FACE SHIELD			

REQUIRED TOOLS/EQUIPMENT/SUPPLIES

<input type="checkbox"/> DRINKING WATER	<input type="checkbox"/> RATCHET WITH EXTENSION	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> BUG REPELLENT	<input type="checkbox"/> WELL MAGNET	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> TRAFFIC CONTROL DEVICES	<input type="checkbox"/> AIR MONITORING SELECT FROM LIST	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> LADDER	<input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:

STOP WORK

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JSA

JOB SAFETY ANALYSIS

For RM Department Use
 JSA NO: EM-007(a)
 Primary Job Category: Environmental Management

DESCRIPTION OF JOB: Underground Utility Locate		REVISION DATE: 04/19/2011	JSA CREATED ON: 2/10/05
PREPARED BY: Christine Anderson	REVIEWED BY: Dan Mickelsen	APPROVED BY: Dan Mickelsen	PAGE: 1 of 2

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

<input checked="" type="checkbox"/> REFLECTIVE VEST	<input checked="" type="checkbox"/> LONG PANTS	<input type="checkbox"/> AIR PURIFYING RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> HARD HAT	<input checked="" type="checkbox"/> COTTON, LEATHER, OR CRAFTSMAN GLOVES	<input type="checkbox"/> SUPPLIED AIR RESPIRATOR	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY TOED BOOTS	<input type="checkbox"/> CHEMICAL RESISTANT GLOVE:	<input type="checkbox"/> CHEMICAL RESISTANT CLOTHING:	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> SAFETY GLASSES	<input type="checkbox"/> HEARING PROTECTION	<input type="checkbox"/> GOGGLES	<input type="checkbox"/> OTHER:
<input type="checkbox"/> FACE SHIELD			<input type="checkbox"/> OTHER:

REQUIRED TOOLS/EQUIPMENT/SUPPLIES

<input type="checkbox"/> DRINKING WATER	<input type="checkbox"/> RATCHET WITH EXTENSION	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> BUG REPELLENT	<input type="checkbox"/> WELL MAGNET	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input checked="" type="checkbox"/> TRAFFIC CONTROL DEVICES	<input type="checkbox"/> AIR MONITORING SELECT FROM LIST	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:
<input type="checkbox"/> LADDER	<input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER:

STOP WORK

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1 JOB STEPS	2 POTENTIAL HAZARDOUS CONDITIONS or UNSAFE PRACTICES	3 SAFE PROCEDURES and PREVENTATIVE MEASURES
Walk site	Trip hazards	<ul style="list-style-type: none"> Always look at where you step Clear vegetation if needed Wear steel toed boots with ankle support
	Vehicles	<ul style="list-style-type: none"> Wear a safety reflective vest Walk with a spotter Be aware of your surroundings
	Heavy equipment	<ul style="list-style-type: none"> Wear a safety reflective vest Walk with a spotter Be aware of your surroundings Heavy equipment operation will not occur while utility locating is being conducted.
	Weather	<ul style="list-style-type: none"> Dress appropriately for the weather Wear layers Drink fluids



JSA

JOB SAFETY ANALYSIS

For RM Department Use
 JSA NO: EM-007(a)
 Primary Job Category: Environmental Management

DESCRIPTION OF JOB:

Underground Utility Locate

REVISION DATE:

04/19/2011

JSA CREATED ON:

2/10/05

PREPARED BY: Christine Anderson

REVIEWED BY: Dan Mickelsen

APPROVED BY: Dan Mickelsen

PAGE: 2 of 2

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

- REFLECTIVE VEST
- HARD HAT
- SAFETY TOED BOOTS
- SAFETY GLASSES
- FACE SHIELD

- LONG PANTS
- COTTON, LEATHER, OR CRAFTSMAN GLOVES
- CHEMICAL RESISTANT GLOVE:
- HEARING PROTECTION

- AIR PURIFYING RESPIRATOR
- SUPPLIED AIR RESPIRATOR
- CHEMICAL RESISTANT CLOTHING:
- GOGGLES

- OTHER:
- OTHER:
- OTHER:
- OTHER:
- OTHER:

REQUIRED TOOLS/EQUIPMENT/SUPPLIES

- DRINKING WATER
- BUG REPELLENT
- TRAFFIC CONTROL DEVICES
- LADDER

- RATCHET WITH EXTENSION
- WELL MAGNET
- AIR MONITORING **SELECT FROM LIST**
- LOCKOUT/TAGOUT EQUIPMENT

- OTHER:
- OTHER:
- OTHER:
- OTHER:

- OTHER:
- OTHER:
- OTHER:
- OTHER:

STOP WORK

ATC and Subcontractor employees must stop work and contact off-site senior personnel when a change in condition, process, or job phase develops on the project site that is not addressed by this JSA or within the project specific HASP. The JSA should be modified with new steps, hazards, and safe procedures agreed upon by all ATC and Subcontractor employees at the project site and approved by off-site senior personnel. Documentation of the modification and review by all affected personnel must take place.

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JSA

JOB SAFETY ANALYSIS

For RM Department Use
 JSA NO: EM-005b
 Primary Job Category: Environmental Management

DESCRIPTION OF JOB: Concrete and Asphalt Cutting		REVISION DATE: 02/13/13	JSA CREATED ON: 12/05/05
PREPARED BY:	REVIEWED BY: Dan Mickelsen	APPROVED BY: Dan Mickelsen	PAGE: 1 of 4

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

<input checked="" type="checkbox"/> REFLECTIVE VEST <input checked="" type="checkbox"/> HARD HAT <input checked="" type="checkbox"/> SAFETY TOED BOOTS <input checked="" type="checkbox"/> SAFETY GLASSES <input type="checkbox"/> FACE SHIELD	<input checked="" type="checkbox"/> LONG PANTS <input type="checkbox"/> HEARING PROTECTION <input type="checkbox"/> GLOVE – 1: 8 MIL Minimum Thickness Nitrile Glove <input type="checkbox"/> GLOVE – 2: <u>Light Duty Cut/Puncture Abrasion - ANSI Cut, Abrasion Resistance Level 2 & EN 388 21xx</u> <input type="checkbox"/> GLOVE – 3: <u>Medium/Heavy Duty Cut/Puncture, - ANSI Cut, Abrasion Resistance Level 3 & EN 388 33xx</u> <input type="checkbox"/> GLOVE – 4: <u>Medium Duty Cut/ Puncture Gloves with Oily Surface Grip – ANSI Cut, Abrasion Resistance Level 3, & EN 388 44xx</u> <input type="checkbox"/> GLOVE – 5: <u>Medium/Heavy Duty Cut/Puncture Gloves with Oily Surface Grip – ANSI Cut, Abrasion Resistance Level 3, & EN 388 4522</u> <input type="checkbox"/> GLOVE – 6: <u>Impact Hazards, Medium/Heavy Duty Cut/Puncture - ANSI Cut, Abrasion Resistance Level 3 & EN 388 4522</u>	<input type="checkbox"/> AIR PURIFYING RESPIRATOR <input type="checkbox"/> SUPPLIED AIR RESPIRATOR <input type="checkbox"/> CHEMICAL RESISTANT CLOTHING: <input type="checkbox"/> GOGGLES	<input type="checkbox"/> GLOVE _____ <input type="checkbox"/> GLOVE _____ <input type="checkbox"/> GLOVE _____ <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER:
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REQUIRED TOOLS/EQUIPMENT/SUPPLIES

<input type="checkbox"/> DRINKING WATER <input type="checkbox"/> BUG REPELLENT <input type="checkbox"/> TRAFFIC CONTROL DEVICES <input type="checkbox"/> LADDER	<input type="checkbox"/> RATCHET WITH EXTENSION <input type="checkbox"/> WELL MAGNET <input type="checkbox"/> AIR MONITORING SELECT FROM LIST <input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER:
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STOP WORK

Cardno ATC and Subcontractor employees must stop work and contact off-site senior personnel when a change in condition, process, or job phase develops on the project site that is not addressed by this JSA or within the project specific HASP. The JSA should be modified with new steps, hazards, and safe procedures agreed upon by all Cardno ATC and Subcontractor employees at the project site and approved by off-site senior personnel. Documentation of the modification and review by all affected personnel must take place.

1 JOB STEPS	2 POTENTIAL HAZARDOUS CONDITIONS or UNSAFE PRACTICES	3 SAFE PROCEDURES and PREVENTATIVE MEASURES
Unload/Load Machine	Back injury from lifting, moving the saw	<ul style="list-style-type: none"> Use proper lifting procedures – avoid lifting with the back and twisting. If over 50 pounds or awkward ask for assistance.
	Hand injuries	<ul style="list-style-type: none"> Glove - _____. Do not use your hand as the tool. Use the right tool for the job. Be aware of hand placement – do not place hands in the path of hammers, knives or between objects. Watch hand placement – always know where your hands are at. Do not place your hand in direct path of a tool or between two objects.
	Falling	<ul style="list-style-type: none"> Always look where you are stepping Have a spotter watch as you are moving the saw to the lift gate.



JSA

JOB SAFETY ANALYSIS

For RM Department Use
 JSA NO: EM-005b
 Primary Job Category: Environmental Management

DESCRIPTION OF JOB:
Concrete and Asphalt Cutting

REVISION DATE:
02/13/13

JSA CREATED ON:
12/05/05

PREPARED BY:

REVIEWED BY: Dan Mickelsen

APPROVED BY: Dan Mickelsen

PAGE: 2 of 4

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

Attach and remove saw blade	Hand, arm cuts	<ul style="list-style-type: none"> Glove - _____. Do not use your hand as the tool. Use the right tool for the job. Be aware of hand placement – do not place hands in the path of hammers, knives or between objects. Watch hand placement – always know where your hands are at. Do not place your hand in direct path of a tool or between two objects.
Fuel the Machine	Fire	<ul style="list-style-type: none"> Eliminate all sources of ignition Clean up any spilled gasoline
	Chemical contact	<ul style="list-style-type: none"> Use a funnel to prevent splash
Cut asphalt or concrete	Back Injuries	<ul style="list-style-type: none"> Use proper lifting procedures – avoid lifting with the back and twisting. If over 50 pounds or awkward ask for assistance.
	Slips, trip and falls	<ul style="list-style-type: none"> Dry up water as quickly as possible. Set up work zone with enough room for staging of equipment and supplies such that there are aisle ways for walking and working. If on pavement or concrete sweep up loose sand, dirt or rock Wear slip resistant safety toed boots. Keep foot wear clean of mud and other debris. Setup areas away from snow and ice. If ice is present wear yak-traks on boots.
	Noise	<ul style="list-style-type: none"> Wear hearing protection. Place hearing protection warning signs on the work zone barrier at intervals of 20 feet. Review hand signals during tailgate meeting.
	Dust	<ul style="list-style-type: none"> Use water.
	Flying Debris	<ul style="list-style-type: none"> Use water. The guard must be in place at all times when the blade is turning. Face shield must be worn while operating the machine.
	Hand Cuts	<ul style="list-style-type: none"> Glove - _____. Be alert for hand injuries. Do not use your hand as the tool. Use the right tool for the job. Be aware of hand placement – do not place hands in the path of hammers, knives or between objects. Blade must stop spinning before picking up any hand-held (i.e., demo) saws.



JSA

JOB SAFETY ANALYSIS

For RM Department Use
 JSA NO: EM-005b
 Primary Job Category: Environmental Management

DESCRIPTION OF JOB: Concrete and Asphalt Cutting		REVISION DATE: 02/13/13	JSA CREATED ON: 12/05/05
PREPARED BY:	REVIEWED BY: Dan Mickelsen	APPROVED BY: Dan Mickelsen	PAGE: 3 of 4

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

Cut asphalt or concrete (cont.)	Weather	<ul style="list-style-type: none"> • Prevent heat and cold illnesses by: drinking water frequently and moderately; rest frequently; wear light colored clothing; eat light meals. • Adjust work schedule to avoid temperature extremes. • Sunscreen • Layer clothing to adjust to changing environmental temperatures • Avoid drinks with caffeine (coffee, tea, or soda) or alcohol. • Use the buddy system (work in pairs).
	Vehicles	<ul style="list-style-type: none"> • Use barrier controls with a height of at least 42 inches. • Wear traffic reflective vest.
	Pedestrians	<ul style="list-style-type: none"> • Use barrier controls with a height of at least 42 inches • Caution tape or snow fence should be used to surround the entire site.



JSA

JOB SAFETY ANALYSIS

For RM Department Use
JSA NO: EM-005b
Primary Job Category: Environmental Management

DESCRIPTION OF JOB:

Concrete and Asphalt Cutting

REVISION DATE:

02/13/13

JSA CREATED ON:

12/05/05

PREPARED BY:

REVIEWED BY: Dan Mickelsen

APPROVED BY: Dan Mickelsen

PAGE: 4 of 4

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

STOP WORK

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JSA

JOB SAFETY ANALYSIS

For RM Department Use
 Primary Category:
EM - Environmental Management
 Secondary Category:
 JSA NO. **EM-002m**

DESCRIPTION OF JOB: Hand augering	OPERATOR JOB CLASSIFICATION: Field Operator	DATE: 09-27-2012	REVISION: 02/24/16
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PREPARED BY: Dan Mickelsen	REVIEWED BY: Dan Mickelsen	APPROVED BY: Dan Mickelsen	PAGE: _____ of _____
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MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

<input checked="" type="checkbox"/> REFLECTIVE VEST <input checked="" type="checkbox"/> HARD HAT <input checked="" type="checkbox"/> SAFETY TOED BOOTS <input checked="" type="checkbox"/> SAFETY GLASSES <input type="checkbox"/> FACE SHIELD	<input checked="" type="checkbox"/> LONG PANTS <input type="checkbox"/> HEARING PROTECTION <input type="checkbox"/> GLOVE – 1: 8 MIL Minimum Thickness Nitrile Glove <input type="checkbox"/> GLOVE – 2: Light Duty Cut/Puncture Abrasion - ANSI Cut, Abrasion Resistance Level 2 & EN 388 21xx <input type="checkbox"/> GLOVE – 3: Medium/Heavy Duty Cut/Puncture, - ANSI Cut, Abrasion Resistance Level 3 & EN 388 33xx <input type="checkbox"/> GLOVE – 4: Medium Duty Cut/ Puncture Gloves with Oily Surface Grip – ANSI Cut, Abrasion Resistance Level 3, & EN 388 44xx <input type="checkbox"/> GLOVE – 5: Medium/Heavy Duty Cut/Puncture Gloves with Oily Surface Grip – ANSI Cut, Abrasion Resistance Level 3, & EN 388 4522 <input type="checkbox"/> GLOVE – 6: Impact Hazards, Medium/Heavy Duty Cut/Puncture - ANSI Cut, Abrasion Resistance Level 3 & EN 388 4522	<input type="checkbox"/> AIR PURIFYING RESPIRATOR <input type="checkbox"/> SUPPLIED AIR RESPIRATOR <input type="checkbox"/> CHEMICAL RESISTANT CLOTHING: <input type="checkbox"/> GOGGLES	<input type="checkbox"/> GLOVE _____ <input type="checkbox"/> GLOVE _____ <input type="checkbox"/> GLOVE _____ <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER:
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REQUIRED TOOLS/EQUIPMENT/SUPPLIES

<input type="checkbox"/> DRINKING WATER <input type="checkbox"/> BUG REPELLENT <input checked="" type="checkbox"/> TRAFFIC CONTROL DEVICES <input type="checkbox"/> LADDER	<input type="checkbox"/> RATCHET WITH EXTENSION <input type="checkbox"/> WELL MAGNET <input type="checkbox"/> AIR MONITORING PID <input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER:	<input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER:
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1 JOB STEPS	2 POTENTIAL HAZARDOUS CONDITIONS or UNSAFE PRACTICES	3 SAFE PROCEDURES and PREVENTATIVE MEASURES
Unload/Load Equipment	Hand injuries	<ul style="list-style-type: none"> Always watch hand placement – do not place your hand in direct path of a tool. Use gloves as specified in PPE section.
	Back injuries	<ul style="list-style-type: none"> Use proper lifting procedures – avoid lifting with the back and twisting. If over 50 pounds or awkward ask for assistance.



JSA

JOB SAFETY ANALYSIS

For RM Department Use
 Primary Category:
EM - Environmental Management
 Secondary Category:
 JSA NO. **EM-002m**

DESCRIPTION OF JOB: Hand augering		OPERATOR JOB CLASSIFICATION: Field Operator	DATE: 09-27-2012	REVISION: 02/24/16
PREPARED BY: Dan Mickelsen	REVIEWED BY: Dan Mickelsen	APPROVED BY: Dan Mickelsen	PAGE: of	
	Slip, trips and falls		<ul style="list-style-type: none"> Maintain housekeeping. Set up work zone with enough room for staging of equipment and supplies such that there are aisle ways for walking and working. If on pavement or concrete sweep up loose sand, dirt or rock. Wear slip resistant steel toed boots. Keep foot wear clean of mud and other debris. Dry up water as quickly as possible. 	
Setup work area	See JSA for site setup		<ul style="list-style-type: none"> See JSA for site setup 	
Asphalt/concrete cutting	See JSA for asphalt and concrete cutting		<ul style="list-style-type: none"> See JSA for asphalt and concrete cutting 	
Assemble hand auger tools	Dropping of tools		<ul style="list-style-type: none"> Use gloves as specified in PPE section. Keep gloves clean and dry. 	
	Back injuries		<ul style="list-style-type: none"> Use proper lifting procedures – avoid lifting with the back and twisting. If over 50 pounds or awkward ask for assistance. 	
	Foot injuries		<ul style="list-style-type: none"> Wear safety toed boots 	
Clear hole	Hand injuries		<ul style="list-style-type: none"> Always watch hand placement – do not place your hand in direct path of a tool. Take frequent breaks and change hand position Use gloves as specified in PPE section. Keep gloves clean and dry. 	
	Back injuries		<ul style="list-style-type: none"> Use proper lifting procedures – avoid lifting with the back and twisting. If over 50 pounds or awkward ask for assistance 	
	Slip, trips and falls		<ul style="list-style-type: none"> Maintain housekeeping. Set up work zone with enough room for staging of equipment and supplies such that there are aisle ways for walking and working. If on pavement or concrete sweep up loose sand, dirt or rock. 	



JSA

JOB SAFETY ANALYSIS

For RM Department Use
 Primary Category:
EM - Environmental Management
 Secondary Category:
 JSA NO. **EM-002m**

DESCRIPTION OF JOB: Hand augering		OPERATOR JOB CLASSIFICATION: Field Operator	DATE: 09-27-2012	REVISION: 02/24/16
PREPARED BY: Dan Mickelsen	REVIEWED BY: Dan Mickelsen	APPROVED BY: Dan Mickelsen	PAGE: of	
			<ul style="list-style-type: none"> Wear slip resistant safety toed boots. Keep foot wear clean of mud and other debris. Dry up water as quickly as possible. Put tools away if they are no longer needed. 	
	Underground utilities		<ul style="list-style-type: none"> Contact the state's one call service at least 48 hours prior to digging. Use private locator company. Look at existing site plans prior to beginning work to determine potential location of underground utilities. Watch for pea gravel or fill material. Stay at least 5 feet away from all marked utility lines. Ensure all affected utilities are marked or have no conflict. 	
	Chemical contact – inhalation and skin		<ul style="list-style-type: none"> Wear nitrile gloves when contacting soil and contaminated equipment. Nitrile gloves can be worn under work gloves specified in PPE section to help protect against cuts and pinches. Have a PID monitoring the breathing zone and exclusion zone. 	
Remove debris	Back injuries		<ul style="list-style-type: none"> Use proper lifting procedures – avoid lifting with the back and twisting. Do not lift over 50 pounds without assistance. Use cart or wheelbarrow to move soil debris or place directly in a drum. See JSA for wheelbarrow. 	
	Hand and foot injuries		<ul style="list-style-type: none"> Always watch hand placement – do not place your hand in direct path of a tool or object. Use gloves as specified in PPE section. Keep gloves clean and dry. Wear safety toed boots 	
Handling drum	See JSA for Drum Handling		<ul style="list-style-type: none"> See JSA for Drum Handling 	



JSA

JOB SAFETY ANALYSIS

For RM Department Use
Primary Category:
EM - Environmental Management
Secondary Category:
JSA NO. **EM-002m**

DESCRIPTION OF JOB: Hand augering	OPERATOR JOB CLASSIFICATION: Field Operator	DATE: 09-27-2012	REVISION: 02/24/16
PREPARED BY: Dan Mickelsen	REVIEWED BY: Dan Mickelsen	APPROVED BY: Dan Mickelsen	PAGE: of

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JSA

JOB SAFETY ANALYSIS

For RM Department Use
 JSA NO: EM-001(d)
 Primary Job Category: Environmental Management

DESCRIPTION OF JOB: Soil Vapor Sampling		REVISION DATE: 1/18/18	JSA CREATED ON: January 18, 2018
PREPARED BY: David Neidigh	REVIEWED BY: Maria Rysavy	APPROVED BY: Dan Mickelsen	PAGE: 1 of 3

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

<input checked="" type="checkbox"/> REFLECTIVE VEST <input checked="" type="checkbox"/> HARD HAT <input checked="" type="checkbox"/> SAFETY TOED BOOTS <input checked="" type="checkbox"/> SAFETY GLASSES <input type="checkbox"/> FACE SHIELD	<input checked="" type="checkbox"/> LONG PANTS <input type="checkbox"/> HEARING PROTECTION <input checked="" type="checkbox"/> GLOVE – 1: 8 MIL Minimum Thickness Nitrile Glove <input checked="" type="checkbox"/> GLOVE – 2: Light Duty Cut/Puncture Abrasion - ANSI Cut, Abrasion Resistance Level 2 & EN 388 21xx <input type="checkbox"/> GLOVE – 3: Medium/Heavy Duty Cut/Puncture, - ANSI Cut, Abrasion Resistance Level 3 & EN 388 33xx <input type="checkbox"/> GLOVE – 4: Medium Duty Cut/ Puncture Gloves with Oily Surface Grip – ANSI Cut, Abrasion Resistance Level 3, & EN 388 44xx <input type="checkbox"/> GLOVE – 5: Medium/Heavy Duty Cut/Puncture Gloves with Oily Surface Grip – ANSI Cut, Abrasion Resistance Level 3, & EN 388 4522 <input type="checkbox"/> GLOVE – 6: Impact Hazards, Medium/Heavy Duty Cut/Puncture - ANSI Cut, Abrasion Resistance Level 3 & EN 388 4522	<input type="checkbox"/> AIR PURIFYING RESPIRATOR <input type="checkbox"/> SUPPLIED AIR RESPIRATOR <input type="checkbox"/> CHEMICAL RESISTANT CLOTHING: <input type="checkbox"/> GOGGLES	<input type="checkbox"/> GLOVE _____ <input type="checkbox"/> GLOVE _____ <input type="checkbox"/> GLOVE _____ <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER:
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REQUIRED TOOLS/EQUIPMENT/SUPPLIES

<input checked="" type="checkbox"/> DRINKING WATER <input type="checkbox"/> BUG REPELLENT <input checked="" type="checkbox"/> TRAFFIC CONTROL DEVICES <input type="checkbox"/> LADDER	<input checked="" type="checkbox"/> RATCHET WITH EXTENSION <input checked="" type="checkbox"/> WELL MAGNET <input checked="" type="checkbox"/> AIR MONITORING: <input type="checkbox"/> LOCKOUT/TAGOUT EQUIPMENT	<input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER: <input type="checkbox"/> OTHER:	<input checked="" type="checkbox"/> OTHER: Pry Bar <input checked="" type="checkbox"/> OTHER: Screw Driver <input checked="" type="checkbox"/> OTHER: Wrench <input checked="" type="checkbox"/> OTHER: SV containers and connectors
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1 JOB STEPS	2 POTENTIAL HAZARDOUS CONDITIONS or UNSAFE PRACTICES	3 SAFE PROCEDURES and PREVENTATIVE MEASURES
1. Loading and Unloading Equipment	<ul style="list-style-type: none"> Back strains due to lifting equipment 	<ul style="list-style-type: none"> Position vehicle to minimize manual transport. Do not lift objects weighing greater than 40 pounds or awkward shapes without assistance.
	<ul style="list-style-type: none"> Hand and/or Foot Injury 	<ul style="list-style-type: none"> Keep aware of proper body positioning and lifting techniques: Bend at knees, lift with legs, keep back straight, tighten core muscles, keep load close to body. Walk path to be taken before taking a load and remove pathway obstructions or modify route.



JSA

JOB SAFETY ANALYSIS

For RM Department Use
 JSA NO: EM-001(d)
 Primary Job Category: Environmental Management

DESCRIPTION OF JOB: Soil Vapor Sampling		REVISION DATE: 1/18/18	JSA CREATED ON: January 18, 2018
PREPARED BY: David Neidigh	REVIEWED BY: Maria Rysavy	APPROVED BY: Dan Mickelsen	PAGE: 2 of 3

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

1. Loading and Unloading Equipment (continued)	<ul style="list-style-type: none"> Hand and/or Foot Injury 	<ul style="list-style-type: none"> Place equipment inside vehicle and secure for transport. Wear Type II or higher cut resistant gloves and steel-toe boots to prevent injuries
2. Setting up Exclusion Zone and Being Visible While Sampling	<ul style="list-style-type: none"> Struck by vehicle 	<ul style="list-style-type: none"> Use delineators and caution tape to set up sampling zone/ work area in high traffic areas Position body and equipment so that sampler has eyes on traffic at all times
3. Handling Equipment / Opening / Removing Well Lids	<ul style="list-style-type: none"> Over Exertion- Lifting Heavy Equipment 	<ul style="list-style-type: none"> Do not lift anything over 40 lbs. without assistance. Bend knees and lift using legs/arms, not your back, keep the load close to your body, tighten stomach.
	<ul style="list-style-type: none"> Crush/pinch/chop hazard from heavy well lids - loss of finger tip or broken finger 	<ul style="list-style-type: none"> When removing/opening well lids, use wrench handle or screwdriver to place block between lid and ring. In case lid slips, it will not close in place and cut off your fingers. Use hand tools (i.e., pry bar) to initially lift and hold heavy covers Keep fingers and toes 6-inches from edge of well vault. Do not have fingers cross into well vault while opening lid.
	<ul style="list-style-type: none"> Biological hazards - bit or stung causing injury 	<ul style="list-style-type: none"> Watch for spiders and other insects before putting hands into well vaults. Use tool (screwdriver) and visual inspection to explore well vault before reaching in with gloved hand.
	<ul style="list-style-type: none"> Slips/Trips/Falls - resulting in broken bones, injured ligaments and tendons 	<ul style="list-style-type: none"> If lid is removable, store as close as possible, but clear of potential walkways, to avoid tripping hazards. Consider placing lid underneath tailgate of truck if feasible.
4. Collecting Soil Vapor Samples	<ul style="list-style-type: none"> Skin irritation or lacerations may occur while handling or opening a sample container, using a sampling tool 	<ul style="list-style-type: none"> Wear nitrile or similar gloves over cut resistant gloves when handling sampling containers and tools.
	<ul style="list-style-type: none"> Ventilation - exposure to vapors 	<ul style="list-style-type: none"> Position body upwind while purging well to avoid vapor exposure. Open shroud away from you to avoid vapor exposure.
	<ul style="list-style-type: none"> Kneeling on hard surfaces - joint pain or cuts/bruises from ground surface 	<ul style="list-style-type: none"> Wear knee pads or use a gardening pad to protect the knees when kneeling down on hard surfaces (i.e., asphalt or concrete) during sampling activities.



JSA

JOB SAFETY ANALYSIS

For RM Department Use
JSA NO: EM-001(d)
Primary Job Category: Environmental Management

DESCRIPTION OF JOB: Soil Vapor Sampling		REVISION DATE: 1/18/18	JSA CREATED ON: January 18, 2018
PREPARED BY: David Neidigh	REVIEWED BY: Maria Rysavy	APPROVED BY: Dan Mickelsen	PAGE: 3 of 3

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT

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APPENDIX B
Chemical Hazard Information
Safety Data Sheets (SDS)

Issuing Date no data available

Revision Date 29-Oct-2015

Revision Number 1

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Product identifier

Product Number 019
 Product Name Hexavalent Chromium - 1000 mg/L, 125 mL
 Synonyms None

Recommended use of the chemical and restrictions on use

Recommended Use Laboratory use only
 Uses advised against No information available

Details of the supplier of the safety data sheet

Supplier ERA a Waters Company
 Supplier Address 16341 Table Mountain Parkway, Golden, CO 80403 USA
 Non-Emergency Telephone Number +1-303-431-8454
 Supplier Email sdsinfo@waters.com
 Emergency telephone number
 Company Emergency Phone Number In case of EMERGENCY call CHEMTREC Day or Night
 Within USA and Canada: 800-424-9300
 International Call Collect: +1-703-527-3887

2. HAZARDS IDENTIFICATION

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

Respiratory sensitization	Category 1
Skin sensitization	Category 1
Germ cell mutagenicity	Category 1B
Carcinogenicity	Category 1A
Reproductive Toxicity	Category 1B

GHS Label elements, including precautionary statements

Emergency Overview

Signal word	Danger	
Hazard Statements	May cause allergy or asthma symptoms or breathing difficulties if inhaled May cause an allergic skin reaction May cause genetic defects May cause cancer May damage fertility or the unborn child	
		
Appearance	Yellow	Physical state Liquid->Liquid
		Odor Odorless

Precautionary Statements - Prevention

Obtain special instructions before use
 Do not handle until all safety precautions have been read and understood
 Use personal protective equipment as required
 Avoid breathing dust/fume/gas/mist/vapors/spray
 In case of inadequate ventilation wear respiratory protection
 Contaminated work clothing should not be allowed out of the workplace
 Wear protective gloves

Precautionary Statements - Response

IF exposed or concerned: Get medical advice/attention
 Specific treatment (see supplemental first aid instructions on this label)

Skin

IF ON SKIN: Wash with plenty of soap and water
 If skin irritation or rash occurs: Get medical advice/attention
 Wash contaminated clothing before reuse

Inhalation

IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing
 If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician

Precautionary Statements - Storage

Store locked up

Precautionary Statements - Disposal

Dispose of contents/container to an approved waste disposal plant

Hazards not otherwise classified (HNOC)

Not applicable

Unknown Toxicity

0 % of the mixture consists of ingredient(s) of unknown toxicity

Other information

Harmful to aquatic life with long lasting effects
 Repeated or prolonged skin contact may cause allergic reactions with susceptible persons

Interactions with Other Chemicals

No information available.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Note: only the components contributing to the product's GHS hazard classification are listed in this section.

Synonyms None.

Chemical Name	CAS-No	Percent
Potassium Dichromate	7778-50-9	0.25

4. FIRST AID MEASURES**First aid measures****General Advice**

Show this safety data sheet to the doctor in attendance.

Eye contact

Rinse thoroughly with plenty of water, also under the eyelids. If symptoms persist, call a physician.

Skin contact

Wash with soap and water. May cause an allergic skin reaction. In the case of skin irritation or allergic reactions see a physician.

Inhalation

MAY CAUSE ALLERGIC RESPIRATORY REACTION. If breathing has stopped, give artificial respiration. Get medical attention immediately. Remove to fresh air. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation. Seek immediate medical attention/advice.

Ingestion

May produce an allergic reaction. If an allergic reaction occurs, stop use and seek medical help right away. Do NOT induce vomiting. Rinse mouth immediately and drink plenty of

Self-protection of the first aider water. Never give anything by mouth to an unconscious person. Call a physician or poison control center immediately.
Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination. Avoid contact with skin, eyes or clothing. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation. Use personal protective equipment as required. Wear personal protective clothing (see section 8).

Most important symptoms and effects, both acute and delayed

Most Important Symptoms and Effects Itching. Rashes. Hives. May cause allergy or asthma symptoms or breathing difficulties if inhaled. Coughing and/ or wheezing.

Indication of any immediate medical attention and special treatment needed

Notes to Physician May cause sensitization in susceptible persons. Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media

Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable Extinguishing Media

CAUTION: Use of water spray when fighting fire may be inefficient.

Specific hazards arising from the chemical

Product is or contains a sensitizer. May cause sensitization by skin contact. May cause sensitization by inhalation and skin contact.

Uniform Fire Code Sensitizer: Liquid

Hazardous Combustion Products

Carbon oxides.

Explosion Data

Sensitivity to Mechanical Impact No.

Sensitivity to Static Discharge No.

Protective equipment and precautions for firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions

Avoid contact with skin, eyes or clothing. Use personal protective equipment as required. Ensure adequate ventilation. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

Other Information

Refer to protective measures listed in Sections 7 and 8.

Environmental precautions

Environmental precautions

Refer to protective measures listed in Sections 7 and 8. Prevent further leakage or spillage if safe to do so.

Methods and material for containment and cleaning up

Methods for containment

Prevent further leakage or spillage if safe to do so.

Methods for cleaning up

Pick up and transfer to properly labeled containers. Soak up with inert absorbent material.

7. HANDLING AND STORAGE

Precautions for safe handling

Handling Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes or clothing. Do not eat, drink or smoke when using this product. Take off contaminated clothing and wash before reuse. Ensure adequate ventilation. In case of insufficient ventilation, wear suitable respiratory equipment.

Conditions for safe storage, including any incompatibilities

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Store locked up. Keep out of the reach of children.

Incompatible Products None known based on information supplied.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Guidelines

Chemical Name	ACGIH TLV	OSHA PEL	NIOSH IDLH
Potassium Dichromate 7778-50-9	TWA: 0.05 mg/m ³ Cr	TWA: 5 µg/m ³ Action Level: 2.5 µg/m ³ Cr (vacated) Ceiling: 0.1 mg/m ³ Ceiling: 0.1 mg/m ³ CrO ₃ applies to any operations or sectors for which the Hexavalent Chromium standard [29 CFR 1910.1026] is stayed or is otherwise not in effect	IDLH: 15 mg/m ³ Cr(VI) TWA: 0.0002 mg/m ³ Cr

ACGIH TLV: American Conference of Governmental Industrial Hygienists - Threshold Limit Value OSHA PEL: Occupational Safety and Health Administration - Permissible Exposure Limits NIOSH IDLH Immediately Dangerous to Life or Health

Appropriate engineering controls

Engineering Measures Showers
Eyewash stations
Ventilation systems

Individual protection measures, such as personal protective equipment

Eyeface protection Wear safety glasses with side shields (or goggles).

Skin and body protection Wear protective gloves and protective clothing.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes or clothing. Wear suitable gloves and eye/face protection. Do not eat, drink or smoke when using this product. Take off contaminated clothing and wash before reuse. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical and Chemical Properties

Physical state	Liquid->Liquid	Odor	Odorless
Appearance	Yellow	Odor Threshold	No information available
Color	No information available		
Property	Values	Remarks	Method
pH	5	None known	
Melting / freezing point	no data available	None known	
Boiling point / boiling range	no data available	None known	
Flash Point	no data available	None known	
Evaporation Rate	no data available	None known	
Flammability (solid, gas)	no data available	None known	

Flammability Limit in Air		
Upper flammability limit	no data available	
Lower flammability limit	no data available	
Vapor pressure	no data available	None known
Vapor density	no data available	None known
Specific Gravity	1	None known
Water Solubility	Soluble in water	None known
Solubility in other solvents	no data available	None known
Partition coefficient: n-octanol/water	no data available	None known
Autoignition temperature	no data available	None known
Decomposition temperature	no data available	None known
Kinematic viscosity	no data available	None known
Dynamic viscosity	no data available	None known
Explosive properties	no data available	
Oxidizing properties	no data available	

Other Information

Softening Point	no data available
Particle Size	no data available
Particle Size Distribution	

10. STABILITY AND REACTIVITY**Reactivity**

no data available.

Chemical stability

Stable under recommended storage conditions.

Possibility of Hazardous Reactions

None under normal processing.

Hazardous Polymerization

Hazardous polymerization does not occur.

Conditions to avoid

None known based on information supplied.

Incompatible materials

None known based on information supplied.

Hazardous Decomposition Products

Carbon oxides.

11. TOXICOLOGICAL INFORMATION**Information on likely routes of exposure****Product Information****Inhalation**

May cause allergy or asthma symptoms or breathing difficulties if inhaled. Specific test data for the substance or mixture is not available. May cause sensitization in susceptible persons. (based on components).

Eye contact

Specific test data for the substance or mixture is not available.

Skin contact

Specific test data for the substance or mixture is not available. Repeated or prolonged skin contact may cause allergic reactions with susceptible persons. (based on components).

Ingestion

Specific test data for the substance or mixture is not available. May cause additional affects as listed under "Inhalation".

Component Information

Chemical Name	Oral LD50	Dermal LD50	Inhalation LC50
Potassium Dichromate 7778-50-9	= 25 mg/kg (Rat) = 48 mg/kg (Rat)	= 1150 mg/kg (Rabbit) = 14 mg/kg (Rabbit)	-

Information on toxicological effects

Symptoms Itching. Rashes. Hives. Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain, or flushing. Coughing and/ or wheezing.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Sensitization May cause sensitization in susceptible persons. May cause sensitization by skin contact. May cause sensitization by inhalation.

Mutagenic Effects

There is no data for this product. Contains a known or suspected mutagen.

Carcinogenicity

The table below indicates whether each agency has listed any ingredient as a carcinogen.

Chemical Name	ACGIH	IARC	NTP	OSHA
Potassium Dichromate 7778-50-9	A1	Group 1	Known	X

ACGIH (American Conference of Governmental Industrial Hygienists)

A1 - Known Human Carcinogen

IARC (International Agency for Research on Cancer)

Group 1 - Carcinogenic to Humans

NTP (National Toxicology Program)

Known - Known Carcinogen

OSHA (Occupational Safety and Health Administration of the US Department of Labor)

X - Present

Reproductive toxicity

Contains a known or suspected reproductive toxin.

STOT - single exposure

No information available.

STOT - repeated exposure

No information available.

Chronic toxicity

No known effect based on information supplied. Prolonged exposure may cause chronic effects. Repeated contact may cause allergic reactions in very susceptible persons. Contains a known or suspected mutagen. Possible risk of irreversible effects. Contains a known or suspected carcinogen. Contains a known or suspected reproductive toxin.

Target Organ Effects

Skin. Respiratory system. Eyes. May affect the genetic material in germ cells (sperm and eggs). Gastrointestinal tract (GI). Reproductive system.

Aspiration Hazard

No information available.

Numerical measures of toxicity Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral)

40,000.00 mg/kg

ATEmix (inhalation-dust/mist)

20.04 mg/L

12. ECOLOGICAL INFORMATION

Ecotoxicity

Harmful to aquatic life with long lasting effects.

Chemical Name	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Daphnia Magna (Water Flea)
Potassium Dichromate 7778-50-9		96h LC50: > 139 mg/L (Cyprinus carpio) 96h LC50: 113.6 - 155.7 mg/L (Lepomis macrochirus) 96h LC50: = 320 mg/L (Lepomis macrochirus) 96h LC50: 65.6 - 137.6 mg/L (Lepomis macrochirus) 96h LC50: = 12.3 mg/L (Oncorhynchus mykiss) 96h LC50: 21.209 - 30.046 mg/L (Oryzias latipes) 96h LC50: 15.41 - 30.36 mg/L (Pimephales promelas) 96h LC50: 14 - 20.9 mg/L (Pimephales promelas) 96h LC50: 24.81 - 34.55 mg/L (Poecilia reticulata) 96h LC50: 23 - 41.2 mg/L (Poecilia reticulata) 96h LC50: = 26 mg/L (Morone saxatilis)		

Persistence and Degradability

No information available.

Bioaccumulation

No information available

Other adverse effects

No information available.

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Disposal methods

This material, as supplied, is not a hazardous waste according to Federal regulations (40 CFR 261). This material could become a hazardous waste if it is mixed with or otherwise comes in contact with a hazardous waste, if chemical additions are made to this material, or if the material is processed or otherwise altered. Consult 40 CFR 261 to determine whether the altered material is a hazardous waste. Consult the appropriate state, regional, or local regulations for additional requirements.

Contaminated Packaging

Dispose of contents/containers in accordance with local regulations.

This product contains one or more substances that are listed with the State of California as a hazardous waste.

Chemical Name	California Hazardous Waste
Potassium Dichromate 7778-50-9	Toxic Corrosive Ignitable

14. TRANSPORT INFORMATION

DOT

Proper Shipping Name
Hazard Class

Not regulated
NON REGULATED
N/A

TDG

Not regulated

MEX	Not regulated
ICAO	Not regulated
IATA	Not regulated
Proper Shipping Name	NON REGULATED
Special Provisions	None
IMDG	Not regulated
Special Provisions	None
Marine Pollutant	Not applicable
RID	Not regulated
Special Provisions	None
ADR	Not regulated
Special Provisions	None
ADN	Not regulated

15. REGULATORY INFORMATION

International Inventories

TSCA	Complies
DSL	All components are listed either on the DSL or NDSL.
ENCS	Contact supplier for inventory compliance status
KECL	Contact supplier for inventory compliance status
PICCS	Contact supplier for inventory compliance status
AICS	Contact supplier for inventory compliance status

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
 DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
 EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
 ENCS - Japan Existing and New Chemical Substances
 IECSC - China Inventory of Existing Chemical Substances
 KECL - Korean Existing and Evaluated Chemical Substances
 PICCS - Philippines Inventory of Chemicals and Chemical Substances
 AICS - Australian Inventory of Chemical Substances

US Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product contains a chemical or chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372

Chemical Name	CAS-No	Percent	SARA 313 - Threshold Values %
Potassium Dichromate - 7778-50-9	7778-50-9	0.25	0.1

SARA 311/312 Hazard Categories

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	No
Sudden release of pressure hazard	No
Reactive Hazard	No

CWA (Clean Water Act)

This product contains the following substances which are regulated pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

Chemical Name	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants	CWA - Hazardous Substances
Potassium Dichromate 7778-50-9	10 lb	X		X

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive

Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Chemical Name	Hazardous Substances RQs	Extremely Hazardous Substances RQs	RQ
Potassium Dichromate 7778-50-9	10 lb		RQ 10 lb final RQ RQ 4.54 kg final RQ

US State Regulations**California Proposition 65**

This product contains the following Proposition 65 chemicals.

U.S. State Right-to-Know Regulations**International Regulations**

Component	Carcinogen Status	Exposure Limits
Potassium Dichromate 7778-50-9 (0.25)	A1	Mexico: TWA 0.05 mg/m ³ Mexico: TWA 0.5 mg/m ³

A1 - Confirmed Human Carcinogen

Canada**WHMIS Hazard Class**

Not determined

16. OTHER INFORMATION

NFPA	Health Hazards 2	Flammability 0	Instability 0	Physical and Chemical Hazards -
HMIS	Health Hazards 2 *	Flammability 0	Physical Hazard 0	Personal Protection X

Chronic Hazard Star Legend * = Chronic Health Hazard

Prepared By Product Stewardship
23 British American Blvd.
Latham, NY 12110
1-800-572-6501

Revision Date 29-Oct-2015

Revision Note No information available

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text



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End of Safety Data Sheet

SAFETY DATA SHEET

Creation Date 04-Oct-2010

Revision Date 19-Jan-2018

Revision Number 4

1. Identification

Product Name Nickel, powder

Cat No. : AC193610000; AC193610250; AC193611000; AC193615000

CAS-No 7440-02-0
Synonyms No information available

Recommended Use Laboratory chemicals.
Uses advised against Not for food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company

Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number

For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US**:001-201-796-7100 / **Europe**: +32 14 57 52 99
CHEMTREC Tel. No.**US**:001-800-424-9300 / **Europe**:001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable solids	Category 2
Skin Sensitization	Category 1
Carcinogenicity	Category 1B
Specific target organ toxicity - (repeated exposure)	Category 1
Target Organs - Kidney, Blood.	

Label Elements

Signal Word

Danger

Hazard Statements

Flammable solid
May cause an allergic skin reaction
May cause cancer
Causes damage to organs through prolonged or repeated exposure

**Precautionary Statements****Prevention**

Obtain special instructions before use
 Do not handle until all safety precautions have been read and understood
 Use personal protective equipment as required
 Contaminated work clothing should not be allowed out of the workplace
 Wear protective gloves
 Do not breathe dust/fume/gas/mist/vapors/spray
 Wash face, hands and any exposed skin thoroughly after handling
 Do not eat, drink or smoke when using this product
 Keep away from heat/sparks/open flames/hot surfaces. - No smoking
 Ground/bond container and receiving equipment
 Use explosion-proof electrical/ventilating/lighting/equipment

Response

IF exposed or concerned: Get medical attention/advice

Skin

IF ON SKIN: Wash with plenty of soap and water
 If skin irritation or rash occurs: Get medical advice/attention
 Wash contaminated clothing before reuse

Fire

In case of fire: Use CO₂, dry chemical, or foam for extinction

Storage

Store locked up

Disposal

Dispose of contents/container to an approved waste disposal plant

Hazards not otherwise classified (HNOC)

Harmful to aquatic life with long lasting effects
WARNING. Cancer - <https://www.p65warnings.ca.gov/>.

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Nickel	7440-02-0	>95

4. First-aid measures

General Advice

Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Eye Contact

Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

Skin Contact

Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.

Inhalation

Move to fresh air. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.

Ingestion	Do not induce vomiting. Call a physician or Poison Control Center immediately.
Most important symptoms and effects	None reasonably foreseeable. . May cause allergic skin reaction. Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	400 °C / 752 °F
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Flammable.

Hazardous Combustion Products
Nickel oxides.

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health
2

Flammability
3

Instability
0

Physical hazards
N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment. Avoid dust formation. Keep people away from and upwind of spill/leak. Evacuate personnel to safe areas.
Environmental Precautions	Should not be released into the environment. Do not flush into surface water or sanitary sewer system. Do not allow material to contaminate ground water system.
Methods for Containment and Clean Up	Sweep up or vacuum up spillage and collect in suitable container for disposal. Avoid dust formation.

7. Handling and storage

Handling	Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Avoid dust formation. Use only under a chemical fume hood. Do not breathe vapors/dust. Do not ingest.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Nickel	TWA: 1.5 mg/m ³	(Vacated) TWA: 1 mg/m ³ TWA: 1 mg/m ³	IDLH: 10 mg/m ³ TWA: 0.015 mg/m ³	TWA: 1 mg/m ³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
 OSHA - Occupational Safety and Health Administration
 NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

- Eye/face Protection** Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
- Skin and body protection** Long sleeved clothing.
- Respiratory Protection** Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
- Hygiene Measures** Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Solid
Appearance	Brown
Odor	Odorless
Odor Threshold	No information available
pH	No information available
Melting Point/Range	1455 °C / 2651 °F
Boiling Point/Range	2730 °C / 4946 °F @ 760 mmHg
Flash Point	No information available
Evaporation Rate	Not applicable
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	1 mmHg @ 1810 °C
Vapor Density	Not applicable
Specific Gravity	No information available
Solubility	Insoluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	400 °C / 752 °F
Decomposition Temperature	No information available
Viscosity	Not applicable
Molecular Formula	Ni
Molecular Weight	58.7

10. Stability and reactivity

- Reactive Hazard** None known, based on information available
- Stability** Stable under normal conditions.
- Conditions to Avoid** Incompatible products. Excess heat. Avoid dust formation. acids.
- Incompatible Materials** Strong oxidizing agents

Hazardous Decomposition Products Nickel oxides

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

**Product Information
Component Information**

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Nickel	LD50 > 9000 mg/kg (Rat)	Not listed	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation No information available

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Nickel	7440-02-0	Group 2B	Reasonably Anticipated	Not listed	X	Not listed

IARC: (International Agency for Research on Cancer)

*Group 2B - Possibly Carcinogenic to Humans
IARC: (International Agency for Research on Cancer)*

*Group 1 - Carcinogenic to Humans
Group 2A - Probably Carcinogenic to Humans*

NTP: (National Toxicity Program)

Known - Known Carcinogen

Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen

NTP: (National Toxicity Program)

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure None known
STOT - repeated exposure Kidney Blood

Aspiration hazard No information available

Symptoms / effects, both acute and delayed Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not flush into surface water or sanitary sewer system. Do not allow material to contaminate ground water system. Do not empty into drains. The product contains following substances which are hazardous for the environment. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Contains a substance which is: Toxic to aquatic organisms. Very toxic to aquatic organisms. May cause long-term adverse effects in the environment. Do not allow material to contaminate ground water

system.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Nickel	EC50: 0.174 - 0.311 mg/L, 96h static (Pseudokirchneriella subcapitata) EC50: = 0.18 mg/L, 72h (Pseudokirchneriella subcapitata)	LC50: = 10.4 mg/L, 96h static (Cyprinus carpio) LC50: = 1.3 mg/L, 96h semi-static (Cyprinus carpio) LC50: > 100 mg/L, 96h (Brachydanio rerio)	Not listed	EC50: = 1 mg/L, 48h Static (Daphnia magna) EC50: > 100 mg/L, 48h (Daphnia magna)

Persistence and Degradability Insoluble in water May persist

Bioaccumulation/ Accumulation No information available.

Mobility Is not likely mobile in the environment due its low water solubility.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No UN3089
 Proper Shipping Name Metal powder, flammable, n.o.s
 Hazard Class 4.1
 Packing Group II

TDG

UN-No UN3089
 Proper Shipping Name METAL POWDER, FLAMMABLE, N.O.S.
 Hazard Class 4.1
 Packing Group II

IATA

UN-No UN3089
 Proper Shipping Name METAL POWDER, FLAMMABLE, N.O.S.
 Hazard Class 4.1
 Packing Group II

IMDG/IMO

UN-No UN3089
 Proper Shipping Name METAL POWDER, FLAMMABLE, N.O.S.
 Hazard Class 4.1
 Packing Group II

15. Regulatory information

All of the components in the product are on the following inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Nickel	X	X	-	231-111-4	-		X	-	X	X	X

Legend:

X - Listed

E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.

F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.

N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.

P - Indicates a commenced PMN substance

R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.

S - Indicates a substance that is identified in a proposed or final Significant New Use Rule

T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
 XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B)).
 Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
 Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Nickel	7440-02-0	>95	0.1

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Nickel	-	-	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Nickel	X		-

OSHA Occupational Safety and Health Administration
Not applicable**CERCLA**

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Nickel	100 lb	-

California Proposition 65 This product contains the following proposition 65 chemicals

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Nickel	7440-02-0	Carcinogen	-	Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Nickel	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ): N
 DOT Marine Pollutant N
 DOT Severe Marine Pollutant N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other Information

Prepared By Regulatory Affairs

Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date	04-Oct-2010
Revision Date	19-Jan-2018
Print Date	19-Jan-2018
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

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End of SDS

SAFETY DATA SHEET

Creation Date 10-Dec-2009

Revision Date 23-Jan-2018

Revision Number 5

1. Identification

Product Name Tetrachloroethylene

Cat No. : AC445690000; ACR445690010; AC445690025; AC445691000

CAS-No 127-18-4

Synonyms Perchloroethylene

Recommended Use Laboratory chemicals.

Uses advised against Not for food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company

Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number

For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US**:001-201-796-7100 / **Europe**: +32 14 57 52 99
CHEMTREC Tel. No.**US**:001-800-424-9300 / **Europe**:001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Skin Corrosion/irritation	Category 2
Serious Eye Damage/Eye Irritation	Category 2
Skin Sensitization	Category 1
Carcinogenicity	Category 1B
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Central nervous system (CNS).	
Specific target organ toxicity - (repeated exposure)	Category 2
Target Organs - Kidney, Liver, Blood.	

Label Elements

Signal Word

Danger

Hazard Statements

Causes skin irritation
Causes serious eye irritation
May cause an allergic skin reaction
May cause drowsiness or dizziness
May cause cancer
May cause damage to organs through prolonged or repeated exposure

**Precautionary Statements****Prevention**

Obtain special instructions before use
 Do not handle until all safety precautions have been read and understood
 Use personal protective equipment as required
 Wash face, hands and any exposed skin thoroughly after handling
 Contaminated work clothing should not be allowed out of the workplace
 Do not breathe dust/fume/gas/mist/vapors/spray
 Use only outdoors or in a well-ventilated area
 Wear protective gloves/protective clothing/eye protection/face protection

Response

IF exposed or concerned: Get medical attention/advice

Inhalation

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing

Skin

IF ON SKIN: Wash with plenty of soap and water
 Take off contaminated clothing and wash before reuse
 If skin irritation or rash occurs: Get medical advice/attention

Eyes

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
 If eye irritation persists: Get medical advice/attention

Storage

Store locked up
 Store in a well-ventilated place. Keep container tightly closed

Disposal

Dispose of contents/container to an approved waste disposal plant

Hazards not otherwise classified (HNOC)

Toxic to aquatic life with long lasting effects
WARNING. Cancer - <https://www.p65warnings.ca.gov/>.

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Tetrachloroethylene	127-18-4	>95

4. First-aid measures

General Advice	If symptoms persist, call a physician.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. If skin irritation persists, call a physician.
Inhalation	Move to fresh air. If not breathing, give artificial respiration. Get medical attention if symptoms occur.
Ingestion	Clean mouth with water and drink afterwards plenty of water.

Most important symptoms and effects

None reasonably foreseeable. May cause allergic skin reaction. Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing

Notes to Physician

Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors. Containers may explode when heated.

Hazardous Combustion Products
Chlorine Hydrogen chloride gas Phosgene

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

<u>NFPA</u>	Health	Flammability	Instability	Physical hazards
	2	0	0	N/A

6. Accidental release measures

Personal Precautions	Use personal protective equipment. Ensure adequate ventilation.
Environmental Precautions	Do not flush into surface water or sanitary sewer system.
Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling	Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Ensure adequate ventilation. Avoid ingestion and inhalation.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from sunlight.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Tetrachloroethylene	TWA: 25 ppm STEL: 100 ppm	(Vacated) TWA: 25 ppm (Vacated) TWA: 170 mg/m ³ Ceiling: 200 ppm TWA: 100 ppm	IDLH: 150 ppm	TWA: 100 ppm TWA: 670 mg/m ³ TWA: 200 ppm TWA: 1250 mg/m ³ STEL: 200 ppm STEL: 1340 mg/m ³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists

OSHA - Occupational Safety and Health Administration

NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures

Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment**Eye/face Protection**

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection

Long sleeved clothing.

Respiratory Protection

Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	Characteristic, sweet
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-22 °C / -7.6 °F
Boiling Point/Range	120 - 122 °C / 248 - 251.6 °F @ 760 mmHg
Flash Point	No information available
Evaporation Rate	6.0 (Ether = 1.0)
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	18 mbar @ 20 °C
Vapor Density	No information available
Density	1.619
Specific Gravity	1.625
Solubility	0.15 g/L water (20°C)
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	> 150°C
Viscosity	0.89 mPa s at 20 °C
Molecular Formula	C ₂ Cl ₄
Molecular Weight	165.83

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under normal conditions.
Conditions to Avoid	Incompatible products. Excess heat. Exposure to moist air or water.
Incompatible Materials	Strong acids, Strong oxidizing agents, Strong bases, Metals, Zinc, Amines, Aluminium
Hazardous Decomposition Products	Chlorine, Hydrogen chloride gas, Phosgene
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Tetrachloroethylene	LD50 = 2629 mg/kg (Rat)	LD50 > 10000 mg/kg (Rat)	LC50 = 27.8 mg/L (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Irritating to eyes and skin

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Tetrachloroethylene	127-18-4	Group 2A	Reasonably Anticipated	A3	X	A3

IARC: (International Agency for Research on Cancer)

NTP: (National Toxicity Program)

ACGIH: (American Conference of Governmental Industrial Hygienists)

Mexico - Occupational Exposure Limits - Carcinogens

IARC: (International Agency for Research on Cancer)

Group 1 - Carcinogenic to Humans

Group 2A - Probably Carcinogenic to Humans

Group 2B - Possibly Carcinogenic to Humans

NTP: (National Toxicity Program)

Known - Known Carcinogen

Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen

A1 - Known Human Carcinogen

A2 - Suspected Human Carcinogen

A3 - Animal Carcinogen

ACGIH: (American Conference of Governmental Industrial Hygienists)

Mexico - Occupational Exposure Limits - Carcinogens

A1 - Confirmed Human Carcinogen

A2 - Suspected Human Carcinogen

A3 - Confirmed Animal Carcinogen

A4 - Not Classifiable as a Human Carcinogen

A5 - Not Suspected as a Human Carcinogen

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure Central nervous system (CNS)

STOT - repeated exposure Kidney Liver Blood

Aspiration hazard No information available

Symptoms / effects, both acute and delayed Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting; Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing

Endocrine Disruptor Information

Component	EU - Endocrine Disruptors Candidate List	EU - Endocrine Disruptors - Evaluated Substances	Japan - Endocrine Disruptor Information
Tetrachloroethylene	Group II Chemical	Not applicable	Not applicable

Other Adverse Effects Tumorigenic effects have been reported in experimental animals.

12. Ecological information

Ecotoxicity

Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. The product contains following substances which are hazardous for the environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Tetrachloroethylene	EC50: > 500 mg/L, 96h (Pseudokirchneriella subcapitata)	LC50: 4.73 - 5.27 mg/L, 96h flow-through (Oncorhynchus mykiss) LC50: 11.0 - 15.0 mg/L, 96h static (Lepomis macrochirus) LC50: 8.6 - 13.5 mg/L, 96h static (Pimephales promelas) LC50: 12.4 - 14.4 mg/L, 96h flow-through (Pimephales promelas)	EC50 = 100 mg/L 24 h EC50 = 112 mg/L 24 h EC50 = 120.0 mg/L 30 min	EC50: 6.1 - 9.0 mg/L, 48h Static (Daphnia magna)

Persistence and Degradability Insoluble in water Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility . Is not likely mobile in the environment due its low water solubility. Will likely be mobile in the environment due to its volatility.

Component	log Pow
Tetrachloroethylene	2.53 - 2.88

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Tetrachloroethylene - 127-18-4	U210	-

14. Transport information

DOT	
UN-No	UN1897
Proper Shipping Name	TETRACHLOROETHYLENE
Hazard Class	6.1
Packing Group	III
TDG	
UN-No	UN1897

Tetrachloroethylene

Revision Date 23-Jan-2018

Proper Shipping Name TETRACHLOROETHYLENE
 Hazard Class 6.1
 Packing Group III

IATA

UN-No UN1897
 Proper Shipping Name TETRACHLOROETHYLENE
 Hazard Class 6.1
 Packing Group III

IMDG/IMO

UN-No UN1897
 Proper Shipping Name TETRACHLOROETHYLENE
 Hazard Class 6.1
 Subsidiary Hazard Class P
 Packing Group III

15. Regulatory information

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Tetrachloroethylene	X	X	-	204-825-9	-		X	X	X	X	X

Legend:

X - Listed

E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.

F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.

N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.

P - Indicates a commenced PMN substance

R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.

S - Indicates a substance that is identified in a proposed or final Significant New Use Rule

T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.

XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B)).

Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.

Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Tetrachloroethylene	127-18-4	>95	0.1

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Tetrachloroethylene	-	-	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Tetrachloroethylene	X		-

OSHA Occupational Safety and Health Administration
 Not applicable

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Tetrachloroethylene	100 lb 1 lb	-

California Proposition 65 This product contains the following proposition 65 chemicals

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Tetrachloroethylene	127-18-4	Carcinogen	14 µg/day	Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Tetrachloroethylene	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ): Y
 DOT Marine Pollutant Y
 DOT Severe Marine Pollutant N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By Regulatory Affairs
 Thermo Fisher Scientific
 Email: EMSDS.RA@thermofisher.com

Creation Date 10-Dec-2009
Revision Date 23-Jan-2018
Print Date 23-Jan-2018
Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS



SAFETY DATA SHEET

Creation Date 03-Feb-2010

Revision Date 14-Jul-2016

Revision Number 2

1. Identification

Product Name Trichloroethylene
Cat No. : T340-4; T341-4; T341-20; T341-500; T403-4
Synonyms Trichloroethene (Stabilized/Technical/Electronic/Certified ACS)
Recommended Use Laboratory chemicals.
Uses advised against

Details of the supplier of the safety data sheet

Company

Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number

CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Skin Corrosion/irritation	Category 2
Serious Eye Damage/Eye Irritation	Category 2
Skin Sensitization	Category 1
Germ Cell Mutagenicity	Category 2
Carcinogenicity	Category 1A
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Central nervous system (CNS).	
Specific target organ toxicity - (repeated exposure)	Category 2
Target Organs - Kidney, Liver, Heart, spleen, Blood.	

Label Elements

Signal Word

Danger

Hazard Statements

Causes skin irritation
Causes serious eye irritation
May cause an allergic skin reaction
May cause drowsiness or dizziness
Suspected of causing genetic defects
May cause cancer
May cause damage to organs through prolonged or repeated exposure

**Precautionary Statements****Prevention**

Obtain special instructions before use
 Do not handle until all safety precautions have been read and understood
 Use personal protective equipment as required
 Wash face, hands and any exposed skin thoroughly after handling
 Contaminated work clothing should not be allowed out of the workplace
 Do not breathe dust/fume/gas/mist/vapors/spray
 Use only outdoors or in a well-ventilated area
 Wear protective gloves/protective clothing/eye protection/face protection

Response

IF exposed or concerned: Get medical attention/advice

Inhalation

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing

Skin

IF ON SKIN: Wash with plenty of soap and water
 Take off contaminated clothing and wash before reuse
 If skin irritation or rash occurs: Get medical advice/attention

Eyes

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
 If eye irritation persists: Get medical advice/attention

Storage

Store locked up
 Store in a well-ventilated place. Keep container tightly closed

Disposal

Dispose of contents/container to an approved waste disposal plant

Hazards not otherwise classified (HNOC)

Harmful to aquatic life with long lasting effects

WARNING! This product contains a chemical known in the State of California to cause cancer, birth defects or other reproductive harm.

3. Composition / information on ingredients

Component	CAS-No	Weight %
Trichloroethylene	79-01-6	100

4. First-aid measures

General Advice	Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.
Inhalation	Move to fresh air. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a

pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.

Ingestion

Do not induce vomiting. Call a physician or Poison Control Center immediately.

Most important symptoms/effects

None reasonably foreseeable. May cause allergic skin reaction. Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing

Notes to Physician

Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Unsuitable Extinguishing Media No information available

Flash Point No information available
Method - No information available

Autoignition Temperature 410 °C / 770 °F

Explosion Limits

Upper 10.5 vol %
Lower 8 vol %

Oxidizing Properties Not oxidising

Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors. Containers may explode when heated. Keep product and empty container away from heat and sources of ignition.

Hazardous Combustion Products

Hydrogen chloride gas Chlorine Phosgene Carbon monoxide (CO) Carbon dioxide (CO₂)

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
2	1	0	N/A

6. Accidental release measures

Personal Precautions Ensure adequate ventilation. Use personal protective equipment. Keep people away from and upwind of spill/leak. Evacuate personnel to safe areas.

Environmental Precautions Should not be released into the environment. Do not flush into surface water or sanitary sewer system.

Methods for Containment and Clean Up Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Use only under a chemical fume hood. Do not breathe vapors or spray mist. Do not ingest.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from light. Do not store in aluminum containers.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Trichloroethylene	TWA: 10 ppm STEL: 25 ppm	(Vacated) TWA: 50 ppm (Vacated) TWA: 270 mg/m ³ Ceiling: 200 ppm (Vacated) STEL: 200 ppm (Vacated) STEL: 1080 mg/m ³ TWA: 100 ppm	IDLH: 1000 ppm	TWA: 100 ppm TWA: 535 mg/m ³ STEL: 200 ppm STEL: 1080 mg/m ³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists

OSHA - Occupational Safety and Health Administration

NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Long sleeved clothing.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	Characteristic
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-85 °C / -121 °F
Boiling Point/Range	87 °C / 188.6 °F
Flash Point	No information available
Evaporation Rate	0.69 (Carbon Tetrachloride = 1.0)
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	10.5 vol %
Lower	8 vol %
Vapor Pressure	77.3 mbar @ 20 °C
Vapor Density	4.5 (Air = 1.0)
Specific Gravity	1.460
Solubility	Slightly soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	410 °C / 770 °F
Decomposition Temperature	> 120°C
Viscosity	0.55 mPa.s (25°C)

Molecular Formula C₂ H Cl₃
 Molecular Weight 131.39

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Light sensitive.

Conditions to Avoid Incompatible products. Excess heat. Exposure to light. Exposure to moist air or water.

Incompatible Materials Strong oxidizing agents, Strong bases, Amines, Alkali metals, Metals,

Hazardous Decomposition Products Hydrogen chloride gas, Chlorine, Phosgene, Carbon monoxide (CO), Carbon dioxide (CO₂)

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Trichloroethylene	LD50 = 4290 mg/kg (Rat) LD50 = 4920 mg/kg (Rat)	LD50 > 20 g/kg (Rabbit) LD50 = 29000 mg/kg (Rabbit)	LC50 = 26 mg/L (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Irritating to eyes and skin

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Trichloroethylene	79-01-6	Group 1	Reasonably Anticipated	A2	X	Not listed

IARC: (International Agency for Research on Cancer)

NTP: (National Toxicity Program)

ACGIH: (American Conference of Governmental Industrial Hygienists)

IARC: (International Agency for Research on Cancer)

Group 1 - Carcinogenic to Humans

Group 2A - Probably Carcinogenic to Humans

Group 2B - Possibly Carcinogenic to Humans

NTP: (National Toxicity Program)

Known - Known Carcinogen

Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen

A1 - Known Human Carcinogen

A2 - Suspected Human Carcinogen

A3 - Animal Carcinogen

ACGIH: (American Conference of Governmental Industrial Hygienists)

Mutagenic Effects Mutagenic effects have occurred in humans.

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure Central nervous system (CNS)
 STOT - repeated exposure Kidney Liver Heart spleen Blood

Aspiration hazard No information available

Symptoms / effects, both acute and delayed Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting; Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity
 Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Do not empty into drains. The product contains following substances which are hazardous for the environment. Contains a substance which is: Harmful to aquatic organisms. Toxic to aquatic organisms.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Trichloroethylene	EC50: = 175 mg/L, 96h (Pseudokirchneriella subcapitata) EC50: = 450 mg/L, 96h (Desmodesmus subspicatus)	LC50: 39 - 54 mg/L, 96h static (Lepomis macrochirus) LC50: 31.4 - 71.8 mg/L, 96h flow-through (Pimephales promelas)	EC50 = 0.81 mg/L 24 h EC50 = 115 mg/L 10 min EC50 = 190 mg/L 15 min EC50 = 235 mg/L 24 h EC50 = 410 mg/L 24 h EC50 = 975 mg/L 5 min	EC50: = 2.2 mg/L, 48h (Daphnia magna)

Persistence and Degradability Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its volatility.

Component	log Pow
Trichloroethylene	2.4

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Trichloroethylene - 79-01-6	U228	-

14. Transport information

DOT
 UN-No UN1710
 Proper Shipping Name TRICHLOROETHYLENE
 Hazard Class 6.1
 Packing Group III

TDG
 UN-No UN1710
 Proper Shipping Name TRICHLOROETHYLENE
 Hazard Class 6.1
 Packing Group III

IATA
 UN-No UN1710
 Proper Shipping Name TRICHLOROETHYLENE

Hazard Class	6.1
Packing Group	III
IMDG/IMO	
UN-No	UN1710
Proper Shipping Name	TRICHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

15. Regulatory information

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Trichloroethylene	X	X	-	201-167-4	-		X	X	X	X	X

Legend:

- X - Listed
- E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
- F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
- N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
- P - Indicates a commenced PMN substance
- R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
- S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
- T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
- XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B)).
- Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
- Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

Component	TSCA 12(b)
Trichloroethylene	Section 5

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Trichloroethylene	79-01-6	100	0.1

SARA 311/312 Hazard Categories

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Trichloroethylene	X	100 lb	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Trichloroethylene	X		

OSHA Occupational Safety and Health Administration
Not applicable

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Trichloroethylene	100 lb 1 lb	-

California Proposition 65 This product contains the following proposition 65 chemicals

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Trichloroethylene	79-01-6	Carcinogen Developmental Male Reproductive	14 µg/day 50 µg/day	Developmental Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Trichloroethylene	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ): Y
 DOT Marine Pollutant N
 DOT Severe Marine Pollutant N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By Regulatory Affairs
 Thermo Fisher Scientific
 Email: EMSDS.RA@thermofisher.com

Creation Date 03-Feb-2010
Revision Date 14-Jul-2016
Print Date 14-Jul-2016
Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

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End of SDS

SAFETY DATA SHEET

Revision Date 17-Jan-2018

Revision Number 3

1. Identification

Product Name Cadmium

Cat No. : C3-500

CAS-No 7440-43-9
Synonyms No information available

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company

Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number

CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable solids	Category 2
Acute oral toxicity	Category 4
Acute dermal toxicity	Category 4
Acute Inhalation Toxicity - Dusts and Mists	Category 2
Germ Cell Mutagenicity	Category 2
Carcinogenicity	Category 1A
Reproductive Toxicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	
Specific target organ toxicity - (repeated exposure)	Category 1
Target Organs - Kidney, Blood.	
Combustible dust	Yes

Label Elements

Signal Word

Danger

Hazard Statements

Flammable solid
 May form combustible dust concentrations in air
 Fatal if inhaled
 Harmful if swallowed
 Harmful in contact with skin
 May cause respiratory irritation
 Suspected of causing genetic defects
 May cause cancer
 Suspected of damaging fertility. Suspected of damaging the unborn child
 Causes damage to organs through prolonged or repeated exposure



Precautionary Statements

Prevention

Obtain special instructions before use
 Do not handle until all safety precautions have been read and understood
 Use personal protective equipment as required
 Wash face, hands and any exposed skin thoroughly after handling
 Do not eat, drink or smoke when using this product
 Do not breathe dust/fume/gas/mist/vapors/spray
 Use only outdoors or in a well-ventilated area
 Ground/bond container and receiving equipment
 Use explosion-proof electrical/ventilating/lighting/equipment

Response

IF exposed or concerned: Get medical attention/advice

Inhalation

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
 Immediately call a POISON CENTER or doctor/physician

Skin

IF ON SKIN: Wash with plenty of soap and water
 Wash contaminated clothing before reuse
 Call a POISON CENTER or doctor/physician if you feel unwell

Ingestion

IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
 Rinse mouth

Fire

Fight fire with normal precautions from a reasonable distance
 Evacuate area

Storage

Store locked up
 Store in a well-ventilated place. Keep container tightly closed

Disposal

Dispose of contents/container to an approved waste disposal plant

Hazards not otherwise classified (HNOC)

Very toxic to aquatic life with long lasting effects
 WARNING. Cancer and Reproductive Harm - <https://www.p65warnings.ca.gov/>.

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
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Cadmium	7440-43-9	100
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4. First-aid measures

General Advice	Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.
Inhalation	Move to fresh air. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.
Ingestion	Do not induce vomiting. Call a physician or Poison Control Center immediately.
Most important symptoms and effects	None reasonably foreseeable. . Kidney disorders: May cause harm to the unborn child: Blood disorders
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors. Fine dust dispersed in air may ignite. Dust can form an explosive mixture in air. Pyrophoric properties of solids and liquids. Do not allow run-off from fire fighting to enter drains or water courses.

Hazardous Combustion Products

Highly toxic fumes

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
4	1	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment. Avoid dust formation. Keep people away from and upwind of spill/leak. Evacuate personnel to safe areas.
Environmental Precautions	Do not flush into surface water or sanitary sewer system. Do not allow material to contaminate ground water system. Prevent product from entering drains. Local authorities should be advised if significant spillages cannot be contained.

Methods for Containment and Clean Up Sweep up or vacuum up spillage and collect in suitable container for disposal. Avoid dust formation.

7. Handling and storage

Handling Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Avoid dust formation. Use only under a chemical fume hood. Do not breathe vapors/dust. Do not ingest.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Store under an inert atmosphere.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Cadmium	TWA: 0.01 mg/m ³ TWA: 0.002 mg/m ³	Ceiling: 0.3 mg/m ³ Ceiling: 0.6 mg/m ³ (Vacated) STEL: 0.3 ppm TWA: 0.1 mg/m ³ TWA: 0.2 mg/m ³ TWA: 5 µg/m ³	IDLH: 9 mg/m ³	TWA: 0.01 mg/m ³ TWA: 0.002 mg/m ³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
 OSHA - Occupational Safety and Health Administration
 NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Long sleeved clothing.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures When using, do not eat, drink or smoke. Provide regular cleaning of equipment, work area and clothing. Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product. Keep away from food, drink and animal feeding stuffs.

9. Physical and chemical properties

Physical State	Solid
Appearance	Silver
Odor	Odorless
Odor Threshold	No information available
pH	No information available
Melting Point/Range	321 °C / 609.8 °F

Cadmium

Boiling Point/Range	765 °C / 1409 °F @ 760 mmHg
Flash Point	No information available
Evaporation Rate	Not applicable
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	No information available
Vapor Density	Not applicable
Specific Gravity	8.64 @ 25°C
Solubility	Insoluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	Not applicable
Molecular Formula	Cd
Molecular Weight	112.40

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under recommended storage conditions. Moisture sensitive. Air sensitive.
Conditions to Avoid	Incompatible products. Excess heat. Avoid dust formation. Exposure to air or moisture over prolonged periods.
Incompatible Materials	Strong oxidizing agents, Strong acids, Sulfur oxides
Hazardous Decomposition Products	Highly toxic fumes
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Cadmium	LD50 = 2330 mg/kg (Rat)	Not listed	LC50 = 25 mg/m ³ (Rat) 30 min

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation No information available

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Cadmium	7440-43-9	Group 1	Known	A2	X	A2

IARC: (International Agency for Research on Cancer)

IARC: (International Agency for Research on Cancer)
 Group 1 - Carcinogenic to Humans
 Group 2A - Probably Carcinogenic to Humans
 Group 2B - Possibly Carcinogenic to Humans
 NTP: (National Toxicity Program)

NTP: (National Toxicity Program)

ACGIH: (American Conference of Governmental Industrial Hygienists)

Known - Known Carcinogen
 Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen
 A1 - Known Human Carcinogen
 A2 - Suspected Human Carcinogen
 A3 - Animal Carcinogen
 ACGIH: (American Conference of Governmental Industrial Hygienists)

Mutagenic Effects	Possible risk of irreversible effects
Reproductive Effects	Possible risk of impaired fertility. May cause harm to the unborn child.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	Respiratory system
STOT - repeated exposure	Kidney Blood
Aspiration hazard	No information available
Symptoms / effects, both acute and delayed	Kidney disorders: May cause harm to the unborn child: Blood disorders
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information



Ecotoxicity

The product contains following substances which are hazardous for the environment. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Cadmium	Not listed	LC50: 0.0004 - 0.003 mg/L, 96h (Pimephales promelas) LC50: = 0.016 mg/L, 96h (Oryzias latipes) LC50: = 21.1 mg/L, 96h flow-through (Lepomis macrochirus) LC50: = 0.24 mg/L, 96h static (Cyprinus carpio) LC50: = 4.26 mg/L, 96h semi-static (Cyprinus carpio) LC50: = 0.002 mg/L, 96h (Cyprinus carpio) LC50: = 0.006 mg/L, 96h static (Oncorhynchus mykiss) LC50: = 0.003 mg/L, 96h	Not listed	EC50: = 0.0244 mg/L, 48h Static (Daphnia magna)

		flow-through (Oncorhynchus mykiss)		
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Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available.

Mobility No information available.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No UN2930
 Proper Shipping Name TOXIC SOLIDS, FLAMMABLE, ORGANIC, N.O.S.
 Proper technical name Cadmium
 Hazard Class 6.1
 Subsidiary Hazard Class 4.1
 Packing Group I

TDG

UN-No UN2930
 Proper Shipping Name TOXIC SOLID, FLAMMABLE, ORGANIC, N.O.S.
 Hazard Class 6.1
 Subsidiary Hazard Class 4.1
 Packing Group I

IATA

UN-No UN2930
 Proper Shipping Name TOXIC SOLID, FLAMMABLE, ORGANIC, N.O.S.
 Hazard Class 6.1
 Subsidiary Hazard Class 4.1
 Packing Group I

IMDG/IMO

UN-No UN2930
 Proper Shipping Name TOXIC SOLID, FLAMMABLE, ORGANIC, N.O.S.
 Hazard Class 6.1
 Subsidiary Hazard Class 4.1
 Packing Group I

15. Regulatory information

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Cadmium	X	X	-	231-152-8	-		X	-	X	X	KE-0439 7

Legend:

- X - Listed
- E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
- F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
- N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
- P - Indicates a commenced PMN substance
- R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
- S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
- T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
- XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B)).
- Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.

Cadmium

Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Cadmium	7440-43-9	100	0.1

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Cadmium	-	-	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Cadmium	X		-

OSHA Occupational Safety and Health Administration
Not applicable

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Cadmium	5 µg/m ³ TWA 2.5 µg/m ³ Action Level	-

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Cadmium	10 lb	-

California Proposition 65 This product contains the following proposition 65 chemicals

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Cadmium	7440-43-9	Carcinogen Developmental Male Reproductive	0.05 µg/day	Developmental Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Cadmium	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ): Y
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security
This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Revision Date 17-Jan-2018

Print Date 17-Jan-2018

Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

**LEAD METAL
SAFETY DATA SHEET****SECTION 1. IDENTIFICATION**

Product Identity: Lead Metal

Trade Names and Synonyms: Lead; Pb; Plumbum; Metallic Lead; Inorganic Lead; ASTM B29; TADANAC Lead, Low-Alpha Lead.

Manufacturer:
Teck Metals Ltd.
Trail Operations
Trail, British Columbia
V1R 4L8
Emergency Telephone: 250-364-4214

Supplier:
In U.S.:
Teck American Metal Sales
Incorporated
501 North Riverpoint Blvd, Suite 300
Spokane, WA
USA, 99202

Preparer:
Teck Metals Ltd.
Suite 3300 – 550 Burrard Street
Vancouver, British Columbia
V6C 0B3

Other than U.S.:
Teck Metals Ltd.
#1700 – 11 King Street West
Toronto, Ontario
M5H 4C7

Date of Last Review: June 29, 2015.

Date of Last Edit: June 29, 2015.

Product Use: Used as a construction material for tank linings, piping, and equipment used in the manufacture of sulphuric acid and the refining and processing of petroleum; used in x-ray and atomic radiation shielding; used in the manufacture of paint pigments, organic and inorganic lead compounds, lead shot, lead wire for bullets, ballast, and lead solders; used as a bearing metal or alloy; used in the manufacture of storage batteries, ceramics, plastics, and electronic devices; used in the metallurgy of steel and other metals; and used in the form of lead oxide for batteries.

SECTION 2. HAZARDS IDENTIFICATION

CLASSIFICATION:

Health	Physical	Environmental
Acute Toxicity (Oral, Inhalation) – Does not meet criteria	Does not meet criteria for any Physical Hazard	Aquatic Toxicity – Short Term (Acute) Category 3
Skin Corrosion/Irritation – Does not meet criteria		
Eye Damage/Eye Irritation – Does not meet criteria		
Respiratory or Skin Sensitization – Does not meet criteria		
Mutagenicity – Does not meet criteria		
Carcinogenicity – Category 2		
Reproductive Toxicity – Category 1A		
Specific Target Organ Toxicity – Category 1		
Chronic Exposure		

LABEL:

Symbols: 	Signal Word: DANGER
Hazard Statements DANGER! Causes damage to kidneys, blood-forming systems, central nervous system and digestive tract through prolonged or repeated exposure. May damage the unborn child. May cause harm to breast-fed children. Suspected of damaging fertility. Suspected of causing cancer. Harmful to aquatic life.	Precautionary Statements: Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wear protective gloves/protective clothing/eye protection. Do not breathe dust or fumes. Wash hands thoroughly after handling. Do not eat, drink or smoke when using this product. If exposed or concerned or you feel unwell: Get medical advice/attention. Avoid release to the environment.

Emergency Overview: A bluish-white to silvery-grey, heavy, soft metal that does not burn in bulk. Finely-divided lead dust clouds are a moderate fire and explosion hazard, however. When heated strongly in air, highly toxic lead oxide fumes can be generated. Inhalation or ingestion of lead may produce both acute and chronic health effects. Possible cancer and reproductive hazard. SCBA and full protective clothing are required for fire emergency response personnel.

Potential Health Effects: Inhalation or ingestion of lead may result in headache, nausea, vomiting, abdominal spasms, fatigue, sleep disturbances, weight loss, anemia and leg, arm, and joint pain. Prolonged exposure may also cause central nervous system damage, hypertension, gastrointestinal disturbances, anemia, kidney dysfunction and possible reproductive effects. Pregnant women should be protected from excessive exposure in order to prevent lead crossing the placental barrier and causing infant neurological disorders. Lead and inorganic lead compounds are listed as an *A3 Carcinogen (Confirmed Animal Carcinogen with Unknown Relevance to Humans)* by the ACGIH. IARC has listed lead compounds as *Group 2A Carcinogens (Probably Carcinogenic to Humans)* while lead metal is listed as *Group 2B (Possibly Carcinogenic to Humans)*. The NTP lists lead and lead compounds as *Reasonably Anticipated to be a Human Carcinogen*. OSHA and the EU does not currently list lead as a human carcinogen (see Toxicological Information, Section 11).

Potential Environmental Effects: Lead metal has relatively low bioavailability; however, compounds which it forms with other elements can be toxic to both aquatic and terrestrial organisms at low concentrations. These compounds can be particularly toxic in the aquatic environment. Lead bioaccumulates in plants and animals in both aquatic and terrestrial environments (see Ecological Information, Section 12).

SECTION 3. COMPOSITION / INFORMATION ON INGREDIENTS

HAZARDOUS COMPONENT	CAS Registry No.	CONCENTRATION (% wgt/wgt)
Lead	7439-92-1	99+%

Note: See Section 8 for Occupational Exposure Guidelines.

SECTION 4. FIRST AID MEASURES

Eye Contact: *Symptoms:* Eye irritation, redness. Gently brush product off face if necessary. Do not rub eye(s). Let the eye(s) water naturally for a few minutes. Look right and left, then up and down. If particle/dust does not dislodge, cautiously rinse eye(s) with lukewarm, gently flowing water for 5 minutes or until particle/dust is removed, while holding eyelid(s) open. If irritation persists, get medical advice/attention. DO NOT attempt to manually remove anything stuck to the eye.

Skin Contact: *Symptoms:* Skin soiling, mild irritation. Gently brush away excess dust. Wash gently and thoroughly with lukewarm, gently flowing water and non-abrasive soap for 5 minutes, or until product is removed. If skin irritation occurs or you feel unwell, get medical advice/attention. *Molten Metal:* Flush contact area to solidify and cool but do not attempt to remove encrusted material or clothing. Cover burns and seek medical attention immediately.

Inhalation: *Symptoms:* Respiratory irritation. Remove source of exposure or move person to fresh air and keep comfortable for breathing. Seek medical attention if you feel unwell.

Ingestion: *Symptoms:* Stomach upset. If you feel unwell or are concerned, get medical advice/attention.

SECTION 5. FIRE FIGHTING MEASURES

Fire and Explosion Hazards: Massive metal is not flammable or combustible. Finely-divided lead dust or powder is a moderate fire hazard and moderate explosion hazard when dispersed in the air at high concentrations and exposed to heat, flame, or other ignition sources. Explosions may also occur upon contact with certain incompatible materials (see Stability and Reactivity, Section 10).

Extinguishing Media: Use any means of extinction appropriate for surrounding fire conditions such as water spray, carbon dioxide, dry chemical, or foam.

Fire Fighting: Do not use direct water streams on fires where molten metal is present, due to the risk of a steam explosion that could potentially eject molten metal uncontrollably. Use a fine water mist on the front-running edge of the spill and on the top of the molten metal to cool and solidify it. If possible, move solid material from fire area or cool material exposed to flame to prevent melting of the metal ingots. Highly toxic lead oxide fumes may evolve in fires. Fire fighters must be fully trained and wear full protective clothing including an approved, self-contained breathing apparatus which supplies a positive air pressure within a full face-piece mask.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Procedures for Cleanup: Control source of spillage if possible to do so safely. Restrict access to the area until completion of clean-up. Clean up spilled material immediately, observing precautions outlined below. Molten metal should be allowed to solidify before cleanup. If solid metal, wear gloves, pick up and return to process. If dust, wear recommended personal protective equipment (see below) and use methods which will minimize dust generation (e.g., vacuum solids). Return uncontaminated spilled material to the process if possible. Place contaminated material in suitable labelled containers for later recovery or disposal. Treat or dispose of waste material in accordance with all local, regional, and national requirements.

Personal Precautions: Persons responding to an accidental release should wear protective clothing, gloves and a respirator (see also Section 8). Close-fitting safety goggles may be necessary in some circumstances to prevent eye contact with dust and fume. Where molten metal is involved, wear heat-resistant gloves and suitable clothing for protection from hot-metal splash as well as a respirator to protect against inhalation of lead fume. Workers should wash and change clothing following cleanup of a lead spill to prevent personal contamination with lead dust.

Environmental Precautions: Lead metal has low bioavailability; however, compounds which it forms with other elements can be toxic to aquatic and terrestrial organisms. Releases of the product to water and soil should be prevented.

SECTION 7. HANDLING AND STORAGE

Store in a DRY, covered area, separate from strong acids, other incompatible materials, active metals and food or feedstuffs. Solid metal suspected of containing moisture should be THOROUGHLY DRIED before being added to a molten bath. Otherwise, entrained moisture could expand explosively and spatter molten metal out of the bath. No special packaging materials are required. Lead metal, in contact with wood or other surfaces, may leave traces of lead particulate that can accumulate over time. Cleaning or disposal of these surfaces requires review to ensure that any effluent or solid waste disposal meets the requirements of regulations in the applicable jurisdiction.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Guidelines:

<u>Component</u>	<u>ACGIH TLV</u>	<u>OSHA PEL</u>	<u>NIOSH REL</u>
Lead	0.05 mg/m ³	0.05 mg/m ³	0.05 mg/m ³

NOTE: OEGs for individual jurisdictions may differ from those given above. Check with local authorities for the applicable OEGs in your jurisdiction.

ACGIH - American Conference of Governmental Industrial Hygienists; OSHA - Occupational Safety and Health Administration; NIOSH - National Institute for Occupational Safety and Health. TLV - Threshold Limit Value, PEL - Permissible Exposure Limit, REL - Recommended Exposure Limit.

NOTE: The selection of the necessary level of engineering controls and personal protective equipment will vary depending upon the conditions of use and the potential for exposure. The following are therefore only general guidelines that may not fit all circumstances. Control measures to consider include:

Ventilation: Use adequate local or general ventilation to maintain the concentration of lead fumes in the working environment well below recommended occupational exposure limits. Supply sufficient replacement air to make up for air removed by the exhaust system. Local exhaust is recommended for melting, casting, welding, grinding, flame cutting or burning, and use of lead powders.

Protective Clothing: Gloves and coveralls or other work clothing are recommended to prevent prolonged or repeated direct skin contact when lead is processed. Appropriate eye protection should be worn where fume or dust is generated. Where hot or molten metal is handled, heat resistant gloves, goggles or face shield, and clothing to protect from radiant heat and hot metal splash should be worn. Safety type boots are recommended.

Respirators: Where lead dust or fumes are generated and cannot be controlled to within acceptable levels by engineering means, use appropriate NIOSH-approved respiratory protection equipment (a 42CFR84 Class N, R or P-100 particulate filter cartridge). When exposure levels are obviously high but the actual concentration is unknown, a self-contained breathing apparatus which supplies a positive air pressure within a full face-piece mask should be worn.

General Hygiene Considerations: Do not eat, drink or smoke in work areas. Thoroughly wash hands before eating, drinking, or smoking in appropriate, designated areas as well as at the end of the workday. A double locker-shower system with separate clean and dirty sides is usually required for lead handling operations to avoid cross-contamination of street clothes. Contaminated clothing should be changed frequently and laundered before each reuse. Inform laundry personnel of contaminants' hazards. Workers should not take dirty work clothes home and launder them with other personal clothing.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Malleable, bluish-white to silvery-grey solid metal	Odour: None	Odour Threshold: Not Applicable	pH: Not Applicable
Vapour Pressure: (negligible @ 20°C)	Vapour Density: Not Applicable	Melting Point/Range: 328°C	Boiling Point/Range: 1,740°C
Relative Density (Water = 1): 11.34	Evaporation Rate: Not Applicable	Coefficient of Water/Oil Distribution: Not Applicable	Solubility: Insoluble in water
Flash Point: None	Flammable Limits (LEL/UEL): Not Flammable	Auto-ignition Temperature: None	Decomposition Temperature: None

SECTION 10. STABILITY AND REACTIVITY

Stability & Reactivity: Massive metal is stable and not considered reactive under normal temperatures and pressures. Hazardous polymerization or runaway reactions will not occur. Freshly cut or cast lead surfaces tarnish rapidly due to the formation of an insoluble protective layer of basic lead carbonate.

Incompatibilities: Lead reacts vigorously with strong acids (e.g., hot concentrated nitric acid, boiling concentrated hydrochloric acid, etc.), strong oxidizers such as peroxides, chlorates, nitrates and halogen or interhalogen compounds such as chlorine trifluoride. Powdered lead metal in contact with disodium acetylide, chlorine trifluoride, sodium carbide or fused ammonium nitrate poses a risk of explosion. Solutions of sodium azide in contact with lead metal can form lead azide, which is a detonating compound. Vigorous reactions can also occur between molten lead and active metals, such as sodium, potassium, lithium and calcium. A lead-zirconium alloy (10-70% Zr) will ignite when struck with a hammer.

Hazardous Decomposition Products: High temperature operations such as oxy-acetylene cutting or burning, electric arc welding or overheating a molten bath will generate highly toxic lead oxide fume. Lead oxide is highly soluble in body fluids and the particle size of the metal fumes is largely within the respirable size range, which increases the likelihood of inhalation and deposition of the fume within the body.

SECTION 11. TOXICOLOGICAL INFORMATION

General: Lead accumulates in bone and body organs once it enters the body. Elimination from the body is slow. Initial and periodic medical examinations are advised for persons repeatedly exposed to levels at or above the exposure limits of lead dust or fumes. Once lead enters the body, it can affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal system. The primary routes of exposure to lead are inhalation or ingestion of dust and fumes.

Acute:

Skin/Eye: Contact with dust or fume may cause local irritation but would not cause tissue damage.

Inhalation: Exposure to lead dust or fume may cause headache, nausea, vomiting, abdominal spasms, fatigue, sleep disturbances, weight loss, anemia, and pain in legs, arms, and joints. An intense, short-term exposure to lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are unlikely in industry today. Kidney damage, as well as anemia, can occur from acute exposure.

Ingestion: Symptoms due to ingestion of lead dust or fume would be similar to those from inhalation. Other health effects such as metallic taste in the mouth and constipation or bloody diarrhea might also occur.

Chronic:

Prolonged exposure to lead dust and fume may produce many of the symptoms of short-term exposure and may also cause central nervous system damage, gastrointestinal disturbances, anemia, and, rarely, wrist drop. Reduced hemoglobin production has been associated with low lead exposures. Symptoms of central nervous system damage due to moderate lead exposure include fatigue, headaches, tremors and hypertension. Very high lead exposure can result in lead encephalopathy with symptoms of hallucinations, convulsions, and delirium. Kidney dysfunction and possible injury has also been associated with chronic lead poisoning. Chronic over-exposure to lead has been implicated as a causative agent for the impairment of male and female reproductive capacity. Pregnant women should be protected from excessive exposure as lead can cross the placental barrier and unborn children may suffer neurological damage or developmental problems due to excessive lead exposure. Teratogenic and mutagenic effects from exposure to lead have been reported in some studies but not in others. The literature is inconsistent and no firm conclusions can be drawn at this time. Lead and lead compounds are listed as an *A3 Carcinogen (Confirmed Animal Carcinogen with Unknown Relevance to Humans)* by the ACGIH. IARC has listed lead compounds as *Group 2A Carcinogens (Probably Carcinogenic to Humans)* while lead metal is listed as *Group 2B (Possibly Carcinogenic to Humans)*. The NTP lists lead and lead compounds as *Reasonably Anticipated to be a Human Carcinogen*. OSHA and the EU do not currently list lead as a human carcinogen.

Animal Toxicity:

<u>Hazardous Ingredient:</u>	<u>Acute Oral Toxicity:</u>	<u>Acute Dermal Toxicity:</u>	<u>Acute Inhalation Toxicity:</u>
Lead	No Data	No Data	No Data

SECTION 12. ECOLOGICAL INFORMATION

While lead metal is relatively insoluble, its processing or extended exposure in aquatic and terrestrial environments may lead to the release of lead compounds in more bioavailable forms. While lead compounds are not particularly mobile in the aquatic environment, they can be toxic to aquatic organisms, especially fish, at low concentrations. Water hardness, pH and dissolved organic carbon content are three major factors which regulate the degree of lead toxicity. Lead in soil is generally neither very mobile nor bioavailable, as it can become strongly sorbed onto soil particles, increasingly so over time, to a degree related to physical properties of the soil. Lead bioaccumulates in plants and animals in both aquatic and terrestrial environments.

SECTION 13. DISPOSAL CONSIDERATIONS

If material cannot be returned to process or salvage, dispose of in accordance with applicable regulations.

SECTION 14. TRANSPORT INFORMATION

PROPER SHIPPING NAME Not a regulated product in ingot form.
 TRANSPORT CANADA AND U.S. DOT CLASSIFICATION Not Applicable

TRANSPORT CANADA AND U.S. DOT PIN Not Applicable
 MARINE POLLUTANT No
 IMO CLASSIFICATION Not Regulated

SECTION 15. REGULATORY INFORMATION

U.S.
 Ingredient Listed on TSCA Inventory Yes
 Hazardous Under Hazard Communication Standard Yes
 CERCLA Section 103 Hazardous Substances Lead RQ: 10 lbs. (4.54 kg.)*
 *reporting not required when diameter of the pieces of solid metal released is equal to or exceeds 100 micrometers (0.004 inches).
 EPCRA Section 302 Extremely Hazardous Substance No
 EPCRA Section 311/312 Hazard Categories Delayed (chronic) health hazard - Carcinogen
 Delayed (chronic) health hazard - Reproductive toxin
 EPCRA Section 313 Toxic Release Inventory Lead CAS No. 7439-92-1
 Percent by Weight - At least 99%

SECTION 16. OTHER INFORMATION

Date of Original Issue: July 23, 1997 **Version:** 01 (*First edition*)
Date of Latest Revision: June 29, 2015 **Version:** 13

The information in this Safety Data Sheet is based on the following references:

- American Conference of Governmental Industrial Hygienists, 2004, Documentation of the Threshold Limit Values and Biological Exposure Indices, Seventh Edition plus updates.
- American Conference of Governmental Industrial Hygienists, 2015, Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.
- American Conference of Governmental Industrial Hygienists, Guide to Occupational Exposure Values – 2015.
- Bretherick's Handbook of Reactive Chemical Hazards, 20th Anniversary Edition. (P. G. Urban, Ed), 1995.
- Canadian Centre for Occupational Health and Safety, Hamilton, ON, CHEMINFO Record No. 608 - Lead (Rev. 2009-05).
- European Regulation (EC) No. 1272/2008 on classification, labelling and packaging of substances and mixtures, amending and repealing directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 (REACH).
- Health Canada, SOR/2015-17, Hazardous Products Regulations, 30 January 2015.
- International Agency for Research on Cancer (IARC), Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, 1972 – present, (multi-volume work), World Health Organization, Geneva.
- International Chemical Safety Cards (WHO/IPC/IL), ICSC:0052 - Lead.
- Merck & Co., Inc., 2001, The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Thirteenth Edition.
- National Library of Medicine, National Toxicology Information Program, Hazardous Substance Data Bank (online version).
- Patty's Toxicology, Fifth Edition, 2001: E. Bingham, B. Cohrssen & C.H. Powell, Ed.
- U.S. Dept. of Health and Human Services, National Institute of Environmental Health Sciences, National Toxicology Program (NTP), 13th Report on Carcinogens, October 2014.
- U.S. Dept. of Health and Human Services, National Institute for Occupational Safety and Health, NIOSH Pocket Guide to Chemical Hazards, on-line edition.
- U.S. Dept. of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Toxicological Profile for Lead, September 2005.
- U.S. Occupational Safety and Health Administration, 1989, Code of Federal Regulations, Title 29, Part 1910.

Notice to Reader

Although reasonable precautions have been taken in the preparation of the data contained herein, it is offered solely for your information, consideration and investigation. Teck American Metal Sales Incorporated and Teck Metals Ltd. extend no warranty and assume no responsibility for the accuracy of the content and expressly disclaim all liability for reliance thereon. This safety data sheet provides guidelines for the safe handling and processing of this product; it does not and cannot advise on all possible situations. Therefore, your specific use of this product should be evaluated to determine if additional precautions are required. Individuals exposed to this product should read and understand this information and be provided pertinent training prior to working with this product.

SECTION 1: Identification

1.1. Identification

Product form : Mixtures
Product name : Cyanide Standard, 1000ppm
Product code : LC13545

1.2. Recommended use and restrictions on use

Use of the substance/mixture : For laboratory and manufacturing use only.
Recommended use : Laboratory chemicals
Restrictions on use : Not for food, drug or household use

1.3. Supplier

LabChem Inc
Jackson's Pointe Commerce Park Building 1000, 1010 Jackson's Pointe Court
Zelienople, PA 16063 - USA
T 412-826-5230 - F 724-473-0647
info@labchem.com - www.labchem.com

1.4. Emergency telephone number

Emergency number : CHEMTREC: 1-800-424-9300 or 011-703-527-3887

SECTION 2: Hazard(s) identification

2.1. Classification of the substance or mixture

GHS-US classification

Hazardous to the aquatic environment - Acute Hazard Category 3	H402	Harmful to aquatic life
Hazardous to the aquatic environment - Chronic Hazard Category 3	H412	Harmful to aquatic life with long lasting effects

Full text of H statements : see section 16

2.2. GHS Label elements, including precautionary statements

GHS-US labeling

Hazard statements (GHS-US) : H412 - Harmful to aquatic life with long lasting effects
Precautionary statements (GHS-US) : P273 - Avoid release to the environment
P501 - Dispose of contents/container to comply with local, state and federal regulations

2.3. Other hazards which do not result in classification

Other hazards not contributing to the classification : None.

2.4. Unknown acute toxicity (GHS US)

Not applicable

SECTION 3: Composition/Information on ingredients

3.1. Substances

Not applicable

3.2. Mixtures

Cyanide Standard, 1000ppm

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Name	Product identifier	%	GHS-US classification
Water	(CAS No) 7732-18-5	99.55	Not classified
Potassium Cyanide	(CAS No) 151-50-8	0.25	Acute Tox. 2 (Oral), H300 Acute Tox. 2 (Dermal), H310 Acute Tox. 2 (Inhalation), H330 Skin Irrit. 2, H315 Eye Irrit. 2A, H319 Aquatic Acute 1, H400 Aquatic Chronic 1, H410
Sodium Hydroxide	(CAS No) 1310-73-2	0.2	Acute Tox. 4 (Dermal), H312 Skin Corr. 1A, H314 Eye Dam. 1, H318 Aquatic Acute 3, H402

Full text of hazard classes and H-statements : see section 16

SECTION 4: First-aid measures

4.1. Description of first aid measures

- First-aid measures general : Never give anything by mouth to an unconscious person. If you feel unwell, seek medical advice (show the label where possible).
- First-aid measures after inhalation : Allow victim to breathe fresh air. Allow the victim to rest.
- First-aid measures after skin contact : Remove affected clothing and wash all exposed skin area with mild soap and water, followed by warm water rinse.
- First-aid measures after eye contact : Rinse immediately with plenty of water. Obtain medical attention if pain, blinking or redness persists.
- First-aid measures after ingestion : Rinse mouth. Do NOT induce vomiting. Obtain emergency medical attention.

4.2. Most important symptoms and effects (acute and delayed)

- Symptoms/injuries after inhalation : EXPOSURE TO HIGH CONCENTRATIONS: Toxic if inhaled.
- Symptoms/injuries after skin contact : Harmful in contact with skin.
- Symptoms/injuries after eye contact : May cause slight irritation.
- Symptoms/injuries after ingestion : AFTER ABSORPTION OF LARGE QUANTITIES: Headache. Dizziness. Feeling of weakness. Cardiac and blood circulation effects. Central nervous system depression.
- Chronic symptoms : Loss of appetite. Nausea. Headache. Dizziness.

4.3. Immediate medical attention and special treatment, if necessary

Hospitalize at once. Specific treatment is necessary.

SECTION 5: Fire-fighting measures

5.1. Suitable (and unsuitable) extinguishing media

- Suitable extinguishing media : Foam. Dry powder. Carbon dioxide. Water spray. Sand.
- Unsuitable extinguishing media : Do not use a heavy water stream.

5.2. Specific hazards arising from the chemical

- Fire hazard : Not flammable.
- Explosion hazard : Not applicable.
- Reactivity : On heating: release of toxic/combustible gases/vapours (hydrogen cyanide). Reacts with (some) acids: release of toxic/combustible gases/vapours (hydrogen cyanide).

5.3. Special protective equipment and precautions for fire-fighters

- Firefighting instructions : Use water spray or fog for cooling exposed containers. Exercise caution when fighting any chemical fire. Prevent fire-fighting water from entering environment.
- Protection during firefighting : Do not enter fire area without proper protective equipment, including respiratory protection.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

- General measures : Ventilate area. Use chemically protective clothing.

6.1.1. For non-emergency personnel

- Protective equipment : Gloves. Safety glasses.
- Emergency procedures : Evacuate unnecessary personnel.

6.1.2. For emergency responders

- Protective equipment : Equip cleanup crew with proper protection.

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Emergency procedures : Ventilate area.

6.2. Environmental precautions

Prevent entry to sewers and public waters. Notify authorities if liquid enters sewers or public waters. Avoid release to the environment.

6.3. Methods and material for containment and cleaning up

Methods for cleaning up : Soak up spills with inert solids, such as clay or diatomaceous earth as soon as possible. Collect spillage. Store away from other materials.

6.4. Reference to other sections

See Heading 8. Exposure controls and personal protection.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Additional hazards when processed : Contact with acids (i.e. battery) liberates very toxic gas.
 Precautions for safe handling : Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Provide good ventilation in process area to prevent formation of vapor.
 Hygiene measures : Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Wash contaminated clothing before reuse. Do not eat, drink or smoke when using this product.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions : Keep only in the original container in a cool, well ventilated place away from : incompatible materials. Keep container closed when not in use.
 Incompatible products : Strong oxidizers. Strong acids.
 Incompatible materials : Direct sunlight.
 Prohibitions on mixed storage : KEEP SUBSTANCE AWAY FROM: strong acids.
 Storage area : Keep container in a well-ventilated place. Meet the legal requirements.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Potassium Cyanide (151-50-8)		
ACGIH	ACGIH Ceiling (mg/m ³)	5 mg/m ³ (Potassium cyanide; USA; Momentary value; TLV - Adopted Value)
OSHA	OSHA PEL (TWA) (mg/m ³)	5 as CN
IDLH	US IDLH (mg/m ³)	25 mg/m ³ as CN
NIOSH	NIOSH REL (ceiling) (mg/m ³)	5 mg/m ³ 10 min., as CN
NIOSH	NIOSH REL (ceiling) (ppm)	4.7 ppm 10 min., as CN
Sodium Hydroxide (1310-73-2)		
ACGIH	ACGIH Ceiling (mg/m ³)	2 mg/m ³ (Sodium hydroxide; USA; Momentary value; TLV - Adopted Value)
OSHA	OSHA PEL (TWA) (mg/m ³)	2 mg/m ³
IDLH	US IDLH (mg/m ³)	10 mg/m ³
NIOSH	NIOSH REL (ceiling) (mg/m ³)	2 mg/m ³
Water (7732-18-5)		
Not applicable		

8.2. Appropriate engineering controls

Appropriate engineering controls : Gas detectors should be used when toxic gases may be released. Emergency eye wash fountains should be available in the immediate vicinity of any potential exposure. Provide adequate general and local exhaust ventilation.

Cyanide Standard, 1000ppm

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8.3. Individual protection measures/Personal protective equipment

Personal protective equipment:

Safety glasses.



Hand protection:

Wear protective gloves

Eye protection:

Chemical goggles or safety glasses

Skin and body protection:

Wear chemically resistant protective gloves.

Respiratory protection:

Respiratory protection not required in normal conditions

Other information:

Do not eat, drink or smoke during use.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Liquid
Appearance	: Clear, colorless liquid.
Color	: Colorless
Odor	: characteristic Bitter almonds
Odor threshold	: No data available
pH	: No data available
Melting point	: No data available
Freezing point	: No data available
Boiling point	: No data available
Flash point	: No data available
Relative evaporation rate (butyl acetate=1)	: No data available
Flammability (solid, gas)	: Non flammable.
Vapor pressure	: No data available
Relative vapor density at 20 °C	: No data available
Relative density	: No data available
Specific gravity / density	: 1 g/ml
Solubility	: Miscible with water.
Log Pow	: No data available
Auto-ignition temperature	: No data available
Decomposition temperature	: No data available
Viscosity, kinematic	: No data available
Viscosity, dynamic	: No data available
Explosion limits	: No data available
Explosive properties	: No data available
Oxidizing properties	: No data available

9.2. Other information

No additional information available

Cyanide Standard, 1000ppm

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SECTION 10: Stability and reactivity

10.1. Reactivity

On heating: release of toxic/combustible gases/vapours (hydrogen cyanide). Reacts with (some) acids: release of toxic/combustible gases/vapours (hydrogen cyanide).

10.2. Chemical stability

Not established.

10.3. Possibility of hazardous reactions

Contact with acids liberates very toxic gas.

10.4. Conditions to avoid

Direct sunlight. Extremely high or low temperatures.

10.5. Incompatible materials

Strong acids. Strong oxidizers.

10.6. Hazardous decomposition products

Hydrogen cyanide. Nitrogen oxides.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Likely routes of exposure : Inhalation; Skin and eye contact

Acute toxicity : Not classified

Cyanide Standard, 1000ppm	
LD50 oral rat	2390 mg/kg
ATE US (oral)	2390.000 mg/kg body weight
Potassium Cyanide (151-50-8)	
LD50 oral rat	7.5 mg/kg (Rat)
LD50 dermal rabbit	14 mg/kg (Rabbit)
ATE US (oral)	7.500 mg/kg body weight
ATE US (dermal)	14.000 mg/kg body weight
ATE US (dust, mist)	0.050 mg/l/4h
Sodium Hydroxide (1310-73-2)	
ATE US (dermal)	1350.000 mg/kg body weight
Water (7732-18-5)	
LD50 oral rat	≥ 90000 mg/kg
ATE US (oral)	90000.000 mg/kg body weight

Skin corrosion/irritation : Not classified

Serious eye damage/irritation : Not classified

Respiratory or skin sensitization : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Reproductive toxicity : Not classified

Specific target organ toxicity – single exposure : Not classified

Specific target organ toxicity – repeated exposure : Not classified

Aspiration hazard : Not classified

Potential Adverse human health effects and symptoms : Based on available data, the classification criteria are not met.

Symptoms/injuries after inhalation : EXPOSURE TO HIGH CONCENTRATIONS: Toxic if inhaled.

Symptoms/injuries after skin contact : Harmful in contact with skin.

Symptoms/injuries after eye contact : May cause slight irritation.

Cyanide Standard, 1000ppm

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Symptoms/injuries after ingestion : AFTER ABSORPTION OF LARGE QUANTITIES: Headache. Dizziness. Feeling of weakness. Cardiac and blood circulation effects. Central nervous system depression.

Chronic symptoms : Loss of appetite. Nausea. Headache. Dizziness.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - water : Harmful to aquatic life.

Cyanide Standard, 1000ppm	
LC50 fish 1	20.7 mg/l
Potassium Cyanide (151-50-8)	
LC50 fish 1	0.043 mg/l (LC50; 96 h)
EC50 Daphnia 1	0.53 - 1.9 mg/l (EC50; 48 h)
Sodium Hydroxide (1310-73-2)	
LC50 fish 1	45.4 mg/l (LC50; Other; 96 h; Salmo gairdneri; Static system; Fresh water; Experimental value)

12.2. Persistence and degradability

Cyanide Standard, 1000ppm	
Persistence and degradability	Not established.
Potassium Cyanide (151-50-8)	
Persistence and degradability	Not readily biodegradable in water.
Chemical oxygen demand (COD)	0.614 g O ₂ /g substance
BOD (% of ThOD)	0 (7 days; Literature study)
Sodium Hydroxide (1310-73-2)	
Persistence and degradability	Biodegradability: not applicable. No test data on mobility of the substance available.
Biochemical oxygen demand (BOD)	Not applicable
Chemical oxygen demand (COD)	Not applicable
ThOD	Not applicable
Water (7732-18-5)	
Persistence and degradability	Not established.

12.3. Bioaccumulative potential

Cyanide Standard, 1000ppm	
Bioaccumulative potential	Not bioaccumulative.
Potassium Cyanide (151-50-8)	
Bioaccumulative potential	Not bioaccumulative.
Sodium Hydroxide (1310-73-2)	
Bioaccumulative potential	No bioaccumulation data available.
Water (7732-18-5)	
Bioaccumulative potential	Not established.

12.4. Mobility in soil

No additional information available

12.5. Other adverse effects

Effect on the global warming : No known effects from this product.

GWPmix comment : No known effects from this product.

Other information : Avoid release to the environment.

Cyanide Standard, 1000ppm

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SECTION 13: Disposal considerations

13.1. Disposal methods

- Waste disposal recommendations : Dispose in a safe manner in accordance with local/national regulations. Dispose of contents/container to comply with local, state and federal regulations.
- Ecology - waste materials : Avoid release to the environment.

SECTION 14: Transport information

Department of Transportation (DOT)

In accordance with DOT
Not regulated

SECTION 15: Regulatory information

15.1. US Federal regulations

All components of this product are listed, or excluded from listing, on the United States Environmental Protection Agency Toxic Substances Control Act (TSCA) inventory

Chemical(s) subject to the reporting requirements of Section 313 or Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR Part 372.

Potassium Cyanide	CAS No 151-50-8	0.25%
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Potassium Cyanide (151-50-8)	
Listed on the United States SARA Section 302	
RQ (Reportable quantity, section 304 of EPA's List of Lists)	10 lb
SARA Section 302 Threshold Planning Quantity (TPQ)	100 lb
SARA Section 311/312 Hazard Classes	Immediate (acute) health hazard Reactive hazard
Sodium Hydroxide (1310-73-2)	
RQ (Reportable quantity, section 304 of EPA's List of Lists)	1000 lb
SARA Section 311/312 Hazard Classes	Immediate (acute) health hazard

15.2. International regulations

CANADA

Potassium Cyanide (151-50-8)	
Listed on the Canadian DSL (Domestic Substances List)	
Sodium Hydroxide (1310-73-2)	
Listed on the Canadian DSL (Domestic Substances List)	

EU-Regulations

No additional information available

National regulations

Potassium Cyanide (151-50-8)	
Listed on the Canadian IDL (Ingredient Disclosure List)	

15.3. US State regulations

California Proposition 65 - This product contains, or may contain, trace quantities of a substance(s) known to the state of California to cause cancer, developmental and/or reproductive harm

Potassium Cyanide (151-50-8)				
U.S. - California - Proposition 65 - Carcinogens List	U.S. - California - Proposition 65 - Developmental Toxicity	U.S. - California - Proposition 65 - Reproductive Toxicity - Female	U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No significant risk level (NSRL)
No	No	No	Yes	

Cyanide Standard, 1000ppm

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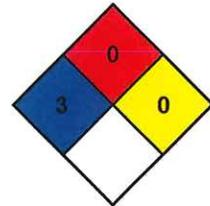
SECTION 16: Other information

Revision date : 05/03/2017
 Other information : None.

Full text of H-phrases: see section 16:

H300	Fatal if swallowed
H310	Fatal in contact with skin
H312	Harmful in contact with skin
H314	Causes severe skin burns and eye damage
H315	Causes skin irritation
H318	Causes serious eye damage
H319	Causes serious eye irritation
H330	Fatal if inhaled
H400	Very toxic to aquatic life
H402	Harmful to aquatic life
H410	Very toxic to aquatic life with long lasting effects
H412	Harmful to aquatic life with long lasting effects

NFPA health hazard : 3 - Materials that, under emergency conditions, can cause serious or permanent injury.
 NFPA fire hazard : 0 - Materials that will not burn under typical dire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand.
 NFPA reactivity : 0 - Material that in themselves are normally stable, even under fire conditions.



HMIS III Rating
 Health : 3 Serious Hazard - Major injury likely unless prompt action is taken and medical treatment is given
 Flammability : 0 Minimal Hazard - Materials that will not burn
 Physical : 0 Minimal Hazard - Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or self-react. Non-Explosives.
 Personal protection : H
 H - Splash goggles, Gloves, Synthetic apron, Vapor respirator

SDS US LabChem

Information in this SDS is from available published sources and is believed to be accurate. No warranty, express or implied, is made and LabChem Inc assumes no liability resulting from the use of this SDS. The user must determine suitability of this information for his application.

APPENDIX C

List of Approved Amendments/changes

HASP Acknowledgement/Agreement Form

Visitors Log

Tailgate Safety Meeting Form

Air Quality Monitoring Record

Equipment Calibration Log

Appendix 07-04: Tailgate Safety Meeting Form

Site Name & Number: _____ ATC Project Number: _____

Date & Time of Meeting: _____ Name of Presenter: _____

Work Being Performed: _____

NOTE: On the initial day of the project, the Project Manager or designee should conduct a visual inspection of the project site prior to the Tailgate Safety Meeting. This inspection should include a review of project site equipment, hazards, specific job tasks, activities or operations to be performed for that day. These specific items must be covered during the Tailgate Safety Meeting. For subsequent days, any changes to the site or operations must be covered in the Tailgate Safety Meeting. In addition, "Task-Specific" Job Safety Analysis (JSA) for the tasks/activities at the project site must be integrated into the HASP and Tailgate discussions. Tailgate Meetings should be performed each day. Employees, client representatives and subcontractors must review the Tailgate Safety Meeting, be briefed on the topics and acknowledge the HSE topics by signing this form. Individuals not fluent in the English language must have the site's health safety and environmental requirements translated to them

<input type="checkbox"/> Are all employees physically able to perform their job duties?	<input type="checkbox"/> Any "Shared Learning" items?
<input type="checkbox"/> Emergency evacuation area identified?	<input type="checkbox"/> Has PPE been checked?
<input type="checkbox"/> Subcontractor interactions or questions?	

Itemize the Specific Topics Discussed (if more space is needed use the back of this page):

Client Requirements - By checking the box to the left, the presenter of the Tailgate Meeting acknowledges that all client-specific requirements have been completed for both ATC and Subcontractor employees.

By signing this Tailgate Safety Meeting form, you are acknowledging that you have read, reviewed and understand the health and safety topics discussed on this form.

Print Name	Signature	Company	Date

APPENDIX D

Risks Associated with Drilling and Subsurface Activities

Checklist for Subsurface Activities

Risks Associated With Drilling and Subsurface Activities

Drilling operations will conform to the Job Safety Analysis and Subsurface Investigation (ATC Policy No. 33). During drilling operations, the subsurface is penetrated to obtain soil and/or groundwater samples. Contaminated soil cuttings and groundwater may be brought to the surface, creating a potential for exposure through skin contact and inhalation of vapors. The open borehole also creates a conduit for vapors to be released to the atmosphere. However, the amount of vapors released to the atmosphere is relatively small and vapors are usually quickly diluted and dispersed in air. Air monitoring is required to determine if protective equipment is necessary, as described in Section 4.0 of this HASP.

In addition to these chemical risks, the risk of drilling into a buried utility, such as a gas, water, electric line, or underground storage tank or other structures, is always present. Complete the Checklist for Subsurface Clearance (33-01) prior to any subsurface work and follow the procedures in Table D-1 for at least the first 5 feet of penetration:

Risks of injury associated with the drilling operation itself also exist. The risks of working near overhead electrical lines may also present a safety hazard. The SSHO will check for the presence of overhead lines and other obstructions. No drilling operations will be performed within 10 feet of overhead lines with voltages 0-50 kV. For other voltages refer to ATC Electrical Safety Policy (No. 12) and Equipment (Drill Rigs, Mobile Equipment) Policy (No. 15). Whenever possible, stay at least two feet from turning or rotating machinery. This includes augers, cathead, engine power takeoff, and drill rods. Learn where the rig kill switch is to shut the rig off in case of an emergency. A discussion should be held with the driller on each drill rig at the startup of the field work to discuss the location and use of the kill switch and for documentation of a Safety Inspection such as the Monthly Heavy Equipment Safety Inspection Checklist found in this section.

TABLE D-1: DRILLING/PROBING PROCEDURES
(First 5 feet below surface)

Step 1 - site Walk	Conduct site walk. Verify that the Checklist for Subsurface Clearance has been fully completed.
Step 2 - Locate Markouts	Locate all utility markouts and borehole locations. Start intrusive activities at least five (5) feet away and perpendicular to all marked utility lines.
Step 3 - Break Surface Cover	Use a jackhammer or concrete saw to break through the asphalt or concrete surface cover. The drill bit on the rig may also be used on the asphalt cover. Do NOT advance bit or cutting tools beyond the asphalt or concrete cover.
Step 4 - Surface Boring	<p>Use air knife with vacuum extractors, hand auger, or hand shovel to remove soil from the borehole to a depth of at least 5 feet below surface. The soil in the borehole should be excavated to a diameter of at least three inches greater than the diameter of the drill bit on the lead auger or drill stem that is to be used.</p> <p>If it is not possible to perform a surface boring which meets the diameter requirements as stated above, surface borings should be installed to the required depth of 5 feet surrounding the proposed well/boring location in such a manner that any lines/utilities passing through the proposed well/boring location will be encountered while installing the investigation borings/well.</p> <p>If pea gravel, fill material, or refusal is encountered, and was not expected to be encountered, abandon the boring and follow instructions from item #9 of section 5.4.1.</p>
Step 5 - Soil Sampling	If soil samples are required to be collected within the first 5 feet below surface, a hand auger should be utilized to collect native, undisturbed soil samples.
Step 6 - Borehole Protection	If no piping or other structures are encountered within the first 5 feet below surface, normal drill/probe activities may proceed with <u>caution</u> . Containerize drill cuttings as appropriate. If excavation of the borehole is conducted the day before actual drilling is conducted, the borehole should be covered with barricades or cones and with a sheet of material sufficient in strength to support a person's weight until it is ready to be drilled. If the borehole is of sufficient size to potentially cause damage to a vehicle if driven over, the borehole should be covered with a material sufficient in strength to support vehicular weight. In lieu of barricades or cones and a material cover, the boring may be temporarily backfilled to surface. If a backfill material is utilized, it is important for the material to be flush with the surrounding pavement.

Appendix 33-01 – Subsurface Clearance Checklist

Must be completed prior to the start of subsurface work.

Project Number: _____ Site Address: _____

State One Call Ticket Information:			
Ticket Number:		Expiration Date of Ticket:	
Request Date of Ticket:		Today's Date:	

Complete Prior to the Start of Work	Yes	No (Stop Work)	Initials
State One Call system contacted within state required time requirement?	<input type="checkbox"/>	<input type="checkbox"/>	
Have all utilities listed on one call ticket been marked onsite or indicated as "no conflict"?	<input type="checkbox"/>	<input type="checkbox"/>	
Is the planned subsurface work area at least 5 feet from any known or marked utility?	<input type="checkbox"/>	<input type="checkbox"/>	
If the subsurface work is on private property, has a private locator located the private utilities?	<input type="checkbox"/>	<input type="checkbox"/>	
Location of all aboveground indicators of underground utilities leading from or to above ground structures been identified and verified as being out of planned subsurface work area?	<input type="checkbox"/>	<input type="checkbox"/>	
Have all utility markings onsite been photograph in relation to the planned subsurface work?	<input type="checkbox"/>	<input type="checkbox"/>	
Has a tailgate safety meeting been held and JSA reviewed with all employees to discuss the subsurface work that will be performed, signs of underground utilities and emergency procedures?	<input type="checkbox"/>	<input type="checkbox"/>	

Select Bore Clearing Method:

Air Knife/Hydro Vac	Hand Auger	N/A - Geotechnical	N/A - Excavation/Trench
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Subsurface Clearance Checklist Completed By:

Printed Name	Signature	Date

APPENDIX M
SAMPLING AND ANALYSIS PLAN



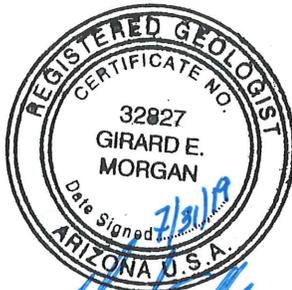
9185 S. Farmer Avenue, Suite 111
Tempe, Arizona 85284
Telephone 480-894-2056
Fax 480-894-2497
www.atcgroupservices.com

**SAMPLING AND ANALYSIS PLAN
FOR
REMEDIAL INVESTIGATION
Building 1122
ChemResearch Company, Inc.
1101 West Hilton Avenue
Phoenix, Arizona 85007**

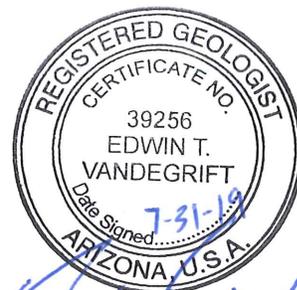
**Submitted to:
Arizona Department of Environmental Quality
Mr. Thomas Titus
Remedial Projects Unit
1100 West Washington Street
Phoenix, Arizona 85007**

**Submitted by:
ATC Group Services LLC
9185 South Farmer Avenue, Suite 111
Tempe, Arizona 85284**

**ATC Project No. 1052000111
July 10, 2019**



**Girard E. Morgan, R.G.
Principal Geologist**



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Senior Project Manager**

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APPENDICES

Appendix A	Airtech Environmental Laboratories Quality Assurance Manual
Appendix B	Pace Analytical Quality Assurance Manual
Appendix C	ATC Field Report Form
Appendix D	ATC Standard Operating Procedures

1.0 INTRODUCTION

ATC Group Services LLC (ATC) was retained by ChemResearch Company, Inc. (CRC) to conduct a Remedial Investigation (RI) of their facility located at 1122 West Hilton Avenue (site) in Phoenix, Arizona (Figure 1, Site Vicinity Map). This Sampling and Analysis Plan (SAP) is intended to be a part of the RI Work Plan prepared for this site and describes how the tasks presented in the RI Work Plan will be performed.

This SAP has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) document Sampling and Analysis Plan Guidance and Template, Version 3, Brownfields Assessment Projects dated 2012. This project is being overseen by the Arizona Department of Environmental Quality (ADEQ) Remedial Projects Unit.

The site consists of an active metal plating facility covering approximately 12,500 square feet. Plating operations have been conducted at the site since the early 1950s. Previous investigations have identified contaminants of concern (COC) in soil vapor (tetrachloroethylene [PCE]) soil (PCE, cadmium, chromium, lead, nickel and hexavalent chrome) and groundwater (PCE, cadmium, chromium, lead, nickel and hexavalent chromium). Remediation activities have included excavation of COC impacted soil in the East Bay and West Bay (Figure 2, East Bay and West Bay Excavations). The purpose of the RI is to define the horizontal and vertical extent of known, and potentially unknown, COC impacts to soil vapor, soil and groundwater.

The property is located in an area characterized by manufacturing operations.

1.1 Site Name

The name of the site is CRC, Building 1122.

1.2 Site Location

The address of the site is 1122 West Hilton Avenue, Phoenix, Arizona 85007. It is located north of the Salt River in an area known as South Phoenix (Figure 1).

1.3 Responsible Agency

The sampling activities described herein will be performed and managed by the ATC Branch Office located in Tempe, Arizona under contract to CRC. The investigation will be performed under oversight of the ADEQ Remedial Projects Unit (Thomas Titus, Project Manager).

1.4 Project Organization

The following table defines the organization of this project.

Title/Responsibility	Name	Phone Number/Email	Address
ADEQ Remedial Projects Unit, Project Manager	Thomas Titus	602-771-0102 Titus.Thomas@azdeq.gov	ADEQ 1110 West Washington Street Phoenix, Arizona 85007
ATC Project Manager	Edwin T. Vandegrift, R.G.	480-355-4672 edwin.vandegrift@atcgs.com	9185 South Farmer Avenue Suite 111 Tempe, Arizona 85284
ATC Quality Assurance Manager	Girard E. Morgan, R.G.	480-355-4613 ric.morgan@atcgs.com	9185 South Farmer Avenue Suite 111 Tempe, Arizona 85284
Airtech Environmental Laboratories	Yu Min Shi	480-968-5888	4620 East Elmwood Drive, Suite 13 Phoenix, Arizona 85040
Pace Analytical	Daphne Richards	615-773-9662 drichards@pacenational.com	12065 Lebanon Road Mount Juliet, Tennessee 37122

1.5 Purpose of the SAP

The purpose of the SAP is to assure practices consisting of policies, procedures, specifications, standards, and documentation are sufficient to produce data of quality adequate to meet project objectives and to minimize loss of data due to out-of-control conditions or malfunctions.

As stated above, this SAP is intended to be utilized in conducting the RI at the CRC Building 1122 Facility.

2.0 SUMMARY OF PREVIOUS CHARACTERIZATION

2.1 Site Description

The site consists of one building owned by CRC. The site has been and is still operated as a metals plating facility.

2.2 Operational History

The site has operated as a metals plating facility since the early 1950s.

2.3 Previous Investigations/Regulatory Involvement

ADEQ became involved with the site based on a soil vapor survey conducted by Roy F. Weston (for ADEQ) in 1992. That survey identified numerous locations exhibiting concentrations of elevated vapor phase PCE (Figure 3, ADEQ [1992] Soil Vapor Survey Map). Based on that survey, CRC conducted a number of soil investigations that resulted in the excavation of soil beneath the East Bay and West Bay plating lines (Figure 2). Groundwater investigations

resulted in the installation, monitoring and sampling of seven groundwater monitor wells both on- and off-site (Figure 4, Groundwater Monitor & Production Well Locations Map).

2.4 Geologic and Groundwater Investigation

The property is located in the East Salt River sub-basin a designated sub-basin in the Phoenix Active Management Area. Soils in the vicinity of the site area consist of valley-fill deposits of unconsolidated to consolidated gravel, sand, silt and clay in varying aggregations to a depth of approximately 800 feet. The upper subsurface soils were deposited as alluvium, forming terraces adjacent to the ancestral Salt River during later Tertiary and Quaternary time. The flat lying site area is composed of overbank silts and fine sands overlying playa, alluvial and fluvial deposits of sandy coarse gravel, cobbles and boulders at depth. Locally, the terrace gravels are heavily cemented by caliche. The thick mass of valley-fill sediments in the East Salt River Valley basin has been divided into four water-bearing units based on the dominant lithology of the materials. These units, from oldest to most recent, are the Red Unit, the Lower Alluvial Unit, the Middle Alluvial Unit and the Upper Alluvial Unit. Groundwater quality within the Salt River Basin typically varies significantly both areally and with depth. ATC did not discover a source indicating the depth to bedrock in the vicinity of the site.

The late Tertiary to Quaternary age Salt River Valley alluvial basin-fill deposits range in thickness from 100 feet near the basin margins to greater than 10,000 feet thick in the center of the basin. The basin-fill deposits consist of interbedded conglomerate, gravel, sand, silt, clay and evaporates. Sediments in the vicinity of the site include channel and floodplain deposits associated with the ancestral and present Salt River. These sediments consist of unconsolidated sand, gravel, cobbles and boulders, with laterally discontinuous silt and clay lenses.

Sampling activities conducted by ATC between 2015 and 2019, indicate the depth to groundwater at the site is approximately 100 feet below grade (FBG). Current and historical data suggests a groundwater flow direction toward the north-northwest under a hydraulic gradient of approximately 0.003 (Table 1, Historical Flow Direction and Gradient).

2.5 Environmental and/or Human Impact

Figure 5, Preliminary Site Conceptual Model, illustrates the potentially completed exposure pathways for currently identified COC at the site.

3.0 PROJECT DATA QUALITY OBJECTIVES

3.1 Project Task and Problem Definition

The objective of this project is to complete a RI to identify the nature and extent of soil vapor, soil and groundwater contamination at the site. This work should be performed in conformance with the procedures and protocols established in this SAP and the RI Work Plan.

3.2 Data Quality Objectives

Data quality objectives are quantitative and qualitative criteria developed using systematic planning to clarify the objectives; define the appropriate type of data; and, specify tolerable

levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Step 1: Problem Statement

Are contaminants present in soil vapor, soil and groundwater at the site?

Step 2: Identify the Decision

If contaminants from previous releases are present beneath the site, are the concentrations above levels that are considered by ADEQ to be protective of human health and the environment?

Step 3: Identify the Inputs to the Decision

The following tasks are designed to provide the analytical data necessary to make the decision posed for Step 2:

1. Collect soil vapor, soil and groundwater samples.
2. Analyze collected samples for volatile organic carbons (VOC), hexavalent chromium, cadmium, chromium, lead and nickel.
3. Compare detected concentrations of COC with Tier 1 Cleanup Levels established by ADEQ (the residential soil remediation level [rSRL], groundwater protection level and EPA Regional Screening Levels subjected to an attenuation factor of 0.03).

Step 4: Define the Boundaries of the Study Area

Because there may be additional potential contributors (responsible parties) in the area, expansion of the investigation area will not be undertaken without additional consultation with the ADEQ Remedial Projects Unit Project Manager. The RI calls for the installation of two groundwater monitor wells one upgradient and one down gradient of the release area. The proposed well locations are shown on Figure 4.

Step 5: Develop a Decision Rule

The following decision rules will be applied to the laboratory analytical results derived from analysis of soil vapor, soil and groundwater samples:

1. If COC are not detected above laboratory reporting limits, then no further action is required.
2. If one or more COC are detected in one or more of the investigative samples, then the total concentration of each COC in each sample will be compared to the appropriate screening level. If the laboratory results do not equal or exceed the appropriate screening level then no further action is required.
3. If one or more COC are detected in an investigative sample at concentrations that equal or exceed the appropriate screening level, then, upon consultation with the

ADEQ Remedial Projects Unit Project Manager, additional investigation to define the extent of contamination may be performed.

Step 6: Specify Tolerable Limits for Decision Errors

A decision error occurs when random and/or systematic errors in the sample data set cause the wrong decision to be made, which in turn causes the wrong response action to be taken. There are typically two components contributing to decision errors, as discussed below:

- Sampling design error: Occurs when the data selection design does not capture the complete variability within the decision unit to the extent appropriate for the decision of interest. This is influenced by the inherent variability of the population over space and time, the sample collection design and the number of samples.
- Measurement error: Random and systematic measurement errors are introduced into the measurement process during physical sample collection, sample handling, sample preparation, sample analysis, data reduction, transmission and storage.

These errors can result in false positive or false negative decisions. The consequences of making either type of decision error are discussed below:

- A false positive decision error would occur if the sample results indicated that the concentration of a COC exceeded its appropriate screening level, when the actual concentration did not exceed the appropriate screening level. The consequence of this type of error would result in unnecessary additional expense for subsequent additional investigations, sample analyses and corrective actions. False positive decision errors are typically minimized by adherence to the proper sampling methodology, use of laboratory control samples and analysis of blanks.
- A false negative decision error would occur if the investigative sample results indicated that the concentration of a COC did not exceed its appropriate screening level, when the actual concentration did exceed the appropriate screening level. The consequences of this type of error are possible threats to human health and the environment. False negative decision errors are typically minimized by adherence to the proper sampling methodology, use of laboratory control samples and analysis of blanks.

3.3 Data Quality Indicators

Data quality indicators (DQI; precision, accuracy, representativeness, completeness and comparability) refer to quality control (QC) criteria established for various aspects of data gathering, sampling or analysis activity. In defining DQI specifically for the project, the level of uncertainty associated with each measurement is defined.

3.3.1 Precision

Precision is the degree of mutual agreement between or among independent measurements of a similar property. Precision is usually reported, depending on the end use of the data, either as relative percent difference (RPD) or standard deviation. The equation for RPD is provided below:

$$\text{RPD} = ([\text{Sample} - \text{Sample Duplicate}] / 0.5 [\text{Sample} + \text{Sample Duplicate}]) \times 100$$

Field precision will be assessed through the collection and analysis of duplicate samples (one duplicate for every 20 soil vapor, soil and groundwater samples or one duplicate sample per day if less than 20 samples are collected). The target RPD for all samples will be within 35 percent of the primary sample result. Duplicate recoveries beyond this range may require further qualification of associated data, but data will not be rejected unless determined unusable by data verification.

Laboratory precision will be based upon laboratory Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses. Table 2, Laboratory Reporting Criteria, provides specific control limits proposed for the CRC Building 1122 RI. The laboratory will perform MS/MSD analyses at a rate of one for every 20 investigative samples. RPD values lower than the limits provided in Table 1 will be considered precise without further discussion. If one or more sample results fall outside the acceptance criteria, they will be flagged. Samples will not be re-extracted and analyzed.

3.3.2 Accuracy

Accuracy is the degree of agreement of a measurement with a known or true value. To determine accuracy, a laboratory or field value is compared to a known or true concentration.

Field accuracy will be assessed by evaluating the results of field equipment and trip blank samples using the same procedures as laboratory samples. Trip blanks will only be required when VOC will be analyzed. Equipment blanks will be performed for each area of contamination that is investigated.

Laboratory accuracy is determined by such QC indicators as matrix spikes, surrogate spikes, laboratory control samples (blank spikes) and performance samples. Laboratory acceptance criteria for accuracy are provided in Table 2. If one or more sample results fall outside the acceptance criteria, they will be flagged.

3.3.3 Representativeness

Representativeness is the expression of the degree to which data accurately and precisely represent a characteristic of an environmental condition or a population.

Field representativeness will be accomplished by adhering to the sampling and analytical procedures and methods used to avoid false positives and false negatives. If any deviations occur, they are to be noted in the field record and an assessment is to be made regarding any impact to data representativeness.

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Laboratory representativeness cannot be quantified, but will be achieved through adherence to prescribed analytical methods and procedures to produce laboratory data representative of site conditions and usable for determinations regarding subject properties. Use of laboratory-specific procedures and sub-sampling routines set forth in the laboratory Quality Assurance (QA) Manuals provided in Appendix A and Appendix B will produce uniform data that represent conditions sufficient to the project decision.

3.3.4 Completeness

Completeness is expressed as the percent of valid, usable data actually obtained compared to the amount that was expected. Sometimes, due to a variety of circumstances, either not all samples scheduled to be collected can be collected or the data from samples cannot be used (for example, samples lost, bottles broken, instrument failures, laboratory error, etc.).

Field completeness will be 85 percent or better for non-critical samples and 90 percent or better for critical samples. Samples will be considered critical if they are subject to definitive analyses and compared to ADEQ Tier 1 Cleanup Levels. Non-critical samples will involve field screening samples used to direct the investigation in the field.

The laboratory completeness objective is for 95 percent of the field samples to be analyzed, with greater than 90 percent meeting QA/QC objectives.

3.3.5 Comparability

Comparability expresses the degree of confidence with which one data set can be compared to another. Comparability also refers to the reporting of data in comparable units so direct comparisons are simplified. For example, this avoids comparison of milligrams per liter (mg/L) for nitrate reported as nitrogen to mg/L of nitrate reported as nitrate, or parts per million versus mg/L discussions.

Field comparability will be achieved by conducting field work consistently in accordance with this SAP and relevant standard operating procedures. This approach will ensure that samples are properly collected, handled and analyzed for comparable evaluation. On-site sample locations will be documented using global positioning system (GPS) technology, surveying, and/or field measurements from on-site, permanent reference points to assist in comparing data sets collected during various investigative phases.

Laboratory comparability will be achieved when the data are collected and preserved in the same manner followed by analysis with the same standard regulatory method and laboratory reporting limits. Laboratory data comparability will therefore be achieved through consistent application of standard EPA analytical methods and associated QC protocols.

3.4 **Data Review and Verification**

Data verification will be performed by the ATC QA Manager (Section 1.4) or his designee, who will not otherwise be involved in the sampling activities. The data verification will consist of an Evaluation Tier 1A review of the laboratory reports to identify analytical issues or deficiencies

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that might affect data quality and the user decisions based on the data. The data verification will consist of the elements discussed below, and will be performed on 50 percent of the data. A completeness check will be performed on 100 percent of the data.

Airtech Environmental Laboratories (AEL) and Pace Analytical (Pace) will internally perform data review and reporting as specified in their Laboratory QA Manual (Appendix A and Appendix B, respectively). The vast majority of QA tasks are required by and the results calculated automatically by the Laboratory Information Management System, objectively and with no conflict of interest.

Other QA/QC assessments (such as review of raw laboratory data, surveillance, peer review, management systems review, readiness review, technical systems audit, performance evaluation, etc.) will not be performed for this project.

3.4.1 Completeness Check

A completeness check will be performed on 100 percent of the laboratory analytical data and shall include a review of:

- Case narrative.
- Chain of custody documentation.
- Sample condition upon receipt.

The completeness check shall ensure that:

- All environmental samples are present.
- QC is present for every environmental sample.
- The most technically valid result is reported for each compound.

3.4.2 Data Verification Criteria

Data verification shall be performed on 50 percent of the data and will include, but is not limited to, reviewing the:

- Completeness, as defined above.
- Case narrative, including but not limited to, a description of non-conformances and corrective actions that were taken, plus anomalies, deficiencies and QC problems that were identified.
- Chain of custody documentation and original chain of custody forms with identification numbers and laboratory receipt signatures, dates and times.
- Sample condition upon receipt, including cooler temperature and shipping documentation.

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- Timeliness and a check for errors, including requested deliverables, preservation and holding times.
- Sample analysis results, with quantitation limits and reporting limits checked against the contract required limits, and verification of dry weights and dilutions.
- QC summary including but not limited to, method blanks, continuing calibration blanks and preparation blanks; surrogate percent recoveries, spike percent recoveries and RPD; and, laboratory QC check sample and laboratory control sample recoveries.
- Field duplicates, if identified, for which reproducibility shall be evaluated.
- Reporting limits.
- Laboratory duplicates.

3.4.3 Data Qualifier Flags

The guidance used for data verification is taken from the EPA Contract Laboratory Program National Function Guidelines for Organic Data Review, as revised, and EPA Contract Laboratory Program National Function Guidelines for Inorganic Data Review, as revised. The data qualification scheme is the basis for determining whether sample results should be qualified, but the reviewer's judgment is also critical in determining whether data quality and usability have been systematically influenced and whether data points require qualification. The staff performing the assessment must understand the analytical procedures being reviewed and understand how the data will be used. If QC results are out of criteria, the data will be qualified using the standard Contract Laboratory Program data flags (i.e., B, J, UJ, NJ and/or R).

Problems or questions about analytical data quality that may require corrective action will be brought to the attention of the laboratory in writing from ATC QA Manager. The request may be initiated if QC results exceed method or project criteria, if reporting or flagging errors are identified, or to request information that has not been reported. The laboratory's response shall include a written explanation of the problem, a plan and a schedule for corrective action, and/or a re-issuance of laboratory reports or electronic data files. If significant data quality problems have occurred and the data are critical to decision making, samples may be required to be reanalyzed, or recollected and reanalyzed at the discretion of ATC and/or the ADEQ Remedial Projects Unit Project Manager.

The EPA has published standardized data qualifier flags that will be used by the laboratory in qualifying analytical results. Any data that is associated with a QC exceedance will be designated by the laboratory using the EPA data qualifier flags to identify the sample results associated with the exceedance.

3.4.4 Data Verification Reports

The ATC QA Manager, will prepare a data review report for each sample delivery group, including:

- A case narrative including, but not limited to, a list of recommended flags; a listing of the items reviewed and the criteria used to evaluate them; a discussion of any problems or QC exceedances associated with the actual analysis that might impact the sample integrity or data quality; and, a summary of all laboratory contacts in which all communications with the laboratory, if any, would be identified.
- The marking of recommended qualifier flags on the laboratory reports and/or in electronic data deliverables. Flags that are marked on hard copy shall be marked directly on copies of the laboratory reports in a contrasting color.

3.5 Data Management

ATC field personnel will maintain an ATC Field Report Form (Appendix C) to document daily field activities. Documentation will contain the project name and number, date, and identification of personnel completing the document (printed name, signature and initials). Information will be entered on the ATC Field Report Form at the time the information is generated or observed.

While being used in the field, the ATC Field Report Form will remain with the ATC field personnel at all times. At the end of each field day ATC Field Report Form will be reviewed and information compared to ensure that the information is accurate and complete. Upon completion of all field activities, the ATC Field Report Forms will be filed and secured at the ATC Tempe Branch Office. Photocopies of the original ATC Field Report Forms will be used as working documents.

Chain of custody forms will be checked against the sample labels and field notes prior to shipping or delivering the samples to the laboratory. Laboratory analytical reports will be reviewed to ensure that the sample information is accurate. The analytical results will be compiled in one or more tables for the project report, and the completed data tables will be compared to the laboratory analytical report to ensure accuracy and completeness.

3.6 Assessment Oversight

Prior to the beginning of fieldwork, ATC field personnel will review the project SAP and health and safety plan (HASP) and will assemble the necessary field equipment, including the ATC Field Report Forms; copies of the project SAP and HASP; sampling and decontamination equipment, sample containers, labels and chain of custody forms and seals; sample shipping coolers and materials; and, any other equipment and materials necessary to undertake the fieldwork. The ATC field personnel will contact the analytical laboratory in advance to schedule sample analyses and will arrange for transportation of samples to the laboratory.

ATC field personnel will generally be working alone or with other consultants and subcontractors, and thus will be responsible for performing fieldwork in accordance with the

SAP, including sampling activities; documentation accuracy, completeness and consistency; and, packaging and transportation of samples to the laboratory.

ATC field personnel will communicate daily to the ATC Project Manager and/or ATC QA Manager regarding field activities and any changes or corrections to be implemented. During and following fieldwork, ATC field personnel will review field documentation and laboratory data for accuracy and completeness and will provide the information to the ATC QA Manager for additional review.

The analytical laboratory report will be reviewed by ATC field personnel and the ATC QA Manager to ensure that the sample information is correct and complete. The ATC QA Manager is granted the corporate and project-specific authority to ensure corrective actions, if necessary, are implemented.

4.0 SAMPLING RATIONALE

The following is a description of the rationale for collection and analysis of soil vapor, soil and groundwater samples associated with the RI of CRC Building 1122 in Phoenix, Arizona. At this time, and into the foreseeable future, there are no plans to change the primary business line at the aforementioned facility.

4.1 Sample Locations

Soil vapor sample locations (Figure 6, Proposed Soil Vapor and Soil Sample Locations Map) are designed to replicate the approximate locations of soil vapor samples collected in the 1992 survey conducted by Roy F. Weston for ADEQ and provide laboratory analytical data regarding the soil near the perimeter of the East Bay and West Bay excavations. In accordance with the ADEQ Remedial Projects Unit Project Manager comments to the Draft RI Work Plan, interior soil vapor samples will be collected just beneath the slab floor and exterior soil vapor samples will be collected at a depth of 15 FBG or auger refusal, whichever is shallower. In accordance with the comments to the Draft RI Work Plan by the ADEQ Remedial Projects Unit Project Manager, soil samples (Figure 6) will be collected at a depth of 15 FBG or auger refusal, whichever is shallower.

Soil samples will be collected at select locations (Figure 6) for analysis of hexavalent chromium, cadmium, chromium, lead and nickel. The ADEQ 3-Phase Partitioning Equation will be used to derive VOC concentrations in soil using the soil vapor sample analytical data. Soil sample locations were selected to determine the approximate volume of COC impacted soil that remains after the excavation of the East Bay and West Bay plating lines.

Groundwater samples will be collected at existing wells CMW-1M, CMW-1D, CMW-3 (if accessible) and AVB-69-02R and newly installed wells CMW-2R and WVB-4R. Groundwater samples will be collected at the static water level and at variable depths (typically 15-foot vertical intervals) below the static water level to determine and verify the vertical extent of COC impacted groundwater.

4.2 Target Analytes or Contaminants of Concern

Soil samples collected at the facility will be analyzed for hexavalent chromium, cadmium, chromium, lead and nickel. Historical soil vapor, soil and groundwater investigations conducted at the site have determined that PCE, hexavalent chromium, cadmium, chromium, lead and nickel are present in the sampled media beneath the site and represent the current COC.

4.3 Sample Depths

Soil vapor samples collected at interior building locations (SV-1 through SV-7; Figure 6) will be collected just beneath the concrete floor. Soil vapor samples collected at exterior locations (SV-8 through VV-17; Figure 6) will be collected at 15 FBG or auger refusal, whichever is shallower. Soil samples will be collected at 15 FBG or auger refusal, whichever is shallower at locations SV-6 through SV-11, SV-14 and SV-15; Figure 6). Groundwater samples will be collected at various depths as discussed above in Section 4.1.

5.0 REQUEST FOR ANALYSES

5.1 Analyses Narrative

As detailed in Table 3, Summary of Samples, Containers and Analytical Methods, eighteen soil vapor samples (at SV-1 through SV-17 and one field duplicate at SV-10; Figure 6); nine soil samples (at SV-6 through SV-11 and SV-14 and SV-15 and one field duplicate at SV-7; Figure 6); and, 100 groundwater samples (collected at monitor wells CMW-1M, CMW-1D, CMW-2R, CMW-3 [if accessible], WVB-4R and AVB-69-02R [Figure 4] and four duplicates collected at CMW-1M at the 140-foot depth range). The number of groundwater samples collected assumes quarterly groundwater sampling for a period of four calendar quarters.

5.2 Analytical Laboratories

Soil vapor samples collected during this project will be analyzed by AEL (Arizona Department of Health Services [ADHS]-certification AZ0740). Pace (ADHS-certification AZ0612) will analyze the collected soil and groundwater samples. The final analytical data package will be provided by AEL and Pace and will meet the applicable requirements of Laboratory Documentation Required for Data Evaluation (R9/QA004.2); EPA Region 9; August 2001. ATC will perform data verification of 50 percent of the data. Data outliers and anomalies will be evaluated by AEL or Pace and data flags and/or discussions will be placed in the analytical report in accordance with Arizona Laboratory Data Qualifiers, Revision 1.0 (March 20, 2002). After verification is completed, qualifiers will be assigned to the data points that are affected by the QC outliers. The qualifiers will indicate the analyte concentrations that may be affected by laboratory or field contamination; unusable because of QC deficiencies; and/or, estimated due to possible bias or reduced confidence in the results.

ATC acknowledges that it understands and agrees to the DQI defined by AEL and Pace which will be used for the project. A copy of the AEL and Pace QA Manuals are included in Appendix A and Appendix B, respectively. Table 2 includes the analytical laboratory data acceptance criteria.

6.0 FIELD METHODS AND PROCEDURES

6.1 Field Equipment

6.1.1 List of Equipment Needed

Soil vapor, soil and groundwater samples will be collected using all or some of the following equipment:

- Blank ATC Field Report Forms
- Plastic decontamination buckets (5-gallon)
- 4-ounce or 8-ounce glass sample jars
- Summa canisters
- Photoionization detector (PID)
- Sample labels
- Nitrile, latex or vinyl gloves
- Permanent markers and ball point pens
- Generator and pump controller
- Trash bags
- Paper towels
- Sample coolers and ice
- Solinst Depth Discrete Sampler
- Plastic bristle brush
- Plastic spray bottle
- 40-milliliter (mL) volatile organic analysis (VOA) bottles
- Chain of custody forms
- Digital camera
- GPS unit
- Plastic sheeting
- Distilled/deionized water
- Low-flow sample pump and tubing
- Non-phosphate soap
- Tape measure or wheel

6.1.2 Calibration of Field Equipment

The PID will be calibrated on a daily basis in accordance with the manufacturer's instructions and recorded on the ATC Field Report Form.

6.2 Field Screening

Visual screening of soil will be performed during sampling activities. Soil exhibiting unusual discoloration, staining or odors will be noted on the ATC Field Report Form.

6.3 Soil Vapor, Soil and Groundwater Sampling

Soil vapor and soil sample locations will be identified with numbered white paint markings. A sketch of the sample location will be entered onto the ATC Field Report Form and any physical reference points will be labeled. All soil vapor samples will be collected in AEL-certified clean

Summa canisters. Ambient air samples will be collected in AEL-certified Summa canisters and the location of the sample shall be recorded on the ATC Field Report Form. Equipment blank samples will be prepared by AEL. Soil vapor sampling will be conducted in general accordance with the protocols provided in Appendix D.

Soil samples will be collected in 4-ounce or 8-ounce jars supplied by Pace. No preservatives are needed in the jars containing soil for metals analysis. Each jar will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being closed to prevent potential contaminant migration to or from the sample. The sample jars will be sealed with a Teflon-lined plastic cap as soon as they are filled and immediately placed into a sample cooler and chilled to 4°C pending delivery to Pace. Soil sampling activities will be completed in accordance with the provisions supplied in Appendix D.

Groundwater samples will be collected using the Solinst Discrete Interval Sampler or the low-flow sampling methodology presented in Appendix D. Samples will be collected in 40-mL preserved VOA bottles supplied by Pace.

6.4 Decontamination Procedures

The decontamination procedures that will be followed are in accordance with approved procedures. Decontamination of sampling equipment will be conducted consistently to assure the quality of samples collected. All equipment that comes into contact with potentially contaminated soil vapor, soil or groundwater will be decontaminated. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Decontamination will occur prior to and after each use of a piece of equipment.

The following will be performed in sequence for the decontamination of sampling equipment (hand-auger, Solinst sampler and other sampling equipment that may be utilized):

- Pre-rinse and scrub equipment if there is an excessive amount of soil adhered to the piece of equipment.
- Wash using tap water, Liquinox soap and a scrub brush in a plastic container.
- Rinse with distilled/deionized water in a plastic container.
- Final rinse with distilled/deionized water using a water sprayer.

Equipment will be decontaminated in a predesignated area on plastic sheeting, and clean bulky equipment will be stored on plastic sheeting in uncontaminated areas. These designated areas may change as the investigation progresses to be near the work areas. Cleaned small equipment will be stored in plastic bags. Materials to be stored more than a few hours will also be covered. Decontamination water will be stored in labeled 55-gallon drums pending transport to a disposal facility.

7.0 SAMPLE CONTAINERS, PRESERVATION AND STORAGE

The number of sample containers, volumes and media are listed in Table 3. The sample containers will be provided by the laboratory and have been pre-cleaned; these containers will not be rinsed or

decontaminated prior to sample collection. Any sample containers that require preservatives will be prepared in advance by the analytical laboratory (Pace) prior to providing the containers to ATC.

Soil vapor sample containers (Summa canisters) will be stored in a cool location out of direct sunlight prior to delivery to the analytical laboratory (AEL). Soil and groundwater samples will be placed into thermally insulated coolers with ice for temporary storage and delivery to the laboratory. All samples will be transported under chain of custody protocol from the collection point to the laboratory.

8.0 DISPOSAL OF RESIDUAL MATERIALS

In the process of collecting soil vapor, soil and groundwater samples at the site, the ATC sampling team will generate a minimal amount of potentially contaminated investigation derived wastes (IDW). These may include the following:

- Soil cuttings.
- Well development water.
- Equipment decontamination (rinseate) water.

IDW generated during hand-augering and equipment decontamination (rinseate) water will be stored in labeled 55-gallon drums onsite. Soil cuttings and groundwater generated during the installation and development of groundwater monitor wells will be temporarily stored in labeled roll-off bins that are located in proximity of the newly installed wells. IDW stored onsite and in proximity of the newly installed wells will be characterized, approved by the receiving landfill facility and transported to the receiving facility subsequent to approval by the receiving landfill. It is anticipated that the IDW generated during the RI will be classified as non-hazardous.

In the event that some portion (or all) of the IDW is characterized as hazardous, arrangements will be made to transport and dispose of the hazardous material in an approved landfill facility.

9.0 SAMPLE DOCUMENTATION AND SHIPMENT

9.1 Field Notes

9.1.1 ATC Field Report Forms

Field personnel will maintain ATC Field Report Forms during the work day. The purpose of the ATC Field Report Form is to document where, when, how and from whom any vital project information was obtained using factual, objective language. ATC Field Report Form entries will be complete and accurate enough to permit reconstruction of field activities. All entries will be legible, written in blue or black ink and signed by the individual making the entries. Errors will be corrected by putting a line through the erroneous information and by entering, initialing and dating the correct information. Blank spaces will have an obliterating line drawn through to prevent addition of information. At a minimum, the following information will be recorded during the collection of each soil vapor, soil and groundwater sample:

- Sample location and description.
- Site or sampling area sketch showing sample location and measured reference distances and GPS coordinates.
- Date and time of sample collection.
- Field instrument readings and calibration.
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.).

In addition to the sampling information, the following specific information will also be recorded on the ATC Field Report Form for each day of field activities:

- Team members present onsite and their responsibilities.
- Time of arrival/entry on site and time of site departure.
- Other personnel on site.
- Summary of any meetings or discussions with any visitors to the project.
- Deviations from work plans, sampling plans and site safety plans.
- Changes in personnel and responsibilities with reasons for the changes.
- Levels of safety protection.
- Calibration readings for any equipment used and equipment model and serial number.

9.1.2 Photographs

Photographs will be taken at sampling locations and at other areas of interest on the site or sampling areas. They will serve to verify information entered on the ATC Field Report Form. For each photograph taken, the following information will be written on the ATC Field Report Form or recorded in a separate Field Photography Log:

- Time, date, location and weather conditions.
- Description of the subject photographed and the general direction faced.

- Digital photograph number or film roll and photograph numbers.
- Name of person taking the photograph.

9.2 Labeling

All samples collected shall be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. At a minimum, the sample labels will contain sample identification number, depth at which the sample was collected and the media sampled. Every sample will be assigned a unique sample identification number that will be recorded on the ATC Field Report Form and the laboratory Chain of Custody form.

Soil vapor samples will be labeled and entered onto the laboratory chain of custody form and ATC Field Report Form using the following convention: Boring Location Number-Depth-Soil Vapor (Example: SV-3-1'-Soil Vapor). Soil samples will be identified and recorded using the following protocol: Boring Location Number-Depth-Soil (Example: SV-6-11'-Soil). Groundwater samples will be labeled using the monitor well ID and depth of the sample (Example: CMW-1M-145').

Ambient air samples will be labeled using the date collected. Example: The ambient air sample collected on September 16, 2019, will be entered onto the laboratory chain of custody form and the ATC Field Report Form as Ambient Air-9/16/2019.

Duplicate samples will be entered as "Blind Duplicate No. X-Date-Media" onto the laboratory chain of custody form. Example: The first duplicate soil sample collected on September 16, 2019, at a depth of 12 FBG at sample location SV-12 would be entered as Duplicate No.1-9/16/2019-Soil on the laboratory chain of custody form and would be recorded as SV-12-12'-Soil-Duplicate on the ATC Field Report Form.

Equipment blank samples shall be labeled for the laboratory chain of custody form and the ATC Field Report Form as "EB-Media-Date". Example: The hand-auger equipment blank for September 16, 2019, would be labeled and entered onto the laboratory chain of custody form and ATC Field Report Form as EB-Soil-9/16/2019.

9.3 Sample Chain of Custody Forms and Custody Seals

All samples shipped or delivered to the analytical laboratory will be accompanied by a completed chain of custody form that is furnished by the laboratory. Chain of custody forms will be completed and sent with the samples for each laboratory and each shipment. If multiple coolers or other containers are sent or delivered to a single laboratory on a single day, chain of custody forms will be completed and sent with the samples for each cooler.

The chain of custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, locked up or kept in a secured area that is restricted to authorized personnel. Until the samples are transferred to the laboratory, the custody of the samples will be the responsibility of ATC. The sampler will sign the chain of custody form in the "relinquished by" box and note date, time and any shipping company names or shipping numbers in the appropriate locations. The sample numbers for all

duplicate samples and blanks will be documented on this form. A photocopy of the completed chain of custody form will be retained by ATC for the project file.

9.4 Packaging and Shipment

It is anticipated that samples will be hand delivered to the laboratory by ATC. All sample containers will be placed in a rigid shipping container (thermally insulated cooler) for transportation to the laboratory. Preservation of samples will be performed as described in Section 7.0. Packaging requirements for shipping of samples does not apply as samples will be transported to the laboratory for analysis by ATC personnel.

10.0 QUALITY CONTROL

10.1 Field Quality Control Samples

10.1.1 Assessment of Field Contamination

Equipment Blanks

Equipment blanks will be collected for this project from rinseate following decontamination of field sampling equipment. One equipment blank will be collected for each day of sampling.

Equipment blanks will be collected to evaluate field sampling and decontamination procedures by pouring distilled or deionized water over the sampling equipment after decontamination has been performed. All surfaces of sampling equipment that potentially came in contact with the sample will be rinsed.

The sample containers used to collect the equipment blanks will be obtained from the laboratory, preserved as appropriate to the analysis, prior to the sampling event. The equipment blanks will be preserved, packaged and sealed in the manner described for the environmental samples. A separate sample number will be assigned to each equipment blank and it will be submitted blind to the laboratory.

Equipment blanks will be collected at the frequency of one blank/day/matrix or one blank/20 samples/matrix, whichever is more frequent.

Field Blanks

No field blanks will be collected.

Trip Blanks

Trip blanks are typically provided and analyzed by the laboratory to evaluate if the shipping and handling procedures are introducing contaminants into the samples, and if cross contamination in the form of VOC migration has occurred between collected samples. Trip blanks are provided and analyzed for each sample container that is shipped or transported to the laboratory.

Temperature Blanks

For each cooler that is shipped or transported to the laboratory, a sealed container or vial will be included that is marked "temperature blank." This blank will be used by the sample custodian to check the temperature of samples upon receipt.

10.1.2 Assessment of Field Variability

Duplicate soil vapor, soil and groundwater samples will be collected at a rate of one duplicate for every 20 samples or one duplicate sample per day, whichever is more frequent. Locations will be determined in the field based on field observations of potential contamination. Contaminated samples will be chosen as duplicates, if possible.

Duplicate samples will be collected in the same sequence and preserved, packaged and sealed using the same methodology as the primary samples. A separate sample number will be assigned to each field duplicate sample, and it will be submitted blind to the laboratory.

10.2 Background Samples

Background samples will not be collected.

10.3 Field Screening and Confirmation Samples

10.3.1 Field Screening Samples

Not applicable.

10.3.2 Confirmation Samples

Not applicable.

10.3.3 Split Samples

Not applicable.

10.4 Laboratory Quality Control Samples

If it becomes necessary to utilize 4-ounce sample jars, soil samples for laboratory QC purposes (MS/MSD) will be obtained by collecting double the number of equivalent sample containers in the same way as described for the primary soil sample. If using 8-ounce sample jars, there is sufficient volume for both routine sample analysis and additional laboratory QC analyses; therefore, a separate soil sample for laboratory QC purposes will not be collected.

The selected QA/QC samples will be samples expected to contain moderate levels of contamination, if present. The MS/MSD samples will be labeled with the same identification number as the primary sample and will also be identified as the MS/MSD sample.

11.0 FIELD VARIANCES

As conditions in the field can vary, it may become necessary to implement minor modifications to sampling as presented in this SAP. When appropriate, the ADEQ Remedial Projects Unit Project Manager will be notified and a verbal approval will be obtained before implementing the modifications. Modifications to the approved SAP will be documented in the ATC Field Report Form and the RI Report.

TABLES

TABLE 1
HISTORICAL FLOW DIRECTION AND GRADIENT

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

Gauging Date	Bearing (degrees)	Hydraulic Gradient
10/16/1995	298	0.003
1/12/1996	291	0.002
7/12/1996	292	0.004
10/17/1996	298	0.003
1/15/1997	300	0.003
4/24/1997	300	0.002
7/31/1997	299	0.005
10/24/1997	294	0.003
1/29/1998	288	0.002
4/13/1998	299	0.004
7/16/1998	305	0.005
10/9/1998	292	0.004
1/22/1999	300	0.002
4/19/1999	293	0.004
7/13/1999	294	0.005
10/13/1999	296	0.004
1/14/2000	300	0.002
10/20/2000	298	0.004
1/14/2001	299	0.002
4/17/2001	295	0.004
10/30/2001	294	0.003
1/14/2002	317	0.009
4/2/2002	191	0.005
1/14/2003	296	0.002
4/29/2003	297	0.004
4/7/2005	334	0.003
7/5/2005	289	0.004
10/11/2005	301	0.003
1/31/2006	294	0.002
1/31/2007	286	0.002
1/27/2010	282	0.002
4/6/2010	306	0.003
7/13/2010	298	0.005
10/28/2010	305	0.003
1/25/2011	299	0.002
4/28/2011	301	0.004
1/30/2012	283	0.020
Average	295	0.003

Note:

Flow direction (bearing) and hydraulic gradient determined using 3-Point Solution based on data collected at monitor wells CMW-1, WVB-1 and WVB-4.

**TABLE 2
LABORATORY REPORTING CRITERIA**

ChemResearch Company, Inc.
1122 West Hilton Avenue
Phoenix, Arizona 85007

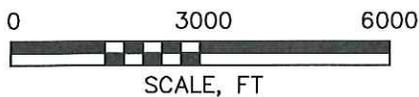
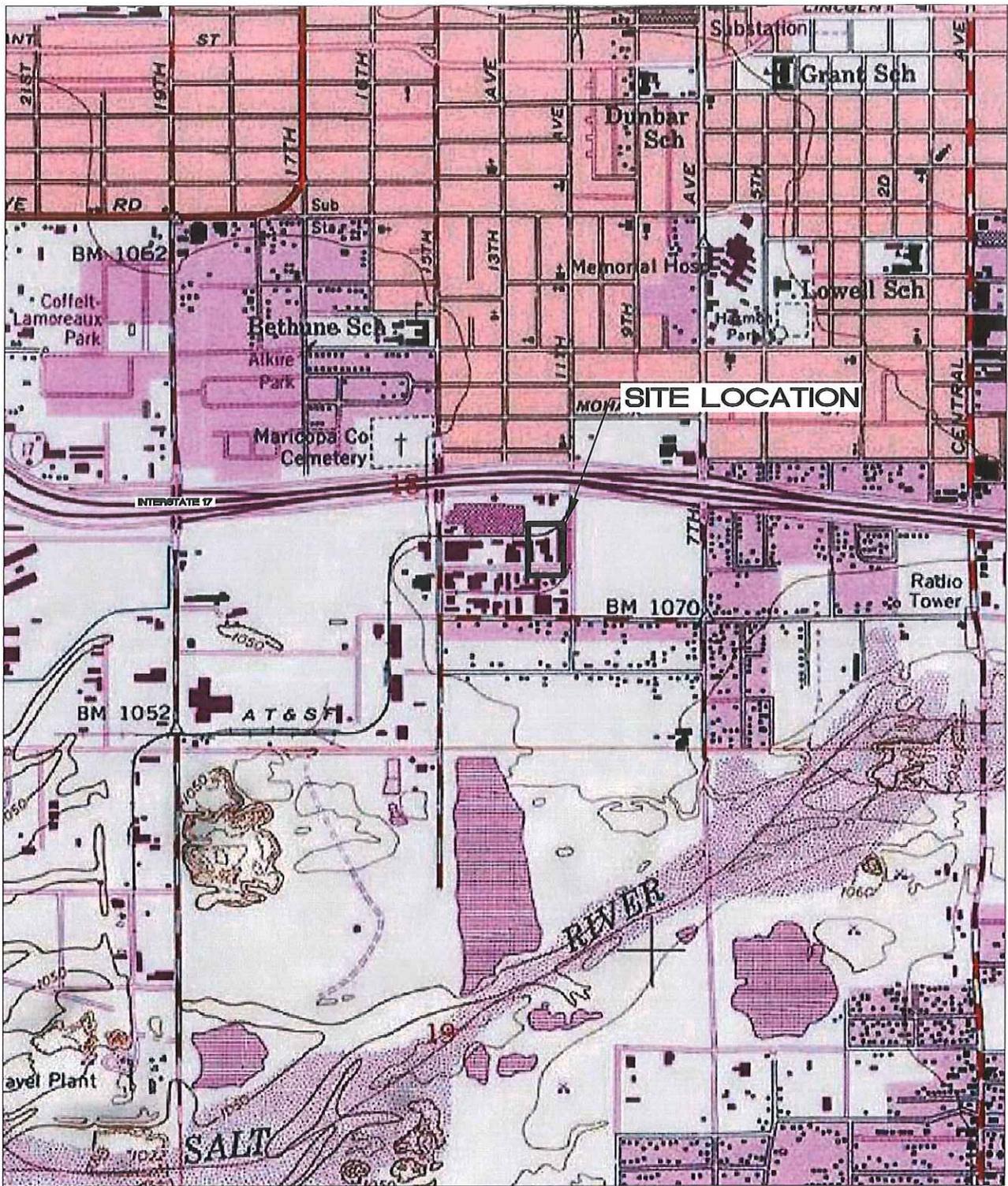
Analyte	Matrix	ADEQ Soil Remediation Levels (milligrams per kilogram [mg/kg])				MRL	MDL	Units	LCS/LCSD (%)			MS/MSD (%)		
		10 ⁻⁶	10 ⁻⁵	NC	NR				Low Limit	High Limit	RPD Limit	Low Limit	High Limit	RPD Limit
Tetrachloroethylene (PCE)	Soil	0.51	5.1	NA	13	0.10	0.05	mg/kg	71	133	20	37	140	30
Hexavalent Chromium	Soil	30	NA	NA	65	2.00	0.640	mg/kg	80	120	20	75	125	20
Cadmium	Soil	NA	NA	39	510	0.500	0.070	mg/kg	80	120	20	75	125	20
Chromium (Total)	Soil	NE	NE	NE	NE	1.00	0.140	mg/kg	80	120	20	75	125	20
Lead	Soil	NA	NA	400	800	0.500	0.190	mg/kg	80	120	20	75	125	20
Nickel	Soil	NA	NA	1,600	20,000	2.00	0.490	mg/kg	80	120	20	75	125	20
Analyte	Matrix	ADEQ Aquifer Water Quality Standard (micrograms per liter [µg/L])				MRL	MDL	Units	LCS/LCSD (%)			MS/MSD (%)		
									Low Limit	High Limit	RPD Limit	Low Limit	High Limit	RPD Limit
Tetrachloroethylene	Groundwater	5.0				1.00	0.372	µg/L	72	132	20	70	130	20
Hexavalent Chromium	Groundwater	100				10.0	3.00	µg/L	80	120	20	85	115	20
Cadmium	Groundwater	5.0				2.00	0.70	µg/L	80	120	20	75	125	20
Chromium (Total)	Groundwater	NE				10.0	1.40	µg/L	80	120	20	75	125	20
Lead	Groundwater	50				5.00	1.90	µg/L	80	120	20	75	125	20
Nickel	Groundwater	100				10.0	4.90	µg/L	80	120	20	75	125	20
Analyte	Matrix	ADEQ Recommended Vapor Screening Level (micrograms per cubic meter [µg/m ³])				MRL	MDL	Units	LCS/LCSD (%)			MS/MSD (%)		
									Low Limit	High Limit	RPD Limit	Low Limit	High Limit	RPD Limit
Tetrachloroethylene	Soil Vapor	1,567				1.0	6.78	µg/m ³	70	130	130	40	150	40
Notes:	ADEQ - Arizona Department of Environmental Quality NC - Non-carcinogenic NR - Non-residential MRL - Laboratory method reporting limit. MDL - Laboratory method detection limit. LCS/LCSD - Laboratory Control Sample/Laboratory Control Sample Duplicate RPD - Relative Percent Difference MS/MSD - Matrix Spike/Matrix Spike Duplicate NA - Not applicable. NE - Not established.													

TABLE 3
SUMMARY OF SAMPLES, CONTAINERS AND ANALYTICAL METHODS

ChemResearch Company, Inc.
 1122 West Hilton Avenue
 Phoenix, Arizona 85007

Sample ID	Matrix	Container	Number of Containers per Sample	EPA Analytical Method(s)	Total Samples
SV-1 to SV-17	Soil Vapor	Summa Canister	1	TO-15	17
SV-11-Duplicate	Soil Vapor	Summa Canister	1	TO-15	1
Ambient	Air	Summa Canister	1	TO-15	1
Equipment Blank	Nitrogen	Summa Canister	1	TO-15	1
SV-6 -Soil to SV-11-Soil	Soil	8-ounce Jar	1	7196A and 6010C	6
SV-14-Soil & SV-15-Soil	Soil	8-ounce Jar	1	7196A and 6010C	2
Equipment Blanks (5)	Water	40-mL VOA	3	6010C	5
IDW-Soil	Soil	8-ounce Jar	4	8260B, 8270C SIM, 6010C, 7471B	1
IDW-Water	Water	40-mL VOA	6	8260B, 8270C SIM, 6010C, 7471B, SM 4500H, 1010A	1
CMW-1M to CMW-1M-185	Groundwater	40-mL Amber VOA, 250-mL HDPE, 500-mL HDPE	3, 1, 1	8260B, 7196A, 6010C	24
CMW-1D-200 to CMW-1D-230	Groundwater	40-mL Amber VOA, 250-mL HDPE, 500-mL HDPE	3, 1, 1	8260B, 7196A, 6010C	12
CMW-2R to CMW-2R-200	Groundwater	40-mL Amber VOA, 250-mL HDPE, 500-mL HDPE	3, 1, 1	8260B, 7196A, 6010C	8
CMW-3	Groundwater	40-mL Amber VOA, 250-mL HDPE, 500-mL HDPE	3, 1, 1	8260B, 7196A, 6010C	8
WVB-4R to WVB-4R-200	Groundwater	40-mL Amber VOA, 250-mL HDPE, 500-mL HDPE	3, 1, 1	8260B, 7196A, 6010C	24
AVB69-02R	Groundwater	40-mL Amber VOA, 250-mL HDPE, 500-mL HDPE	3, 1, 1	8260B, 7196A, 6010C	4
Duplicate	Groundwater	40-mL Amber VOA, 250-mL HDPE	3, 1	8260B and 7196A	4
Notes:	EPA	- U.S. Environmental Protection Agency			
	mL	- Milliliter			
	VOA	- Volatile organic analysis.			
	IDW	- Investigative derived waste.			
	HDPE	- High density polyethylene			

FIGURES



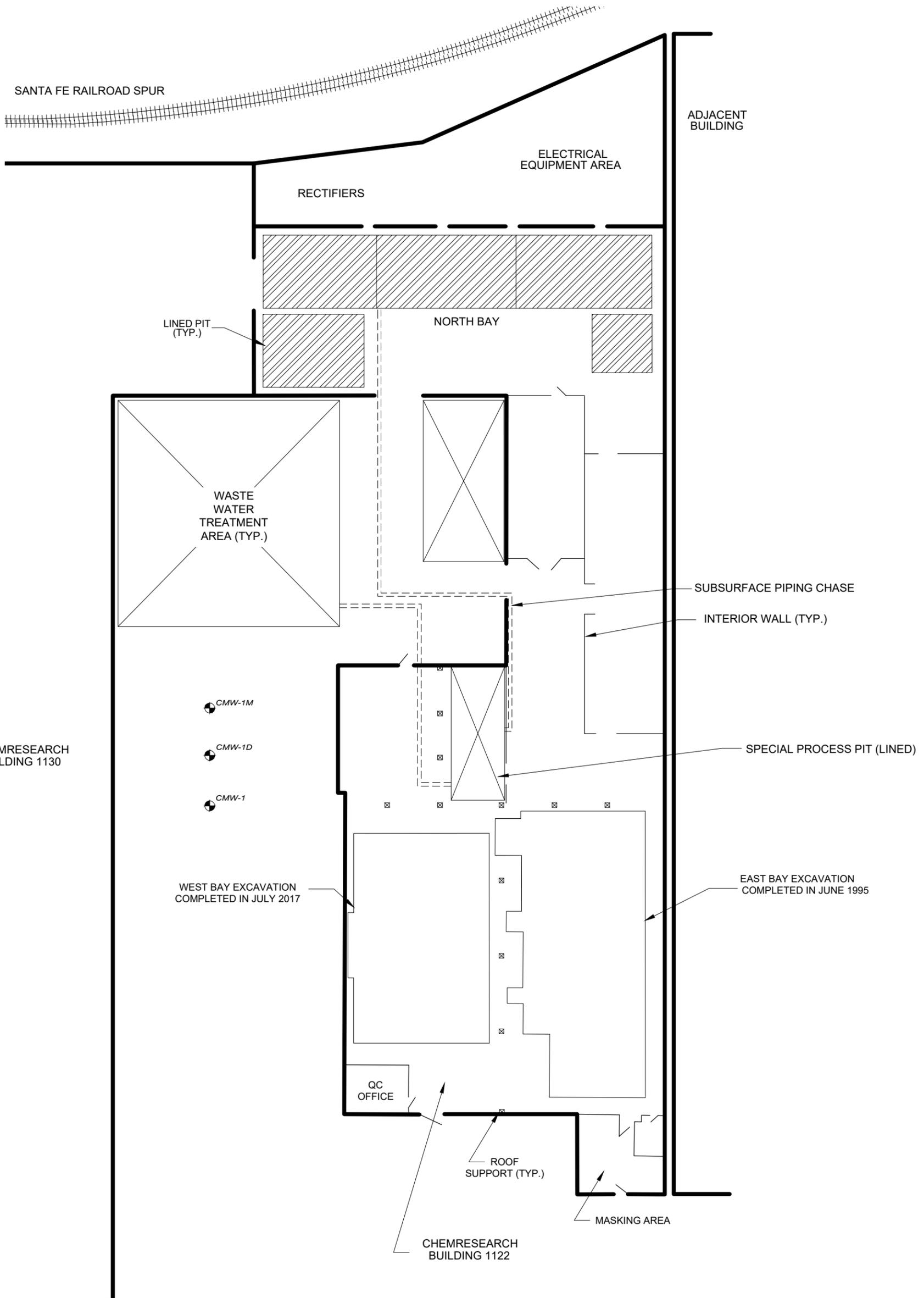
NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

SITE VICINITY MAP

CHEMRESEARCH COMPANY INC.
1122 WEST HILTON AVENUE
PHOENIX, ARIZONA 85007

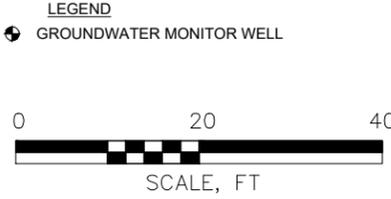
PROJECT NUMBER: 105200075	DATE: 12/7/17	FIGURE
APPROVED BY: RM	DRAWN BY: TV	1

ATC 9185 S. Farmer Ave., Ste. #111
Tempe, Arizona 85284-2912
Ph: (480) 894-2056 *** Fax: (480) 894-2497



CHEMRESEARCH BUILDING 1130

- CMW-1M
- CMW-1D
- CMW-1



NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.

EAST BAY AND WEST BAY EXCAVATIONS

CHEMRESEARCH COMPANY, INC.
 1122 W. HILTON AVENUE
 PHOENIX, ARIZONA 85007

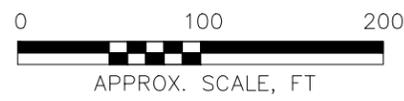
PROJECT NUMBER: 1052000111	DATE: 3/29/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	2
9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		



LEGEND

-  BUILDING
-  ROADWAY
-  RAILROAD
-  SOIL VAPOR SAMPLE LOCATION WITH TETRACHLOROETHYLENE CONCENTRATION IN $\mu\text{g}/\text{m}^3$ AT 15 FEET BELOW GROUND SURFACE.
-  NOT ANALYZED.

NOTES: DETECTIONS LISTED WITH ONE VALUE REPRESENT FIVE FOOT DEPTH RESULTS UNLESS OTHERWISE NOTED. SCALE AND LOCATIONS ARE APPROXIMATE.



ADEQ (1992) SOIL VAPOR SURVEY MAP

CHEMRESEARCH COMPANY, INC.
1122 WEST HILTON AVENUE
PHOENIX, ARIZONA 85007

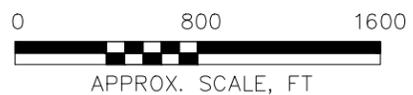
PROJECT NUMBER: 1052000111	DATE: 4/1/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	3
ATC 9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		



LEGEND

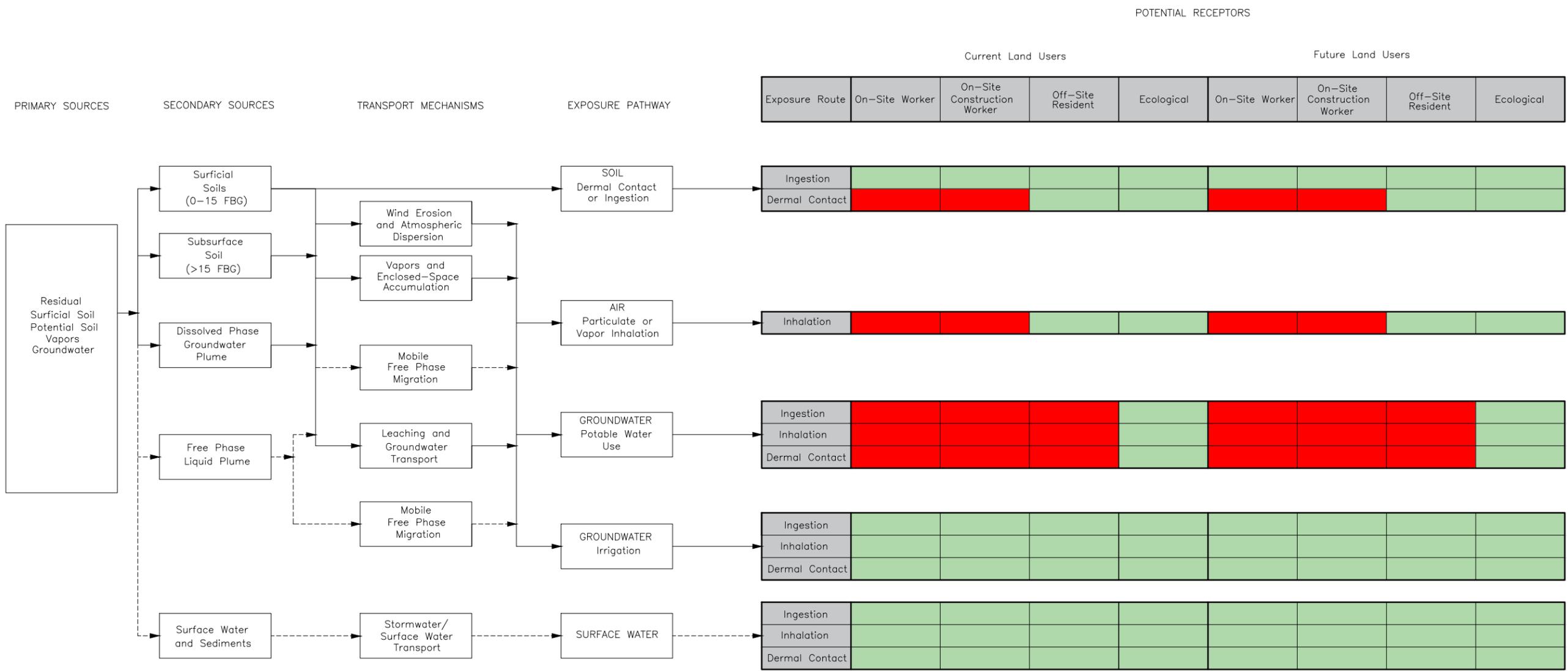
- PROPOSED GROUNDWATER MONITOR WELL LOCATION
- GROUNDWATER MONITOR WELL (INSTALLED BY ADEQ)
- ◆ GROUNDWATER MONITOR WELL (INSTALLED BY CHEMRESEARCH CO. INC.)
- ⊗ ROOSEVELT IRRIGATION DISTRICT PRODUCTION WELL
- ◆ 19TH AVENUE LANDFILL SUPERFUND SITE MONITOR WELL

NOTE: SCALE AND LOCATIONS ARE APPROXIMATE.



**GROUNDWATER MONITOR & PRODUCTION
WELL LOCATIONS MAP**
 CHEMRESEARCH COMPANY, INC.
 1122 WEST HILTON AVENUE
 PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 5/2/19	FIGURE
APPROVED BY: GEM	DRAWN BY: BK	4
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LEGEND

- A dashed line indicates an incomplete or broken exposure pathway.
- = Absent/insignificant exposure concern.
- = Potentially complete exposure pathway.
- FBG = Feet below grade.

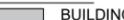
PROJECT NUMBER: 1052000111
 APPROVED BY: GEM
 DATE: 4/16/19
 DRAWN BY: TV
FIGURE 5

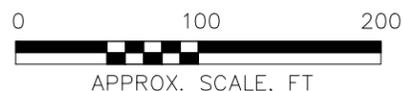
PRELIMINARY SITE CONCEPTUAL MODEL
 CHEMRESEARCH COMPANY, INC.
 1122 W. HILTON AVENUE
 PHOENIX, ARIZONA 85007

ATC
 9185 S. Farmer Ave., Ste. #111
 Tempe, Arizona 85284-2912
 Ph: (480) 894-2056 *** Fax: (480) 894-2497



LEGEND

-  BUILDING
-  ROADWAY
-  RAILROAD
-  SOIL VAPOR SAMPLE LOCATION WITH TETRACHLOROETHYLENE CONCENTRATION IN µg/m³ AT 15 FEET BELOW GROUND SURFACE.
-  NOT ANALYZED.
-  PROPOSED SOIL VAPOR SAMPLE LOCATIONS.
-  PROPOSED SOIL VAPOR AND SOIL SAMPLE LOCATIONS.



NOTES: DETECTIONS LISTED WITH ONE VALUE REPRESENT FIVE FOOT DEPTH RESULTS UNLESS OTHERWISE NOTED. SCALE AND LOCATIONS ARE APPROXIMATE.

PROPOSED SOIL VAPOR AND SOIL SAMPLE LOCATIONS MAP
 CHEMRESEARCH COMPANY, INC.
 1122 WEST HILTON AVENUE
 PHOENIX, ARIZONA 85007

PROJECT NUMBER: 1052000111	DATE: 4/1/19	FIGURE
APPROVED BY: GEM	DRAWN BY: TV	6
ATC 9185 S. Farmer Ave., Ste. #111 Tempe, Arizona 85284-2912 Ph: (480) 894-2056 *** Fax: (480) 894-2497		

APPENDICES

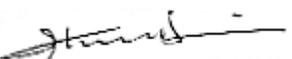
APPENDIX A

AIRTECH ENVIRONMENTAL LABORATORIES QUALITY ASSURANCE MANUAL

Laboratory LQM (LQM)

Yu Min Shi - Laboratory Director

**Airtech Environmental Laboratories, LLC.
4620 E. Elwood St., Suite 13
Phoenix, Arizona 85040**

Approved: 
Laboratory Director's Signature

10/01/2017
Date

Approved: 
Quality Assurance Manager Signature

10/01/2017
Date

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Annual Review (Performed if document has not been revised in the past 12 months)

Approved: _____
Laboratory Director's Signature
Date

Training Record

The following laboratory staff has read this Manual.

_____ Name	_____ Title	_____ Date



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1.0 Quality Policy

It is Airtech Environmental Laboratories objective to produce technically defensible laboratory test results of known and acceptable precision and accuracy, as prescribed by the approved method for each analyte. The test results are scientifically valid and legally defensible. The Laboratory is committed to routinely performing laboratory work in conformance to ISO 17025 and the standards adopted by the state of Arizona's Department of Health Services (ADHS) as well as the Arizona's Department of Environmental Quality (AZDEQ). Demonstration of the laboratory's commitment to reach its objective will result in the following:

*Adequately staffed and equipped laboratory facility.

*Internal audits with management review.

*Timely reporting of laboratory test results to our clients.

*Laboratory test results that are supported by quality control data and documented laboratory testing procedures.

The quality policy is communicated to employees during the training of new hires. It is understood, implemented, and maintained by employees at all levels. This is documented by management through the employee evaluation process, the training procedure, the internal audit process, and the document control process. The Laboratory Director shall ensure that the lab's policies and objectives for quality of testing services are documented. The Laboratory Director shall assure that the LQM is communicated to, understood, and implemented by all personnel concerned. Documentation includes signed statements in each analyst's training file.

1.1 Terms and Definitions

Accuracy: the degree of agreement between a measurement and true or expected value, or between the average of a number of measurements and the true or expected value.

Audit: a systematic evaluation to determine the conformance to specifications of an operational function or activity.

Batch: environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation batch is composed of 1 to 20 environmental samples of a similar matrix, meeting the above mentioned criteria, unless otherwise specified by the analytical method. Where no preparation method exists the batch is defined as environmental samples that are analyzed together with the same process and personnel, using the same lots of reagents, not to exceed 20 environmental samples. An analytical batch is composed of prepared environmental samples, that are analyzed together as a group.

Chain of Custody (COC): A system of documentation demonstrating the physical possession and traceability of samples.

Confidential Business Information (CBI): information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products.



Confirmation: verification of the presence of a component using an additional analytical technique. These may include second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors, or additional cleanup procedures.

Corrective Action: action taken to eliminate the causes of an existing non-conformance, defect or other undesirable situation in order to prevent recurrence.

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

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Document Control: the act of ensuring that documents (electronic or hardcopy and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

Field Blank: a blank matrix brought to the field and exposed to field environmental conditions.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Instrument Blank: a blank matrix that is the same as the processed sample matrix (i.e. extract, digestate, condensate, etc.) and introduced onto the instrument for analysis.

Internal Standard: A standard added to samples in known amount and carried through the procedure as a reference for calibration and controlling instrumental and analytical precision and bias.

Instrument Detection Limit (IDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is +100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Initial Demonstration of Capability (IDC): A procedure to establish the ability of the analyst to generate acceptable precision and accuracy. This process is typically part of the initial training for analysts learning new methodology.

Initial Demonstration of Proficiency (IDP): Method 8000D – See IDC.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

Laboratory Quality Manual (LQM): a document stating the quality policy, quality system and quality



practices of the laboratory. The LQM may include by reference other documentation relating to the laboratory's quality system.

Limit of Detection (LOD): an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte- and matrix-specific and may be laboratory-dependent.

Lower Limit of Quantitation (LLOQ): The lowest concentration at which the laboratory has demonstrated target analytes can be reliably measured and reported with a certain degree of confidence, which must be \geq the lowest point in the calibration curve.

Matrix: the substrate of a test sample. Common matrix descriptions are defined in Table 3.

Matrix Duplicate (MD): duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate; Laboratory Duplicate.

Relative Standard Error (RSE): Evaluation of the difference between the measured and the true amounts used to create the calibration curve model

2.0 Accredited Test Methods

Test	Description
EPA TO-15	Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC-MS).
8260B AZ Vapor	Volatile Organic Compounds in Vapor Samples
EPA 8260B – Water EPA 5030C - Water EPA 8260C - Water	Determination of Volatile Organic Compounds (VOCs) in Water by purge and trap GC/MS.

2.1 Environmental Containers, Preservative and Holding Times

Method	Parameter	Amount	Container	Preservative	Hold Time
EPA TO-15	Volatile Organics (GC/MS)	1 Canister	1 Canister	None	30 days from the time of collection.
8260B AZ Vapor	Volatile Organics – Purge and Trap (GC/MS)	10 mL	Tedlar Bag Air Tight Syringes Canister	None	-Tedlar Bags – 72 hr -Air Tight Syringes – 2 hr -Stainless Steel Canisters – 30 days



EPA 8260B – Water	Volatile Organics – Purge and Trap (GC/MS)	40 ml in triplicate or duplicate w/o headspace	40 mL fused silica screw cap vials with PTFE-faced silicone septum.	1:1 HCl 4.0 ± 2.0°C on the day of collection and maintained at that temperature until analysis.	Samples must be analyzed within 14 days of collection.
EPA 8260C- Water					

2.2 Summary of Calibration and QC Procedures for GC/MS Organics

Method	QC Check	Frequency	Acceptance Criteria ¹	Corrective Action ²
TO-15	Check of mass spectral ion intensities, i.e., Tune with BFB	Prior to initial calibration or Continuing calibration verification, every 24 hours	Refer to criteria listed in the method SOP for Tune criteria	Retune the instrument and verify (instrument maintenance may be needed).
	Minimum five-point initial calibration (Primary Source) for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	The calculated %RSD for the relative response factor (RRF) for each compound that is calibrated, must be < 30% with at most two (2) exceptions up to a limit of 40%, or $r \geq 0.995$ / $r^2 \geq 0.999$ for linear curves	Correct problem then repeat initial calibration.
	Method Blank (MBLK)	Each Analytical run, not to exceed the 24 hr clock	No detectable target compounds > RL	1) Re-inject the MBLK. 2) Correct problem then repeat the MBLK.
	Initial calibration verification (ICV)	Following ICAL and before sample analysis.	The % RSD of the response factor for each target analyte must be ± 30% from the average response factor in the ICAL. Or % D ≤ 30%	Correct problem then repeat initial calibration and re-analyze all samples since last successful ICV.
	Second Source calibration verification (PT Canister)	Following ICAL and before sample analysis.	PT acceptance limits provided by the PT Provider	Correct problem then repeat initial calibration and re-analyze all samples since last successful ICV.
	Internal Standards	Every sample/standard and blank	Retention time ±30 seconds from retention time of the mid-point std. in the CCV/ICAL (sample/standard). IS area ± 40% of ICAL mid-point std for the CCV and ± 40% of the prior CCV for the samples.	Inspect mass spectrometer and GC for malfunctions; mandatory re-analysis of samples analyzed while system was malfunctioning (dilution of the sample may be required, see the Department Manager for advice).
	LCS - CCV / LCSD (primary Source)	One per prep batch, not to exceed the 24 hr clock	± 30% of true value. RPD ≤ 25%	Correct problem then reanalyze the LCS - CCV / LCSD and all samples in the affected analytical batch.



Method	QC Check	Frequency	Acceptance Criteria ¹	Corrective Action ²
TO-15 (Cont)	Surrogate(s)	Every sample, spike, standard, and blank	± 30% of true value.	Check system, re-analyze.
Method	QC Check	Frequency	Acceptance Criteria ¹	Corrective Action ²
TO-15	Check of mass spectral ion intensities, i.e., Tune with BFB	Prior to initial calibration or Continuing calibration verification, every 24 hours	Refer to criteria listed in the method SOP for Tune criteria	Retune the instrument and verify (instrument maintenance may be needed).
	Minimum five-point initial calibration LCSD (primary Source) for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	The calculated %RSD for the relative response factor (RRF) for each compound that is calibrated, must be < 30% with at most two (2) exceptions up to a limit of 40%, or $r \geq 0.995 / r_2 \geq 0.990$ for linear curves	Correct problem then repeat initial calibration.
	Method Blank (MBLK)	Each Analytical run	No detectable target compounds > RL	1) Re-inject the MBLK. 2) Correct problem then repeat the MBLK.
	Initial calibration verification (ICV)	Following ICAL and before sample analysis	The % RSD of the response factor for each target analyte must be ± 30% from the average response factor in the ICAL. Or $\% D \leq 30\%$	Correct problem then repeat initial calibration and re-analyze all samples since last successful ICV.
	Internal Standards	Every sample/standard and blank	Retention time ±30 seconds from retention time of the mid-point std. in the CCV/ICAL (sample/standard). IS area ± 40% of ICAL midpoint std for the CCV and ± 40% of the prior CCV for the samples.	Inspect mass spectrometer and GC for malfunctions; mandatory re-analysis of samples analyzed while system was malfunctioning (dilution of the sample may be required, see the Department Manager for advice).
	LCS-CCV / LCSD (primary Source)	One per prep batch	± 30% of true value. RPD ≤ 25%	Correct problem then re-prepare and analyze the LCS and all samples in the affected analytical batch
	Surrogate(s)	Every sample, spike, standard, and blank	± 30% of true value.	Check system, re-analyze, re-prepare

1 - This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.

2 - All abnormalities must be noted on the raw data



Method	QC Check	Frequency	Acceptance Criteria ¹	Corrective Action ²
8260 B	Check of mass spectral ion intensities ¹ , i.e., Tune	Prior to initial calibration or Continuing calibration verification, every 12 hours	Refer to criteria listed in the method SOP for Tune criteria	Retune the instrument and verify (instrument maintenance may be needed).
	Minimum five-point initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per quarter minimum.	SPCCs average RF ≥ 0.30 or 0.1 depending on the compound and %RSD for RFs CCCs $\leq 30\%$ and all other target analytes %RSD for RF $\leq 20\%$.	Correct problem then repeat initial calibration
			<i>option (if %RSD is > 20%)</i> – linear regression $r^2 \geq 0.99$, $r \geq 0.995$.	If the calibration is not considered linear by either %RSD or linear regression, then correct the problem and re-calibrate.
	Initial calibration verification (ICV) must be from a 2 nd source.	Immediately following five-point initial calibration	All analytes meet CCV Criteria	Correct problem then repeat initial calibration
	Relative Retention time window	Each sample	Relative retention time (RRT) of the analyte within 0.06 RRT units of the RRT of the internal standard	Correct problem then reprocess or re-analyze all samples analyzed since the last retention time check
	Continuing calibration verification (CCV)	Daily, before sample analysis and every 12 hours of analysis time	SPCCs average RF ≥ 0.30 or 0.1 depending on the compound; and	Correct problem then repeat initial calibration and re-analyze all samples since last successful CCV.
			CCCs: $\leq 20\%$ difference (when using RFs) or drift (when using least squares regression). All other target compounds within the historical limits.	
	Method blank	One per analytical prep batch	No analytes detected > RL	Correct problem then re-prep ⁵ and analyze method blank and all samples processed with the contaminated blank
	Internal Standards	Every sample/standard and blank	Retention time ± 30 seconds from retention time of the mid-point std. in the CCV/ICAL (sample/standard). EICP area within -50% to +100% of ICAL mid-point std for the CCV and -50% to +100% of the prior CCV for the samples.	Inspect mass spectrometer and GC for malfunctions; mandatory re-analysis of samples analyzed while system was malfunctioning (dilution of the sample may be required, see the supervisor or the Laboratory Director for advice).



Method	QC Check	Frequency	Acceptance Criteria ¹	Corrective Action ²
	LCS/LCSD	One per prep batch, not to exceed the 20 samples in a batch.	See QC Limit Summary	Correct problem then re- ⁵ prep and analyze the LCS and all samples in the affected analytical batch
	MS/MSD	One per batch per matrix, if insufficient sample for MS/MSD, then a LCS/LCSD will be analyzed.	See QC Limit Summary	None (the LCS/LCSD is used to evaluate to determine if the batch is acceptable).
	Surrogate(s)	Every sample, spike, standard, and blank	≥ 30% Recovery	Check system, re-analyze, re- ⁵ prep
	pH check	All 8260 water samples.	pH ≤ 2.	If the pH is > 2, then comment the data, in the CAR database, and LIMS.
8260 C	Check of mass spectral ion intensities ¹ , i.e., Tune	Prior to initial calibration or Continuing calibration verification, every 12 hours	Refer to criteria listed in the method SOP for Tune criteria	Retune the instrument and verify (instrument maintenance may be needed).
	Minimum five-point initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per quarter minimum.	%RSD is ≤ 20% If linear regression $r^2 \geq 0.99$, $r \geq 0.995$.	Correct problem then repeat initial calibration. Must recalibrate if >10% of target compounds exceed the %RSD or regression criteria.
	If linear calibration is used:	Must verify the reporting level by reprocessing lowest calibration standard.	≥ 30% Recovery	Correct problem then repeat initial calibration.
	Initial calibration verification (ICV) must be from a 2 nd source.	Immediately following five-point initial calibration	≥ 30% Recovery or meet in-house historical limits.	
	Relative Retention time window	Each sample	Relative retention time (RRT) of the analyte within 0.06 RRT units of the RRT of the internal standard	Correct problem then reprocess or re-analyze all samples analyzed since the last retention time check
	Continuing calibration verification (CCV)	Daily, before sample analysis and every 12 hours of analysis time	RF ≥ Table 4 %RSD is ≤ 20% ≤20% difference (when using RFs) or drift (when using least squares regression). If criterion is not met for more than 20% of compounds included in the ICAL	In cases where compounds fail, they may still be reported as non-detects if you can demonstrate adequate sensitivity to detect the compound at the applicable quantitation level. If failed compounds are present the result may still be reported but qualified as an estimated value. Correct problem then repeat initial calibration and re-analyze all samples since last successful CCV.



Method	QC Check	Frequency	Acceptance Criteria ¹	Corrective Action ²
	Method blank	One per analytical prep batch	No analytes detected > RL	Correct problem then re- ⁵ prep and analyze method blank and all samples processed with the contaminated blank
	Internal Standards	Every sample/standard and blank	Retention time ± 30 seconds from retention time of the mid-point std. in the CCV/ICAL (sample/standard). EICP area within -50% to +100% of ICAL mid-point std for the CCV and -50% to +100% of the prior CCV for the samples.	Inspect mass spectrometer and GC for malfunctions; mandatory re-analysis of samples analyzed while system was malfunctioning (dilution of the sample may be required, see the supervisor or the Laboratory Director for advice).
	LCS/LCSD	One per prep batch, not to exceed the 20 samples in a batch.	See QC Limit Summary	Correct problem then re- ⁵ prep and analyze the LCS and all samples in the affected analytical batch
	MS/MSD	One per batch per matrix, if insufficient sample for MS/MSD, then a LCS/LCSD will be analyzed.	See QC Limit Summary	None (the LCS/LCSD is used to evaluate to determine if the batch is acceptable).
	Surrogate(s)	Every sample, spike, standard, and blank	$\geq 30\%$ Recovery	Check system, re-analyze, re- ⁵ prep
	pH check	All 8260 water samples.	pH ≤ 2 .	If the pH is > 2, then comment the data, in the CAR database, and LIMS.
8260B AZ Vapor	Check of mass spectral ion intensities, i.e., Tune with BFB	Prior to initial calibration or Continuing calibration verification, every 24 hours	Refer to criteria listed in the method SOP for Tune criteria	Retune the instrument and verify (instrument maintenance may be needed).
	Minimum five-point initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per quarter minimum.	SPCCs average RF ≥ 0.30 or 0.1 depending on the compound and %RSD for RFs CCCs $\leq 30\%$ and all other target analytes %RSD for RF $\leq 20\%$.	Correct problem then repeat initial calibration
			<i>option (if %RSD is > 20%)</i> – linear regression $r^2 \geq 0.99$, $r \geq 0.995$.	If the calibration is not considered linear by either %RSD or linear regression, then correct the problem and re-calibrate.
	Initial calibration verification (ICV) must be from a 2 nd source.	Immediately following five-point initial calibration	All analytes meet CCV Criteria	Correct problem then repeat initial calibration



Method	QC Check	Frequency	Acceptance Criteria ¹	Corrective Action ²
	Continuing calibration verification (CCV)	Daily, before sample analysis and every 12 hours of analysis time	SPCCs average RF ≥ 0.30 or 0.1 depending on the compound; and	Correct problem then repeat initial calibration and re-analyze all samples since last successful CCV.
			CCCs: $\leq 20\%$ difference (when using RFs) or drift (when using least squares regression). All other target compounds within the historical limits.	
	Method blank	One per analytical prep batch	No analytes detected > RL	Correct problem then re- ⁵ prep and analyze method blank and all samples processed with the contaminated blank
	Internal Standards	Every sample/standard and blank	Retention time ± 30 seconds from retention time of the mid-point std. in the CCV/ICAL (sample/standard). EICP area within -50% to +100% of ICAL mid-point std for the CCV and -50% to +100% of the prior CCV for the samples.	Inspect mass spectrometer and GC for malfunctions; mandatory re-analysis of samples analyzed while system was malfunctioning (dilution of the sample may be required, see the supervisor or the Laboratory Director for advice).
	LCS/LCSD	One per prep batch, not to exceed the 20 samples in a batch.	RPD $\geq 30\%$	Correct problem then re- ⁵ prep and analyze the LCS and all samples in the affected analytical batch
	SAMPLE DUPLICATE	One per batch per matrix,	RPD $\geq 30\%$	None (the LCS/LCSD is used to evaluate to determine if the batch is acceptable).
	Surrogate(s)	Every sample, spike, standard, and blank	$\geq 30\%$ Recovery	Check system, re-analyze, re- ⁵ prep

2.3 Schedule of Routine Maintenance

Instrument	Procedure	Frequency	
Hewlett Packard GC/MS	Ion gauge tube degassing	As required	
	Pump oil-level check	Monthly	
	Pump oil changing	As Needed	
	Analyzer bake-out	As required	
	Analyzer cleaning	As required	
	Resolution adjustment	As required	
	COMPUTER SYSTEM AND PRINTER:		
	Air filter cleaning	As required	
	Change data system air filter	As required	
	Printer head carriage lubrication	As required	
	Paper sprocket cleaning	As required	
Drive belt lubrication	As required		



Instrument	Procedure	Frequency
Gas Chromatograph	Compare standard response to previous day or since last initial calibration Check carrier gas flow rate in column Check temp. of detector, inlet, column oven Septum replacement Check system for gas leaks with SNOOP Check for loose/frayed wires and insulation ½" Bake injector/column Change/remove sections of guard column Replace connectors/liners Change/replace column(s)	Daily Daily via use of known compound retention Daily As required W/cylinder change as required Monthly As Required As Required As Required As Required

3.0 Quality System

3.1 The quality system applies to all personnel who perform activities affecting data quality.

3.2 Through a formal documented system of planned surveillance activities, the quality system is based on the most recent revisions of the relevant requirements of ISO 17025, and the ADHS administrative codes Title 9, Chapter 14 (a.k.a. Arizona Rules).

3.3 The Quality Assurance Manager maintains the LQM and ensures it is current and up-to-date.

3.4 The laboratory defines its policy for each applicable standard element in the LQM. For each element, as appropriate, the laboratory has documented procedures that describe how the specific policy objectives and goals are met. These procedures may be documented in the LQM or in a separate document such as a SOP or work instruction.

3.5 The LQM references these documented procedures. Where applicable, SOPs and work instructions are referenced in the documented procedures or in the LQM.

3.6 Quality procedures and instructions are implemented as written. The procedures explain how the laboratory implements the standard requirements in accordance with its quality policy.

3.6.1 The quality system documents are revised, as necessary, to reflect the actual objectives, flow of tasks, and staff responsibilities. **Quality records include reports from internal audits and management reviews as well as records of corrective and preventive actions.**

3.7 Work instructions are also controlled and maintained in the laboratory if applicable.

4.0 Job Descriptions of Staff

The specific duties and responsibilities of the Laboratory Director, Quality Assurance Manager, Department Managers, Sample Receiving Manager and Safety Officer are as follows:

NOTE: In the absence of any one individual, the staff or assistant within each department is professionally skilled in the ability to administer the function of the administrator or support personnel. This will allow for the continuance of the day-to-day operations of the laboratory.



4.1 Laboratory Director

- 4.1.1 Responsible for implementation and adherence by lab staff to the AEL LQM, and all policies and procedures within the laboratory.
- 4.1.2 Has signature authority for LQM, policies, SOPs, and contracts.
- 4.1.3 Periodically assesses the effectiveness of the quality system within the lab.
- 4.1.4 Maintains adequately trained staffing.
- 4.1.5 Responsible for implementing corrective actions for internal and external audits.
- 4.1.6 Responsible for coordinating the development and implementation of methods and SOPs.
- 4.1.7 Performs technical training in area(s) of expertise.
- 4.1.8 Manages technical needs and solving day-to-day technical issues.
- 4.1.9 Determines qualifications required for technical positions and evaluates job candidates against those requirements.
- 4.1.10 Investigates technical issues related to projects as directed by the Quality Assurance Manager.
- 4.1.11 Certifies technical laboratory personnel based on education and background to ensure that staff has demonstrated capability in the activities for which they are responsible.

4.2 Quality Assurance Manager

- 4.2.1 Reports directly to the Laboratory Director on all QA matters to maintain independence of QA oversight.
- 4.2.2 Serves as the focal point for QA/QC and is responsible for the oversight and/or review of quality control data.
- 4.2.3 Responsible for implementing corrective actions for internal and external audits.
- 4.2.4 Maintains, approves, communicates and implements the LQM.
- 4.2.5 Has joint signature authority, with the Laboratory Director for approval of quality documents, e.g., LQM, policies, and SOPs.
- 4.2.6 Directs controlled distribution of laboratory quality documents.
- 4.2.7 Provides QA training to all new personnel.
- 4.2.8 Reviews and approves documentation of analyst training records.
- 4.2.9 Reviews corrective actions and recommends resolution for recurring nonconformances within



the laboratory.

4.2.10 Assists in maintaining regulatory analytical compliance, including maintaining certifications.

4.2.11 Performs systems, data, contract compliance, and surveillance audits.

4.2.12 Hosts external audits conducted by outside agencies.

4.2.13 Oversees the selection, review, and approval of analytical subcontractors.

4.2.14 Prepares periodic QA Reports to management describing significant quality events.

4.3 Department Manager

4.3.1 Supervises daily activities of their operational group.

4.3.2 Schedules analytical operations.

4.3.3 Supervises QC activities performed as a part of routine analytical operations.

4.3.4 Implements data review procedures.

4.3.5 Supervises the preparation and maintenance of laboratory records.

4.3.6 Supervises maintenance of instruments and scheduling of repairs.

4.3.7 Works as the Project Managers to ensure that the requirements of projects are met in a timely manner.

4.3.8 Responsible for meeting quality requirements.

4.3.9 Responsible for implementing corrective actions for internal and external audits.

4.4 Sample Receiving Manager

4.4.1 Ensures implementation of proper sample receipt procedures, including maintenance of chain-of-custody.

4.4.2 Reports nonconformances associated with condition-upon-receipt of samples.

4.4.3 Logs in samples.

4.4.4 Ensures that all samples are stored in the proper environment.

4.4.5 Responsible for meeting quality requirements.

4.5 Safety Officer

4.5.1 Responsible with the Laboratory Director for the safety and well being of all employees while



at the laboratory.

- 4.5.2 Responsible for implementing and communicating the Safety Manual.
- 4.5.3 Addresses laboratory compliance issues related to the Safety Manual.
- 4.5.4 Provides SDS training and review.
- 4.5.5 Conducts laboratory safety orientation and tours for all new employees.
- 4.5.6 Also works as the Chemical Hygiene officer.
- 4.5.7 Ensures OSHA regulatory requirements are met.
- 4.5.8 Ensures periodic safety inspections are performed, documented and corrective actions are implemented.
- 4.5.9 Provides instructions on safety equipment, PPE, cleaning up laboratory spills, and instructing personnel of laboratory procedures for emergency situations.
- 4.5.10 Manages the laboratory-generated hazardous waste if applicable in accordance with appropriate regulations.
- 4.5.11 On-call 24-hours a day, 7-days a week for all laboratory situations.

4.6 Chemists / Project Chemist

- 4.6.1 Performs analytical methods and data recording in accordance with documented procedures.
- 4.6.2 Performs and documents calibration and preventive maintenance.
- 4.6.3 Performs data processing and data review procedures.
- 4.6.4 Reports nonconformances to the Department Manager and QA Manager.
- 4.6.5 Responsible for meeting quality requirements defined in this LQM and other supporting QA procedures.

5.0 Document Control

- 5.1 All operating procedures, manuals including this LQM, and documents are subject to document control. Distribution of controlled documents is limited to those indicated on the document distribution list. A controlled document identification number in the footer indicates controlled documents. Uncontrolled copies are indicated by a watermark indicating "Uncontrolled" on each page of the document. The Quality Assurance Manager or designee controls the distribution of controlled copies.
- 5.2 The purpose of the document control system is to ensure that only the most recent revisions are available to the appropriate personnel, revisions are timely, and receive the required



approvals. All internal regulatory documentation, standard operating procedures, work instructions, service manuals, and product instructions are under document control.

5.3 All data, including original observations, calculations and derived data, calibration records, QC records, and copies of the test reports, resulting from the analyses of samples are recorded and kept for **five years** to allow historical reconstruction of the final result.

5.4 Raw data and reports are documented and stored in a manner that is easily retrievable. The procedure for maintaining raw data records is briefly described below:

- All raw data, for example, instrument print-outs and logbooks, are maintained in a secured storage area or records are scanned and retained on electronic media.
- The computer information is backed up on tape regularly, and stored in a secured and temperature/humidity controlled environment to maintain the integrity of the electronic information in the event of system failure. Copies of all back-up tapes are maintained in secured off-site locations.
- All copies of client final reports are maintained in hard copy format or electronically (e.g., Adobe Acrobat).

5.5 The Quality Assurance Manager is responsible for the document control system and keeps a master list of the location of all documents and their current revision.

5.6 The Laboratory Director and the Quality Assurance Manager approve all newly released documents and revised documents. Any employee can request a change to a document. Obsolete documents are retained for legal reasons or for knowledge preservation.

5.7 The Quality Assurance Manager stores retained obsolete documents. Each page of documents produced by the laboratory will contain the effective date, revision number, Document number, and Document title. Controlled documents will have an approval signature page, and a distribution list.

5.8 All SOPs and internal controlled documents are reviewed periodically. If a document is revised during the year the revision record in the document shall demonstrate review. If a document has not been revised during the year, the review record shall be the signature of the person responsible for the document and the date of the review. Amendment of documents is allowed pending formal re-issue. Such revisions will be dated and initialed, and the document will be formally revised when practicable.

6.0 Traceability of Measurements

6.1 All calibration standards and supporting equipment shall be traceable to the National Institute of Standards and Technology (NIST) or equivalent national standard.

6.2 A certified company shall calibrate the supporting equipment periodically as required by the manufacturer.



7.0 Review of all Requests, Tenders and Contracts

- 7.1 All new work is initiated by the Laboratory Director who delegates responsibilities for the new work according to available resources.
- 7.2 The staff meets prior to initiation of new work in order to determine if appropriate facilities and resources are available.
- 7.3 The plan for any new testing shall be reviewed and approved by the Laboratory Director before commencing such work.
- 7.4 If the review uncovers any potential conflicts, deficiencies, inappropriate accreditation status, and/or inability to perform the work, the laboratory shall notify the client.
- 7.5 In cases where differences exist between the request/tender and contract they shall be resolved prior to starting work.
 - 7.5.1 The review shall document that facilities and resources are organized to efficiently perform the work, including subcontracted work.
 - 7.5.2 The record of contract review includes pertinent discussions with the client regarding their requirements and results submitted during the contract period.
 - 7.5.3 For routine reviews of ongoing work a date and a signature of the laboratory official responsible for the contract is sufficient.
 - 7.5.4 For any new testing requirements, the designated official shall ensure that standard operating procedures and demonstration of capability to perform those tests prior to reporting results are available.
 - 7.5.5 The SOP(s) shall be under document control and a Demonstration of Capability (DOC) statement(s) shall be on file. Copies are held in the contract review file.
- 7.6 Clients are notified immediately in situations where the laboratory cannot conform to the contract and if there is a change in laboratory accreditation status.

8.0 Calibration/ Verification of Test Procedures.

- 8.1 Calibration and/or verification procedures are designed to ensure that the data will be of known quality and be appropriate for the needs of the client. Details of instrument calibration and/or test verification procedures including calibration range, minimum reporting levels, calculations and acceptance criteria are included or referenced in each test method SOP.
- 8.2 Sufficient raw data are retained to reconstruct the calibration used to calculate the sample result.
- 8.3 All calibrations are verified with a second source standard, which is traceable to a national standard, when available.



- 8.4 Calibration standards include a concentration at or below the regulatory / decision level but above the laboratory's detection limit (MDL/PQL).
- 8.5 Results of samples must be within the calibration range (bracketed by standards) or the test may be repeated at a dilution and reported or the results must be flagged as an estimated value.
- 8.6 No data associated with a calibration that is out-of-control will be reported unless approved by the client.

9.0 Sample Handling

9.1 Sample Acceptance Policy

- 9.1.1 Designated employees and trained sample collectors are the only official collectors of samples.
- 9.1.2 Samples that have not been properly stored during transport to the laboratory will be appropriately qualified and all discrepancies will be communicated to the client prior to analysis of the sample.
- 9.1.3 Sample containers that are found at receipt to be compromised will also be appropriately qualified and all discrepancies will be communicated to the client prior to analysis of the sample.
- 9.1.4 Each container will be uniquely identified and correspond with the associated Chain of Custody (CoC). The CoC will have the following information:
- Clients address
 - Collection date
 - Collection time
 - Date and time the sample is submitted to the laboratory
 - Date and time the sample was accepted by the laboratory.
- 9.1.5 If any samples, upon arrival to the laboratory do not meet any requirements of the acceptance policy, the samples the client will be immediately notified and asked how to proceed. The data will be qualified with the appropriate data qualifier.

- 9.1.6 If the client cannot be contacted, a resample may be requested.

9.2 Procedures for handling submitted samples

- 9.2.1 The sample acceptance policy is documented and available to the sample collectors.
- 9.2.2 If any samples do not meet any requirements of the acceptance policy, the data is flagged in an unambiguous manner clearly defining the nature and substance of the variation.



9.2.3 The sample receipt protocol is documented. The condition of the sample, including any abnormalities or departures from standard condition as prescribed in the relevant test method, is recorded.

9.2.4 Receipt of all samples is recorded in a permanent chronological computer record. The record contains project name, date and time of laboratory receipt, laboratory ID, initials of recorder.

10.0 Laboratory Environment

10.1 Testing occurs in a controlled environment where sources of contamination have been investigated and eliminated by utilizing engineering controls.

10.2 All equipment and reference materials required for the accredited tests are available in the laboratory. Records are maintained for all equipment, reference measurement materials, and services used by the laboratory.

10.3 Certificates of Traceability are available for all reference materials and major supporting equipment such as time integrated samplers. The reference materials are used only for calibration to maintain the validity of performance.

11.0 Procedures for Calibration, Verification, and Maintenance of Equipment

11.1 Equipment is identified with a specific ID#, maintained, inspected, and cleaned according to the written Equipment Maintenance Procedures. Any defective item of equipment is clearly marked and taken out of service until it has been shown to perform satisfactorily.

11.2 All instrument maintenance is documented in the associated maintenance logbook.

11.3 Each item of equipment or reference material is labeled to show its calibration status.

11.4 Equipment and reference material records include:

- Name of item of equipment or reference material
- Manufacturer, identification, serial number
- Date received and placed in service
- Current location
- Condition when received
- Copy of manufacturer's instructions or manuals
- Dates and results of calibrations/verifications and date of next calibration/verification
- Details of maintenance carried out to date and planned for the future
- History of any damage, malfunction, modification, or repair

11.5 Service of equipment is performed by qualified service organizations. All records and certificates from service calls are retained.

12.0 Verification Practices

12.1 AEL reports its participation in an accredited proficiency testing (PT) program if available for each licensed parameter on a semi-annual frequency.



12.2 AEL may participate in voluntary “round robin” performance studies.

13.0 Internal Quality Control Procedures

13.1 The data acquired from quality control (QC) procedures are used to estimate the quality of analytical data, to determine the need for corrective action, and to interpret results after corrective actions are implemented.

13.2 Each method standard operating procedure (SOP) includes detailed QC procedures and QC limits. QC limits are generated internally where no method limits exist.

13.3 Duplicate limits for the precision range from the mean of the historical differences or relative percent differences.

13.4 Background checks are performed during calibration. The results are used to determine batch acceptance. When blanks exceed the method SOP limits, the source of the contamination is investigated and measures are taken to correct, minimize and eliminate the problem.

13.5 Laboratory duplicates, if available are performed at a frequency of 20 percent of the batch.. Duplicates are a measure of precision. If a duplicate result falls outside QC limits the original sample and the duplicate sample data qualified with a data qualifier.

14.0 Control of Non-Conforming Environmental Testing

14.1 Specific corrective action protocols for handling out-of control events are in each method SOPs. In addition, general procedures are followed to determine when departures from quality control have occurred.

14.2 Isolated deviations from the standard procedures and the required documentation is determined by the Corrective Action Procedure. Because of the sampling schedule and the time frame of the analysis, it is not always possible to repeat the analysis if all quality control measures are not found acceptable. Therefore, if a quality control measure is found to be out-of-control, and the data is to be reported, all samples associated with the failed quality control measure are reported with the appropriate data qualifier (See Appendix B).

14.3 All employees have the authority to stop work on samples when any aspect of the testing and reporting process does not conform to the laboratory’s SOPs or client’s requirements. The employee who stopped work shall immediately notify the Department Manager, Quality Assurance Manager and /or the Laboratory Director.

14.4 The Quality Assurance Manager evaluates the significance of the non-conforming work. A corrective action is defined as an out-of-control event that requires a change in procedure, retraining of the staff or indication of a systematic problem identified by multiple out-of-control events of the same or similar nature.

14.5 If necessary, the client is notified and reports may be recalled, revised and reissued. The Laboratory Director is responsible for authorizing the resumption of work.

15.0 Corrective Action Procedure

15.1 Corrective action is the process of identifying, investigating, approving, implementing and



validating measures to counter unacceptable departures from policies and procedures or out of control QC performance which can affect data quality.

- 15.1 Deficiencies cited in the external assessment (external audits), internal quality audit, complaints, and managerial review are documented.
- 15.2 Records shall be available to show that the root cause(s) of the deficiencies are investigated, including the results of the investigation.
- 15.3 Records shall be available to document the intended corrective action.
- 15.4 Records shall be available to show that the implemented corrective action is monitored for effectiveness.
- 15.5 The Quality Assurance Manager maintains these records.
- 15.6 The Laboratory Director will ensure that the corrective actions are discharged within the agreed upon time frame.
- 15.7 When nonconformance and departures from SOPs cause doubt about the laboratory's operations, the affected areas may be audited by the QA Manager.
- 15.8 Method SOPs provide QC acceptance criteria and specific protocols for corrective actions.
- 15.9 Any QC measure result that falls outside of acceptance limits requires corrective action.
- 15.10 When testing discrepancies are detected such as out-of-control QC, the analyst will follow the specific protocol for corrective action as stated in the method SOP.
- 15.11 In addition, any discrepancies are documented in the Corrective Action Logbook maintained in the laboratory.
- 15.12 The discrepancy will be identified, and the sample data associated with the discrepancy will be flagged.
- 15.13 The QA Manager will recommend corrective actions to be initiated by the analyst and ensure implementation and documentation of the corrective action.
- 15.14 Each corrective action log entry is reviewed, signed, and dated by the QA Manager and the Laboratory Director.
- 15.15 Corrective actions are performed prior to the reporting of the effected data.
- 16.0 **Exceptionally Permitted Departures from Documented Policies and Procedures or From Standard Specifications.**
- 16.1 The Laboratory Director has responsibility for ensuring the lab's policies and procedures are adhered to. Arrangements for known and controlled departures from documented policies and procedures are allowed. Planned departures do not require audits, however, the departure will be fully documented by the Quality Assurance Manager and include the reason for the departure, the effected SOP(s), the intended results of the departure and the actual results. If



the data reported to the authority or client is affected adversely, it will be notified in writing. The corrective action procedure is used for documenting this process.

17.0 Preventive Action

17.1 Preventive action is the pro-active process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints.

17.2 All employees have the authority to recommend preventive action. Recommendations are made to the QA Manager. If warranted, the QA Manager develops an action plan to develop, implement and monitor the action. The plan must include controls that will enable objective evaluation of its suitability. The preventive action is audited under the direction of the QA Manager.

18.0 Complaints

18.1 All complaints about the laboratory's activities received from clients or other parties will be documented in a complaint file maintained in the laboratory. The file will contain the date and name of the person receiving the complaint, a description of the complaint, source of the complaint, the resolution, and any written material accompanying the complaint.

18.2 The QA Manager investigates complaints may audit all areas of activity and responsibility involved. The Laboratory Director reviews the written results of the investigation including actions taken by the laboratory. The results of the investigation are signed and dated by the Laboratory Director and the QA Manager.

19.0 Internal Audit and Data Review

19.1 Data Review

19.1.1 All original observations and calculations are reviewed and evaluated by the second analyst or the QA Manager before it is reported. The data is reviewed, per the relevant SOPs, to ensure that calculations are correct, manual integrations are properly performed and to detect any transcription errors.

19.1.2 The second analyst reviewer will sign and date the raw data on the signature space on the data review checklist.

19.1.3 Errors detected in the review process are referred to the analyst for corrective action. The QA Manager assures that all errors found in the review process are documented along with the corrective action.

19.1.4 As needed, the QA Manager will audit 1 data package and 1 final report. The purpose of the review is to verify that all data integrity requirements are met.

19.2 Internal Quality System Audits

19.2.1 The QA Manager will perform for an internal quality system review on an as needed basis.

19.2.2 The audit will be carried out by trained personnel who are independent (if possible) of the activity being audited.



- 19.2.3 The QA Manager will review the requirements of the appropriate standards against laboratory operations, and laboratory operations against the laboratory LQM and SOPs.
- 19.2.4 The results of the audits will be documented in writing.
- 19.2.5 Where audit findings cast doubt on the validity or correctness of the data, the lab will take immediate corrective action.
- 19.2.6 Any corrective actions will be documented.
- 19.2.7 Any Authority/client whose work was possibly adversely affected shall be notified in writing.
- 19.2.8 Documented reviews are performed with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity.
- 19.2.9 Allegations are confidentially investigated. All investigations that result in findings of inappropriate activity are documented and shall include any disciplinary actions involved, corrective actions taken, and all appropriate notifications to clients. Documentation is maintained for five years.

19.3 Managerial Review

- 19.3.1 The Laboratory Director shall review the LQM and its testing and calibration activities periodically to introduce any necessary changes or improvements. The review will be take into account:
 - 19.3.1.1 The outcome of recent internal audits.
 - 19.3.1.2 Reports from managerial and supervisory personnel.
 - 19.3.1.3 Suitability of policies and procedures.
 - 19.3.1.4 Assessments by external bodies (ADHS).
 - 19.3.1.5 The results of proficiency tests.
 - 19.3.1.6 Any changes in the volume and type of work undertaken.
 - 19.3.1.7 Feedback from clients or Authorities.
 - 19.3.1.8 Corrective and preventive actions and complaints.
 - 19.3.1.9 Other factors such as quality control activities, resources and staff training.
 - 19.3.1.10 The findings and any corrective actions from this review will be documented.

20.0 Training and Review of Personnel Qualifications

- 20.1 Laboratory management reviews an applicant's level of qualification, experience, and skills against the laboratory's job description requirements before assigning an employee to the



laboratory.

20.2 Each analyst has adequate experience and education to demonstrate specific knowledge

20.3 The laboratory will maintain a training file which contains:

20.3.1 Employees resume.

20.3.2 The employee has read and understands the Safety Policy.

20.3.3 A statement from each employee that they have read, understood, and is using the latest version of the laboratory LQM and SOPs. The statement will be signed and dated.

20.3.4 A statement from each employee that they have read, acknowledged and understood their personal ethical and legal responsibilities including the potential punishments and penalties for improper, unethical or illegal actions. The statement will be signed and dated.

20.3.5 Demonstration of Capability (DOC) for each employee for each accredited method.

20.3.6 Documentation of any training courses, seminars, and/or workshops.

20.3.7 Documentation of each employee's continued proficiency to perform each test method by one of the following annually:

- acceptable performance of a blind sample (single blind to the analyst) for each accredited method;
- another Demonstration of Capability;
- At least four consecutive Laboratory Control Samples with acceptable levels of precision and accuracy.
- If I-iv cannot be performed, analysis of authentic samples that have been analyzed by another trained analyst with statistically indistinguishable results.

20.4 Demonstration of Capability (DOC)

20.4.1 A DOC must be performed prior to using any test method, and any time there is a change in instrument type, personnel, or method.

20.4.2 This laboratory, through QC charting, has historical data adequately demonstrating analyst's capability to meet the laboratory-generated acceptance criteria.

20.4.3 Where the analyst has demonstrated capability through analysis and QC charting of Laboratory Control Samples with acceptable results, the procedure for demonstrating continued proficiency to perform the test method (above) will be used for the DOC Certification Statement.

21.0 Data Integrity

21.1 Data Integrity/Ethics training shall occur for each employee required to perform laboratory testing either at the initial hiring orientation or within two weeks after assignment to laboratory functions.



- 21.2 Ongoing training is also required for all employees. Training may be conducted in-house or externally. A record of training and a signed attestation by the trained employee shall be placed in the employee's training file.
- 21.3 Topics covered are documented in writing and provided to all trainees. Key topics covered are the organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting, how and when to report data integrity issues and record keeping.
- 21.4 Training includes discussion regarding all data integrity procedures, data integrity training documentation, in-depth data monitoring and data integrity procedure documentation.
- 21.5 Trainees are required to understand that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious consequences including immediate termination, or civil/criminal prosecution.
- 21.6 Specific examples of breaches of ethical behavior should be discussed including improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards.
- 21.7 Data integrity requires emphasis on 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.
- 21.8 Senior managers/department heads acknowledge their support of these procedures by upholding the spirit and intent of the laboratory's data integrity procedures and effectively implement the specific requirements of the procedures. See Appendix A and SOP DI-01, Data Integrity.
- 22.0 Reporting Analytical Results**
- 22.1 The results of each test carried out by the laboratory are reported accurately, clearly, unambiguously, and objectively.
- 22.2 The following information shall be made available on the final reports:
 - 22.2.1 Title of analytical report.
 - 22.2.2 Name and address of laboratory, and phone number with name of contact person for questions.
 - 22.2.3 Unique identification of report and each page, including the total number of pages.
 - 22.2.4 Name and address of client, where appropriate, and project name, if applicable.
 - 22.2.5 Address of the property location where test was carried out (street address and zip code), floor level where testing occurred, and unambiguous description of monitor's placement within the property.
 - 22.2.6 Identification of results derived from any sample that did not meet sample acceptance



requirements, such as failure to maintain closed-house conditions, tampering, etc.

22.2.7 Identification of test method used, or unambiguous description of any non-standard method used.

22.2.8 Analysis date.

22.2.9 If the laboratory collected the sample, reference to the sampling procedure.

22.2.10 Any deviations from (such as failed QC), additions to, or exclusions from the test method (such as environmental conditions), and any non-standard conditions that may have affected the quality of the results, including the use and definitions of data qualifiers.

22.2.11 Final results and final units.

22.2.12 The final reporting level.

22.2.13 A signature and title, or an equivalent electronic identification of the person(s) accepting responsibility for the content of the of the report, and date of report's issue.

22.2.14 Clear indication of data provided by outside sources, such as subcontracted laboratories, clients etc; subcontracted laboratories are identified by name and/or accreditation number on the report.

22.2.15 Clear identification of numerical results with values outside of quantitation limits.

22.2.16 If errors are detected in the report, a subsequent revised report will be issued. The updated report will be titled "Revised Report", it will state what items have been revised, and it will reference the original report it replaces.

22.2.17 If the laboratory discovers equipment used to derive results in any report casts doubt on the validity of the result it shall notify the client(s) in writing.

22.2.18 The laboratory shall, where clients require transmission of test results by telephone, telex, facsimile or other electronic or electromagnetic means, follow documented procedures that ensure that the above requirements are met and that confidentiality is preserved.

23.0 Confidentiality and Proprietary Rights

Reports of laboratory analysis will be considered confidential only if requested by client. Proprietary information, if provided by the client, will be protected as Confidential Business Information in accordance with Title 40, Code of Federal Regulations, Part 2, Subpart B.

24.0 References

24.1 General Requirements for the Competence of Testing and Calibration Laboratories, ISO/IEC 17025, May 15, 2005.

24.2 "Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)", Method 8260B, USEPA, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, with integrated updates I, II, IIA, IIB, and III, June 1997.



- 24.3 “*Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)*”, Method 8260C, USEPA, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, August 2006.
- 24.4 Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, US EPA, January 1999.
- 24.5 ADHS administrative codes Title 9, Chapter 14 (a.k.a. Arizona Rules).



APPENDIX A - Code of Ethics

1. Conflict of interest. No employee should have any interest, financial or otherwise, direct or indirect, or engage in any business or transaction or professional activity or incur any obligation of any nature, which is in substantial conflict with the proper discharge of his duties in the public interest.
2. No employee should accept other employment, which will impair his independence of judgment in the exercise of his official duties.
3. No employee should accept employment or engage in any business or professional activity, which will require him to disclose confidential information, which he has gained by reason of his official position or authority.
4. No employee should disclose confidential information acquired by him in the course of his official duties nor use such information to further his personal interests.
5. No employee should use or attempt to use his official position to secure unwarranted privileges or exemptions for his self or others.
6. No employee should engage in any transaction as representative or agent of the government with any business entity in which he has a direct or indirect financial interest that might reasonably tend to conflict with the proper discharges of his official duties.
7. An employee should not by his conduct give reasonable basis for the impression that any person can improperly influence him or unduly enjoy his favor in the performance of his official duties, or that he is affected by kinship, rank, position or influence of any party or person.
8. An employee should abstain from making personal investments in enterprises which he has reason to believe may be directly involved in decisions to be made by him or which will otherwise create substantial conflict between his duty in the public interest and his private interest.
9. An employee should endeavor to pursue a course of conduct which will not raise suspicion among the public that he is likely to be engaged in acts that are in violation of his trust.
10. No employee employed on a full time basis nor any firm or association of which such an employee is a member nor corporation a substantial portion of the stock of which is owned or controlled directly or indirectly by such an employee, should sell goods or services to any person, firm, corporation or association which is licensed or whose rates are fixed by the agency in which such an employee serves.
11. If any employee shall have a financial interest, direct or indirect, having a value of ten thousand dollars or more in any activity which is subject to the jurisdiction of a regulatory agency, he should file a written statement that he has such a financial interest in such activity which statement shall be open to public inspection.
12. Violations
 - 12.1 In addition to any penalty contained in any other provision of law any such employee who shall knowingly and intentionally violate any of the provisions of this Code of Ethics may be fined, suspended or removed from office or employment in the manner provided by law.



The following laboratory staff have read this Code of Ethics. I certify that the requirements of this Code of Ethics have been communicated to me and that I am trained in its use. A copy of this page will be distributed to the employee training record file. I will not engage in any activities that could possibly negatively impact the integrity of data produced in this organization.

_____ Name	_____ Title	_____ Date



APPENDIX B – Arizona Department of Environmental of Quality (ADEQ) – Data Qualifiers

Arizona Data Qualifiers Revision 3.0 9/20/2007

Developed by the Sub-committee of the Arizona Environmental Laboratory Advisory Committee

This is an updated list of the Rev. 2.0 Arizona Data Qualifiers dated 11/26/2003, with some new qualifiers added, some obsolete ones deleted and some modified.

Using the following Arizona Data Qualifiers does not automatically denote acceptability to the Regulatory Agency. Arizona Department of Environmental Quality expects that data reported utilizing the following qualifiers, unless stated otherwise, is useable, scientifically valid and defensible. In the laboratory's judgment if the data should not be used for compliance, the T6 qualifier must be used. Other general guidelines for use and application of the following data qualifiers can be found as an attachment to this document (ATTACHMENT A).

Note: For drinking water samples, please use the [AZ Drinking Water Data Qualifiers 10/23/2001 \[PDF 23K\]](#)

Microbiology:

- A1 = Too numerous to count.
- A2 = Sample incubation period exceeded method requirement.
- A3 = Sample incubation period was shorter than method requirement.
- A4 = Target organism detected in associated method blank.
- A5 = Incubator/water bath temperature was outside method requirements.
- A6 = Target organism not detected in associated positive control.
- A7 = Micro sample received without adequate headspace.
- A8 = Plate count was outside the method's reporting range. Reported value is estimated.

Method/calibration blank:

- B1 = Target analyte detected in method blank at or above the method reporting limit.
- B2 = Non-target analyte detected in method blank and sample, producing interference.
- B3 = Target analyte detected in calibration blank at or above the method reporting limit.
- B4 = Target analyte detected in blank at or above method acceptance criteria.
- B5 = Target analyte detected in method blank at or above the method reporting limit, but below trigger level or MCL.
- B6 = Target analyte detected in calibration blank at or above the method reporting limit, but below trigger level or MCL.
- B7 = Target analyte detected in method blank at or above method reporting limit.



Concentration found in the sample was 10 times above the concentration found in the method blank.

Confirmation:

- C1 = Confirmatory analysis not performed as required by the method.
- C2 = deleted
- C3 = Qualitative confirmation performed.
- C4 = Confirmatory analysis was past holding time.
- C5 = Confirmatory analysis was past holding time. Original result not confirmed.
- C6 = deleted
- C7 = deleted
- C8 = Sample RPD between the primary and confirmatory analysis exceeded 40%. Per EPA Method 8000C, the lower value was reported as there was no evidence of chromatographic problems.

Dilution:

- D1 = Sample required dilution due to matrix.
- D2 = Sample required dilution due to high concentration of target analyte.
- D3 = deleted.
- D4 = Minimum Reporting Limit (MRL) adjusted to reflect sample amount received and analyzed.
- D5 = Minimum Reporting Limit (MRL) adjusted due to sample dilution; analyte was non-detect in the sample.
- D6 = Minimum Reporting Limit (MRL) adjusted due to an automatic 10X dilution performed on this sample for the purpose of reporting traditional drinking water analytes for wastewater requirements.

Estimated concentration:

- E1 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not possible due to insufficient sample.
- E2 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to sample matrix.
- E3 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to holding time requirements.
- E4 = Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL).
- E5 = Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL), but not confirmed by alternate analysis.
- E6 = Concentration estimated. Internal standard recoveries did not meet method acceptance criteria.
- E7 = Concentration estimated. Internal standard recoveries did not meet laboratory acceptance criteria.



E8 = Analyte reported to MDL per project specification. Target analyte was not detected in the sample.

Hold time:

- H1 = Sample analysis performed past holding time.
- H2 = Initial analysis within holding time. Reanalysis for the required dilution was past holding time.
- H3 = Sample was received and analyzed past holding time.
- H4 = Sample was extracted past required extraction holding time, but analyzed within analysis holding time.
- H5 = This test is specified to be performed in the field within 15 minutes of sampling; sample was received and analyzed past the regulatory holding time.

BOD/CBOD:

- K1 = The sample dilutions set-up for the BOD/CBOD analysis did not meet the oxygen depletion criteria of at least 2 mg/L. Any reported result is an estimated value.
- K2 = The sample dilutions set up for the BOD/CBOD analysis did not meet the criteria of a residual dissolved oxygen of at least 1 mg/L. Any reported result is an estimated value.
- K3 = deleted.
- K4 = deleted.
- K5 = The dilution water D.O. depletion was > 0.2 mg/L.
- K6 = Glucose/glutamic acid BOD/CBOD was below method acceptance criteria.
- K7 = A discrepancy between the BOD and COD results has been verified by reanalysis of the sample for COD.
- K8 = Glucose/glutamic acid BOD/CBOD was above method acceptance levels.

Laboratory fortified blank/blank spike:

- L1 = The associated blank spike recovery was above laboratory acceptance limits
- L2 = The associated blank spike recovery was below laboratory acceptance limits.
- L3 = The associated blank spike recovery was above method acceptance limits.
- L4 = The associated blank spike recovery was below method acceptance limits.

Matrix spike:

- M1 = Matrix spike recovery was high; the associated blank spike recovery was acceptable.
- M2 = Matrix spike recovery was low; the associated blank spike recovery was acceptable.
- M3 = The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The associated blank spike recovery was acceptable.



- M4 = The analysis of the spiked sample required a dilution such that the spike recovery calculation does not provide useful information. The associated blank spike recovery was acceptable.
- M5 = Analyte concentration was determined by the method of standard addition (MSA).
- M6 = Matrix spike recovery was high. Data reported per ADEQ policy 0154.000.
- M7 = Matrix spike recovery was low. Data reported per ADEQ policy 0154.000.

General:

- N1 = See case narrative.
- N2 = See corrective action report.
- N3 = deleted.
- N4 = The Minimum Reporting Limit (MRL) verification check did not meet the laboratory acceptance limit.
- N5 = The Minimum Reporting Limit (MRL) verification check did not meet the method acceptance limit.
- N6 = Data suspect due to quality control failure, reported per data user's request.

Sample quality:

- Q1 = Sample integrity was not maintained. See case narrative.
- Q2 = Sample received with head space.
- Q3 = Sample received with improper chemical preservation.
- Q4 = Sample received and analyzed without chemical preservation.
- Q5 = Sample received with inadequate chemical preservation, but preserved by the laboratory.
- Q6 = Sample was received above recommended temperature.
- Q7 = Sample inadequately dechlorinated.
- Q8 = Insufficient sample received to meet method QC requirements. Batch QC requirements satisfy ADEQ policies 0154.000 and 0155.000.
- Q9 = Insufficient sample received to meet method QC requirements.
- Q10 = Sample received in inappropriate sample container.
- Q11 = Sample is heterogeneous. Sample homogeneity could not be readily achieved using routine laboratory practices.

Duplicates:

- R1 = RPD/RSD exceeded the method acceptance limit.
- R2 = RPD/RSD exceeded the laboratory acceptance limit.
- R3 = deleted.
- R4 = MS/MSD RPD exceeded the method acceptance limit. Recovery met acceptance criteria.
- R5 = MS/MSD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.



R6 = LFB/LFBD RPD exceeded the method acceptance limit. Recovery met acceptance criteria.

R7 = LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.

R8 = Sample RPD exceeded the method acceptance limit.

R9 = Sample RPD exceeded the laboratory acceptance limit.

R10 = deleted.

R11 = The RPD calculation for MS/MSD does not provide useful information due to the varying sample weights when Encore samplers/methanol field preserved samples are used.

Surrogate:

S1 = Surrogate recovery was above laboratory acceptance limits, but within method acceptance limits.

S2 = deleted.

S3 = Surrogate recovery was above laboratory acceptance limits, but within method acceptance limits. No target analytes were detected in the sample.

S4 = Surrogate recovery was above laboratory and method acceptance limits. No target analytes were detected in the sample.

S5 = Surrogate recovery was below laboratory acceptance limits, but within method acceptance limits.

S6 = Surrogate recovery was below laboratory and method acceptance limits.

Reextraction and/or reanalysis confirms low recovery caused by matrix effect.

S7 = Surrogate recovery was below laboratory and method acceptance limits. Unable to confirm matrix effect.

S8 = The analysis of the sample required a dilution such that the surrogate recovery calculation does not provide useful information. The associated blank spike recovery was acceptable.

S9 = deleted.

S10 = Surrogate recovery was above laboratory and method acceptance limits. See case narrative.

S11 = Surrogate recovery was high. Data reported per ADEQ policy 0154.000.

S12 = Surrogate recovery was low. Data reported per ADEQ policy 0154.000.

Method/analyte discrepancies:

T1 = Method approved by EPA, but not yet licensed by ADHS.

T2 = Cited ADHS licensed method does not contain this analyte as part of method compound list.

T3 = Method not promulgated either by EPA or ADHS.

T4 = Tentatively identified compound. Concentration is estimated and based on the closest internal standard.

T5 = Laboratory not licensed for this parameter.

T6 = The reported result cannot be used for compliance purposes.



T7 = Incubator/Oven temperatures were not monitored as required during all days of use.

Calibration verification:

V1 = CCV recovery was above method acceptance limits. This target analyte was not detected in the sample.

V2 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample. The sample could not be reanalyzed due to insufficient sample.

V3 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample, but the sample was not reanalyzed. See case narrative.

V4 = deleted.

V5 = CCV recovery after a group of samples was above acceptance limits. This target analyte was not detected in the sample; acceptable per EPA Method 8000C.

V6 = Data reported from one-point calibration criteria per ADEQ policy 0155.000.

V7 = deleted.

V8 = deleted.

V9 = CCV recovery was below method acceptance limits.

Calibration:

W1= deleted.

W2= deleted.



ATTACHMENT A

“Guidance on the Usage of Data Qualifiers”

These standardized data qualifiers are for use in qualifying analytical results for compliance samples in Arizona to represent events that occurred during analysis. The technical subcommittee has endeavored to develop qualifiers that are succinct and narrow in scope to eliminate broad or multiple interpretations when assessing the impact on data. It must also be noted that due to the specialized nature of the individual qualifiers, it is likely that more than one qualifier may be needed in order to accurately represent the data.

- Note:
1. Using the Arizona Data Qualifiers does not automatically denote acceptability to the Regulatory Agency.
 2. As specified in the Arizona Adopted Rules, R9-14-615.C.9, *for each parameter tested at the laboratory for which quality control acceptance criteria are not specified in the approved method or by EPA or ADEQ.:*
 - a. Use default limits provided in Exhibit II; or
 - b. Statistically develop limits from historical data

The laboratory has an option of using ADHS Default Limits which can be accessed at <http://www.azdhs.gov/lab/license/tech/altdefaultlimit.pdf>

Microbiology:

None.

Method/calibration blank:

Apply appropriate qualifier to affected analyte in the blank if target analyte is not detected at \geq RL in the samples. If analytes are detected, then all corresponding analytes for the associated samples should also be qualified.

Confirmation:

For methods that require qualitative confirmation. C3 applies to methods that require quantitative confirmation.

Dilution:

If all analytes are reported from the diluted sample, apply qualifier to the entire sample. Otherwise apply qualifier to each analyte that required dilution.



Estimated concentration:

Appropriate qualifier must be used for any analyte result reported outside the calibration range. Affects data reported outside the calibration range or down to the MDL. E8 is only required if additional clarification is necessary.

Hold time:

Qualify samples appropriately when method extraction and/ or analysis holding time have been exceeded.

BOD/CBOD:

Qualifiers K5, K6, & K8 indicate situations that may impact all results in an analytical run and should be used to qualify all affected samples as well as any affected quality control samples when reported.

Laboratory fortified blank/blank spike:

Appropriate qualifier must be applied to the affected analytes in the Laboratory fortified blank/blank spike and to all corresponding analytes in the associated samples.

Matrix spike:

Appropriate qualifier must be applied to the affected analytes in the matrix spike and should also be added to all corresponding analytes in the associated_spiked sample. If a batch spike recovery is outside of the acceptable range, it is permissible to only flag the sample that was spiked and not the other samples in the batch. As required in the Arizona Adopted Rules A.A.C. R9-14-617.8.d, clients must always be informed if the batch QC result is unacceptable whether one of their samples was spiked or not. The laboratory can choose how the unacceptable QC is reported to the client (e.g., cover letter or flag).

The ADEQ policy 0154.000 can be accessed at <http://www.azdeq.gov/function/business/download/spike8.pdf>

General:

None.



Sample quality:

Flag samples with appropriate qualifier when sample quality may be potentially impacted or when method requirements were not met.

The ADEQ policy 0154.000 can be accessed at

<http://www.azdeq.gov/function/business/download/spike8.pdf>

The ADEQ policy 0155.000 can be accessed at

http://www.azdeq.gov/function/business/download/one_pt3.pdf

Duplicates:

For use with sample, matrix spike, LFB and LFB/blank spike duplicates. Qualify all affected analytes. For MS/MSD or sample duplicates qualify only the original source sample.

Surrogate:

Qualify surrogates appropriately when they do not meet criteria. Surrogate failures in quality control samples will most likely require additional narration. S11 & S12 are used to qualify sample surrogates and only in cases where the Laboratory Fortified Blank/ blank spike has acceptable surrogate recoveries.

Method/analyte discrepancies:

For use with methods or analytes that are not currently approved under the Environmental Laboratory Licensure Rules or for which the lab is not licensed.

Calibration verification:

Appropriate qualifier must be applied to all affected analytes in any samples associated with the calibration verification.

The ADEQ policy 0155.000 can be accessed at

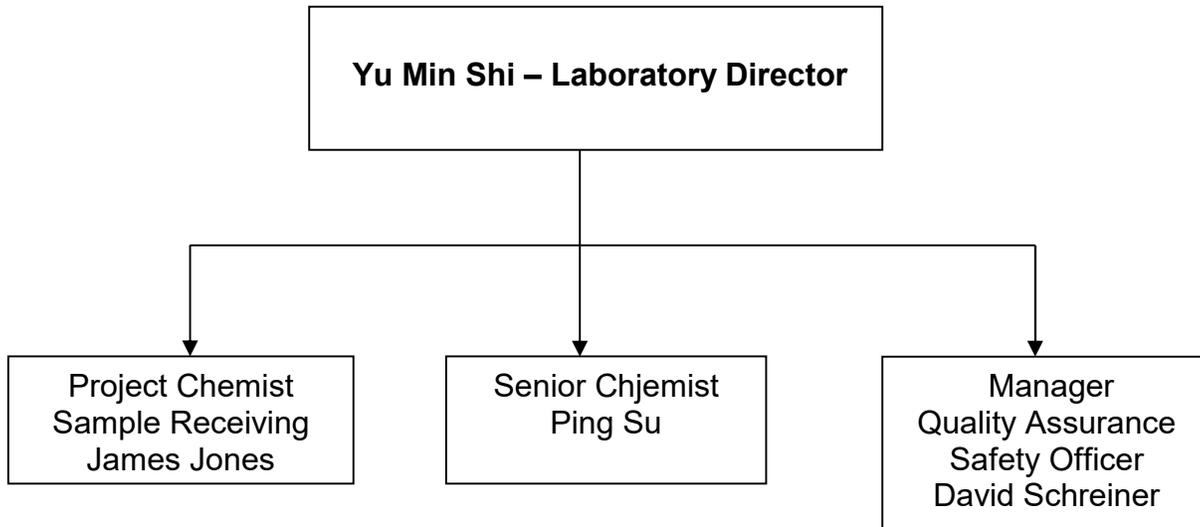
http://www.azdeq.gov/function/business/download/one_pt3.pdf

Calibration:

None.



Appendix C - Organization Chart





Appendix D – Floor Plan

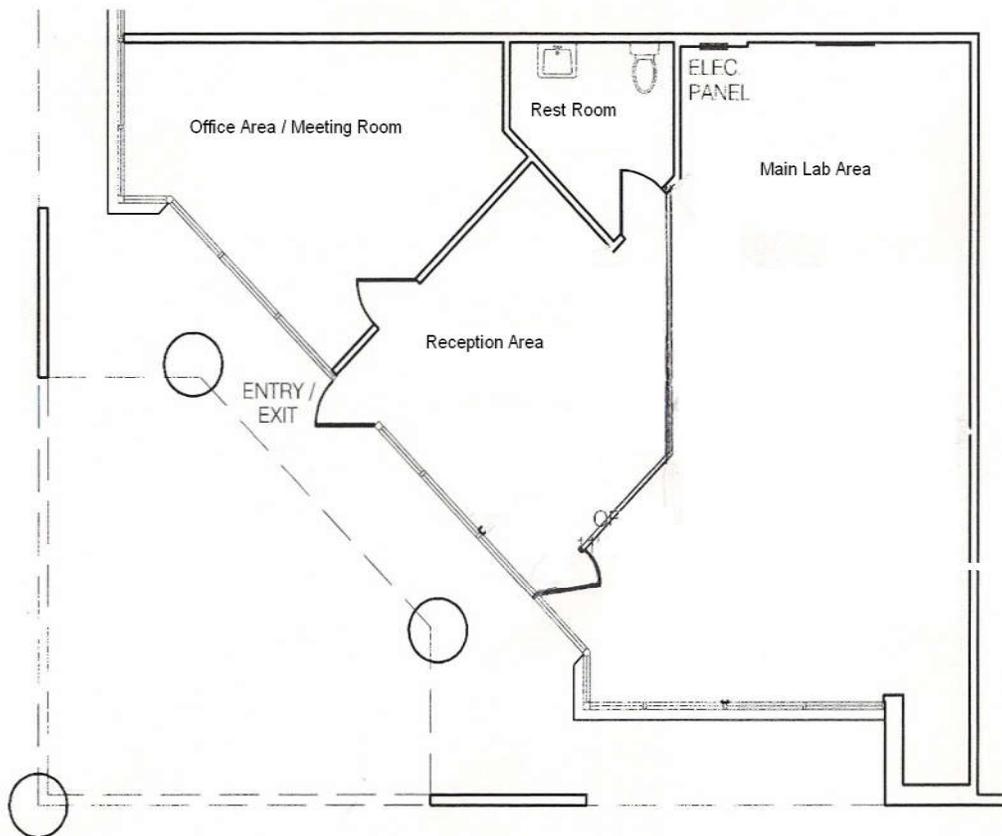
WESTECH BUSINESS CENTER

4620 EAST ELWOOD STREET

APPROXIMATELY

PHOENIX, ARIZONA 85040

1,072 Sq. Ft.



FLOOR PLAN - SUITE 13



Appendix E – Laboratory License and Parameters





Laboratory Methods, Instrument & Softwares

AZ License: AZ0740, Lab Name: Airtech Environmental Laboratories, LLC

Arizona Department Of Health Services Office of Laboratory Licensure and Certification 250 N.17th Avenue, Phoenix, Arizona 85007-3246

AIR

Parameter	EPA Method	Certified On
VOCS IN VAPOR	8260B AZ (VAPOR) (0.0)	11/28/2011 12:00:00 AM
VOLATILE ORGANIC COMPOUNDS	METHOD TO-15	11/18/2008 12:00:00 AM
		Total Count: 2

SW

Parameter	EPA Method	Certified On
PURGE AND TRAP FOR AQUEOUS SAMPLES	EPA 5030C	10/23/2017 2:14:12 PM
VOCs by GC/MS, INCLUDING N-HEXANE	EPA 8260B	11/28/2011 12:00:00 AM
		Total Count: 2

Instrument

Instrument	Instrument Code	Quantity	Certified On
GAS CHROMATOGRAPH/MASS SPECTROMETER	GC/MS	3	10/9/2013 12:00:00 AM
			Total Count: 1

Software

Software Code	Certified On	
ENVIROQUANT/CHEMSTATION - GC/MS	10/22/2008 12:00:00 AM	
		Total Count: 1



Appendix F – List Of SOPs

Document ID	Title
AIR - AIR Volatiles	
AIR-SOP-01	TO-15
AIR-SOP-02	Canister Cleaning
AIR-SOP-03	Sampler Cleaning
AIR-SOP-04	Time Integrated Sampler Calibration
AIR-SOP-05	Analytical Working Standard Prep
AIR-SOP-06	EPA TO-15 Mod - Determination of Total Gasoline Range Hydrocarbons in Air
AIR-SOP-09	Total VOC Analyzed by GC-MS
AIR-SOP-10	EPA Method 8015 by GC-MS
AIR-SOP-11	EPA TO-15 VOCs in Air Analyzed by GC-MS using SIM Method .doc
AIR SOP-12	EPA Method 8260 AZ Vapor
AQU - Wastewater Volatiles	
AQU-SOP-01	EPA Method 8260B
AQU-SOP-02	EPA Method 8260B-1,4 Dioxane (SIM)
AQU-003.00	DRAFT - EPA Method 8260C
QAD - Quality Assurance	
QAD-LQM-01	AEL Laboratory Quality Manual
QAD-SOP-01	Method Detection Limit Studies
QAD-SOP-02	Good Calibration Practices
QAD-SOP-03	Reporting Analytical Data
QAD-SOP-04	Qualifying Data Using Data Qualifiers and Corrective Action Reports (CAR)
QAD-SOP-06	Manual Integrations
QAD-SOP-07	Measurment Traceability
QAD-SOP-09	Electronic Data Backup & Computer Security
QAD-SOP-10	IDC
SMP - Sample Control	
SMP-SOP-01	Sample Receipt and Log-in
SAF - Safety	
SAF-LSM-01	AEL Safety Manual / Chemical Hygeine Plan

**Appendix G – Equipment List – Example**

Active Equipment List						
#	Use	Manufacture	Model	ID	Quantity	SN#
1	GC (GC/MS System)	Agilent	6890N	MS001	1	CN10334014
2	Mass Selective Detector (MSD)	Agilent	5973	MS001	1	US33220004
3	Ion Guage Controller	HP	59864A	MS001	1	US60100456
4	GC (GC/MS System) Purge & Trap	Agilent	5890 series II	MS002	1	
5	Mass Selective Detector (MSD)	Agilent	5972	MS002	1	3501A02465
6	Ion Guage Controller	Fissons Inst.		MS002	1	330019
7	P & T Controller	Teckmar	3000	MS002	1	98075011
8	P & T Autosampler	Teckmar	2016	MS002	1	US02234006
9	GC (GC/MS System) Purge & Trap	Agilent	5890 series II	MS003	1	3235A43898
10	Mass Selective Detector (MSD)	Agilent	5972	MS003	1	3501A02332
11	Ion Guage Controller	HP	59822B	MS003	1	
12	P & T Controller	Teckmar	3000	MS003	1	94104003
13	P & T Autosampler	Teckmar	2016	MS003	1	00270007
	GC (GC/MS System)	Agilent	6890N	MS004	1	US10453032
	Mass Selective Detector (MSD)	Agilent	5973	MS004	1	US44621150
14	Can Cleaner	Custom	NA	CC01	1	N/A
15	Can Evacuator	Custom	NA	CE01	2	NA
16	Pre Concentrator	Entech	7100A	PC01	1	1468
	Pre Concentrator	Entech	7016CA	PC02	1	
17	Autosampler	Entech	7160	AUTO01	1	1231
	Autosampler	Entech		AUTO02	1	
18	Dynamic Dilutor	Entech	4600A	DD01	1	1210
19	Vacuum oven	BlueM	VO914A	OV01	1	X11K-500936-XK
20	6.0 L canisters	Restek	SilkCan	N/A	60	NA
21	1.0 L canisters	Restek	SilkCan	N/A	400	NA
22	400 mL canisters	Restek	SilkCan	N/A	30	NA
23	Time integrated sampler calibrator	Custom	NA	NA	1	NA
24	Grab sampler back flusher	Custom	NA	BF01	1	NA
25	Time integrated sampler back flusher	Custom	NA	BF02	2	NA
26	Canister Clean Module 01	Custom	NA	CCM01	3	NA
27	Canister Clean Module 02	Custom	NA	CCM02	4	NA

APPENDIX B
PACE ANALYTICAL QUALITY ASSURANCE MANUAL

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Quality Assurance Manual

Quality Assurance/Quality Control Policies and Procedures

Pace National
12065 Lebanon Road, Mt. Juliet, TN 37122
615-758-5858

Pace National – Davis
2795 2nd Street, Davis, CA 95618
530-297-4800

Pace National – Decatur
2220 Beltline Road, SW, Decatur, AL 35601
256-350-0846

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	Document No.: Quality Assurance Manual revision 18.0	Issuing Authorities: Quality Office of Pace National

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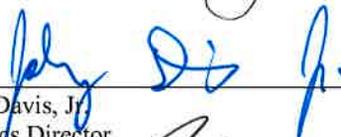
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4/24/19

Date

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Disclaimer

This Quality Assurance Manual for Pace National is a living document. It is reviewed at least annually and revised when needed. The information stated herein is subject to change at any time due to updates to laboratory systems, methods, operations, equipment, staff, etc.

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1.0. INTRODUCTION AND ORGANIZATIONAL STRUCTURE

“Working together to protect our environment and improve our health”

Pace Analytical Services LLC - Mission Statement

“Be the Lab of Choice for our Clients and Staff”

Pace National - Mission Statement

1.1. Introduction to Pace and Pace National

1.1.1. Pace Analytical Services, LLC is a privately held, full-service analytical testing firm operating a nationwide system of laboratories. Pace offers extensive services beyond standard analytical testing, including: bioassay for aquatic toxicity, air toxics, dioxins and coplanar PCB's by high resolution mass spectroscopy, radiochemical analyses, product testing, pharmaceutical testing, field services and mobile laboratory capabilities.

1.1.2. Pace laboratories are capable of analyzing a full range of environmental samples from a variety of matrices, including air, surface water, wastewater, groundwater, soil, sediment, biota, and other waste products. Methods are applied from regulatory and professional sources including EPA, ASTM, USGS, NIOSH, Standard Methods, and State Agencies. Section 10 of this document is a representative listing of general analytical protocol references.

1.1.3. Pace National is a subsidiary of Pace Analytical and is structured to provide environmental support services in compliance with numerous federal, state, and local regulations as well as to meet the analytical needs of the customer. This document defines the Quality System and Quality Assurance (QA)/Quality Control (QC) protocols for Pace National.

1.1.4. The scope of Pace National's management system is comprehensive and covers all technical and supporting work conducted at all facilities including the primary Lebanon Road location, the Davis, CA location, the Decatur, AL location as well as various customer support and shipping operations across the US. This includes ensuring analytical/operational activities and the quality of the data reported is appropriately recorded. Pace National's senior management team ensures that the integrity of the management system is maintained when changes to the management system are planned and implemented.

1.2. Statement of Purpose and Vision

1.2.1. Statement of Purpose – Pace Analytical: To meet the business needs of our customers for high quality, cost-effective analytical measurements and services.

1.2.2. Vision Statement – Pace National: To lead our industry in quality, service, and productivity

1.3. Quality Policy Statement and Goals of the Quality System

1.3.1. Pace and Pace National management are committed to maintaining the highest possible standard of service and quality for our customers by following a documented quality system that is compliant with all current applicable state, federal, and industry standards (such as the NELAC Standard, the TNI Standard, AIHA-LAP, LLC, and applicable ISO standards) and is in accordance with any stated methods and/or customer requirements. The overall objective of this quality system is to provide reliable data of known quality through adherence to rigorous quality assurance policies and quality control procedures as documented in this Quality Assurance Manual.

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1.3.2. Management is committed to using good professional practices and demonstrates its commitment to quality by providing the personnel, equipment, and facilities necessary to ensure the laboratory gives our customers the highest possible standard of service.

1.3.3. All personnel within Pace National and the Pace network are required to be familiar with all facets of the quality system relevant to their position and implement these policies and procedures in their daily work.

1.3.4. Pace and Pace National management is committed to the development, implementation, and continual improvement of the laboratory's management system. Evidence of this commitment can be found in the policies and procedures that are included in this Quality Assurance Manual which includes, but is not limited to, records of management review meetings as per section 7.3 below.

1.4. Core Values

1.4.1. The following are the Pace Core Values:

- **Integrity**
- **Value Employees**
- **Know Our Customers**
- **Honor Commitments**
- **Flexible Response To Demand**
- **Pursue Opportunities**
- **Continuously Improve**

1.4.2. The following are the Pace National Values:

- **C – Client Focused**
- **H – Honest with our Clients and Staff**
- **O – Open and Shared Financial and Operational Information**
- **I – Innovative Solutions and Systems**
- **C – Committed to Excellence in our Operation**
- **E – Environmentally Responsible**

1.5. Code of Ethics

1.5.1. Each employee is responsible for the propriety and consequences of his or her actions;

1.5.2. Each employee must conduct all aspects of Company business in an ethical and strictly legal manner, and must obey the laws of the United States and of all localities, states and nations where Pace and Pace National does business or seeks to do business;

1.5.3. Each employee must reflect the highest standards of honesty, integrity and fairness on behalf of the Company with customers, suppliers, the public, and one another.

1.5.4. Each employee must recognize and understand that our daily activities in environmental laboratories affect public health as well as the environment and that environmental laboratory analysts are a critical part of the system society depends upon to improve and guard our natural resources.

1.5.5. All Pace National personnel, including contract and temporary, are required to sign an "Attestation of Ethics and Confidentiality" at the time of employment and during annual refresher training. Violations of this document result in serious consequences, including prosecution and

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termination, if necessary. For more information see the Pace National Policy Manual and SOP ENV-SOP-MTJL-0002, *Ethics, Data Integrity, and Confidentiality*.

1.5.6. Strict adherence by each employee to this Code of Ethics and to the Standards of Conduct below is essential to the continued vitality of Pace and Pace National to continue the pursuit of our common mission to protect our environment and improve our health.

1.5.7. Failure to comply with the Code of Ethics and Standards of Conduct will result in disciplinary action up to and including termination and referral for civil or criminal prosecution where appropriate. An employee will be notified of an infraction and given an opportunity to explain, as prescribed under current disciplinary procedures.

1.6. Standards of Conduct

1.6.1. Data Integrity

1.6.1.1. The accuracy and integrity of the analytical results and its supporting documentation produced at Pace and Pace National are the cornerstones of the company. Employees are to accurately prepare and maintain all technical records, scientific notebooks, calculations, and databases. Employees are prohibited from making false entries or misrepresentations of data for any reason.

1.6.1.2. Managerial staff must make every effort to ensure that personnel are free from any undue pressures that may affect the quality or integrity of their work including commercial, financial, over-scheduling, and working condition pressures.

1.6.1.3. The data integrity system includes in-depth, periodic monitoring of data integrity including peer data review and validation, internal raw data audits, proficiency testing studies, etc.

1.6.1.4. Any documentation related to data integrity issues, including any disciplinary actions involved, corrective actions taken, and notifications to customers must be retained for a minimum of five years.

1.6.1.5. Pace National's Data Integrity System

Pace National is committed to ensuring the integrity of its data and providing valid data of known and documented quality to its customers. Pace National is also committed to creating and maintaining a culture of quality throughout the organization. The elements in Pace National's data integrity system include:

- A standardized data integrity training program that is given to all new employees and a yearly refresher course is also presented to all employees.
- All Pace National personnel, including contract and temporary, are required to sign an "Attestation of Ethics and Confidentiality" at the time of employment and during annual refresher training.
- An in-depth periodic monitoring of data integrity which includes, but is not limited to, the following: peer data review, internal audits, QA data review of raw data, and proficiency testing studies.
- A process that allows for confidential reporting of alleged data integrity issues. Currently, an anonymous hotline is available to all employees that is managed by an outside vendor. Messages are collected, documented, reviewed, and will be followed up

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on by senior management to resolve the matter. Comments made on this hotline are confidential, and callers will remain anonymous.

Anonymous Hotline Number: 1-800-398-1496

Additional information about the laboratory's data integrity system can be found in SOP ENV-SOP-MTJL-0002 *Ethics, Data Integrity, and Confidentiality*. This SOP is signed by top management and is reviewed at least annually.

1.6.2. Confidentiality

1.6.2.1. All employees must not use or disclose confidential or proprietary information except when in connection with their duties at Pace and/or Pace National. This is effective over the course of employment and for an additional period of two years thereafter.

1.6.2.2. Confidential or proprietary information (belonging to either Pace, Pace National, and/or its customers) includes but is not limited to test results, trade secrets, research and development matters, procedures, methods, processes and standards, company-specific techniques and equipment, marketing and customer information, inventions, materials composition, etc.

1.6.2.3. Pace National's confidentiality policy is to not divulge or release any information to a third party without proper authorization. All information pertaining to a particular customer will remain confidential. Data will be released to outside agencies only with authorization from the customer or where federal or state law requires the laboratory to do so. Samples are generally identified with laboratory identification numbers, and access to electronic records and reports is password protected. Confidentiality statements are applied to fax and e-mail communications. All personnel, including contract and temporary, are required to sign an "Attestation of Ethics and Confidentiality" at the time of employment and during annual refresher training. Violations of this document result in serious consequences, including prosecution and termination, if necessary. For more information see the Pace National Policy Manual and SOP ENV-SOP-MTJL-0002, *Ethics, Data Integrity, and Confidentiality*.

1.6.3. Conflict of Interest

1.6.3.1. All employees must avoid situations that might involve a conflict of interest or could appear questionable to others. This includes participation in activities that conflict or appear to conflict with the employees' Company responsibilities. This would also include offering or accepting anything that might influence the recipient or cause another person to believe that the recipient may be influenced to behave in a different manner than he would normally (such as bribes, gifts, kickbacks, or illegal payments).

1.6.3.2. Employees are not to engage in outside business or economic activity relating to a sale or purchase by the Company. Other problematic activities include service on the Board of Directors of a competing or supplier company, significant ownership in a competing or supplier company, employment for a competing or supplier company, or participation in any outside business during the employee's work hours.

1.6.3.3. Pace National's management ensures that personnel are free from any undue pressures and influences that may adversely affect the quality of their work. Pace National's organizational structure is designed to minimize the potential for conflicts or undue stresses that might influence the technical judgment of analytical personnel. Analytical personnel are generally isolated from customer contact as much as practical. In addition, the laboratory

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workload is continually reviewed and managed in such a way as to reduce the potential for undue production pressure on analytical personnel.

1.7. Anonymous Compliance Alertline

1.7.1. An ethical and safe workplace is important to the long-term success of Pace, Pace National, and the well-being of its employees. Pace and Pace National have the responsibility to provide a work environment where employees feel safe and can report unethical or improper behavior in complete confidence. With this in mind, Pace has engaged Lighthouse Services, Inc. to provide all employees with access to an anonymous ethics and compliance alertline for reporting possible ethics and compliance violations. The purpose of this service is to ensure that any employee can report anonymously and without fear of retaliation.

1.7.2. Lighthouse Services provides a toll-free number along with several other reporting methods, all of which are available 24 hours a day, seven days a week for use by employees and staff.

1.7.3. Telephone: English speaking USA and Canada: (844)-970-0003.

1.7.4. Telephone: Spanish speaking North America: (800)-216-1288.

1.7.5. Website: www.lighthouse-services.com/pacelabs.

1.7.6. Email: reports@lighthouse-services.com (must include company name with report).

1.7.7. Pace National provides an anonymous hotline that is available to all employees that is managed by an outside vendor. Messages are collected, documented, reviewed, and will be followed up on by senior management to resolve the matter. Comments made on this hotline are confidential, and callers will remain anonymous.

Anonymous Hotline Number: 1-800-398-1496

1.8. Laboratory Organization

1.8.1. Each Pace laboratory operates with local management, but all Pace labs share common systems and receive support from the Corporate Office. See Attachment III for the Corporate Organizational structure.

1.8.2. Pace National has a defined organization and management structure. See Attachment II for Pace National's organizational chart.

1.8.3. Pace National's managerial and technical personnel have the authority and resources needed to carry out their duties. Management bears the specific responsibility for the implementation, maintenance, and improvement of the laboratory's management system. This includes the identification of any departures from the management system or standard operating procedures, and to initiate actions to prevent or minimize such departures.

1.8.4. Pace National has specifications of the responsibility, authority, and interrelationships of all personnel who manage, perform, or verify work affecting the quality of the analytical results. Job descriptions are documented and maintained by the Human Resources department. It is the laboratory's policy that each individual understands his or her particular responsibilities and how to report problems when they occur.

1.8.5. Pace National has adequate supervision provided to all analytical staff, including trainees, by persons familiar with the analytical methods and procedures.

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1.8.6. Pace National has technical management which has overall responsibility for the technical operations. This includes providing the resources needed to ensure the required quality of laboratory operations is met as per the policies and procedures documented in this Quality Assurance Manual. This technical management includes the Vice President of Operations, the Director of Operations, the Organics Director, the Inorganics Director, and each individual department supervisor.

1.8.7. Pace National has quality management which has the responsibility and authority for ensuring that the management system related to quality is implemented and followed at all times. Currently the Quality Assurance Director, the Regulatory Affairs Director, and the Compliance Director have been appointed for this task. The Quality Assurance Director has direct access to the highest level of management at which decisions are made on laboratory policy and resources.

1.8.8. The lab is required to appoint deputies for key managerial personnel. These deputies must be documented for auditing purposes. The following table defines who assumes the responsibilities of key personnel in their absence:

PRIMARY	DEPUTY
Vice President of Operations	Director of Operations
Director of Operations	Vice President of Operations and Technical Services Manager
Organics Director	Vice President of Operations and Department Supervisors/Leads
Inorganics Director	Vice President of Operations and Department Supervisors/Leads
Radiochemistry Director	Vice President of Operations and Department Supervisors/Leads
Quality Assurance Director	Regulatory Affairs Director and Compliance Director
Information Systems Director	Ad Hoc (Applicable IT personnel as needed)
Client Operations Manager	Director of Operations and Senior Project Manager(s)
Biology Manager	Director of Operations and Department Supervisors/Leads

Note for TNI Technical Managers: A Technical Manager who is absent for a period of time exceeding 15 consecutive calendar days shall designate another full-time staff member meeting the qualifications of a TNI technical manager to temporarily perform this function. The laboratory's senior management team has the authority to make this designation in the event the existing Technical Manager is unable to do so. If this absence exceeds 35 consecutive calendar days, the primary accrediting authority shall be notified in writing.

1.8.9. The technical staff of each laboratory is generally organized into the following functional groups (as applicable for each location):

- Organic Sample Preparation
- Wet Chemistry Analysis
- Metals Analysis
- Volatiles Analysis
- Semi-volatiles Analysis
- Radiochemical Analysis

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- Microbiological Analysis
- Bioassay Analysis

1.8.10. Pace National has personnel that are aware of the relevance and importance of their activities and how they contribute to the achievement of the objectives of the management system. Laboratory management ensures that all personnel are aware that their job is needed, and how each role contributes to the laboratory's business goals. All personnel are required to familiarize themselves with the quality documentation relevant to their position and implement these policies and procedures in their work. All personnel must ensure that the generation and reporting of quality analytical data is a fundamental priority.

1.9. Laboratory Job Descriptions

The roles and responsibilities of some technical and quality management are defined below. Laboratory management determines the specific education and experience requirements for individual positions within the laboratory based on the specific department needs. More information can be found in the job descriptions that are maintained by the Human Resources department. All managers and supervisors are responsible to ensure that their respective departments comply with all the applicable state, federal, and industry standards.

1.9.1. Vice President of Operations

- Oversees all functions of Pace National
- Authorizes personnel development including staffing, recruiting, training, workload scheduling, employee retention and motivation;
- Prepares budgets and staffing plans;
- Monitors the Quality Systems of the laboratory and advises the Quality Assurance Director accordingly;
- Presents the Ethics/Data Integrity training annually to all Pace National employees as an instructor-led training.
- Ensures compliance with all applicable state, federal and industry standards.

1.9.2. Operations Director

- In the absence of the Vice President of Operations, performs all duties as listed above;
- Oversees the daily production and quality activities of assigned departments;
- Manages assigned departments and works with staff to ensure department objectives are met;
- Works with assigned departments to ensure capacity and customer expectations are accurately understood and met;
- Works with Vice President of Operations to prepare appropriate budget and staffing plans for applicable departments;
- Responsible for prioritizing personnel and production activities within assigned departments;
- Performs formal and informal performance reviews of applicable departmental staff.
- Ensures compliance with all applicable state, federal and industry standards.

1.9.3. Organics Director

- Monitors the standards of performance in the Volatiles and Semi-volatiles Departments;
- Monitors the validity of analyses performed and data generated in the Volatiles and Semi-volatiles Departments;
- Provides technical guidance in the review, development, and validation of new methodologies in the Volatiles and Semi-volatiles Departments;

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- Oversees production and quality assurance activities in the Volatiles and Semi-volatiles Departments;
- Ensures that quality assurance and quality control criteria of analytical methods and projects are satisfied in the Volatiles and Semi-volatiles Departments;
- Assesses data quality in the Volatiles and Semi-volatiles Departments and takes corrective action when necessary;
- Approves and releases technical and data management reports;
- Ensures compliance with all applicable state, federal and industry standards.

1.9.4. Inorganics Director

- Monitors the standards of performance in the Metals and Wet Chemistry Departments;
- Monitors the validity of analyses performed and data generated in the Metals and Wet Chemistry Departments;
- Provides technical guidance in the review, development, and validation of new methodologies in the Metals and Wet Chemistry Departments;
- Oversees production and quality assurance activities in the Metals and Wet Chemistry Departments;
- Ensures that quality assurance and quality control criteria of analytical methods and projects are satisfied in the Metals and Wet Chemistry Departments;
- Assesses data quality in the Metals and Wet Chemistry Departments and takes corrective action when necessary;
- Approves and releases technical and data management reports;
- Ensures compliance with all applicable state, federal and industry standards.

1.9.5. Radiochemistry Director

- Monitors the standards of performance in the Radiochemistry Department;
- Monitors the validity of analyses performed and data generated in the Radiochemistry Department;
- Provides technical guidance in the review, development, and validation of new methodologies in the Radiochemistry Department;
- Oversees production and quality assurance activities in the Radiochemistry Department;
- Ensures that quality assurance and quality control criteria of analytical methods and projects are satisfied in the Radiochemistry Department;
- Assesses data quality in the Radiochemistry Departments and takes corrective action when necessary;
- Approves and releases technical and data management reports;
- Ensures compliance with all applicable state, federal and industry standards

1.9.6. Quality Assurance Director

- Responsible for implementing, maintaining and improving the quality system while functioning independently from laboratory operations. Reports directly to the highest level of local laboratory facility management, however named, that routinely makes day-to-day decisions regarding laboratory operations, but receives direction and assistance from the Corporate Director of Environmental Quality;
- Ensures that communication takes place at all levels within the lab regarding the effectiveness of the quality system and that all personnel understand their contributions to the quality system;

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- Monitors QA/QC activities to ensure that the laboratory achieves established standards of quality (as set forth by the Corporate Environmental Quality office);
- Maintains records of quality control data and evaluates data quality;
- Conducts periodic internal audits and coordinates external audits performed by regulatory agencies or customer representatives;
- Reviews and maintains records of proficiency testing results;
- Maintains the document control system;
- Assists in development and implementation of appropriate training programs;
- Provides technical support to laboratory operations regarding methodology and project QA/QC requirements;
- Reviews tenders, contracts and QAPPs to ensure the laboratory can meet the data quality objectives for any given project;
- Maintains certifications from federal and state programs;
- Ensures compliance with all applicable state, federal and industry standards;
- Maintains the laboratory training records and evaluates the effectiveness of training;
- Monitors corrective and preventive actions;
- Maintains the currency of the Quality Manual.

1.9.7. Client Operations Manager

- Oversees all the day to day activities of the Client Services Departments which includes Project Management, Sample Receiving, and Shipping;
- Responsible for staffing and all personnel management related issues for Client Services;
- Serves as the primary senior consultant to customers on all project related issues such as set up, initiation, execution and closure;
- Performs or is capable of performing all duties listed for that of Project Manager.

1.9.8. Project Manager

- Coordinates daily activities including taking orders, reporting data and analytical results;
- Serves as the primary technical and administrative liaison between customers and the laboratory;
- Communicates with operations staff to update and set project priorities;
- Provides results to customers in the requested format (verbal, hardcopy, electronic, etc.);
- Works with customers, laboratory staff, and other appropriate staff to develop project statements of work or resolve problems of data quality;
- Responsible for solicitation of work requests, assisting with proposal preparation and project initiation with customers and maintain customer records;
- Mediation of project schedules and scope of work through communication with internal resources and management;
- Responsible for preparing routine and non-routine quotations, reports and technical papers;
- Interfaces between customers and management personnel to achieve customer satisfaction;
- Manages large-scale complex projects;
- Supervises less experienced project managers and provide guidance on management of complex projects;
- Arranges bottle orders and shipment of sample kits to customers;
- Verifies login information relative to project requirements and field sample Chains-of-Custody.

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1.9.9. Department Manager/Supervisor/Lead

- Oversees the day-to-day production and quality activities of their assigned department;
- Ensures that quality assurance and quality control criteria of analytical methods and projects are satisfied;
- Assesses data quality and takes corrective action when necessary;
- Approves and releases technical and data management reports;
- Ensures compliance with all applicable state, federal and industry standards.

1.10. Training and Orientation

1.10.1. Pace National management ensures the competency of all who operate specific equipment, who perform analyses, and who evaluate results and approve data reports. Personnel performing specific tasks are qualified on the basis of appropriate education, training, experience, and/or demonstrated skills, as required.

1.10.2. Pace National management ensures all personnel (including part-time, temporary, contracted, and administrative personnel) are competent, appropriately supervised, and work in accordance to the established management system. This includes training in policies, procedures, ethics, laboratory quality assurance, and safety as applicable to their role in the laboratory.

1.10.3. All personnel are trained and competent in their assigned tasks before they contribute to functions that can affect data quality. It is management's responsibility to ensure personnel are appropriately trained. All training and education requirements are outlined in SOP ENV-SOP-MTJL-0015, *Technical Training and Personnel Qualifications* and in SOP ENV-SOP-MTJL-0274, *Technical Training and Personnel Qualifications for Biology*. These procedures are reviewed/updated periodically by laboratory management.

1.10.4. Pace National management authorizes specific personnel to perform particular technical duties. Records of the relevant authorization(s), education, and experience of all technical personnel are maintained by the Human Resources Department. Confirmation of competence of all technical personnel is required initially by successfully performing a demonstration of capability. All technical personnel are also required to continue to demonstrate their capability at least annually to produce reliable results through accurate analysis of certified reference materials, proficiency testing samples, and/or routine quality control samples to remain authorized to perform particular technical duties.

1.10.5. Demonstration of Capability (DOC)

Analysts complete an initial demonstration of capability (IDOC) study prior to performing a method or when there is a change in instrument type, personnel, or test method. IDOCs may also be performed when a method has not been performed by the laboratory or analyst in a 12-month period. The mean recovery and percent relative standard deviation of each analyte, taken from 4 replicates of laboratory control samples, is calculated and compared to method criteria or established laboratory criteria for evaluation of acceptance. For methods or procedures that do not lend themselves to the "4-replicate" approach, the demonstration of capability requirements will be specified in the applicable SOP. Copies of all demonstrations of capability are maintained for future reference.

Demonstrations of capability are verified on an annual basis. These are Continuing Demonstrations of Capability (CDOC). For CDOCs Performance Testing (PT) samples may be used in lieu of the 4-replicate approach listed above.

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For more information see the SOP ENV-SOP-MTJL-0015, *Technical Training and Personnel Qualifications* and SOP ENV-SOP-MTJL-0274, *Technical Training and Personnel Qualifications for Biology*.

1.10.6. Training for New Staff

New staff members are given the following training, where appropriate:

- Ethics and Data Integrity
- Pace National Policy Manual
- Pace National Quality Assurance Manual
- Chemical Hygiene Plan (safety)
- Applicable standard operating procedures
- Basic laboratory tasks such as balance, thermometer, and pipette operations
- Use of laboratory records
- Any other specific training as appropriate to their function

Analysts must complete training satisfactory before they can work independently. When staff members undergo training, adequate and appropriate supervision by fully trained analysts is provided. Only when a new analyst has successfully passed their Initial Demonstration of Capability (IDOC) described above, may he or she conduct testing of customer samples.

For more information see the SOP ENV-SOP-MTJL-0015, *Technical Training and Personnel Qualifications* and SOP ENV-SOP-MTJL-0274, *Technical Training and Personnel Qualifications for Biology*

1.10.7. Ongoing Training

Staff members are given the following ongoing training:

- Ethics and Data Integrity Training
- Safety Training
- Routine Training – Routine training may become necessary for a person to perform a particular job effectively. This includes any changes in policies and procedures as appropriate.
- Special Training – Special training may become required as a result of new technologies, contracts, expanding markets, company-wide improvement programs, new method development, etc.

Analysts must satisfactorily perform Continuing Demonstrations of Capability (CDOC) on an annual basis.

For more information see the SOP ENV-SOP-MTJL-0015, *Technical Training and Personnel Qualifications* and SOP ENV-SOP-MTJL-0274, *Technical Training and Personnel Qualifications for Biology*.

1.10.8. Ethics and Data Integrity Training

Data integrity training is provided to all new employees (including contract and temporary), and a refresher is given at least annually for all employees. Employees are required to understand that any infractions of the laboratory data integrity procedures shall result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment, or civil/criminal prosecution. The initial data integrity training and the annual refresher training needs to have a signature attendance sheet or other form of

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documentation that demonstrates all staff have participated and understand their obligations related to data integrity.

All Pace National personnel, including contract and temporary, are required to sign an “Attestation of Ethics and Confidentiality” at the time of employment and during annual refresher training. This document clearly identifies inappropriate and questionable behavior. Violations of this document result in serious consequences, including prosecution and termination, if necessary. The Pace National Policy Manual addresses this subject in detail. Also see SOP ENV-SOP-MTJL-0002, *Ethics, Data Integrity, and Confidentiality* for more information.

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. The following topics and activities are covered:

- Pace National’s mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting
- How and when to report data integrity issues
- Record keeping
- Training, including discussion regarding all data integrity procedures
- Data integrity training documentation
- In-depth data monitoring and data integrity procedure documentation
- Specific examples of breaches of ethical behavior such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards.

1.10.9. Identification of Training Needs

In order to ensure personnel are appropriately trained, laboratory management is responsible for identifying training needs for both current and future anticipated laboratory tasks. This includes (but is not limited to) the following:

- Evaluation of routine quality control data
- Proficiency testing results
- Findings of internal and external audits
- Management reviews
- Periodic performance reviews

1.10.10. Evaluation of the Effectiveness of Training

In order to ensure personnel are appropriately trained, laboratory management is responsible for evaluating the effectiveness of the training program. This includes (but is not limited to) the following:

- Evaluations of Demonstrations of Capability (DOCs)
- Monitoring ongoing quality control data
- Proficiency testing results

1.11. Laboratory Safety and Waste

1.11.1. It is the policy of Pace and Pace National to make safety and waste compliance an integral part of daily operations and to ensure that all employees are provided with safe working conditions,

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personal protective equipment, and requisite training to do their work without injury. Each employee is responsible for his/her own safety as well as those working in the immediate area by complying with established company rules and procedures. These rules and procedures as well as a more detailed description of the employees' responsibilities are contained in the local Safety Manual/Chemical Hygiene Plan.

1.12. Laboratory Facilities & Security

1.12.1. The design of Pace National's facilities supports good laboratory practices and does not adversely affect measurement integrity. All laboratory facilities, analytical areas, energy sources, lighting, heating, and ventilation facilitate proper performance of calibrations and tests. Pace National management ensures that housekeeping, electromagnetic interference, humidity, line voltage, temperature, sound and vibration levels are appropriately controlled to ensure the integrity of specific measurement results and to prevent adverse effects on accuracy or increases in the uncertainty of each measurement.

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

1.12.3. Pace National maintains multiple buildings on its Mt. Juliet, TN campus. This allows for physical separation of incompatible analytical activities. For example, the analysis for volatile organic compounds is in a separate building from where samples are extracted for semi-volatile organic compounds. Each laboratory structure is specifically designed for the type of analytical activity that it contains. The air handling systems, power supplies, and gas supplies are specific for each laboratory department. The Davis laboratory occupies a single unit in a multi-business building that analyzes volatile organics only. The Decatur operation is contained in a single building facility where laboratory space is arranged to minimize cross-contamination between incompatible areas of the laboratory. The volatiles lab is isolated from other areas to prevent methylene chloride contamination and potable water bacteriological testing is performed separately from wastewater testing.

1.12.4. Laboratory security is maintained by controlled access at all three laboratories and through video surveillance at the Mt. Juliet laboratory. Entrance into any Pace National-Mt. Juliet building and the Davis building requires an electronic ID badge with appropriate assigned access. Access is controlled to each area depending on the required personnel, the sensitivity of the operations performed, and possible safety concerns. For the Mt. Juliet, Davis and Decatur locations the main entrance is kept unlocked during normal business hours for visitors, and is continuously monitored by laboratory staff. All visitors must sign a visitor's log, and a staff member must accompany them during the duration of their stay.

1.12.5. Pace National management ensures good housekeeping practices in all facilities to maintain a standard of cleanliness necessary for analytical integrity and personnel health and safety. Where necessary, areas are periodically monitored to detect and resolve specific contamination and/or possible safety issues.

1.13. Communications

1.13.1. Pace National has established, implemented, and maintains a management system appropriate to the scope of its activities. Pace National has documented its policies and procedures to the extent necessary to assure the quality of the analytical test results. The Pace National management system's documentation is communicated to, understood by, available to, and implemented by the appropriate laboratory personnel.

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1.13.2. Pace National management bears the responsibility of ensuring that appropriate communication processes are established within the laboratory and that communication takes place regarding the effectiveness of the management/quality system. These communication processes may include email, staff meetings, management meetings, etc.

1.13.3. Pace National's management also communicates to the organization the importance of meeting customer and regulatory requirements. This is accomplished in writing through this Quality Assurance Manual, Pace National's Policy Manual, and through Pace National's Standard Operating Procedures. This is also accomplished verbally through staff meetings.

1.13.4. Pace corporate management bears the responsibility of ensuring that appropriate communication processes are established within the network of facilities and that communication takes place at a company-wide level regarding the effectiveness of the management/quality systems of all Pace facilities. These communication processes may include email, quarterly continuous improvement conference calls for all lab departments, and annual continuous improvement meetings for all department supervisors, quality managers, client services managers, and other support positions.

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2.0. SERVICE TO THE CUSTOMER & SAMPLE CUSTODY

2.1. Service to the Customer

2.1.1. Pace National's Customer Service Department provides specific project service through the use of Project Managers (PMs)/Technical Service Representatives (TSRs). The PM/TSR is responsible for all contract requirements and laboratory/customer communication, including information concerning schedules, delays, and major deviations in the testing process. For additional information see SOP ENV-SOP-MTJL-0007, *Project Management*.

2.1.2. It is Pace National's policy is to cooperate with its customers and to meet their expectations. The PM/TSR works closely with the customer to clarify the customer's requests and to monitor the laboratory's performance in relation to the work requested, while ensuring confidentiality to other customers.

2.1.3. Pace National seeks customer feedback (both positive and negative) through various means including surveys and personal communication. This feedback is utilized to improve the management system, quality system, analytical activities, and customer services.

2.1.4. Upon customer request, Pace National provides reasonable access to relevant areas of the laboratory for witnessing capability and analytical performance. Confidentiality of all customers during this process is maintained.

2.1.5. Upon request, customers are provided supplementary information and records as needed. This includes, but is not limited to, the following: sample preparation records, packaging information, verification of calibrations, and analytical reference material information.

2.1.6. Pace National's PMs/TSRs are required to maintain good communication with customers. Customers are informed of any delays or major deviations in the analytical work of the laboratory.

2.2. Project Initiation

2.2.1. Prior to accepting new work, the laboratory reviews its performance capability. The laboratory confirms that sufficient personnel, equipment capacity, analytical method capability, etc., are available to complete the required work. Customer needs, certification requirements, and data quality objectives are defined and the appropriate sampling and analysis plan is developed to meet the project requirements by project managers or sales representatives. Members of the management staff review current instrument capacity, personnel availability and training, analytical procedures capability, and projected sample load. Management then informs the sales and client services personnel whether or not the laboratory can accept the new project.

2.2.2. Records of these reviews (including significant changes) are maintained. Records are also maintained of pertinent discussions with the customer relating to the customer's requirements and the results of the work during the period of execution of the contract.

2.2.3. For routine/non-complex projects, a review by appropriate customer service personnel is considered adequate. Customer service confirms that the laboratory can meet the customer's data quality objectives, and the laboratory has any required certifications.

2.2.4. The reviews described above also encompass any work that will need to be subcontracted to another laboratory. See section 2.8 below for more information about subcontracting work.

2.2.5. Applicable customers are informed of any deviation from any contract. Waivers from the Department of Defense (DoD) Quality Systems Manual (QSM) requirements must be requested in

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writing from the appropriate DoD Chemist or Contractor Project Chemist (however named) on a project-specific basis and shall include technical justification for the waiver. Documentation of approval for the waiver must be maintained by the laboratory and readily available for review.

2.2.6. If a contract requires amendment after work has commenced, the same contract review process is repeated and any amendments are communicated to all affected parties.

2.2.7. Additional information regarding specific procedures for reviewing new work requests can be found in SOP ENV-SOP-MTJL-0009, *Contract Review* or its equivalent revision or replacement.

2.3. Sampling Materials and Support

2.3.1. Each individual Pace/Pace National laboratory provides shipping containers, properly preserved sample containers, custody documents, and field quality control samples to support field-sampling events. Guidelines for sample container types, preservatives, and holding times for a variety of methods are listed in Attachment VII. Note that all analyses listed are not necessarily performed at all Pace/Pace National laboratories and there may be additional laboratory analyses performed that are not included in these tables. Customers are encouraged to contact their local Pace Project Manager for questions or clarifications regarding sample handling. Pace/Pace National may provide pick-up and delivery services to their customers when needed

2.3.2. Some Pace facilities provide sampling support through a Field Services department. Field Services operates under the Pace Corporate Quality System, with applicable and necessary provisions to address the activities, methods, and goals specific to Field Services. All procedures and methods used by Field Services are documented in SOPs and Procedure Manuals.

2.3.3. Laboratory Subsampling – In order for analysis results to be representative of the sample collected in the field, the laboratory has subsampling procedures. For more information see SOP ENV-SOP-MTJL-0030, *Sample Homogenization*.

2.4. Chain of Custody

2.4.1. A chain of custody (COC) provides the legal documentation of samples from time of collection to completion of analysis.

2.4.2. Field personnel or client representatives must complete a COC for all samples that are received by the laboratory. Samplers are required to properly complete a COC. This is critical to efficient sample receipt and to ensure the requested methods are used to analyze the correct samples. If sample shipments are not accompanied by the correct documentation, the Sample Receiving department notifies a Project Manager. The Project Manager then obtains the correct documentation/information from the customer in order for analysis of samples to proceed.

2.4.3. The COC is filled out completely and legibly with indelible ink. Errors are corrected by drawing a single line through the initial entry and initialing and dating the change. All transfers of samples are recorded on the chain of custody in the “relinquished” and “received by” sections. All information except signatures is printed.

2.4.4. Additional information can be found in SOP ENV-SOP-MTJL-0060 *Sample Receiving* or its equivalent revision or replacement.

2.5. Sample Acceptance Policy

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2.5.1. In accordance with regulatory guidelines, Pace and Pace National comply with the following sample acceptance policy for all samples received.

2.5.2. If the samples do not meet the sample receipt acceptance criteria outlined below, the laboratory is required to document all non-compliances, contact the customer, and either reject the samples or fully document any decisions to proceed with analyses of samples which do not meet the criteria. Any results reported from samples not meeting these criteria are appropriately qualified on the final report.

2.5.2.1. For Ohio EPA/VAP samples, the case narrative will include a discussion of bias as appropriate when qualification of samples is required due to insufficient sample or other occurrence outside of the laboratory's control. The laboratory has the option to report the data as Not VAP-certified as an exception in the affidavit.

2.5.3. Sample Acceptance Policy requirements:

- Clearly identify the collector's name, the preservation type, and the sample type.
- Have unique client identification that are clearly marked with durable waterproof labels on the sample containers and that match the chain of custody.
- Have clear documentation on the chain of custody related to the location of the sampling site with the time and date of sample collection.
- Have all requested analyses clearly designated on the COC.
- Be in appropriate sample containers with clear documentation of the preservatives used.
- Be correctly preserved unless the method allows for laboratory preservation.
- Be received within holding time. Any samples with hold times that are exceeded will not be processed without prior customer approval.
- Have sufficient sample volume to proceed with the analytical testing. If insufficient sample volume is received, analysis will not proceed without customer approval.
- Be received within appropriate temperature ranges (not frozen but $\leq 6^{\circ}\text{C}$) unless program requirements or customer contractual obligations mandate otherwise. The cooler temperature is recorded directly on the COC. Samples that are delivered to the laboratory immediately after collection are considered acceptable if there is evidence that the chilling process has been started. For example, by the arrival of the samples on ice. If samples arrive that are not compliant with these temperature requirements, the customer will be notified. The analysis will NOT proceed unless otherwise directed by the customer. If less than 72 hours remain in the hold time for the analysis, the analysis may be started while the customer is contacted to avoid missing the hold time. Data associated with any deviations from the above sample acceptance policy requirements will be appropriately qualified.
- Samples for drinking water analysis that are improperly preserved, or are received past holding time, are rejected at the time of receipt, with the exception of VOA samples that are tested for pH at the time of analysis.

2.5.4. Upon sample receipt, the following items are also checked and recorded:

- Presence of custody seals or tapes on the shipping containers;
- Sample condition: Intact, broken/leaking, bubbles in VOA samples;
- Sample holding time;
- Sample pH and residual chlorine when required;
- Appropriate containers.

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2.5.5. Additional information can be found in SOP ENV-SOP-MTJL-0060, *Sample Receiving* or its equivalent revision or replacement.

2.5.6. Personnel dealing with radioactive samples are trained in radioactive sample management procedures. For more information see SOP ENV-SOP-MTJL-0342, *Radioactive Sample Receiving, Handling, and Shipping* and SOP ENV-SOP-MTJL-0345, *Sample Control of Licensed Material for WET Analysis* or their equivalent revisions or replacements.

2.6. Sample Receipt Inspection and Log-in

2.6.1. All samples are verified upon receipt as meeting its description and being free from damage. In the event of a sample being lost, damaged or otherwise unsuitable for use, full details of the incident are recorded and reported to the customer by the Project Manager via a nonconformance form, prior to any analytical action being taken. Any further action taken is at the direction of the customer.

2.6.2. Login Technicians are responsible for sample login and assessing sample container integrity, documentation, and identification. Samples are inspected and noted for temperature, pH using narrow-range pH paper, headspace, proper container type, container integrity (broken or leaking), and volume levels. Samples requiring thermal preservation must arrive at the laboratory above freezing but $\leq 6^{\circ}\text{C}$. If the samples are not appropriately preserved, the problem is noted on a sample nonconformance form, the customer is notified, and, if the lab is instructed to proceed, proper preservation is performed. The sample nonconformance sheet becomes a permanent part of the COC.

2.6.3. Login Technicians are trained to recognize analyses with immediate, 24-hour, and 48-hour holding times. Those samples are designated as “short-holds”. When short-hold samples arrive at the laboratory, the Login procedure for those samples takes place immediately. All analysts are trained to assess incoming samples for holding time limitations.

2.6.4. If a sample has a holding time limitation, the Laboratory Information Management System (LIMS) issues a due date on the bench sheet to ensure that the extraction or analysis is completed within the time allowed. In the event that a holding time is exceeded, the Project Manager contacts the customer, informs them of the situation, and requests further direction. If instructed by the customer to proceed with the analysis, a qualifier is added to the benchsheet, which is then carried on to reporting. The final report bears the explanation in the form of a qualifier.

2.6.5. After sample inspection, all sample information on the COC is entered into the LIMS. The lab’s permanent records for samples received include the following information:

- Customer name and contact information
- The laboratory’s unique sample identification numbers
- Sample descriptions
- Due dates
- List of analyses requested
- Date and time of laboratory receipt
- Field ID code
- Date and time of collection
- Any comments resulting from inspection for sample rejection
- Identification of the person making the above entries into LIMS

2.6.6. A unique sample identification number is generated for each sample submitted to the laboratory and is used throughout the analytical and disposal cycle. A record of all samples is established and maintained.

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2.6.7. Each sample is assigned a unique and consecutive log number. After a sample is entered into the LIMS database it is assigned a specific log number identifier. The LIMS automatically assigns the next consecutive number any subsequent samples. Log numbers are not available for reuse and cannot be altered.

2.6.8. A durable laboratory sample label with the log number is printed from LIMS and is affixed to the sample. Each label contains a unique container ID, represents the sample ID number, and is clearly marked with preservative and requested analysis.

2.6.9. All documentation that is sent to the laboratory by the customer is retained in laboratory records.

2.6.10. Additional information for sample log-in can be found in SOP ENV-SOP-MTJL-0060 *Sample Receiving* or its equivalent revision or replacement.

2.7. Sample Storage and Protection

2.7.1. The samples are stored according to method and regulatory requirements as per the applicable analytical SOPs. While in storage, samples are stored by sample ID and analyses required. Samples are stored away from all standards, reagents, or other potential sources of contamination. Samples are stored in a manner that prevents cross contamination. Volatile samples are stored separately from other samples. All sample fractions, extracts, leachates, and other sample preparation products are stored in the same manner as actual samples or as specified by the analytical method.

2.7.2. Refrigerated storage areas are maintained at $\leq 6^{\circ}\text{C}$ (but not frozen) and freezer storage areas are maintained at $\leq -10^{\circ}\text{C}$ (unless otherwise required per method or program). The temperature of each storage area is checked and documented at least once for each day of use. If the temperature falls outside the acceptable limits, then corrective actions are taken and appropriately documented.

2.7.3. The laboratories are operated under controlled access protocols to ensure sample and data integrity. Visitors must register at the front desk and be properly escorted at all times. Samples are taken to the appropriate storage location immediately after sample receipt and login procedures are completed. All sample storage areas have limited access. Samples are removed from storage areas by designated personnel and returned to the storage areas as soon as possible after the required sample quantity has been taken.

2.7.4. Additional information on sample storage can be found in SOP ENV-SOP-MTJL-0061, *Sample Storage and Disposal* and SOP ENV-SOP-MTJL-0066, *Cold Storage Management* or their equivalent revisions or replacements.

2.8. Subcontracting Analytical Services

2.8.1. Pace National only performs analytical techniques that are within its documented capability, when this is not possible, the laboratory follows SOP ENV-SOP-MTJL-0019, *Subcontracting*. Subcontracting also occurs in the special circumstances where technical, safety, or efficiency issues dictate need. When subcontracting analytical services, whether inside or outside the Pace network, Pace National assures work requiring specific accreditation is placed with an accredited laboratory or one that meets applicable statutory and regulatory requirements of the project/customer. When possible, subcontracting will be to a TNI-accredited laboratory.

2.8.2. When subcontracting analytical services, whether inside or outside the Pace network, Pace National notifies the customer of the intent to subcontract the work in writing. The laboratory typically gains the approval of the customer to subcontract their work prior to implementation, preferably in writing.

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2.8.3. Potential subcontract laboratories must be approved by Pace National based on the criteria listed in SOP ENV-SOP-MTJL-0019, *Subcontracting* or its equivalent revision or replacement. Pace National maintains a list of all approved subcontract laboratories. All analytical reports, which contain data from subcontracted laboratories, include a statement which references the subcontractor laboratory/service.

2.8.4. Any work sent to other labs within the Pace network is handled as inter-regional work and all final reports are labeled clearly with the name of the laboratory performing the work. Any non-TNI work is clearly identified. Pace National assumes responsibility for the qualifications of the subcontractor except when the customer or an authority specifies the subcontractor.

2.8.5. Subcontracted labs used for DoD work must be accredited by DoD or its designated representatives. Subcontracted labs must receive project specific approval from the DoD client before any samples are analyzed. These requirements also apply to the use of any laboratory under the same corporate umbrella, but at a different facility or location.

2.8.6. Additional information can be found in SOP ENV-SOP-MTJL-0019, *Subcontracting* or its equivalent revision or replacement.

2.9. Sample Retention and Disposal

2.9.1. Samples, extracts, digestates, and leachates must be retained by the laboratory for the period of time necessary to protect the interests of the laboratory and the customer.

2.9.2. The minimum sample retention time is 45 days from receipt of the samples. Samples requiring thermal preservation may be stored at ambient temperature when the hold time is expired, the report has been delivered, and/or allowed by the customer, program, or contract. Samples requiring storage beyond the minimum sample retention time due to special requests or contractual obligations may be stored at ambient temperature unless the laboratory has sufficient capacity and their presence does not compromise the integrity of other samples.

2.9.3. After this period expires, non-hazardous samples are properly disposed of as non-hazardous waste. The preferred method for disposition of hazardous samples is to return the excess sample to the customer. If it is not feasible to return samples, or the customer requires Pace National to dispose of excess samples, proper arrangements will be made for disposal by an approved contractor.

2.9.4. Additional information can be found in SOP ENV-SOP-MTJL-0061, *Sample Storage and Disposal*; SOP ENV-SOP-MTJL-0066, *Cold Storage Management*; and SOP #030309, *Waste Management Plan* or their equivalent revisions or replacements.

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3.0. QUALITY CONTROL PROCEDURES

3.1. Quality Control Samples

3.1.1. Pace National has established quality control procedures for monitoring the validity of the testing it performs. The quality control results are recorded in such a way that trends are detectable, and where practicable, are statistically evaluated. This monitoring is planned and reviewed, and includes the utilization of certified reference materials (where available), participation in proficiency testing programs, replicate or confirmation analyses, correlation of results from related analyses, comparison to historical data, etc.

3.1.1.1. The generation, maintenance, and review of control charts to detect trends and prevent out-of-control conditions is discussed in ENV-SOP-MTJL-0017, *Generation of Control Limits*

3.1.2. The quality controls described below are analyzed as applicable to the analytical method used. Acceptance criteria must be established for all quality controls. When quality controls are found to be outside of the pre-defined criteria action is taken to correct the problem, samples reanalyzed, and/or final reports must be appropriately qualified.

3.1.3. Quality control samples must be processed in the same manner as associated customer samples.

3.1.4. Please reference the glossary of this document for definitions of all quality controls mentioned in this section.

3.1.5. For more information see the applicable analytical SOPs. Any deviations to the policies and procedures governing quality controls must be approved by the QA Director.

3.2. Initial Calibration Verification (ICV) or Second Source Verification (SSV)

3.2.1. It is possible for a calibration curve to meet method criteria but still not have the ability to obtain accurate results because all calibration points are from the same source. To assess the accuracy of new calibration curves relative to the purity of the standards, a single standard from a secondary source is analyzed. This secondary source must be from an alternative vendor or from a different lot if the same vendor is used for the preparation of the calibration standards. The laboratory follows specific guidelines for ICV/SSV recoveries and further information can be found in the applicable laboratory SOP. It is Pace National's policy is to analyze a standard that is not the same source as the calibration standards. Some departments this second source could be the LCS or CCV when a method or regulation requires it.

3.3. Continuing Calibration Verification (CCV)

3.3.1. Analytical instrumentation is checked periodically to determine if the analytical response has changed significantly since the initial calibration was established. The values obtained from the analysis of the CCV are compared to the true values and a percent change calculated. The laboratory follows specific guidelines for CCV frequency and recoveries. Further information can be found in the applicable laboratory SOP.

3.4. Method Blank

3.4.1. A method blank is a negative control used to assess the preparation/analysis system for possible contamination and is processed through all preparation and analytical steps with its associated client samples. The method blank is processed at a minimum frequency of one per

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preparation batch and is comprised of a matrix similar to the associated client samples. Method blanks are not applicable for certain analyses (i.e., pH, flash point, temperature, etc.).

3.4.2. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for method blanks.

3.4.3. For DoD samples, the method blank will be considered to be contaminated if: 1) The concentration of any target analyte in the blank exceeds 1/2 the reporting limit and is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit whichever is greater; 2) The concentration of any common laboratory contaminant in the blank exceeds the reporting limit and is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit whichever is greater or 3) The blank result otherwise affects the sample results as per the test method requirements or the project-specific objectives. If the method blank is contaminated as described above, then the laboratory shall reprocess affected samples in a subsequent preparation batch, except when sample results are below the LOD. If insufficient sample volume remains for reprocessing, the results shall be reported with appropriate data qualifiers.

3.4.4. For Ohio EPA/VAP projects, the laboratory must minimize the use of qualified data. In the case of method blank having any reportable contamination, the laboratory is required to re-prepare and reanalyze the associated samples with an acceptable method blank if there is sufficient sample remaining. Acceptable method blanks are those that are free of contamination below the reporting limit. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding method blanks for Ohio EPA/VAP projects. The case narrative will include a discussion of bias as appropriate when qualification of samples is required due to insufficient sample or other occurrence outside of the laboratory's control. The laboratory has the option to report the data as Not VAP-certified as an exception in the affidavit.

3.5. Laboratory Control Sample

3.5.1. The Laboratory Control Sample (LCS) is a positive control used to assess the performance of the entire analytical system including preparation and analysis. The LCS is processed at a minimum frequency of one per preparation batch and is comprised of a matrix similar to the associated client samples.

3.5.2. The LCS contains all analytes required by a specific method or by the customer or regulatory agency, which may include full list of target compounds, with certain exceptions. The lab must ensure that all target components are included in the spike mixture for the LCS over a two (2) year period.

Pace National spikes all target analytes for methods with greater than 20 compounds in the Semivolatile and Volatile Departments. Pace National does use a representative standard for multi-peak analytes.

3.5.3. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for LCSs.

3.5.4. For LCSs containing a large number of analytes, it is statistically likely that a few recoveries will be outside of control limits. This does not necessarily mean that the system is out of control, and therefore no corrective action would be necessary (except for proper documentation). TNI has allowed for a minimum number of marginal exceedances, defined as recoveries that are beyond the LCS control limits (3X the standard deviation) but within than the marginal exceedance limits (4X the standard deviation). The number of allowable exceedances depends on the number of compounds in the LCS. If more analyte recoveries exceed the LCS control limits than is allowed (see below) or

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if any one analyte exceeds the marginal exceedance limits, then the LCS is considered non-compliant and corrective actions are necessary. The number of allowable exceedances is as follows:

- >90 analytes in the LCS- 5 analytes
- 71-90 analytes in the LCS- 4 analytes
- 51-70 analytes in the LCS- 3 analytes
- 31-50 analytes in the LCS- 2 analytes
- 11-30 analytes in the LCS- 1 analyte
- <11 analytes in the LCS- no analytes allowed out)

Note: The use of marginal exceedances is not approved for work from the state of South Carolina. The use of marginal exceedances is also not allowed in the Ohio EPA/VAP.

3.5.5. For Ohio EPA/VAP projects, the laboratory must minimize the use of qualified data. In the case of LCS failures, the laboratory is required to re-prepare and reanalyze the associated samples with an acceptable LCS for all target compounds if there is sufficient sample remaining. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCSs for Ohio EPA/VAP projects. If the LCS has a high bias and the associated samples/analytes are non-detect, the samples can be reported with appropriate qualifiers. The case narrative will include a discussion of bias as appropriate when qualification of samples is required due to insufficient sample or other occurrence outside of the laboratory's control. The laboratory has the option to report the data as Not VAP certified as an exception in the affidavit.

3.5.6. For DoD projects, the laboratory is not allowed to have any target analytes that exceed DoD LCS control limits. In the case of LCS failures, the laboratory is required to reanalyze the associated samples with an acceptable LCS for all target compounds if there is sufficient sample remaining. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCSs for DoD projects. All LCS failures must be accounted for in project case narratives. See applicable method SOPs for further corrective action.

3.6. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

3.6.1. A matrix spike (MS) is a positive control used to determine the effect of the sample matrix on compound recovery for a particular method. A matrix spike/matrix spike duplicate (MS/MSD) set or matrix spike/sample duplicate set is processed at a frequency specified in a particular method or as determined by a specific customer request. The MS and MSD consist of the sample matrix that is spiked with known concentrations of target analytes.

3.6.2. The MS and MSD contain all analytes required by a specific method or by the customer or regulatory agency. In the absence of specified components, the laboratory will spike the MS/MSD with the same number of compounds as previously discussed in the LCS section. However, the lab must ensure that all targeted components are included in the spike mixture for the MS/MSD over a two (2) year period.

3.6.3. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for MS/MSDs.

3.6.4. For Ohio EPA/VAP projects, the laboratory must minimize the use of qualified data. In the case of MS/MSD failures, the laboratory is required to reanalyze the associated samples only when the associated LCS also fails acceptance criteria and if there is sufficient sample remaining. When an LCS is acceptable and the MS results are outside of criteria, and no system anomaly is detected, the samples will be reported with appropriate data qualifiers indicating matrix interference. The

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laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCSs for Ohio EPA/VAP projects.

3.6.5. For DoD work, each preparation batch of samples must contain an associated MS and MSD (or sample duplicate) using the same matrix collected for the specific DoD project. If adequate sample material is not available, then the lack of MS/MSDs shall be noted in the case narrative. Additional MS/MSDs may be required on a project-specific basis. The MS/MSD must be spiked with all target analytes with the exception of PCB analysis, which is spiked per the method. The concentration of the spiked compounds shall be at or below the midpoint of the calibration range or at the appropriate concentration of concern. Multiple spiked samples may need to be prepared to avoid interferences.

3.6.6. For DoD work, the results of all MS/MSD must be evaluated using the same acceptance criteria used for the LCS.

3.7. Sample Duplicate

3.7.1. A sample duplicate is a second portion of sample that is prepared and analyzed in the laboratory along with the first portion. It is used to measure the precision associated with preparation and analysis. A sample duplicate is processed at a frequency specified by the particular method or as determined by a specific customer.

3.7.2. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for sample duplicates.

3.7.3. For Ohio EPA/VAP projects, the laboratory must minimize the use of qualified data. In the case of duplicate samples exceeding the RPD criteria found in applicable analytical SOPs, the laboratory is required to reanalyze the associated sample and duplicate as long as no sampling error was detected if there is sufficient sample remaining. If the sample and duplicate still do not agree, a comment would be made stating there may be sample non-homogeneity. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding sample duplicates for Ohio EPA/VAP projects. The case narrative will include a discussion of bias as appropriate when qualification of samples is required due to insufficient sample or other occurrence outside of the laboratory's control. The laboratory has the option to report the data as Not VAP-certified as an exception in the affidavit.

3.8. Surrogates

3.8.1. Surrogates are compounds that reflect the chemistry of target analytes, are not expected to be present in environmental samples, are typically added to samples for organic analyses to measure the extraction or purge efficiency, and also serve to monitor the potential effects of the sample matrix on compound recovery.

3.8.2. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for surrogates.

3.8.3. For Ohio EPA/VAP samples, the case narrative will include a discussion of bias as appropriate when qualification of samples is required due to insufficient sample or other occurrence outside of the laboratory's control. The laboratory has the option to report the data as Not VAP-certified as an exception in the affidavit.

3.9. Internal Standards

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3.9.1. Internal Standards are method-specific analytes that are added, as applicable, to every standard, QC sample, and client sample at a known concentration, prior to analysis for the purpose of adjusting the response factor used in quantifying target analytes.

3.9.2. Please reference method-specific SOPs for acceptance criteria and associated corrective actions for internal standards.

3.9.3. For Ohio EPA/VAP projects, samples with internal standard that are outside of method criteria must be reanalyzed to confirm sample matrix effect. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding internal standards for Ohio EPA/VAP projects. The case narrative will include a discussion of bias as appropriate when qualification of samples is required due to insufficient sample or other occurrence outside of the laboratory's control. The laboratory has the option to report the data as Not VAP-certified as an exception in the affidavit.

3.10. Limit of Detection (LOD)

3.10.1. Pace National uses a documented procedure to determine a limit of detection (LOD) for each analyte of concern in each matrix reported. Unless otherwise noted in a published method, the procedure used to determine LODs is based on the Method Detection Limit (MDL) procedure outlined in 40 CFR Part 136, Appendix B. All sample processing steps of the preparation and analytical methods are included in the LOD determination including any clean ups.

3.10.2. For Ohio EPA/VAP projects, a valid MDL must be in place prior to sample analysis. MDLs must be spiked at or below the reporting limit and will not be accepted if it was spiked higher than the reporting limit.

3.10.3. DoD definition for LOD- The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the LOD, the false negative rate is 1%.

3.10.4. Additional information can be found in SOP ENV-SOP-MTJL-0016, *Method Detection Limit (MDL), Limit of Detection (LOD), and Limit of Quantitation (LOQ)* or its equivalent revision or replacement.

3.11. Limit of Quantitation (LOQ)

3.11.1. A limit of quantitation (LOQ) for every analyte of concern must be determined. This LOQ is also referred to as the RL, or Reporting Limit. Results reported below the reporting limit are not allowed to be reported without qualification. For methods with a determined LOD, results can be reported out below the LOQ but above the LOD if they are properly qualified (e.g., J flag).

3.11.2. For DoD approved methods, the LOQ and LOD shall be verified quarterly and valid LOQ must be in place prior to sample analysis.

3.11.3. Additional information can be found in SOP ENV-SOP-MTJL-0016, *Method Detection Limit (MDL), Limit of Detection (LOD), and Limit of Quantitation (LOQ)* or its equivalent revision or replacement.

3.12. Estimate of Analytical Uncertainty

3.12.1. When required, or upon customer request, Pace National can provide an estimate of the analytical uncertainty of test results.

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3.12.2. The exact nature of some test methods may preclude rigorous, statistically valid estimation of analytical uncertainty. In these cases the laboratory attempts to identify all components of analytical uncertainty and make a reasonable estimation, and ensures that the form of data reporting does not give a wrong impression of the uncertainty. A reasonable estimation shall be based on knowledge of method performance and previous experience. When estimating the analytical uncertainty, all uncertainty components which are of importance in the given situation shall be taken into account.

3.12.3. In those cases where a well-recognized test method specifies limits to the values of the major source of uncertainty of measurement and specifies the form of presentation of calculated results, the laboratory is considered to have satisfied the requirements on analytical uncertainty by following the test method and reporting instructions.

3.12.4. For more information about the estimation of analytical measurement uncertainty see SOP ENV-SOP-MTJL-0031, *Measurement of Uncertainty*

3.13. Proficiency Testing (PT) Studies

3.13.1. The laboratory participates in proficiency testing programs. PT samples are obtained from approved providers and analyzed and reported at a minimum of two times per year for the relevant fields of testing per matrix. PT samples are treated as typical customer samples. They are included in the laboratory's normal analytical processes and do not receive extraordinary attention due to their nature.

3.13.2. The laboratory does not share PT samples with other laboratories, does not communicate with other laboratories regarding current PT sample results, and does not attempt to obtain the assigned value of any PT sample from the PT provider.

3.13.3. The laboratory initiates an investigation and corrective action plan whenever PT results are deemed unacceptable by the PT provider. Additional PTs will be analyzed and reported as needed for certification purposes.

3.13.4. Additional information can be found in the SOP ENV-SOP-MTJL-0022, *Proficiency Testing Program*

3.14. Rounding and Significant Figures

3.14.1. In general, the laboratory reports data to no more than three significant figures. Therefore, all measurements made in the analytical process must reflect this level of precision. In the event that a parameter that contributes to the final result has less than three significant figures of precision, the final result must be reported with no more significant figures than that of the parameter in question.

3.14.2. Pace National uses traditional/arithmetic rules for rounding data: all numbers, regardless of even or odd, is rounded up if the number ends in 5 or higher. If the number ends in less than 5, the number is rounded down. Example: When rounding to three significant figures 16.15 would become 16.2 and 16.25 would become 16.3

3.14.3. Additional information can be found in the SOP ENV-SOP-MTJL-0043, *Significant Figures and Rounding of Data*

3.15. Retention Time Windows

3.15.1. When chromatographic conditions are changed, retention times and analytical separations are often affected. As a result, two critical aspects of any chromatographic method are the determination and verification of retention times and analyte separation. Retention time windows

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must be established for the identification of target analytes. The retention times of all target analytes in all calibration verification standards must fall within the retention time windows. If an analyte falls outside the retention time window in an ICV or CCV, new absolute retention time windows must be calculated, unless instrument maintenance fixes the problem. When a new column is installed, a new retention time window study must be performed.

3.15.2. Please reference method-specific SOPs for the proper procedure for establishing retention time windows.

3.16. Analytical Method Selection and Validation

3.16.1. Pace National uses appropriate methods for all analyses within its scope which meet the needs of the customer. Methods are supplemented with Standard Operating Procedures (SOPs) that list additional details to ensure consistent application. These SOPs contain information about the use and operation of all relevant equipment as well as the handling and preparation of samples for analysis. All instructions, standards, manuals and reference data relevant to the work of the laboratory are maintained current and are readily available to personnel. Deviations from methods occur only if the deviation has been documented, technically justified, authorized, and accepted by the customer.

3.16.2. The laboratory will inform customers when methods they choose are considered inappropriate and/or out of date. When a customer does not specify the method to be used, the laboratory selects appropriate and approved methods that have been designated by the project's regulatory program. The customer is informed as to the method chosen.

3.16.3. Methods utilized are preferably those published as international, regional, or national standards. The laboratory ensures that it uses the latest valid edition of a method unless it is not appropriate or possible to do so or unless regulatory requirements dictate specific revision use.

3.16.4. The laboratory validates all analytical methods used to some degree. For methods that are published and/or approved by industry standards; validation includes an evaluation of sensitivity, precision, and accuracy to ensure that it can properly operate the method before the analysis of samples.

3.16.5. Introduction of analytical methods developed by the laboratory for its own use is a planned activity and is assigned to qualified personnel equipped with adequate resources. Plans are updated as development proceeds and effective communication is maintained with all personnel involved in the development process.

3.16.6. When it is necessary to employ methods not published and/or approved by industry standards, these are subject to agreement with the customer and must include a clear specification of the customer's requirements and the purpose of the analysis. Prior to the analysis of samples, non-standard method procedures must be developed and validated appropriately. The validation is as extensive as is necessary to meet the needs in the given application. The laboratory records the results obtained, the procedure used for the validation, and a statement as to whether the non-standard method is fit for the intended use. The minimum requirements for non-standard method validation include evaluation of sensitivity, quantitation, precision, bias, and selectivity of each analyte of interest. Procedures developed for non-standard methods must contain at least the following information:

- Appropriate identification
- Scope
- Description of the type of item to be analyzed
- Parameters or quantities and ranges to be determined
- Apparatus and equipment, including technical performance requirements

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

3.16.7. Additional information about validation of methods can be found in the SOP ENV-SOP-MTJL-0021, *Method Validation*

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4.0. DOCUMENT MANAGEMENT AND CHANGE CONTROL

4.1.Document Management

4.1.1. Pace National has an established procedure for managing documents that are part of the quality system. SOP ENV-SOP-MTJL-0003, *Document Control and Distribution* ensures the following:

- Only currently approved document versions are available at points of use
- Documents are reviewed periodically and revised if necessary
- Invalid or obsolete documents are promptly removed from general use
- Obsolete documents retained for audit or knowledge preservation purposes are suitably marked and/or isolated to prevent accidental use
- Affected personnel are notified of changes to management systems documents and supporting procedures, including technical documents
- Reviews of management system documentation shall be maintained and made available for assessment
- Any documents providing instructions to laboratory personnel (e.g. operator aids) are considered part of the management system and are subject to document control procedures

4.1.2. Documents are reviewed and approved for use by authorized personnel prior to issue. Several master lists of managed documents are maintained identifying the current revision status of the controlled documents. This establishes that there are no invalid or obsolete documents in use. Copies of all quality systems documentation provided to DoD for review must be in English. The lists of managed documents may be found at:

H:\QAQC\Public\Controlled Docs\#Controlled Docs Log.xlsx

H:\QAQC\SOPs\SOP Database.accdb

H:\QAQC\Reports\Reference\External Document List\External Document List April 2018.xlsx

4.1.3. Each managed document is uniquely identified to include the date of issue, the revision identification, page numbers, the total number of pages (or a mark to indicate the end of the document), and the electronic storage pathway.

4.1.4. **Quality Assurance Manual (QAM)**

4.1.4.1. The Quality Assurance Manual is the company-wide document that describes all aspects of the quality system for Pace National. The base QAM template is distributed by the Pace Corporate Environmental Quality Department to all applicable local laboratory locations. The local management personnel modify the necessary and permissible sections of the base template and then all applicable local lab staff sign. Each local Quality Department is then in charge of distribution to employees, external customers or regulatory agencies and maintaining a distribution list of controlled document copies. The Quality Assurance Manual template is reviewed on an annual basis and revised accordingly by the Corporate Quality office. Pace National's Quality Assurance Manual is based on this template and is reviewed/revised annually or whenever a change is deemed necessary by laboratory management to ensure it still reflects current practices and meets the requirements of any applicable regulations or customer specifications.

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4.1.4.2. The Quality Assurance Manual may not be reproduced, in part or in full, without written consent of Pace National. The Quality Assurance Manual may not be altered in any way. Whether distributed internally or as a courtesy copy to customers or regulatory agencies, this document is considered confidential and proprietary information. The Quality Assurance Manual can only be deemed official if proper signatures are present. All copies in use within Pace National have been reviewed, approved, and are properly controlled. Any distributed copies outside of Pace National are uncontrolled, unless a controlled copy is specifically requested.

4.1.5. **Standard Operating Procedures (SOPs)**

4.1.5.1. Standard Operating Procedures (SOPs) are written procedures that describe in detail how to accurately and consistently reproduce laboratory processes or provide additional direction for laboratory personnel. Copies of all current SOPs are accessible to all personnel. SOPs consist of three types:

- Technical SOPs pertaining to a laboratory process which have specifically required details.
- Administrative SOPs which document the more general organizational procedures.
- Quality SOPs that provide background and process for quality policy.

4.1.5.2. All SOPs are scheduled for review annually. Reviews are monitored by the QA department and draft copies of the document are issued for review/revision. If it is determined that revision is not necessary the review is documented by recording the date in the appropriate field of the Revision History Form. A note specifying that 'Reviewed with no changes' is also placed in the Description of Revisions section along with the reviewer's name(s).

4.1.5.3. For Ohio EPA/VAP certification, it is required by the Ohio Administrative Code that the laboratory must seek Ohio EPA/VAP review and approval of all SOPs and Quality Manual subsequent modifications prior to implementation.

4.1.5.4. For DoD approval, all technical SOPs are reviewed for accuracy and adequacy annually and whenever method procedures change and updated as appropriate. All such reviews are documented and made available for assessment. Non-technical SOPs that are not required elements of the quality system are considered administrative SOPs and are not required to be reviewed annually.

4.1.5.5. All copies of superseded SOPs are removed from general use and the original copy of each SOP is archived for audit or knowledge preservation purposes. This ensures that all employees use the most current version of each SOP and a historical record is maintained for each SOP.

4.1.5.6. Each SOP indicates the effective date, the revision number, and the issuing authorities. Department Director/Manager/Supervisor approval is required on technical procedures.

4.1.5.7. The laboratory has SOPs for all analytical methods within its scope of accreditation. Any deviation from a method is documented in the method modifications section of the respective SOP, including both a description of the change made and a technical justification.

4.1.5.8. Deviations from SOPs are not allowed without the permission of the QA Director, or designee. In the event that a deviation is requested, the circumstance is considered and the procedure is evaluated for necessary change and allowance.

4.1.5.9. Each determinative method SOP includes or references (as applicable) the following:

- Scope and Application

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- Method Summary and Definitions
- Health and Safety
- Sample Preservation, Containers, Handling and Storage
- Interferences
- Equipment and Supplies
- Reagents and Standards
- Procedure
- Data Analysis and Calculations
- Quality Control and Method Performance
- Data Validation and Corrective Action
- Pollution Prevention and Waste Management
- Method Modifications/Clarifications
- References
- Procedure Revision/Review History

4.1.5.10. Additional sections required for SOPs used in Conjunction with DoD Projects are typically included as an SOP attachment. The DoD QSM currently requires the following additional sections in technical SOPs:

- Equipment/Instrument Maintenance
- Computer Hardware and Software
- Troubleshooting

4.1.5.11. SOPs may not be reproduced, in part or in full, without written consent of Pace National. SOPs may not be altered in any way. Whether distributed internally or as a courtesy copy to customers or regulatory agencies, SOPs are considered confidential and proprietary information. Any copies in use within Pace National have been reviewed, approved, and properly controlled. Any copies of SOPs distributed outside of Pace National are uncontrolled, unless a customer or regulator specifically requests a controlled copy.

4.1.5.12. Additional information about SOPs can be found in SOP ENV-SOP-MTJL-0001, *Writing, Revising, and Maintaining Standard Operating Procedures* or its equivalent revision or replacement.

4.2. Document Change Control

4.2.1. Document changes are reviewed and approved by the original approving authorities unless specifically designated otherwise. Designated authorities are required to have pertinent background information upon which to base their review and approval.

4.2.2. Where practicable, the altered text or new text in the draft is identified during the revision or review process to provide for easy identification of the modifications. Minor SOP changes that occur in the interim of each major revision of the procedure are indicated in the Pace National SOP/Minor Revision Form that is attached to the SOP. All SOPs contain a revision history that provides details of changes during periodic reviews and/or major SOP revisions.

4.2.3. The document management process allows for “minor revisions” or amendments to SOPs where changes are not sufficient to cause a full procedure change. Minor revisions may take the form of handwritten or typed notes on an approved SOP Minor Revision form. Approval of these minor revisions is indicated by the initials of the approval authorities. The modified document is

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then distributed, and obsolete documents are removed. Minor revisions to documents are incorporated into the next full revision as soon as practical.

4.2.4. Electronic documents, such as the Quality Assurance Manual and SOPs, are maintained electronically on protected directories. All laboratory personnel have access to directories that contain the currently approved versions, but edit rights are restricted to authorized personnel only. Obsolete versions of electronic documents are maintained in directories that can only be accessed by authorized personnel.

4.2.5. Additional information can be found in SOP ENV-SOP-MTJL-0003, *Document Control and Distribution* and SOP ENV-SOP-MTJL-0001, *Writing, Revising, and Maintaining Standard Operating Procedures* or their equivalent revisions or replacements.

4.3. Policy for Use and Control of Electronic Signatures

4.3.1. Electronic signatures must be controlled by the individual as electronic files. Electronic signature files must be stored in a secure password protected environment, and are not sent to or used by other individuals. Electronic signatures carry the same weight as handwritten signatures with regards to document approval. Forging another person's signature, handwritten or electronic, will result in disciplinary action.

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5.0. SUPPLIES, EQUIPMENT, AND MEASUREMENT TRACEABILITY

5.1. Purchasing Services and Supplies

5.1.1. Pace National maintains SOP ENV-SOP-MTJL-0020, *Materials Procurement for Analytical Processes*, which describes the purchasing process, including vendor selection and acceptance criteria, for the purchase, storage, and evaluation of supplies and services. When relevant to the measurement integrity of analyses, Pace National uses only services and supplies of adequate quality.

5.1.2. Pace National maintains records of services and supplies that may affect the quality of the laboratory's analytical data. These records include the following, where applicable:

- Date of Receipt
- Expiration Date
- Source
- Lot or Serial Number
- Calibration and Verification Records
- Accreditation or Certification Scopes/Certificates

5.1.3. Department supervisors are responsible for ensuring only supplies/chemicals that meet specified requirements are ordered. Where assurance of the quality of services or supplies is unavailable, the laboratory uses these items only after they have been inspected or otherwise verified for adequate quality. Records of inspections and verifications are maintained in the laboratory.

5.1.4. Purchasing documents are maintained and they contain information that describes the services and supplies that were ordered. These purchasing documents are reviewed and approved by applicable personnel prior to release.

5.1.5. Suppliers of critical services and supplies are evaluated. An approved list of material/service suppliers is maintained where products/services purchased affect the quality of data generated by the laboratory.

5.2. Standards and Traceability

5.2.1. Each Pace facility (including Pace National) retains pertinent information for standards, reagents, and chemicals to assure traceability to a national standard. This includes documentation of purchase, receipt, preparation, and use.

5.2.2. Upon receipt, all purchased standard reference materials are recorded into a standard logbook or database and assigned a unique identification number. The entries include the facility's unique identification number, the chemical name, manufacturer name, manufacturer's identification numbers, receipt date, and expiration date. Vendor's certificates of analysis for all standards, reagents, or chemicals are retained for future reference. For more information see SOP ENV-SOP-MTJL-0041, *Standards Logger*.

5.2.3. Reference standards and materials are used to derive the laboratory's analytical measurements; therefore, it is essential that the reference standards and materials used are of very high quality.

5.2.3.1. Reference Standards

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The laboratory uses ASTM Class 1 reference weights and NIST traceable reference thermometers which are calibrated and/or verified for accuracy by an ISO 17025 (or equivalent) accredited vendor that can provide traceability to national or international standards at a minimum frequency of every 5 years. All working thermometers are calibrated or verified at least annually using a NIST traceable thermometer.

5.2.3.2. Reference Materials

Whenever possible, reference materials must be purchased from a vendor that is accredited to ISO 17034 or Guide 34. Purchased reference materials require a Certificate of Analysis (COA) where available. If a reference material cannot be purchased with a Certificate of Analysis (COA), it must be verified by analysis and comparison to a certified reference material and/or there must be a demonstration of capability for characterization. For additional information see SOP# 030231, Standard Recertification.

5.2.4. Subsequent preparations of intermediate or working solutions are also documented in a standard logbook or database. These entries include the stock standard name and lot number, the manufacturer name, the solvents used for preparation, the solvent lot number and manufacturer, the preparation steps, preparation date, expiration dates, preparer's initials, and a unique identification number. This number is used in any applicable sample preparation or analysis records so the standard can be traced back to the standard preparation record. This process ensures traceability back to the national standard.

5.2.5. Reference material standards used for instrument calibration are verified by using a second source of the material. The second source materials are from a different manufacturer or different lot from the same manufacturer. Reference material standards are checked frequently and replaced if degradation or evaporation is suspected. The laboratory also provides satisfactory evidence of correlation of results by participation in a suitable program of inter-laboratory comparisons or proficiency testing whenever possible.

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

5.2.7. Documentation and Labeling

5.2.7.1. The laboratory retains records for all standards, reagents, and reference materials. These records include the manufacturer/vendor, the manufacturer's Certificate of Analysis or purity (if available), the date of receipt, and recommended storage conditions. These records also include manufacturer lot numbers when applicable.

5.2.7.2. For the original containers, the expiration date provided by the manufacturer is recorded on the container if the expiration date is not already present. If an expiration date is not provided then no expiration date labeling is required.

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5.2.7.3. All prepared standard or reagent containers include the laboratory's unique identification number, the standard or chemical name, the date of preparation, the date of expiration, and the preparer's initials. For containers that are too small to accommodate labels that list all of the above information associated with a standard, the minimum required information will be the laboratory's unique identification number, date prepared, and expiration date. The expiration date of prepared standards does not exceed the expiration date of any parent standard used.

5.2.7.4. Standards, reference materials, and reagents are not used after their expiration dates unless their reliability is thoroughly documented and verified by the laboratory. If a standard exceeds its expiration date and is not re-certified, the laboratory removes the standard and/or clearly designates it as acceptable for qualitative/troubleshooting purposes only. All prepared standards, reference materials, and reagents are verified to meet the requirements of the test method through routine analyses of quality control samples. For additional information see SOP ENV-SOP-MTJL-0042, *Standard Recertification*.

5.3. Analytical Equipment/Instrumentation

5.3.1. Pace National management ensures that all laboratories are furnished with all the equipment required for the correct performance of the analytical tests they performs. Analytical equipment used that is significant to the analytical results is uniquely identified when practical. Calibration procedures are established for instruments and equipment that have a significant effect on the analytical results. All applicable instrumentation are calibrated or checked before use to ensure proper functioning and verify that laboratory, client and regulatory requirements are met. All calibrations are performed by, or under the supervision of, an experienced analyst at scheduled intervals against either certified standards traceable to recognized national standards or reference standards whose values have been statistically validated.

5.3.2. Calibration standards for each parameter are chosen to establish the linear range of the instrument and must bracket the concentrations of those parameters measured in the samples. The lowest calibration standard is the lowest concentration for which quantitative data may be reported. Data reported below this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in a narrative. The highest calibration standard is the highest concentration for which quantitative data may be reported. Data reported above this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in the narrative.

5.3.3. For analytical instrumentation, the most appropriate curve fitting model from among the following choices must be utilized (given in the order of preference):

- Average Response Factor
- Linear – No Weighting
- Linear – 1/X Weighting
- Linear – 1/X² Weighting
- Quadratic

5.3.4. When second order (quadratic) curves are evaluated, acceptability must include an assessment of a graphic representation of the curve to confirm that this fit type is not being used to mask detector saturation and that the curve (which defines a parabola) does not result in two concentrations for one response. When quadratic curves are used there must be a minimum of six initial calibration standards. Higher order polynomial curves (i.e., third-order and greater) are not allowed at Pace National.

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5.3.5. Analytical equipment is operated only by authorized personnel. Up-to-date instructions and procedures for the use and maintenance of analytical equipment are readily available for use by the appropriate laboratory personnel. This includes any relevant equipment manuals provided by the manufacturer.

5.3.6. Records are maintained for analytical equipment used that is significant to the analytical results. These records include at least the following:

- Identity of the equipment (and software if applicable)
- Manufacturer's name, type of equipment, and serial number or other unique identification
- Checks that equipment complies with specifications
- Current location, where appropriate
- Manufacturer's instructions, if available, or reference to their location
- Dates, results, and reports of all calibrations, adjustments, acceptance criteria, and the due date of next calibration where appropriate
- Maintenance carried out to date. Also, the maintenance plan where appropriate
- Any damage, malfunction, modification, or repair to the equipment
- Date placed in service
- Condition when received (e.g., new, used, reconditioned)
- Operational status
- Instrument configuration and settings

5.3.7. The laboratory has established procedures for the safe handling, transport, storage, use, and any planned maintenance of analytical equipment to ensure proper functioning and in order to prevent contamination or deterioration. These procedures include the checks necessary to ensure proper functionality when analytical equipment is returned from being used outside of the permanent control of the laboratory. For additional information see SOP ENV-SOP-MTJL-0056, *Instrument Transport*.

5.3.8. Instrumentation or support equipment that cannot be calibrated to specification or is otherwise defective is clearly labeled as out-of-service until it has been repaired and tested to demonstrate it meets the laboratory's specifications. All repair and maintenance activities including service calls are documented in the maintenance log. Equipment sent off-site for calibration testing is packed and transported to prevent breakage and is in accordance with the calibration laboratory's recommendations. For additional information see SOP ENV-SOP-MTJL-0047, *Lockout/Tagout*.

5.3.9. In the event that recalibration of a piece of test equipment indicates the equipment may have been malfunctioning during the course of sample analysis, an investigation is performed to determine if any analytical results were affected. See section 6.1 below for the Control of Non-Conforming Data policies and procedures.

5.3.10. Whenever practicable, all laboratory equipment requiring calibration is labelled, coded, or otherwise identified to indicate the status of calibration, including the date when last calibrated and the date or expiration criteria when recalibration is due. This requirement is mostly applicable to support equipment such as balances, mechanical pipettes, and temperature reading devices which require periodic calibration. Major analytical equipment that is calibrated and/or verified at time of use does not need to be labeled with its calibration status. Calibration records described above are sufficient to indicate the calibration status.

5.3.11. When, for whatever reason, equipment goes outside the direct control of the laboratory, the laboratory ensures that the function and calibration status of the equipment are checked and shown to be

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satisfactory before the equipment is returned to service. For additional information see SOP ENV-SOP-MTJL-0056, *Instrument Transport*.

5.3.12. When intermediate checks are needed to maintain confidence in the calibration status of the equipment, these checks are carried out according to a defined procedure. These intermediate checks include continuing calibration verification checks performed on major analytical equipment, and also periodic checks of support equipment such as balances and pipettes.

5.3.13. Where calibrations give rise to a set of correction factors, the laboratory has procedures to ensure that copies (e.g., in computer software) are correctly updated.

5.3.14. Analytical and supporting equipment is protected from inadvertent adjustments that could affect the integrity of the laboratory results. Instruments are located in access-protected areas. Software is tested and approved before use. Spreadsheets used in the calculation of analytical results are tested, approved, and locked before being placed into service.

5.4. Support Equipment Calibration and Verification Procedures

5.4.1. All support equipment is calibrated or verified using NIST traceable references, as applicable. The results of calibrations or verifications must be within the specifications required or the equipment will be removed from service until brought back into control. Raw data records are retained to document equipment performance. On each day the equipment is used, balances, ovens, refrigerators, freezers and water baths are checked and recorded.

5.4.2. Analytical Balances

5.4.2.1. Each analytical balance is calibrated or verified at least annually by a qualified service technician. The calibration of each balance is verified each day of use with weights traceable to NIST bracketing the range of use. Calibration weights are ASTM Class 1 or other class weights that have been calibrated against a NIST standard weight and are re-certified every 5 years at a minimum against a NIST traceable reference. Some accrediting agencies may require more frequent checks. If balances are calibrated by an external agency, verification of their weights must be provided. All information pertaining to balance maintenance and calibration is recorded in the individual balance logbook and/or is maintained on file in the local Quality department.

5.4.3. Thermometers

5.4.3.1. Certified, or reference, thermometers are maintained for checking calibration of working thermometers. Reference thermometers are provided with NIST traceability for initial calibration and are re-certified, at a minimum, every 5 years with equipment directly traceable to NIST.

5.4.3.2. Working thermometers are compared with the reference thermometers annually according to corporate metrology procedures (working digital thermometers are calibrated quarterly). Each thermometer is individually numbered and assigned a correction factor based on the NIST reference source. In addition, working thermometers are visually inspected by laboratory personnel prior to use and temperatures are documented.

5.4.3.3. Laboratory thermometer calibration data are maintained in the local Quality department.

5.4.4. pH/Electrometers

5.4.4.1. The meter is calibrated according to manufacturer's instructions before use each day, using fresh buffer solutions.

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5.4.5. Spectrophotometers

5.4.5.1. During use, spectrophotometer performance is checked at established frequencies in analysis sequences against initial calibration verification (ICV) and continuing calibration verification (CCV) standards.

5.4.6. Mechanical Volumetric Dispensing Devices

5.4.6.1. Mechanical volumetric dispensing devices including bottle top dispensers (those that are critical in measuring a required amount of reagent), pipettes, and burettes, excluding Class A volumetric glassware, are checked for accuracy, at a minimum, on a quarterly basis.

5.5. Instrument/Equipment Maintenance

5.5.1. The objectives of the laboratory's maintenance program are twofold: to establish a system of instrument care that maintains instrumentation and equipment at required levels of calibration and sensitivity, and to minimize loss of productivity due to repairs.

5.5.2. Department Managers/Supervisors are responsible for providing technical leadership to evaluate new equipment, solve equipment problems, and coordinate instrument repair and maintenance. Analysts have the primary responsibility to perform routine maintenance.

5.5.3. To minimize downtime and interruption of analytical work, preventive maintenance may be routinely performed on each analytical instrument. Up-to-date instructions on the use and maintenance of equipment are available to staff in the department where the equipment is used.

5.5.4. Department Managers/Supervisors are responsible for maintaining an adequate inventory of spare parts required to minimize equipment downtime. This inventory includes parts and supplies that are subject to frequent failure, have limited lifetimes, or cannot be obtained in a timely manner should a failure occur.

5.5.5. All instrument maintenance (including service calls) is documented in maintenance logbooks that are assigned to each particular instrument or system.

5.5.6. The maintenance log entry must include a summary of the results of that analysis and verification by the analyst that the instrument has been returned to an in-control status. In addition, each entry must include the reason for performing the maintenance, the initials (or other identifier) of the analyst making the entry, the dates the maintenance actions were performed, and the date the entry was made in the maintenance logbook (if different from the date(s) of the maintenance).

5.5.7. Any equipment that has been subjected to overloading or mishandling, or that gives suspect results, or has been shown to be defective, is taken out of service and clearly identified. The equipment shall not be used to analyze customer samples until it has been repaired and shown to perform satisfactorily. In the event of instrumentation failure, to avoid hold time issues, the lab may subcontract the necessary samples to another Pace lab or to an outside subcontract lab if possible. For additional information see SOP ENV-SOP-MTJL-0047, *Lockout/Tagout*.

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6.0. CONTROL OF RECORDS & DATA

Pace National has established and maintains procedures for the identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. Mechanisms have been established for records to remain legible, readily identifiable, and retrievable. These mechanisms also ensure that records are retained for all original observations, calculations and derived data, calibration records, and analytical reports. These observations, data, and calculations are recorded at the time they are made and are identifiable to the specific task. These records allow for the historical reconstruction of laboratory activities related to sample handling and analysis. For more information about the control of records see SOP ENV-SOP-MTJL-0003, *Document Control and Distribution Procedure*, SOP ENV-SOP-MTJL-0014, *Data Handling*, SOP ENV-SOP-MTJL-0058, *IT Processes*; and SOP ENV-SOP-MTJL-0010, *Protection and Transfer of Records*.

Pace National has internal auditing procedures for the independent review of records to ensure they are legible, accurate, and complete. For more information see Section 7.1 below and SOP ENV-SOP-MTJL-0005, *Internal Audits* or its equivalent revision or replacement.

Analytical results processing, verification, and reporting are procedures employed that result in the delivery of defensible data. These processes include, but are not limited to, calculation of raw data into final concentration values, review of results for accuracy, evaluation of quality control criteria and assembly of technical reports for delivery to the data user.

All analytical data undergo a documented multi-tier review process prior to being reported to the customer. This section describes procedures used for translating raw analytical data into accurate final sample reports as well as data storage policies.

When analytical, field, or product testing data is generated, it is documented appropriately. These logbooks and other laboratory records are kept in accordance with each facility's SOP for documentation storage and archival. In this case, the laboratory must ensure that there are sufficient redundant electronic copies so no data is lost due to unforeseen computer issues.

To ensure that data is protected from inadvertent changes or unintentional destruction, the laboratory uses procedures to check calculations and data transfers. This includes (but is not limited to) the following:

- Peer data review and internal audits of raw data
- Calculations on electronic benchsheets/spreadsheets are password protected
- Where possible, version control software features are utilized to prevent electronic data from being overwritten when changes are made.
- Where possible, audit trail software features are utilized. Audit trails serve as an electronic log to record changes to electronic data including the identification of the person who made the change.
- Where possible, data is uploaded directly from the instrument
- Electronic data files are backed-up routinely. For more information see SOP ENV-SOP-MTJL-0058, *Information Technology Processes*.

6.1. Control of Non-Conforming Data

6.1.1. Identification of Non-Conforming Data

6.1.1.1. Non-conforming work is work that does not conform to customer requirements, standard specifications, or documented laboratory policies/procedures. Some examples of non-conformances are departures from SOPs/test methods or quality control results that do not meet

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acceptance criteria. Identification of non-conforming work can come through various sources which include, but are not limited to; results of quality control samples and instrument calibrations, observations of laboratory personnel, data review, and internal audits.

6.1.2. Policies and Procedures for the Control of Non-Conforming Data

6.1.2.1. Many types of non-conformances are listed in the applicable SOPs along with the responsibilities and actions that are needed. Any needed corrections for these non-conformance events are taken immediately together with any decision about the acceptability of the nonconforming data.

6.1.2.2. In the event that a non-conformance is likely to reoccur or that there is doubt about the compliance of the laboratory's operations with its own policies or procedures; laboratory personnel will investigate the significance of the non-conformance and document corrective actions if applicable. When quality of the analytical data has been adversely affected, customers are notified and work is recalled as necessary. For more information see section 8 below for corrective actions and the SOP ENV-SOP-MTJL-0018, *Corrective and Preventive Action*.

6.1.2.3. Customer requests for departures must be pre-approved by appropriate laboratory personnel. These planned and pre-approved departures/non-conformances do not require reviews/investigations; however, they still must be documented. When necessary, planned and pre-approved non-conformances are noted in the final analytical report to advise the data user of any ramification to data quality.

6.1.3. Release of Nonconforming Data

6.1.3.1. The laboratory allows the release of nonconforming data only with approval on a case-by-case basis by the department supervisor, or their designee. Permitted non-conformances, such as QC failures, are fully documented and include the reason for the deviation and the impact of the departure on the data. Where necessary, customer service will notify the customer of the situation and will advise of any ramifications to data quality. Also where necessary, non-conformances are noted in the final analytical report to advise the data user of any ramification to data quality.

6.1.4. Stop Work Procedures

6.1.4.1. Personnel in the quality assurance department have the responsibility and authority to ensure the laboratory's quality system is implemented and followed at all times. In circumstances where a laboratory is not meeting the established level of quality or not following the policies set forth in this Quality Assurance Manual, the Quality Assurance Director has the authority to halt laboratory operations should he or she deem such an action necessary. The Quality Assurance Director will immediately communicate the halting of operations to the rest of Pace National's senior management team and will keep them posted on the progress of corrective actions.

6.1.4.2. If the Quality Assurance Director and the rest of Pace National's senior management team are not in agreement with regards to the halting of operations, then Pace corporate personnel (such as the Chief Operating Officer and the Director of Environmental Quality) are called in to mediate the situation.

6.1.4.3. The department supervisors and members of senior management also have the authority to halt laboratory operations should they deem this action necessary. If this is done they will

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notify personnel in the quality assurance department, and they will keep them informed about the progress of corrective actions.

6.1.4.4. All laboratory personnel have the authority to halt laboratory operations in the event that a situation impacts data validity or safety. When this action is deemed necessary, then the applicable supervisor must be notified of the situation as soon as possible. The supervisor and/or members of senior management will evaluate the severity of the situation for further decision making.

6.1.4.5. Once a stop work order has been approved and implemented, personnel in the quality assurance department have the responsibility of ensuring the effectiveness of the corrective actions taken and authorizing the resumption of work.

6.1.5. For DoD work, all affected DoD customers of potential data quality issues resulting from nonconforming work must be notified within 15 business days from discovery. Records of corrections taken or proposed corrective actions to resolve the nonconformance must be submitted to the customers within 30 business days of discovery.

6.1.6. For DoD work, instances of inappropriate and prohibited laboratory practices (as detailed in Section 5.2.7 of the DoD QSM) must be reported to the laboratory's DoD accrediting body (currently A2LA) within fifteen 15 business days of discovery. Records of corrections taken or proposed corrective actions must be submitted to the laboratory's DoD accrediting body (currently A2LA) within 30 business days of discovery.

6.2. Primary Data Review

6.2.1. Analysts performing the analysis are responsible for the initial data reduction and review, and have the primary responsibility for the quality of the data produced. The analysts initiate the data review process by reviewing and accepting/rejecting the data. This includes, but is not limited to; confirming all samples were prepared/analyzed according to the appropriate method and laboratory SOP, verifying dilutions are calculating properly, ensuring good chromatography, verifying proper spectral interpretations, evaluating quality control data, verifying that any customer/project specific requirements are met, and noting any non-conformances. The primary analyst is also responsible for compiling the initial data package for further data review.

6.2.2. The primary analyst compiles the initial data for secondary data review. This compilation must include sufficient documentation for secondary data review.

6.2.3. Additional information regarding the data reduction and review process can be found in SOP ENV-SOP-MTJL-0014, *Data Handling & Reporting* and SOP ENV-SOP-MTJL-0038, *Data Review* or their equivalent revision(s) or replacement(s).

6.3. Secondary Data Review

6.3.1. Secondary data review is the process of examining data and accepting or rejecting it based on pre-defined criteria. This review step is designed to ensure that reported data are free from calculation and transcription errors, that quality control parameters are evaluated, and that any non-conformances are properly documented.

6.3.2. The completed data from the primary analyst is sent to a designated qualified secondary data reviewer (this cannot be the primary analyst). The secondary data reviewer provides an independent technical assessment of the data package and technical review for accuracy according to methods employed and laboratory protocols. This assessment involves a quality control review for use of the proper methodology and detection limits, compliance to quality control protocol and criteria, presence

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and completeness of required deliverables, and accuracy of calculations and data quantitation.

Secondary data reviews must also verify that all manual entries of raw data are accurate and there are no transcription errors.

6.3.3. Additional information regarding the data reduction and review process can be found in SOP ENV-SOP-MTJL-0014, *Data Handling & Reporting* and SOP ENV-SOP-MTJL-0038, *Data Review* or their equivalent revision(s) or replacement(s).

6.4. Final Administrative Review

6.4.1. All final reports receive a final administrative review of some degree. Once the data have been technically reviewed and approved in the secondary data review process, authorization for release of the data from the analytical section is indicated in the LIMS. A Project Manager (PM) or Technical Service Representatives (TSR) will then perform a final administrative review of the data which includes examining the report for method appropriateness, detection limit/QC acceptability, and any other apparent errors. If no errors are found, the PM or TSR approves the report in LIMS and the customer has the reports emailed to them. If errors are noted, the data is returned to the department for correction and resubmission to the PM or TSR. In the case of DoD work, 100% of all packages must have a final administrative review to confirm that primary and secondary reviews were recorded properly and the data package is complete.

6.5. Compliance Data Review

6.5.1. Compliance data reviews are performed by the Quality Department staff and are considered to be part of the overall internal audit program of the laboratory. These reviews are typically performed after the data has been released to the customer. A list is produced weekly from LIMS showing all methods run by the laboratory and how many batches were analyzed the previous week. Some of these data packages will undergo a compliance data review as per a schedule set by this department. For DoD work, at least 10% of all data packages will reviewed for technical completeness/accuracy.

6.6. Data Reporting

6.6.1. The results of each analysis carried out by the laboratory are reported accurately, clearly, unambiguously, objectively, and in accordance with any specific instructions in regulatory requirements, analytical method(s), and/or laboratory standard operating procedures. The analytical data is reported in an analytical report that is issued to the customer. Analytical reports include all information requested by the customer, any necessary information for the interpretation of the results, and all information required by the analytical method(s) used.

6.6.2. Final reports are prepared according to the level of reporting required by the customer and can be transmitted to the customer via hardcopy or electronic deliverable. For more information see SOP ENV-SOP-MTJL-0014, *Data Handling and Reporting*.

6.6.3. Standard analytical reports contain the following information:

- A title (e.g. Analytical Report)
- Pace National name and address
- Telephone number and name of a laboratory contact to where questions can be referred
- A unique identification number for the report. The pages of the report are numbered and a total number of pages are indicated.
- Name and address of the customer
- Identification of the analytical methods used

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- The unique laboratory's identification of the samples analyzed as well as customer's identification of the samples
- The condition of the samples received and the identification of any sample that did not meet acceptable sampling requirements such as improper sample containers, holding times missed, sample temperature, etc.
- Dates and times of sample collection, sample receipt by the laboratory, sample preparation, and sample analysis
- Reference to the sampling plan and sampling procedures used if sampling was conducted by the laboratory
- The analytical results with the units of measurement and reporting limits.
- The name, title, and signature of the person authorizing the analytical report
- A statement about the results relate only to the items tested
- Deviations from the analytical methods. These can include failed quality control parameters, deviations caused by the matrix of the sample, etc. This can be part of the case narrative or as defined footnotes to the analytical data.
- For Whole Effluent Toxicity, identification of the statistical method used to provide data
- Date report was issued
- For solid samples, identification of whether results are on a dry weight or wet weight basis
- Identification of all test results provided by a subcontracted laboratory or other outside source
- Any non-accredited tests are identified as such
- Identification and qualification of results obtained outside of quantitation levels
- Definitions of any data qualifiers used
- In conjunction with Ohio EPA/VAP projects, a signed affidavit is also required.

6.6.4. In addition to the requirements listed above, final reports also contain the following items when necessary for the interpretation of results:

- Deviations from, additions to, or exclusions from the analytical method(s) used. Also where relevant, information on specific analytical conditions such as environmental conditions
- Where relevant, a statement of compliance/non-compliance with requirements and/or specifications (e.g. TNI Standard)
- Where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer's instruction so requires, or when the uncertainty affects compliance to a specification limit
- Where appropriate and needed, opinions and interpretations (see note below)
- Note: When opinions and interpretations are included in the analytical reports, the laboratory documents the basis upon which the opinions and interpretations have been made. These may include opinions on the compliance/non-compliance of the results with regulatory requirements, fulfillment of contractual requirements, and recommendations on how to use the results. Opinions and interpretations are clearly marked as such in the analytical report and are contained in the case narrative.
- Any additional information required by the customer and/or a specific analytical method.

6.6.5. When the analytical reports contain results of tests performed by subcontractors, these results are clearly identified. When analytical work has been subcontracted, the subcontracted laboratory issues analytical reports to Pace National in writing and/or electronically. Copies of analytical reports from

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subcontracted laboratories are made available to customers. For more information see Section 2.8 above and SOP ENV-SOP-MTJL-0019, *Subcontracting*.

6.6.6. Customer data that requires transmission by electronic means undergoes appropriate steps to include all the required reporting information and to adequately maintain data integrity and confidentiality.

6.6.7. The format of the laboratory's analytical reports are designed to accommodate each type of analytical test carried out by the laboratory and to minimize the possibility of misunderstanding or misuse of analytical results.

6.6.8. Any changes made to a final report shall be designated as "Revised" or equivalent wording. The laboratory must keep sufficient archived records of all laboratory reports and revisions. This process is described in SOP ENV-SOP-MTJL-0033, *Report Revision*.

6.6.9. For higher levels of data deliverables, a copy of all supporting raw data is sent to the customer along with a final report of results. Pace and Pace National will provide electronic data deliverables (EDD) as required by contracts or upon customer request.

6.6.10. The following positions are the only approved signatories for Pace National final reports:

- Vice President of Operations
- Operations Director
- Quality Assurance Director
- Client Operations Manager
- Project Manager
- Assistant Project Manager

6.7. Data Security

6.7.1. All data including electronic files, logbooks, extraction/digestion/distillation worksheets, calculations, project files and reports, and any other information used to produce the technical report are maintained secured and retrievable by the laboratory.

6.7.2. When computers or automated equipment are used for the acquisition, processing, recording, reporting, storage or retrieval of data, the laboratory ensures that:

- Computer software developed by the laboratory is documented in sufficient detail and suitably validated as being adequate for use
- Procedures are established and implemented for protecting the data. Such procedures include (but are not be limited to) integrity and confidentiality of data entry or collection, data storage, data transmission, and data processing
- Computers and automated equipment are maintained to ensure proper function and are provided with the environmental and operating conditions necessary to maintain the integrity of data
- Individual user names and passwords are required for all LIMS
- Upon employment, laboratory employees are provided initial training in computer security awareness and ongoing refresher training is conducted an annual basis
- Periodic inspections of LIMS are performed to ensure the integrity of electronic data
- Customers are notified prior to changes in LIMS software or hardware configurations that will adversely affect the customer's electronic data

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- Spreadsheets used for calculations are verified before initial use and after any changes to equations or formulas, including software revision upgrades. Formula cells are write-protected to minimize inadvertent changes to the formulas.
- Procedures have been established for:
 - Methods of software development that are based on the size and nature of the software being developed
 - Testing and QC methods to ensure that all software accurately performs its intended functions, including:
 - § Acceptance criteria
 - § Tests to be used
 - § Personnel responsible for conducting the tests
 - § Records of test results
 - § Frequency of continuing verification of the software
 - § Test review and approvals
 - Software change control methods that include instructions for requesting, authorizing, requirements to be met by the software change, testing, QC, approving, implementing changes, and establishing priority of change requests
 - Software version control methods that record the software version currently used. Data sets are recorded with the date and time of generation and/or the software version used to generate the data set;
 - Maintaining a historical file of software, software operating procedures, software changes, and software version numbers
 - Defining the acceptance criteria, testing, records, and approval required for changes to LIMS hardware and communication equipment.
- Records maintained in the laboratory to demonstrate the validity of laboratory generated software include:
 - Software description and functional requirements
 - Listing of algorithms and formulas
 - Testing and QA records
 - Installation, operation and maintenance records
- Electronic data security measures ensure the following:
 - Individual user names and passwords have been implemented
 - Operating system privileges and file access safeguards are implemented to restrict the user of the LIMS data to users with authorized access
 - All LIMS users are trained in computer awareness security on an annual basis
 - System events, such as log-on failures or break-in attempts are monitored
 - The electronic data management system is protected from the introduction of computer viruses
 - System backups occur on a regular and published schedule and can be performed by more than just one person
 - Testing of the system backups must be performed and recorded to demonstrate that the backup systems contain all required data
 - Physical access to the servers is limited by security measures
- Commercial “off the shelf” software, e.g., word processing, database and statistical programs in general use within its designed application range may be considered sufficiently validated. However, laboratory software configuration/modifications are validated as above.

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6.8. Data Archiving

6.8.1. All records compiled by the laboratory are archived in a suitable, limited-access environment to prevent loss, damage, or deterioration by fire, flood, vermin, theft, and/or environmental deterioration. Records are retained for a minimum of ten years unless superseded by federal, state, contractual, and/or accreditation requirements.

6.8.2. Records that are computer-generated have either a hard copy or electronic backup copy. Hardware and software necessary for the retrieval of electronic data is maintained with the applicable records. Archived electronic records are stored protected against electronic and/or magnetic sources.

6.8.3. In the event of a change in ownership, accountability or liability, reports of analyses performed pertaining to accreditation will be maintained per the purchase agreement. In the event of bankruptcy, laboratory reports and/or records will be transferred to the customer and/or the appropriate regulatory entity upon request. Additional information can be found in SOP ENV-SOP-MTJL-0012, Business Continuity and Disaster Preparedness Plan.

6.9. Data Disposal

6.9.1. Data that has been archived for the facility's required storage time may be disposed of in a secure manner by shredding, returning to customer, or utilizing some other means that does not jeopardize data confidentiality. Records are retained for a minimum of ten years unless superseded by federal, state, contractual, and/or accreditation requirements.

6.9.2. For Ohio EPA/VAP labs, all documents and data prepared or acquired in connection to VAP work must be retained for a period of 10 years after the data of reporting. After 10 years, if the laboratory wishes to dispose of the records, the laboratory must notify the VAP agency by certified mail of such intent and provide the agency an opportunity to request the materials from Pace. The documents must not be disposed of until notification has been received in response to the Pace request for disposal.

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7.0. QUALITY SYSTEM AUDITS AND REVIEWS

7.1. Internal Audits

7.1.1. Responsibilities

7.1.1.1. The Quality Assurance Department is responsible for managing and/or conducting internal audits in accordance with a predetermined schedule and procedure. Since internal audits represent an independent assessment of laboratory functions, the auditor must be independent from laboratory operations to ensure objectivity. The auditor must be trained, qualified, and familiar enough with the objectives, principles, and procedures of laboratory operations to be able to perform a thorough and effective evaluation. The Quality Assurance Department evaluates audit observations and verifies the completion of corrective actions. In addition, a periodic Pace corporate audit will be conducted. The Pace corporate audits will focus on the effectiveness of the Quality System as outlined in this manual but may also include other quality programs applicable to an individual laboratory.

7.1.1.2. Additional information can be found in SOP ENV-SOP-MTJL-0005, *Internal Audits* or its equivalent revision or replacement.

7.1.2. Scope and Frequency of Internal Audits

7.1.2.1. The complete internal audit process consists of the following sections:

- System and Method Audits – These are the traditional internal audit function and include analyst interviews to help determine whether laboratory practice matches method requirements and SOP language. Applicable raw analytical data and/or final report reviews are usually conducted in conjunction with these traditional internal audits. These audits are conducted according to a predetermined schedule.
- Compliance Data Reviews – These are thorough raw data and record reviews conducted by the quality assurance department that include (but are not limited to) sample receipt records, sample preparation records, analytical records, and the final analytical reports. A portion of the analytical data produced by the laboratory is randomly selected to undergo a compliance data review. These reviews are outside of the laboratory production environment which allows the data to be very closely examined without the pressure of time constraints.
- Corrective action follow-up audits are conducted on an as needed basis to ensure that documented corrective actions are implemented and to verify their effectiveness.

7.1.2.2. Internal systems audits are conducted yearly at a minimum. The scope of these audits includes evaluation of specific analytical departments or a specific quality related system as applied throughout the laboratory.

7.1.2.3. In addition to the scheduled internal audits, unscheduled internal audits are conducted whenever doubts are cast on the laboratory's compliance with regulatory requirements or its own policies and procedures. These unscheduled internal audits may be conducted at any time and may be performed without an announcement to laboratory personnel.

7.1.2.4. Certain projects may require an internal audit to ensure laboratory conformance to site work plans, sampling and analysis plans, QAPPs, etc.

7.1.2.5. The laboratory, as part of their overall internal audit program, ensures that a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery and reporting of potential data integrity issues are handled in a confidential

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manner. All investigations that result in findings of inappropriate activity are fully documented, including the source of the problem, the samples and customers affected the impact on the data, the corrective actions taken by the laboratory, and which final reports had to be re-issued. Customers must be notified within 30 days after the data investigation is completed and the impact to final results is assessed. For DoD work, instances of inappropriate and prohibited laboratory practices (as detailed in Section 5.2.7 of the DoD QSM) must be reported to the laboratory's DoD accrediting body (currently A2LA) within fifteen 15 business days of discovery. Records of corrections taken or proposed corrective actions must be submitted to the laboratory's DoD accrediting body (currently A2LA).

7.1.3. Internal Audit Reports and Corrective Action Plans

7.1.3.1. A full description of the audit, including the identification of the operation audited, the date(s) on which the audit was conducted, the specific systems examined, and the observations noted are summarized in an internal audit report. Although other personnel may assist with the performance of the audit, the quality assurance personnel will write and issue the internal audit report identifying which audit observations are deficiencies that require corrective action.

7.1.3.2. Findings from all internal audits will be routed to the applicable laboratory personnel for corrective action. The responsible party will propose a plan of correction in a timely manner to correct all of the cited deficiencies. The proposed plan should include a time frame for the completion of the corrective actions. This time frame should depend on the complexity of the deficiencies and the amount of resources needed to properly correct the deficiency. The quality department reviews the responses to the internal audit findings. If the responses are determined to be adequate, then the quality department will use the action plan with the given time frame for verifying the completion of the corrective action(s). If the responses are determined to be inadequate, then the response is returned to the responsible party for modification.

7.1.3.3. To complete the internal audit process, the quality department performs a re-examination of the areas where deficiencies were found to verify that all proposed corrective actions have been implemented. An audit deficiency is considered closed once implementation of the necessary corrective action has been audited and verified. If corrective action cannot be verified, the associated deficiency remains open until that action is completed

7.1.3.4. When audit findings cast doubt on the effectiveness of the operations or on the correctness of validity of the laboratory's environmental test results, the laboratory will take timely corrective action and notify the customer in writing within one week, if investigations show that the laboratory results may have been affected. If the issue is complex and the full scope of affected customers is not easily determined, then additional time might be required. However, this additional timeframe for customer notification of complex issues should not exceed one month of discovery. For DoD work, all affected DoD customers must be notified within 15 business days from discovery of any investigation that casts doubt upon the validity of test results.

7.1.3.5. Additional information can be found in SOP ENV-SOP-MTJL-0005, *Internal Audits* or its equivalent revision or replacement.

7.2.External Audits

7.2.1. Pace laboratories (including Pace National) are audited regularly by regulatory agencies to maintain laboratory certifications and by customers to maintain appropriate specific protocols.

7.2.2. It is the laboratory's policy to cooperate and assist with all external audits, whether performed by customers or an accrediting body. Management ensures that all areas of the laboratory are

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accessible to auditors as applicable and that appropriate personnel are available to assist in conducting the audit.

7.2.3. External audit teams review the laboratory to assess the effectiveness of quality systems. The quality assurance department personnel will host the external audit team and assist in facilitation of the audit process. After the audit, the external auditors will usually prepare a formalized audit report listing deficiencies observed and follow-up requirements for the laboratory. The laboratory staff and supervisors develop corrective action plans to address any deficiencies with the guidance of the quality assurance department. Laboratory management will ensure that the necessary resources are provided to effectively develop and implement the corrective action plans. The quality assurance department collates this information and provides a written response to the external audit team. The response contains the corrective action plan and expected completion dates for each element of the plan. The quality department is also responsible for following-up with laboratory personnel to ensure corrective actions are implemented and they are effective.

7.3. Annual Managerial Review

7.3.1. A managerial review of Management and Quality Systems is performed on an annual basis at a minimum. This allows for assessing program effectiveness and introducing changes and/or improvements. Additional information can be found in SOP ENV-SOP-MTJL-0006, *Management Review* or its equivalent revision or replacement.

7.3.2. The managerial review must include the following topics of discussion:

- Suitability of quality management policies and procedures
- Manager/Supervisor reports
- Internal audit results
- Corrective and preventive actions
- External assessment results
- Proficiency testing studies
- Sample capacity and scope of work changes
- Customer feedback, including complaints
- Recommendations for improvement,
- Other relevant factors, such as quality control activities, resources, and staffing.

7.3.3. This managerial review must be documented for future reference and copies of the report are distributed to appropriate laboratory staff. Results must feed into the laboratory planning system and must include goals, objectives, and action plans. Laboratory management ensures that any actions identified during the review are carried out within an appropriate and agreed upon timescale.

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8.0. CORRECTIVE AND PREVENTIVE ACTION

During the process of sample handling, preparation, and analysis, or during review of quality control records, or during reviews of non-technical portions of the lab, certain occurrences may warrant the necessity of corrective actions. These occurrences may take the form of analyst errors, deficiencies in quality control, method deviations, or other unusual circumstances. The laboratory's quality system provides systematic procedures for the documentation, monitoring, completion of corrective actions, and follow-up verification of the effectiveness of these corrective actions. This can be done using the laboratory's corrective action system that lists at a minimum, the deficiency by issue number, the deficiency source, responsible party, root cause, resolution, due date, and date resolved.

Additional information can be found in SOP ENV-SOP-MTJL-0018, *Corrective and Preventive Action* or its equivalent revision or replacement.

8.1. General Corrective Action Procedure

8.1.1. The following items are examples of sources of laboratory deviations or non-conformances that may warrant some form of documented corrective action:

8.1.1.1. Laboratory Non-Conformance Trends

Below are several types of non-conformances that may occur in the laboratory that would require some sort of a corrective action. One time instances are typically handled with a comment or qualifier. A systemic problem with any of these categories may require an official corrective action process.

- Login error
- Preparation Error
- Contamination
- Calibration Failure
- Internal Standard Failure
- LCS Failure
- Laboratory accident
- Spike Failure
- Instrument Failure
- Final Reporting error

8.1.1.2. Proficiency Testing (PT) Results

Any PT result assessed as "not acceptable" requires an investigation and applicable corrective actions. The operational staff is made aware of the PT failures and they are responsible for reviewing the applicable raw data and calibrations and list possible causes for error. The quality assurance department reviews and approves their findings.

Additional information can be found in SOP ENV-SOP-MTJL-0022, *Proficiency Testing Program* or its equivalent revision or replacement

8.1.1.3. Internal and External Audits

The quality assurance department is responsible for documenting all audit findings and their corrective actions. This documentation must include the initial finding, the persons responsible for the corrective action, the due date for responding to the auditing body, the root cause of the finding, and the corrective actions needed for resolution. The quality

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department is also responsible for providing any back-up documentation used to demonstrate that a corrective action has been completed

8.1.1.4. Data Review

In the course of performing primary and secondary review of data or in the compliance data reviews done by the quality assurance department, errors may be found which require corrective actions. Any finding that affects the quality of the data requires some form of corrective action, which may include revising and re-issuing of final reports

8.1.1.5. Customer Complaints

Sales and/or customer service personnel are responsible for initiating corrective actions, when warranted, for customer complaints. The possible causes of the problem are communicated to the appropriate laboratory personnel for investigation. After potential corrective actions have been determined, sales and/or customer service personnel review the corrective action(s) to ensure all customer needs or concerns are being adequately addressed. Records of all complaints, investigations, and corrective actions are maintained. For more information see SOP ENV-SOP-MTJL-0008, *Client Complaint Resolution*.

8.1.1.6. Holding Time Violations

In the event that a holding time has been missed, the analyst or supervisor is responsible for initiating corrective action. Appropriate laboratory management must be made aware of all holding time violations so the customer can be contacted. Laboratory personnel will work with the customer so that appropriate decisions can be made regarding the hold time excursion. The ultimate resolution is then documented and included in the customer's project file.

8.1.2. Documentation of corrective actions may be in the form of a comment or qualifier on the final report that explains the deficiency (e.g., matrix spike recoveries outside of acceptance criteria) or it may be a more formal corrective action report that is entered into the laboratory's corrective action system. This depends on the extent of the deficiency, the impact on the data, and the method or customer requirements for documentation.

8.1.3. The person who discovers the deficiency or non-conformance initiates the corrective action process. If a formal corrective action report is warranted, then the person initiating the corrective action must document the issue, the affected projects/samples, any known causes of the issue, and any corrective actions that they have taken.

8.2. Root Cause Analysis

8.2.1. It is necessary that corrective actions taken address the root cause of the issue in order to prevent reoccurrences. In some cases, an identified cause equals to the "root cause" of the issue. In other cases, an identified cause is actually the outcome or symptoms of an underlying "root cause". Root cause analysis is the key and sometimes the most difficult part in the corrective action procedure. Often the root cause is not obvious and thus a careful analysis of all potential causes of the problem is required. Potential causes could include customer requirements, the samples, sample specifications, methods and procedures, staff skills and training, consumables, or equipment and its calibration.

8.2.2. In the event that the root cause is not obvious, laboratory personnel and management staff will start a root cause analysis by going through an investigative process. During this process, the following general steps must be taken into account: defining the non-conformance, assigning responsibilities,

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determining if the condition is significant, and investigating the root cause of the nonconformance. General non-conformance investigative techniques follow the path of the sample through the process looking at each individual step in detail. The root cause must be documented within the laboratory's corrective action system.

8.2.3. Based on the root cause(s) determined, the lab implements applicable corrective actions and verifies their effectiveness. In the event that analytical testing or results do not conform to documented laboratory policies or procedures Project Management will notify the customer of the situation and will advise of any ramifications to data quality if impacted (with the possibility of work being recalled).

8.3.Selection, Implementation, and Monitoring of Corrective Actions

8.3.1. Where uncertainty arises regarding the best corrective action approach for addressing the root cause of an issue, appropriate laboratory personnel will recommend corrective actions that are appropriate to the magnitude and risk of the problem that will most likely eliminate the problem and prevent recurrence. If needed, senior laboratory management will then decide the best course of action needed. The corrective action that is chosen will then be implemented and documented in the laboratory's corrective action system.

8.3.2. Personnel in the quality assurance department are responsible for monitoring the implementation and documentation of corrective actions to ensure that the corrective actions taken are effective. This verification of the corrective actions effectiveness is documented laboratory's corrective action system.

8.4.Additional Audits

8.4.1. When the identification of non-conformances or departures casts doubt on compliance with the laboratory's policies, procedures, or regulatory requirements; laboratory management ensures that appropriate areas of activity are audited in accordance with Section 7.1 as soon as possible. These additional audits can be short and focused to follow-up with the implementation of the corrective actions to confirm their effectiveness. Additional full-scale audits are only necessary when a serious issue or risk to the laboratory's business is identified.

8.5.Preventive Action

8.5.1. Preventive action is a pro-active process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints. Pace National takes advantage of several information sources to identify opportunities for improvement in all its systems including technical, managerial, and quality systems. These sources include, but are not limited to, the following:

- Identification of trends
- Staff meetings
- Customer feedback
- Managerial reviews

8.5.2. Some examples of preventive action include, but are not limited to, the following:

- Scheduled instrument maintenance (Preventive maintenance)
- Adding additional staff
- Acquisition of new equipment
- Training activities

8.5.3. All laboratory personnel have the authority to offer suggestions for improvements and to recommend preventive actions. However, it is ultimately the responsibility of laboratory management for implementing preventive action. When improvement opportunities are identified or if preventive

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action is required; then action plans are developed, implemented, and monitored to reduce the likelihood of the occurrence of non-conformities and/or to take advantage of the opportunities for improvement.

8.5.4. For more information see SOP ENV-SOP-MTJL-0018, *Corrective and Preventive Action*.

9.0. GLOSSARY

The source of some of the definitions is indicated previous to the actual definition (e.g., TNI, DoD).

Terms and Definitions	
3P Program	The Pace continuous improvement program that focuses on Process, Productivity, and Performance. Best Practices are identified that can be used by all Pace labs.
Absolute Pressure	Pressure measured with reference to absolute zero pressure expressed in psia. An absolute pressure value of zero is indicative of an evacuated system (vacuum).
Acceptance Criteria	TNI- Specified limits placed on characteristics of an item, process, or service defined in requirement documents.
Accreditation	TNI- The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. DoD- Refers to accreditation in accordance with the DoD ELAP.
Accreditation Body (AB)	TNI- The organization having responsibility and accountability for environmental laboratory accreditation and which grants accreditation under this program. DoD- Entities recognized in accordance with the DoD-ELAP that are required to operate in accordance with ISO/IEC 17011, <i>Conformity assessment: General requirements for accreditation bodies accrediting conformity assessment bodies</i> . The AB must be a signatory, in good standing, to the International Laboratory Accreditation Cooperation (ILAC) mutual recognition arrangement (MRA) that verifies, by evaluation and peer assessment, that its signatory members are in full compliance with ISO/IEC 17011 and that its accredited laboratories comply with ISO/IEC 17025.
Accuracy	TNI- The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.
Activity, Absolute	TNI- Rate of nuclear decay occurring in a body of material, equal to the number of nuclear disintegrations per unit time. NOTE: Activity (absolute) may be expressed in becquerels (Bq), curies (Ci), or disintegrations per minute (dpm), and multiples or submultiples of these units.
Activity, Areic	TNI- Quotient of the activity of a body of material and its associated area.
Activity, Massic	TNI- Quotient of the activity of a body of material and its mass; also called specific activity.
Activity, Volumic	TNI- Quotient of the activity of a body of material and its volume; also called activity concentration. NOTE: In this module [TNI Volume 1, Module 6], unless otherwise stated, references to activity shall include absolute activity, areic activity, massic activity, and volumic activity.

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Activity Reference Date	TNI- The date (and time, as appropriate to the half-life of the radionuclide) to which a reported activity result is calculated. NOTE: The sample collection date is most frequently used as the Activity Reference Date for environmental measurements, but different programs may specify other points in time for correction of results for decay and ingrowth.
AIHA-LAP, LLC	American Industrial Hygiene Association, Laboratory Accreditation Program, LLC
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
American Society for Testing and Materials (ASTM)	An international standards organization that develops and publishes voluntary consensus standards for a wide range of materials, products, systems and services.
Analysis	DoD- A combination of sample preparation and instrument determination.
Analysis Code (Acode)	All the set parameters of a test, such as Analytes, Method, Detection Limits and Price.
Analysis Sequence	A compilation of all samples, standards and quality control samples run during a specific amount of time on a particular instrument in the order they are analyzed.
Analyst	TNI- The designated individual who performs the “hands-on” analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.
Analyte	TNI- A substance, organism, physical parameter, property, or chemical constituent(s) for which an environmental sample is being analyzed. DoD- The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family and are analyzed together.
Analytical Method	DoD- A formal process that identifies and quantifies the chemical components of interest (target analytes) in a sample.
Analytical Uncertainty	TNI- A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
Annual (or Annually)	Defined by Pace as every 12 months \pm 30 days.
Assessment	TNI - The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its system to defined criteria (to the standards and requirements of laboratory accreditation). DoD- An all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection, or surveillance conducted on-site.
Atomic Absorption Spectrometer	Instrument used to measure concentration in metals samples.
Atomization	A process in which a sample is converted to free atoms.

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Audit	TNI- A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.
Batch	TNI- Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same quality systems matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed 20 samples. South Carolina- same definition as TNI except 24 hours should be changed to 8 hours.
Batch, Radiation Measurements (RMB)	TNI- An RMB is composed of 1 to 20 environmental samples that are counted directly without preliminary physical or chemical processing that affects the outcome of the test (e.g., non-destructive gamma spectrometry, alpha/beta counting of air filters, or swipes on gas proportional detectors). The samples in an RMB share similar physical and chemical parameter, and analytical configurations (e.g., analytes, geometry, calibration, and background corrections). The maximum time between the start of processing of the first and last in an RMB is 14 calendar days.
Bias	TNI- The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).
Blank	TNI and DoD- A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results (See Method Blank). DoD- Blank samples are negative control samples, which typically include field blank samples (e.g., trip blank, equipment (rinsate) blank, and temperature blank) and laboratory blank samples (e.g., method blank, reagent blank, instrument blank, calibration blank, and storage blank).
Blind Sample	A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.
BNA (Base Neutral Acid compounds)	A list of semi-volatile compounds typically analyzed by mass spectrometry methods. Named for the way they can be extracted out of environmental samples in an acidic, basic or neutral environment.
BOD (Biochemical Oxygen Demand)	Chemical procedure for determining how fast biological organisms use up oxygen in a body of water.

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Calibration	TNI- A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. 1) In calibration of support equipment, the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI); 2) In calibration according to test methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.
Calibration Curve	TNI- The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.
Calibration Method	A defined technical procedure for performing a calibration.
Calibration Range	DoD- The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.
Calibration Standard	TNI- A substance or reference material used for calibration.
Certified Reference Material (CRM)	TNI- Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute.
Chain of Custody	An unbroken trail of accountability that verifies the physical security of samples, data, and records.
Chain of Custody Form (COC)	TNI- Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and type of containers; the mode of collection, the collector, time of collection; preservation; and requested analyses.
Chemical Oxygen Demand (COD)	A test commonly used to indirectly measure the amount of organic compounds in water.
Client (referred to by ISO as Customer)	Any individual or organization for whom items or services are furnished or work performed in response to defined requirements and expectations.
Code of Federal Regulations (CFR)	A codification of the general and permanent rules published in the Federal Register by agencies of the federal government.
Comparability	An assessment of the confidence with which one data set can be compared to another. Comparable data are produced through the use of standardized procedures and techniques.
Completeness	The percent of valid data obtained from a measurement system compared to the amount of valid data expected under normal conditions. The equation for completeness is: % Completeness = (Valid Data Points/Expected Data Points)*100

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Confirmation	<p>TNI- Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second-column confirmation; alternate wavelength; derivatization; mass spectral interpretation; alternative detectors; or additional cleanup procedures.</p> <p>DoD- Includes verification of the identity and quantity of the analyte being measured by another means (e.g., by another determinative method, technology, or column). Additional cleanup procedures alone are not considered confirmation techniques.</p>
Conformance	An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.
Congener	A member of a class of related chemical compounds (e.g., PCBs, PCDDs).
Consensus Standard	DoD- A standard established by a group representing a cross-section of a particular industry or trade, or a part thereof.
Continuing Calibration Blank (CCB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method.
Continuing Calibration Check Compounds (CCC)	Compounds listed in mass spectrometry methods that are used to evaluate an instrument calibration from the standpoint of the integrity of the system. High variability would suggest leaks or active sites on the instrument column.
Continuing Calibration Verification	DoD- The verification of the initial calibration. Required prior to sample analysis and at periodic intervals. Continuing calibration verification applies to both external and internal standard calibration techniques, as well as to linear and non-linear calibration models.
Continuing Calibration Verification (CCV) Standard	Also referred to as a Calibration Verification Standard (CVS) in some methods, it is a standard used to verify the initial calibration of compounds in an analytical method. CCVs are analyzed at a frequency determined by the analytical method.
Continuous Emission Monitor (CEM)	A flue gas analyzer designed for fixed use in checking for environmental pollutants.
Continuous Improvement Plan (CIP)	The delineation of tasks for a given laboratory department or committee to achieve the goals of that department.
Contract Laboratory Program (CLP)	A national network of EPA personnel, commercial labs, and support contractors whose fundamental mission is to provide data of known and documented quality.
Contract Required Detection Limit (CRDL)	Detection limit that is required for EPA Contract Laboratory Program (CLP) contracts.
Contract Required Quantitation Limit (CRQL)	Quantitation limit (reporting limit) that is required for EPA Contract Laboratory Program (CLP) contracts.
Control Chart	A graphic representation of a series of test results, together with limits within which results are expected when the system is in a state of statistical control (see definition for Control Limit)

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Control Limit	A range within which specified measurement results must fall to verify that the analytical system is in control. Control limit exceedances may require corrective action or require investigation and flagging of non-conforming data.
Correction	DoD- Action taken to eliminate a detected non-conformity.
Corrective Action	DoD- The action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence. A root cause analysis may not be necessary in all cases.
Corrective and Preventive Action (CAPA)	The primary management tools for bringing improvements to the quality system, to the management of the quality system's collective processes, and to the products or services delivered which are an output of established systems and processes.
Critical Value	TNI- Value to which a measurement result is compared to make a detection decision (also known as critical level or decision level). NOTE: The Critical Value is designed to give a specified low probability α of false detection in an analyte-free sample, which implies that a result that exceeds the Critical Value, gives high confidence ($1 - \alpha$) that the radionuclide is actually present in the material analyzed. For radiometric methods, α is often set at 0.05.
Customer	DoD- Any individual or organization for which products or services are furnished or work performed in response to defined requirements and expectations.
Data Integrity	TNI- The condition that exists when data are sound, correct, and complete, and accurately reflect activities and requirements.
Data Quality Objective (DQO)	Systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use or end user.
Data Reduction	TNI- The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more usable form.
Definitive Data	DoD- Analytical data of known quantity and quality. The levels of data quality on precision and bias meet the requirements for the decision to be made. Data that is suitable for final decision-making.
Demonstration of Capability (DOC)	TNI- A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. DoD- A procedure to establish the ability of the analyst to generate analytical results by a specific method that meet measurement quality objectives (e.g., for precision and bias).
Department of Defense (DoD)	An executive branch department of the federal government of the United States charged with coordinating and supervising all agencies and functions of the government concerned directly with national security.
Detection Limit (DL)	DoD- The smallest analyte concentration that can be demonstrated to be different than zero or a blank concentration with 99% confidence. At the DL, the false positive rate (Type 1 error) is 1%. A DL may be used as the lowest concentration for reliably reporting a detection of a specific analyte in a specific matrix with a specific method with 99% confidence.

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Detection Limit (DL) for Safe Drinking Water Act (SDWA) Compliance	TNI- Laboratories that analyze drinking-water samples for SDWA compliance monitoring must use methods that provide sufficient detection capability to meet the detection limit requirements established in 40 CFR 141. The SDWA DL for radioactivity is defined in 40 CFR Part 141.25.c as the radionuclide concentration, which can be counted with a precision of plus or minus 100% at the 95% confidence level (1.96σ where σ is the standard deviation of the net counting rate of the sample).
Deuterated Monitoring Compounds (DMCs)	DoD- SIM specific surrogates as specified for GC/MS SIM analysis.
Diesel Range Organics (DRO)	A range of compounds that denote all the characteristic compounds that make up diesel fuel (range can be state or program specific).
Digestion	DoD- A process in which a sample is treated (usually in conjunction with heat and acid) to convert the target analytes in the sample to a more easily measured form.
Document Control	The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.
Documents	DoD- Written components of the laboratory management system (e.g., policies, procedures, and instructions).
Dry Weight	The weight after drying in an oven at a specified temperature.
Duplicate (also known as Replicate or Laboratory Duplicate)	The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results of duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.
Dynamic Calibration	Calibration of the analytical system with gas standard concentrations at similar concentrations, in a form identical and through the same analytical path as in the real samples.
Dynamic Dilution	Preparation of calibration mixtures in which concentrated standard gas are continually blended with zero air in a manifold and introduced at the inlet of the analytical system or a receiving canister.
Electron Capture Detector (ECD)	Device used in GC methods to detect compounds that absorb electrons (e.g., PCB compounds).
Electronic Data Deliverable (EDD)	A summary of environmental data (usually in spreadsheet form) which clients request for ease of data review and comparison to historical results.
Eluent	A solvent used to carry the components of a mixture through a stationary phase.
Elute	To extract, specifically, to remove (absorbed material) from an absorbent by means of a solvent.
Elution	A process in which solutes are washed through a stationary phase by movement of a mobile phase.
Environmental Data	DoD- Any measurements or information that describe environmental processes, locations, or conditions; ecological or health effects and consequences; or the performance of environmental technology.
Environmental Monitoring	The process of measuring or collecting environmental data.

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Environmental Protection Agency (EPA)	An agency of the federal government of the United States which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.
Environmental Sample	<p>A representative sample of any material (aqueous, non-aqueous, or multimedia) collected from any source for which determination of composition or contamination is requested or required. Environmental samples can generally be classified as follows:</p> <ul style="list-style-type: none"> • Non Potable Water (Includes surface water, ground water, effluents, water treatment chemicals, and TCLP leachates or other extracts) • Drinking Water - Delivered (treated or untreated) water designated as potable water • Water/Wastewater - Raw source waters for public drinking water supplies, ground waters, municipal influents/effluents, and industrial influents/effluents • Sludge - Municipal sludges and industrial sludges. • Soil - Predominately inorganic matter ranging in classification from sands to clays. • Waste - Aqueous and non-aqueous liquid wastes, chemical solids, and industrial liquid and solid wastes
Equipment Blank	A sample of analyte-free media used to rinse common sampling equipment to check effectiveness of decontamination procedures.
Extracted Internal Standard Analyte	Isotopically labeled analogs of analytes of interest added to all standards, blanks and samples analyzed. Added to samples and batch QC samples prior to the first step of sample extraction and to standards and instrument blanks prior to analysis. Used for isotope dilution methods.
Facility	A distinct location within the company that has unique certifications, personnel and waste disposal identifications.
False Negative	DoD- A result that fails to identify (detect) an analyte or reporting an analyte to be present at or below a level of interest when the analyte is actually above the level of interest.
False Positive	DoD- A result that erroneously identifies (detects) an analyte or reporting an analyte to be present above a level of interest when the analyte is actually present at or below the level of interest.
Field Blank	A blank sample prepared in the field by filling a clean container with reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken.
Field Measurement	Determination of physical, biological, or radiological properties, or chemical constituents that are measured on-site, close in time and space to the matrices being sampled/measured, following accepted test methods. This testing is performed in the field outside of a fixed-laboratory or outside of an enclosed structure that meets the requirements of a mobile laboratory.
Field of Accreditation	TNI- Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.
Field of Proficiency Testing (FoPT)	TNI- Matrix, technology/method, analyte combinations for which the composition, spike concentration ranges and acceptance criteria have been established by the PTPEC.

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Finding	<p>TNI- An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement.</p> <p>DoD- An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive, negative, or neutral and is normally accompanied by specific examples of the observed condition. The finding must be linked to a specific requirement (e.g., this standard, ISO requirements, analytical methods, contract specifications, or laboratory management systems requirements).</p>
Flame Atomic Absorption Spectrometer (FAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the fact that ground state metals absorb light at different wavelengths. Metals in a solution are converted to the atomic state by use of a flame.
Flame Ionization Detector (FID)	A type of gas detector used in GC analysis where samples are passed through a flame which ionizes the sample so that various ions can be measured.
Gas Chromatography (GC)	Instrumentation which utilizes a mobile carrier gas to deliver an environmental sample across a stationary phase with the intent to separate compounds out and measure their retention times.
Gas Chromatograph/Mass Spectrometry (GC/MS)	In conjunction with a GC, this instrumentation utilizes a mass spectrometer which measures fragments of compounds and determines their identity by their fragmentation patterns (mass spectra).
Gasoline Range Organics (GRO)	A range of compounds that denote all the characteristic compounds that make up gasoline (range can be state or program specific).
Gauge Pressure	Pressure measured with reference to the surrounding atmospheric pressure expressed in units of psi. A gauge pressure value of zero is equal to atmospheric pressure.
GC/MS Scan Mode	A GC/MS system in Full Scan mode will monitor a range of masses known as mass to charge ratio (abbreviated m/z). A typical mass scan range will cover from 35-500 m/z four times per second and will detect compound fragments within that range over a set time period. The Full Scan mode is quite useful when identifying unknown compounds in a sample and providing confirmation of results from GC using other types of detectors.
GC/MS SIM Mode	(Gas Chromatography/Mass Spectroscopy- Selective Ion Monitoring) Operation of a GC/MS in SIM mode allows for detection of specific analytes with increased sensitivity relative to full scan mode. In SIM mode the MS gathers data for masses of interest rather than looking for all masses over a wide range. Because the instrument is set to look for only masses of interest it can be specific for particular analytes of interest. Typically two to four ions are monitored per compound and the ratios of those ions are unique to the analyte of interest. In order to increase sensitivity, the mass scan rate and dwell times (the time spent looking at each mass) are adjusted. When properly setup and calibrated, GC/MS SIM can increase sensitivity by a factor of 10 to 100 times that of GC/MS Full Scan.
Graphite Furnace Atomic Absorption Spectrometry (GFAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the absorption of light at different wavelengths that are characteristic of different analytes.

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High Pressure Liquid Chromatography (HPLC)	Instrumentation used to separate, identify and quantitate compounds based on retention times which are dependent on interactions between a mobile phase and a stationary phase.
Holding Time	<p>TNI- The maximum time that can elapse between two specified activities.</p> <p>40 CFR Part 136- The maximum time that samples may be held prior to preparation and/or analysis as defined by the method and still be considered valid or not compromised.</p> <p>For sample prep purposes, hold times are calculated using the time of the start of the preparation procedure.</p> <p>DoD- The maximum time that may elapse from the time of sampling to the time of preparation or analysis, or from preparation to analysis, as appropriate.</p>
Homogeneity	The degree to which a property or substance is uniformly distributed throughout a sample.
Homologue	One in a series of organic compounds in which each successive member has one more chemical group in its molecule than the next preceding member. For instance, methanol, ethanol, propanol, butanol, etc., form a homologous series.
Improper Actions	DoD- Intentional or unintentional deviations from contract-specified or method-specified analytical practices that have not been authorized by the customer (e.g., DoD or DOE).
Incremental Sampling Method (ISM)	Soil preparation for large volume (1 kg or greater) samples.
In-Depth Data Monitoring	TNI- When used in the context of data integrity activities, a review and evaluation of documentation related to all aspects of the data generation process that includes items such as preparation, equipment, software, calculations, and quality controls. Such monitoring shall determine if the laboratory uses appropriate data handling, data use and data reduction activities to support the laboratory's data integrity policies and procedures.
Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)	Analytical technique used for the detection of trace metals which uses plasma to produce excited atoms that emit radiation of characteristic wavelengths.
Inductively Coupled Plasma- Mass Spectrometry (ICP/MS)	An ICP that is used in conjunction with a mass spectrometer so that the instrument is not only capable of detecting trace amounts of metals and non-metals but is also capable of monitoring isotopic speciation for the ions of choice.
Infrared Spectrometer (IR)	An instrument that uses infrared light to identify compounds of interest.
Initial Calibration (ICAL)	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response relationship of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method.
Initial Calibration Blank (ICB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method. This blank is specifically run in conjunction with the Initial Calibration Verification (ICV) where applicable.

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Initial Calibration Verification (ICV)	DoD- Verifies the initial calibration with a standard obtained or prepared from a source independent of the source of the initial calibration standards to avoid potential bias of the initial calibration.
Injection Internal Standard Analyte	Isotopically labeled analogs of analytes of interest (or similar in physiochemical properties to the target analytes but with a distinct response) to be quantitated. Added to all blanks, standards, samples and batch QC after extraction and prior to analysis.
Instrument Blank	A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination.
Instrument Detection Limits (IDLs)	Limits determined by analyzing a series of reagent blank analyses to obtain a calculated concentration. IDLs are determined by calculating the average of the standard deviations of three runs on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day.
Interference, spectral	Occurs when particulate matter from the atomization scatters incident radiation from the source or when the absorption or emission from an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible.
Interference, chemical	Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte.
Internal Standard	TNI and DoD- A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.
International Organization for Standardization (ISO)	An international standard-setting body composed of representatives from various national standards organizations.
Intermediate Standard Solution	Reference solutions prepared by dilution of the stock solutions with an appropriate solvent.
International System of Units (SI)	The coherent system of units adopted and recommended by the General Conference on Weights and Measures.
Ion Chromatography (IC)	Instrumentation or process that allows the separation of ions and molecules based on the charge properties of the molecules.
Isomer	One of two or more compounds, radicals, or ions that contain the same number of atoms of the same element but differ in structural arrangement and properties. For example, hexane (C ₆ H ₁₄) could be n-hexane, 2-methylpentane, 3-methylpentane, 2,3-dimethylbutane, 2,2-dimethylbutane.
Laboratory	A body that calibrates and/or tests.
Laboratory Control Sample (LCS)	TNI- (also known as laboratory fortified blank (LFB), spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to evaluate the performance of all or a portion of the measurement system.
Laboratory Duplicate	Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.

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Laboratory Information Management System (LIMS)	DoD- The entirety of an electronic data system (including hardware and software) that collects, analyzes, stores, and archives electronic records and documents.
LabTrack	Database used by Pace to store and track corrective actions and other laboratory issues.
Learning Management System (LMS)	A web-based database used by the laboratories to track and document training activities. The system is administered by the corporate training department and each laboratory's learn centers are maintained by a local administrator.
Legal Chain-of-Custody Protocols	TNI- Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain-of-Custody (COC) Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.
Limit(s) of Detection (LOD)	TNI- The minimum result, which can be reliably discriminated from a blank with predetermined confidence level. DoD- The smallest concentration of a substance that must be present in a sample in order to be detected at the DL with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. A LOD may be used as the lowest concentration for reliably reporting a non-detect of a specific analyte in a specific matrix with a specific method at 99% confidence.
Limit(s) of Quantitation (LOQ)	TNI- The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. DoD- The smallest concentration that produces a quantitative result with known and recorded precision and bias. For DoD/DOE projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard and within the calibration range.
Linear Dynamic Range	DoD- Concentration range where the instrument provides a linear response.
Liquid chromatography/tandem mass spectrometry (LC/MS/MS)	Instrumentation that combines the physical separation techniques of liquid chromatography with the mass analysis capabilities of mass spectrometry.
Lot	TNI- A definite amount of material produced during a single manufacturing cycle, and intended to have uniform character and quality.
Management	Those individuals directly responsible and accountable for planning, implementing, and assessing work.
Management System	System to establish policy and objectives and to achieve those objectives.
Manager (however named)	The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual.
Matrix	TNI- The substrate of a test sample.
Matrix Duplicate	TNI- A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.

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Matrix Spike (MS) (spiked sample or fortified sample)	TNI- A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
Matrix Spike Duplicate (MSD) (spiked sample or fortified sample duplicate)	TNI- A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.
Measurement Performance Criteria (MPC)	DoD- Criteria that may be general (such as completion of all tests) or specific (such as QC method acceptance limits) that are used by a project to judge whether a laboratory can perform a specified activity to the defined criteria.
Measurement Quality Objective (MQO)	TNI- The analytical data requirements of the data quality objectives are project- or program-specific and can be quantitative or qualitative. MQOs are measurement performance criteria or objectives of the analytical process. Examples of quantitative MQOs include statements of required analyte detectability and the uncertainty of the analytical protocol at a specified radionuclide activity, such as the action level. Examples of qualitative MQOs include statements of the required specificity of the analytical protocol, e.g., the ability to analyze for the radionuclide of interest given the presence of interferences.
Measurement System	TNI- A method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s). DoD- A test method, as implemented at a particular laboratory, and which includes the equipment used to perform the sample preparation and test and the operator(s).
Measurement Uncertainty	DoD- An estimate of the error in a measurement often stated as a range of values that contain the true value within a certain confidence level. The uncertainty generally includes many components which may be evaluated from experimental standard deviations based on repeated observations or by standard deviations evaluated from assumed probability distributions based on experience or other information. For DoD/DOE, a laboratory's Analytical Uncertainty (such as use of LCS control limits) can be reported as the minimum uncertainty.
Method	TNI- A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.
Method Blank	TNI- A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

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Method Detection Limit (MDL)	TNI- One way to establish a Detection Limit; defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
Method of Standard Additions	A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration.
Minimum Detectable Activity (MDA)	TNI- Estimate of the smallest true activity that ensures a specified high confidence, $1 - \beta$, of detection above the Critical Value, and a low probability β of false negatives below the Critical Value. For radiometric methods, β is often set at 0.05. NOTE 1: The MDS is a measure of the detection capability of a measurement process and as such, it is an a priori concept. It may be used in the selection of methods to meet specified MQOs. Laboratories may also calculate a “sample specific” MDA, which indicates how well the measurement process is performing under varying real-world measurement conditions, when sample-specific characteristics (e.g., interferences) may affect the detection capability. However, the MDA must never be used instead of the Critical Value as a detection threshold. NOTE 2: For the purpose of this Standard, the terms MDA and minimum detectable concentration (MDC) are equivalent.
MintMiner	Program used by Pace to review large amounts of chromatographic data to monitor for errors or data integrity issues.
Mobile Laboratory	TNI- A portable enclosed structure with necessary and appropriate accommodation and environmental conditions for a laboratory, within which testing is performed by analysts. Examples include but are not limited to trailers, vans, and skid-mounted structures configured to house testing equipment and personnel.
National Environmental Laboratory Accreditation Conference (NELAC)	See definition of The NELAC Institute (TNI).
National Institute of Occupational Safety and Health (NIOSH)	National institute charged with the provision of training, consultation and information in the area of occupational safety and health.
National Institute of Standards and Technology (NIST)	TNI- A federal agency of the US Department of Commerce’s Technology Administration that is designed as the United States national metrology institute (or NMI).
National Pollutant Discharge Elimination System (NPDES)	A permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.
Negative Control	Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.
Nitrogen Phosphorus Detector (NPD)	A detector used in GC analyses that utilizes thermal energy to ionize an analyte. With this detector, nitrogen and phosphorus can be selectively detected with a higher sensitivity than carbon.

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Nonconformance	An indication or judgment that a product or service has not met the requirement of the relevant specifications, contract, or regulation; also the state of failing to meet the requirements.
Not Detected (ND)	The result reported for a compound when the detected amount of that compound is less than the method reporting limit.
Operator Aid	DoD- A technical posting (such as poster, operating manual, or notepad) that assists workers in performing routine tasks. All operator aids must be controlled documents (i.e., a part of the laboratory management system).
Performance Based Measurement System (PBMS)	An analytical system wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner.
Physical Parameter	TNI- A measurement of a physical characteristic or property of a sample as distinguished from the concentrations of chemical and biological components.
Photo-ionization Detector (PID)	An ion detector which uses high-energy photons, typically in the ultraviolet range, to break molecules into positively charged ions.
Polychlorinated Biphenyls (PCB)	A class of organic compounds that were used as coolants and insulating fluids for transformers and capacitors. The production of these compounds was banned in the 1970's due to their high toxicity.
Positive Control	Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.
Post-Digestion Spike	A sample prepared for metals analyses that has analytes spike added to determine if matrix effects may be a factor in the results.
Power of Hydrogen (pH)	The measure of acidity or alkalinity of a solution.
Practical Quantitation Limit (PQL)	Another term for a method reporting limit. The lowest reportable concentration of a compound based on parameters set up in an analytical method and the laboratory's ability to reproduce those conditions.
Precision	TNI- The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.
Preservation	TNI and DoD- Any conditions under which a sample must be kept in order to maintain chemical, physical, and/or biological integrity prior to analysis.
Primary Accreditation Body (Primary AB)	TNI- The accreditation body responsible for assessing a laboratory's total quality system, on-site assessment, and PT performance tracking for fields of accreditation.
Procedure	TNI- A specified way to carry out an activity or process. Procedures can be documented or not.
Proficiency Testing (PT)	TNI- A means to evaluate a laboratory's performance under controlled conditions relative to a given set of criteria, through analysis of unknown samples provided by an external source.
Proficiency Testing Program (PT Program)	TNI- The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories.

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Proficiency Testing Provider (PT Provider)	TNI- A person or organization accredited by a TNI-approved Proficiency Testing Provider Accreditor to operate a TNI-compliant PT Program.
Proficiency Testing Provider Accreditor (PTPA)	TNI- An organization that is approved by TNI to accredit and monitor the performance of proficiency testing providers.
Proficiency Testing Reporting Limit (PTRL)	TNI- A statistically derived value that represents the lowest acceptable concentration for an analyte in a PT sample, if the analyte is spiked into the PT sample. The PTRLs are specified in the TNI FoPT tables.
Proficiency Testing Sample (PT)	TNI- A sample, the composition of which is unknown to the laboratory, and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria.
Proficiency Testing (PT) Study	TNI- a) Scheduled PT Study: A single complete sequence of circulation and scoring of PT samples to all participants in a PT program. The study must have the same pre-defined opening and closing dates for all participants; b) Supplemental PT Study: A PT sample that may be from a lot previously released by a PT Provider that meets the requirements for supplemental PT samples given in Volume 3 of this Standard [TNI] but that does not have a pre-determined opening date and closing date.
Proficiency Testing Study Closing Date	TNI- a) Scheduled PT Study: The calendar date by which all participating laboratories must submit analytical results for a PT sample to a PT Provider; b) Supplemental PT Study: The calendar date a laboratory submits the results for a PT sample to the PT Provider.
Proficiency Testing Study Opening Date	TNI- a) Scheduled PT Study: The calendar date that a PT sample is first made available to all participants of the study by a PT Provider; b) Supplemental PT Study: The calendar date the PT Provider ships the sample to a laboratory.
Protocol	TNI- A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed.
Qualitative Analysis	DoD- Analysis designed to identify the components of a substance or mixture.
Quality Assurance (QA)	TNI- An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.
Quality Assurance Manual (QAM)	A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality Assurance Project Plan (QAPP)	A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.
Quality Control (QC)	TNI- The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against “out of control” conditions and ensuring that the results are of acceptable quality.

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Quality Control Sample (QCS)	TNI- A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control.
Quality Manual	TNI- A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality System	TNI and DoD- A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control activities.
Quality System Matrix	<p>TNI and DoD- These matrix definitions shall be used for purposes of batch and quality control requirements and may be different from a field of accreditation matrix:</p> <ul style="list-style-type: none"> • Air and Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device • Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts. • Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples shall be grouped according to origin. • Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined. • Drinking Water: Any aqueous sample that has been designated a potable or potentially potable water source. • Non-aqueous liquid: Any organic liquid with <15% settleable solids • Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake. • Solids: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.
Quantitation Range	DoD- The range of values (concentrations) in a calibration curve between the LOQ and the highest successively analyzed initial calibration standard used to relate instrument response to analyte concentration. The quantitation range (adjusted for initial sample volume/weight, concentration/dilution and final volume) lies within the calibration range.
Quantitative Analysis	DoD- Analysis designed to determine the amounts or proportions of the components of a substance.

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Random Error	The EPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test due to random error. As the number of compounds measured increases in a given sample, the probability for statistical error also increases.
Raw Data	TNI- The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records.
Reagent Blank (method reagent blank)	A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.
Reagent Grade	Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.
Records	DoD- The output of implementing and following management system documents (e.g., test data in electronic or hand-written forms, files, and logbooks).
Reference Material	TNI- Material or substance one or more of whose property values are sufficiently homogenized and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.
Reference Method	TNI- A published method issued by an organization generally recognized as competent to do so. (When the ISO language refers to a “standard method”, that term is equivalent to “reference method”). When a laboratory is required to analyze by a specified method due to a regulatory requirement, the analyte/method combination is recognized as a reference method. If there is no regulatory requirement for the analyte/method combination, the analyte/method combination is recognized as a reference method if it can be analyzed by another reference method of the same matrix and technology.
Reference Standard	TNI- Standard used for the calibration of working measurement standards in a given organization or at a given location.
Relative Percent Difference (RPD)	A measure of precision defined as the difference between two measurements divided by the average concentration of the two measurements.
Reporting Limit (RL)	<p>The level at which method, permit, regulatory and customer-specific objectives are met. The reporting limit may never be lower than the Limit of Detection (i.e., statistically determined MDL). Reporting limits are corrected for sample amounts, including the dry weight of solids, unless otherwise specified. There must be a sufficient buffer between the Reporting Limit and the MDL.</p> <p>DoD- A customer-specified lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.</p>
Reporting Limit Verification Standard (RLVS)	A standard analyzed at the reporting limit for an analysis to verify the laboratory’s ability to report to that level.

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Representativeness	A quality element related to the ability to collect a sample reflecting the characteristics of the part of the environment to be assessed. Sample representativeness is dependent on the sampling techniques specified in the project work plan.
Requirement	Denotes a mandatory specification; often designated by the term “shall”.
Retention Time	The time between sample injection and the appearance of a solute peak at the detector.
Revocation	TNI- The total or partial withdrawal of a laboratory’s accreditation by an accreditation body.
Sample	Portion of material collected for analysis, identified by a single, unique alphanumeric code. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis.
Sample Condition Upon Receipt Form (SCURF)	Form used by sample receiving personnel to document the condition of sample containers upon receipt to the laboratory (used in conjunction with a COC).
Sample Delivery Group (SDG)	A unit within a single project that is used to identify a group of samples for delivery. An SDG is a group of 20 or fewer field samples within a project, received over a period of up to 14 calendar days. Data from all samples in an SDG are reported concurrently.
Sample Receipt Form (SRF)	Letter sent to the client upon login to show the tests requested and pricing.
Sample Tracking	Procedures employed to record the possession of the samples from the time of sampling until analysis, reporting and archiving. These procedures include the use of a chain-of-custody form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.
Sampling	TNI- Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.
Selected Ion Monitoring (SIM)	A mode of analysis in mass spectrometry where the detector is set to scan over a very small mass range, typically one mass unit. The narrower the range, the more sensitive the detector. DoD- Using GC/MS, characteristic ions specific to target compounds are detected and used to quantify in applications where the normal full scan mass spectrometry results in excessive noise.
Selectivity	TNI- The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.
Sensitivity	TNI- The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.
Serial Dilution	The stepwise dilution of a substance in a solution.
Shall	Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification as long as the requirement is fulfilled.
Should	Denotes a guideline or recommendation whenever noncompliance with the specification is permissible.

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Signal-to-Noise Ratio (S/N)	DoD- A measure of signal strength relative to background noise. The average strength of the noise of most measurements is constant and independent of the magnitude of the signal. Thus, as the quantity being measured (producing the signal) decreases in magnitude, S/N decreases and the effect of the noise on the relative error of a measurement increases.
Source Water	TNI- When sampled for drinking water compliance, untreated water from streams, rivers, lakes, or underground aquifers, which is used to supply private and public drinking water supplies.
Spike	A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.
Standard (Document)	TNI- The document describing the elements of a laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.
Standard (Chemical)	Standard samples are comprised of a known amount of standard reference material in the matrix undergoing analysis. A standard reference material is a certified reference material produced by US NIST and characterized for absolute content, independent of analytical test method.
Standard Blank (or Reagent Blank)	A calibration standard consisting of the same solvent/reagent matrix used to prepare the calibration standards without the analytes. It is used to construct the calibration curve by establishing instrument background.
Standard Method	A test method issued by an organization generally recognized as competent to do so.
Standard Operating Procedure (SOP)	TNI- A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks.
Standard Reference Material (SRM)	A certified reference material produced by the US NIST or other equivalent organization and characterized for absolute content, independent of analytical method.
Statement of Qualifications (SOQ)	A document that lists information about a company, typically the qualifications of that company to compete on a bid for services.
Stock Standard	A concentrated reference solution containing one or more analytes prepared in the laboratory using an assayed reference compound or purchased from a reputable commercial source.
Storage Blank	DoD- A sample of analyte-free media prepared by the laboratory and retained in the sample storage area of the laboratory. A storage blank is used to record contamination attributable to sample storage at the laboratory.
Sub-atmospheric Sampling	Collection of ambient air into an evacuated canister with a final canister pressure below atmospheric pressure. This is the normal practice when collecting air with passive sampling devices since the sample collection must be stopped prior to completely filling the canister.
Supervisor	The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses.

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Surrogate	DoD- A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.
Suspension	TNI- The temporary removal of a laboratory's accreditation for a defined period of time, which shall not exceed 6 months or the period of accreditation, whichever is longer, in order to allow the laboratory time to correct deficiencies or area of non-conformance with the Standard.
Systems Audit	An on-site inspection or assessment of a laboratory's quality system.
Target Analytes	DoD- Analytes or chemicals of primary concern identified by the customer on a project-specific basis.
Technical Director	Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory.
Technology	TNI- A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.
Test	A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate.
Test Method	DoD- A definitive procedure that determines one or more characteristics of a given substance or product.
Test Methods for Evaluating Solid Waste, Physical/ Chemical (SW-846)	EPA Waste's official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with RCRA regulations.
Test Source	TNI- A radioactive source that is tested, such as a sample, calibration standard, or performance check source. A Test Source may also be free of radioactivity, such as a Test Source counted to determine the subtraction background, or a short-term background check.
The NELAC Institute (TNI)	A non-profit organization whose mission is to foster the generation of environmental data of known and documented quality through an open, inclusive, and transparent process that is responsive to the needs of the community. Previously known as NELAC (National Environmental Laboratory Accreditation Conference).
Total Petroleum Hydrocarbons (TPH)	A term used to denote a large family of several hundred chemical compounds that originate from crude oil. Compounds may include gasoline components, jet fuel, volatile organics, etc.
Toxicity Characteristic Leaching Procedure (TCLP)	A solid sample extraction method for chemical analysis employed as an analytical method to simulate leaching of compounds through a landfill.
Traceability	TNI- The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical conditions or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.

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Training Document	A training resource that provides detailed instructions to execute a specific method or job function.
Trip Blank	This blank sample is used to detect sample contamination from the container and preservative during transport and storage of the sample. A cleaned sample container is filled with laboratory reagent water and the blank is stored, shipped, and analyzed with its associated samples.
Tuning	A check and/or adjustment of instrument performance for mass spectrometry as required by the method.
Ultraviolet Spectrophotometer (UV)	Instrument routinely used in quantitative determination of solutions of transition metal ions and highly conjugated organic compounds.
Uncertainty, Counting	TNI- The component of Measurement Uncertainty attributable to the random nature of radioactive decay and radiation counting (often estimated as the square root of observed counts (MARLAP). Older references sometimes refer to this parameter as Error, Counting Error or Count Error (c.f., Total Uncertainty).
Uncertainty, Expanded	TNI- The product of the Standard Uncertainty and a coverage factor, k, which is chosen to produce an interval about the result that has a high probability of containing the value of the measurand (c.f., Standard Uncertainty). NOTE: Radiochemical results are generally reported in association with the Total Uncertainty. Either if these estimates of uncertainty can be reported as the Standard Uncertainty (one-sigma) or as an Expanded Uncertainty (k-sigma, where $k > 1$).
Uncertainty, Measurement	TNI- Parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand.
Uncertainty, Standard	TNI- An estimate of the Measurement Uncertainty expressed as a standard deviation (c.f., Expanded Uncertainty).
Uncertainty, Total	TNI- An estimate of the Measurement Uncertainty that accounts for contributions from all significant sources of uncertainty associated with the analytical preparation and measurement of a sample. Such estimates are also commonly referred to as Combined Standard Uncertainty or Total Propagated Uncertainty, and in some older references as the Total Propagated Error, among other similar items (c.f., Counting Uncertainty).
Unethical actions	DoD- Deliberate falsification of analytical or quality control results where failed method or contractual requirements are made to appear acceptable.
United States Department of Agriculture (USDA)	A department of the federal government that provides leadership on food, agriculture, natural resources, rural development, nutrition and related issues based on public policy, the best available science, and effective management.
United States Geological Survey (USGS)	Program of the federal government that develops new methods and tools to supply timely, relevant, and useful information about the Earth and its processes.
Unregulated Contaminant Monitoring Rule (UCMR)	EPA program to monitor unregulated contaminants in drinking water.
Validation	DoD- The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

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Verification	TNI- Confirmation by examination and objective evidence that specified requirements have been met. In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.
Voluntary Action Program (VAP)	A program of the Ohio EPA that gives individuals a way to investigate possible environmental contamination, clean it up if necessary and receive a promise from the State of Ohio that no more cleanup is needed.
Whole Effluent Toxicity (WET)	The aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater (effluent).

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10.0. REFERENCES

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11.0. REVISIONS

The Pace Corporate Environmental Quality Office files an electronic version of a Microsoft Word document with tracked changes detailing all revisions made to previous versions of the Quality Assurance Manual template. Pace National files an electronic version of a Microsoft Word document with tracked changes detailing all revisions made to this template. These documents are available upon request. All current revisions are summarized in the table below.

Document Number	Reason for Change	Date
Quality Assurance Manual 18.0	Updated laboratory name to Pace National throughout document. Updated SOP numbers to new MasterControl system. Added section 3.1.1.1 about control charts. Added a few terms and definitions in the glossary.	4/22/19

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ATTACHMENT I- QUALITY CONTROL CALCULATIONS

PERCENT RECOVERY (%REC)

$$\% REC = \frac{(MSConc - SampleConc)}{TrueValue} * 100$$

NOTE: The SampleConc is zero (0) for the LCS and Surrogate Calculations

PERCENT DIFFERENCE (%D)

$$\% D = \frac{MeasuredValue - TrueValue}{TrueValue} * 100$$

where:

TrueValue = Amount spiked (can also be the \overline{CF} or \overline{RF} of the ICAL Standards)

Measured Value = Amount measured (can also be the CF or RF of the CCV)

PERCENT DRIFT

$$\% Drift = \frac{CalculatedConcentration - TheoreticalConcentration}{TheoreticalConcentration} * 100$$

RELATIVE PERCENT DIFFERENCE (RPD)

$$RPD = \frac{|(R1 - R2)|}{(R1 + R2) / 2} * 100$$

where:

R1 = Result Sample 1

R2 = Result Sample 2

CORRELATION COEFFICIENT (R)

$$CorrCoeff = \frac{\sum_{i=1}^N W_i * (X_i - \bar{X}) * (Y_i - \bar{Y})}{\sqrt{\left(\sum_{i=1}^N W_i * (X_i - \bar{X})^2 \right) * \left(\sum_{i=1}^N W_i * (Y_i - \bar{Y})^2 \right)}}$$

With: N Number of standard samples involved in the calibration
 i Index for standard samples
 Wi Weight factor of the standard sample no. i
 Xi X-value of the standard sample no. i
 X(bar) Average value of all x-values
 Yi Y-value of the standard sample no. i
 Y(bar) Average value of all y-values

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ATTACHMENT I- QUALITY CONTROL CALCULATIONS (CONTINUED)

CALIBRATION FACTOR (CF)

$$CF = \frac{A_s}{C_s}$$

where:

A_s = Average Peak Area over the number of peaks used for quantitation

C_s = Concentration of the analyte in the standard

RESPONSE FACTOR (RF)

$$RF = \frac{(Conc_{.IStd})(Area_{Analyte})}{(Conc_{.analyte})(Area_{IStd})}$$

where:

A_s = Response for analyte to be measured

A_{is} = Response for the internal standard

C_{is} = Concentration of the internal standard

C_s = Concentration of the analyte to be measured

LINEAR CALIBRATION MODEL

$$y = mx + b$$

where:

m = Slope of the line

b = The y intercept

QUADRATIC CALIBRATION MODEL

$$y = ax^2 + bx + c$$

where:

c = The y intercept

STANDARD DEVIATION (S)

$$S = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{(n-1)}}$$

where:

n = number of data points

X_i = individual data point

\bar{X} = average of all data points

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ATTACHMENT I- QUALITY CONTROL CALCULATIONS (CONTINUED)

AVERAGE (\bar{X})

$$\bar{X} = \frac{\sum_{n=1}^i X_i}{n}$$

where:

n = number of data points

X_i = individual data point

RELATIVE STANDARD DEVIATION (RSD)

$$RSD = \frac{S}{\bar{X}} * 100$$

where:

S = Standard Deviation of the data points

\bar{X} = average of all data points

PERCENT ERROR

$$\% Error = \frac{x_i - x'_i}{x_i} * 100$$

where:

x'_i = Measured amount of analyte at calibration level i

x_i = True amount of analyte at calibration level i

RELATIVE STANDARD ERROR (RSE)

$$RSE = 100 \times \sqrt{\frac{\sum_{i=1}^n \left[\frac{x'_i - x_i}{x_i} \right]^2}{(n - p)}}$$

where:

x_i = True amount of analyte at calibration level i

x'_i = Measured amount of analyte at calibration level i

p = Number of terms in fitting equation (Average = 1, Linear = 2, Quadratic = 3)

n = Number of calibration points

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ATTACHMENT I- QUALITY CONTROL CALCULATIONS (CONTINUED)

MINIMUM DETECTABLE ACTIVITY (MDA)

The MDA is used for radiochemical analysis and is calculated with the following equations:

MDA with Blank Population

$$MDA = \frac{3.29 * S_b}{KT_s} + \frac{3}{KT_s}$$

Where:

$$K = E \times V \times R \times Y \times F \times 2.22$$

E = efficiency

V = sample volume

R = tracer recovery

Y = gravimetric carrier recovery

F = ingrowth or decay factor

2.22 = conversion from dpm to pCi

T_s = count time of sample in minutes

S_b = standard deviation of the blank population

MDA without Blank Population

$$MDA = \frac{3.29 * \sqrt{\frac{b}{T_s} + \frac{b}{T_b}}}{K} + \frac{3}{KT_s}$$

MDA =

Where:

b = background count rate in cpm

T_b = Count time of background in minutes

RELATIVE ERROR RATIO (RER)/NORMALIZED ABSOLUTE DIFFERENCE (NAD)/DUPLICATE ERROR RATIO (DER)

RER, NAD, and DER are used for radiochemical analysis and are calculated by the following:

$$RER/NAD/DER = \frac{|S - R|}{\sqrt{U_S^2 + U_R^2}}$$

Where:

S = Sample Value

U_S = Sample Uncertainty (at 2 sigma)

R = Replicate Value

U_R = Replicate Uncertainty (at 2 sigma)

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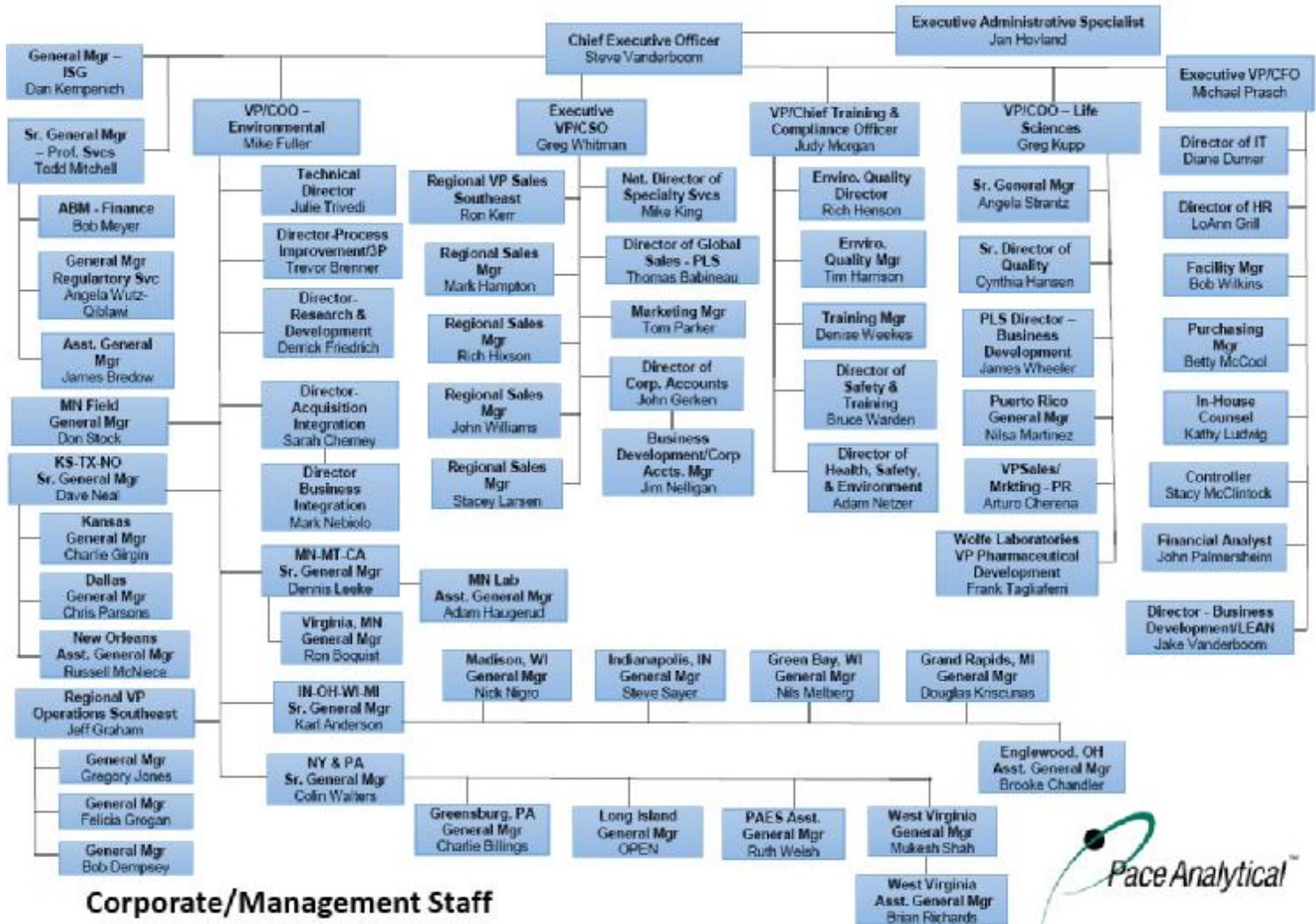
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ATTACHMENT III- CORPORATE ORGANIZATIONAL CHART



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ATTACHMENT IV- EQUIPMENT LISTS

Pace National – MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Air Analysis <i>This table is subject to revision without notice</i>					
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Instrument Name</i>	<i>Serial #</i>	<i>Location</i>
GC/FID	Agilent	6890N	AIRGC2	US10137006	Air Lab
Headspace Autosampler	EST/PTS	LGX50	AIRGC2	2688	Air Lab
Gas Chromatograph	HP	6890N TCD	AIRGC3	US10726007	Air Lab
Headspace Autosampler	EST/PTS	LGX50	AIRGC3	2689	Air Lab
Gas Chromatograph/Mass Spectrometer	HP	6890/5973	AIRMS1	GCUS00024616 MSUS63810244	Air Lab
Thermal Desorber	Markes	TO100-XR	AIRMS1	GB00K21022-16/9	Air Lab
Gas Chromatograph/Mass Spectrometer	Agilent	6890N/5975	AIRMS2	CN10551083	Air Lab
Preconcentrator	Entech	7200	AIRMS2	2290	Air Lab
Tedlar Autosampler	Entech	7032A	AIRMS2	1017	Air Lab
Canister Autosampler	Entech	7016CA	AIRMS2	1039	Air Lab
Gas Chromatograph/Mass Spectrometer	Agilent	6890/5973	AIRMS3	US000011333 US91911078	Air Lab
Injector	Agilent	G2614A	AIRMS3	US14213143	Air Lab
Gas Chromatograph/Mass Spectrometer	Agilent	6890/5973	AIRMS4	US00024695 US82311265	Air Lab
Canister Autosampler	Entech	7016CA	AIRMS4	0203	Air Lab
Gas Chromatograph/Mass Spectrometer	Agilent	6890/5973	AIRMS5	GCUS0003961 MSUS0340681	Air Lab
Preconcentrator	Entech	7200	AIRMS5	1162	Air Lab
Canister Autosampler	Entech	7016D	AIRMS5	1422	Air Lab
Tedlar Autosampler	Entech	7032AB	AIRMS5	1044	Air Lab
Gas Chromatograph/Mass Spectrometer	Agilent	7890A/5975C	AIRMS6	GCUS10831022 MSU91732329	Air Lab
Canister Autosampler	Entech	7016D	AIRMS6	1505	Air Lab
Preconcentrator	Entech	7200	AIRMS6	1322	Air Lab
Tedlar Autosampler	Entech	7032A	AIRMS6	1044	Air Lab
Canister Autosampler	Entech	7016CA	AIRMS7	0218	Air Lab
Gas Chromatograph/Mass Spectrometer	Agilent	7890A/5975	AIRMS7	GCCN13231014 MSUS50680012	Air Lab
Thermal Desorber	Markes	Unity-XR	AIRMS7	GB00U32627-16/9	Air Lab
Dynamic Diluter	Entech	Model 4600A		1086	Air Lab
TO Canister	Restek/Entech	TO-Can/ SiloniteCan	2100 cans owned	N/A	Air Lab
Passive Sampling Kit	Restek/Entech		1578 owned	N/A	Air Lab
Field hand held PID	RAE Systems	MiniRAE3000		592-917273	Air Lab
Canister Cleaner	Entech	3100A	Oven 1	1448	Air Lab
Oven	Entech	3513ENT	Oven 1	1482060344516	Air Lab
Oven	Entech	3513ENT	Oven 1	1482060344515	Air Lab
Canister Cleaner	Entech	3100A	Oven 2	1178	Air Lab
Oven	Entech	3513ENT	Oven 2	1482060344518	Air Lab
Oven	Entech	31-350ER	Oven 2	B33ER-01180	Air Lab
Canister Cleaner	Entech	3100A	Oven 3	1473	Air Lab

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Pace National – MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Air Analysis <i>This table is subject to revision without notice</i>					
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Instrument Name</i>	<i>Serial #</i>	<i>Location</i>
Oven	Entech	31-350	Oven 3	B33-02663	Air Lab
Oven	Entech	31-350ER	Oven 3	B33ER-01142	Air Lab
Canister Cleaner	Entech	3100D	Oven 4	1741	Air Lab
Oven	Entech	09-OV6L12	Oven 4	0144	Air Lab
Oven	Entech	09-OV6L12	Oven 4	0143	Air Lab
Canister Cleaner	Entech	3100D	Oven 5	1866	Air Lab
Oven	Entech	09-OV6L8	Oven 5	0134	Air Lab
Oven	Entech	09-OV6L8	Oven 5	0135	Air Lab

Pace National MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Aquatic Toxicity Lab <i>This table is subject to revision without notice</i>			
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Location</i>
Analytical Balance	Mettler	XSE 105 Dual Range	Aquatic Tox Lab
Class “I” weights (2)	Troemner	SN # 67812	Aquatic Tox Lab
Conductivity Meter	Orion	150 A+	Aquatic Tox Lab
Dissolved Oxygen Meter	YSI	Model 5000	Aquatic Tox Lab
Stereoscope	Olympus	SZX-IIIK100 (ESC1709)	Aquatic Tox Lab
Oven (1)	Fisher	655F	Aquatic Tox Lab
Cold Room	Thermo-Kool	Walk-In Refrigerator	Aquatic Tox Lab
pH meter	Beckman	SN 2192	Aquatic Tox Lab
Incubator-I9	Thermo Scientific Precision	3759	Aquatic Tox Lab
Incubator I4	Thermo Scientific Precision.	3759	Aquatic Tox Lab
Incubator	VWR	2030-ZZMFG	Aquatic Tox Lab
Stereoscope	Olympus	SZX2-ILLD (ESCP0004)	Aquatic Tox Lab
pH Meter	Orion	VersaStar	Aquatic Tox Lab
Waterbath	Lindberg/Blue	WB1130A	Aquatic Tox Lab
Stereoscope	Olympus	SZH-ILLD (ESC125)	Aquatic Tox Lab
Stereoscope	Olympus	SZH-ILLD (No ESC ID)	Aquatic Tox Lab
Waterbath	Lindberg Blue M	MW-1110A-1	Aquatic Tox Lab
Refrigerator	True	T-49	Aquatic Tox Lab
Water Purifier	ELGA Pure lab	4LXXXSCM2	Aquatic Tox Lab
Mini fridge	Haier	HC27SG42RB	Aquatic Tox Lab
pH/Conductivity Benchtop meter	Thermo Scientific Orion	VSTAR 52	Aquatic Tox Lab
RDO Probe	Thermo Scientific Orion	VSTAR-RD	Aquatic Tox Lab
Oven (2)	Thermoscientific	Heratherm OGS400	Aquatic Tox Lab
Stereoscope	Olympus	SZH-ILLD (ESC005820)	Aquatic Tox Lab
Freezer	Kenmore	198.8130582	Aquatic Tox Lab
Incubator	Crown Tonka	Walk-In	Aquatic Tox Lab

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Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Metals Analysis and Preparation <i>This table is subject to revision without notice</i>						
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Name</i>	<i>#</i>	<i>Serial number</i>	<i>Location</i>
Balance- Top Loading	Torbil	AGN100	METBAL4 Analytical	1	701001026	Metals Prep
Balance - Top Loading	Mettler Toledo	PB3002-5	METBAL2	1	1119070828	Metals Prep
Balance - Top Loading	Mettler Toledo	PB3002-5	METBAL4	1	1121462199	Metals Prep
Balance - Top Loading	Mettler Toledo	XS4002S	METBAL3	1	B712847753	Metals Prep
Hot Block	Thomas Cain/Seal Analytical	SmartBlock	MPH	1	123009	Metals Prep
Hot Block	Env. Express	SC154	MPE	1	9062CECW3953	Metals Prep
Hot Block	Env. Express	SC154	MPF	1	2015CECW4278	Metals Prep
Hot Block	Env. Express	SC154	MPG	1	2015CECW4338	Metals Prep
Prep station	Thomas Cain/Seal Analytical	Deena II	Deena1	1	020050	Metals Prep
Prep station	Thomas Cain/Seal Analytical	Deena II	Deena2	1	020093	Metals Prep
Microwave	CEM	MARS 5 Xpress	1	1	MD-7441	Metals Prep
Microwave	CEM	MARS 5 Xpress	2	1	MD-9640	Metals Prep
Microwave	CEM	MARS 5 Xpress	3	1	MD-4692	Metals Prep
Microwave	CEM	MARS 6	4	1	MJ2771	Metals Prep
Microwave	CEM	MARS 5 Xpress	5	1	MD-9972	Metals Prep
Centrifuge	Thermo	Heraeus Megaforge 40	NA	1	41123868	Metals Prep
Turbidimeter	HACH	2100N	NA	1	05090C020685	Metals Prep
Water Purification - Nanopure	Elga	Pure Lab Ultra	NA	1	ULT00002665	Metals Prep
Auto pipettors	Eppendorf, Oxford	Varies	NA		NA	Metals Prep
ICPMS with autosampler	Agilent	7700	ICPMS7	1	JP12482187	Metals Lab
ICPMS with autosampler	Agilent	7900	ICPMS8	1	JP16281469	Metals Lab
ICPMS with autosampler	Agilent	7900	ICPMS9	1	JP14400452	Metals Lab
ICPMS with autosampler	Agilent	7900	ICPMS10	1	JP14080164	Metals Lab
ICP Simultaneous with autosampler	Thermo	ICAP 7400 DUO	ICP12	1	IC74DC141801	Metals Lab
ICP Simultaneous with autosampler	Thermo	ICAP 7400 DUO	ICP13	1	IC74DC143804	Metals Lab
ICP Simultaneous with autosampler	Thermo	ICAP 7400 DUO	ICP14	1	IC74DC151103	Metals Lab
Hot Block	Env. Express	SC154	HG1	1	2122097	Mercury Lab
Hot Block	Env. Express	SC154	HG2	1	2121806	Mercury Lab
Hot Block	Env. Express	SC154	MPC	1	1120213057	Mercury Lab
Hot Block	Env. Express	SC154	MPD	1	212415	Mercury Lab
Mercury Auto Analyzer	Perkin Elmer	(1) FIMS 100	III	1	110156051101	Mercury Lab

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Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Metals Analysis and Preparation <i>This table is subject to revision without notice</i>						
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Name</i>	<i>#</i>	<i>Serial number</i>	<i>Location</i>
Mercury Auto Analyzer	Teledyne	QuickTrace 7600	HG6	1	US17016008	Mercury Lab
Mercury Auto Analyzer	Leeman	Hydra II AA	HG5	1	65043	Mercury Lab
Balance - Top Loading	Mettler Toledo	PB3002-5	HGBAL1	1	71242213216	Mercury Lab
TCLP Extraction Unit	Env. Express	6 Position	K	1	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	A	5	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	E	5	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	I	5	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	L	5	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	O	2	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	S	2	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	1	2	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	2	2	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	10 Position	C	1	NA	TCLP Lab
TCLP Zero Headspace Extractor	Env. Express	Vessels	NA	41	NA	TCLP Lab
PH Meter	Thermo	Orion Versastar	1	1	V04967	TCLP Lab
PH Meter	Thermo	Orion VersastarPro	2	1	V11227	TCLP Lab
Balance	Mettler Toledo	MS3002S		1	B246522879	TCLP Lab
Balance	Mettler Toledo	PB3002-5		1	1128150150	TCLP Lab
Auto pipetters 1000 1 to 20 1	Oxford	Varies	NA		NA	Metals Lab
MAX/MIN Thermometer	Fischer Scientific	MAX/MIN	TCLP #1		122376671	TCLP Lab
Hotplate/Stirrer	Thermo	Cimarec+	1	1	C30100131115141 15	TCLP Lab
Hotplate/Stirrer	IKA	RT15	2	1	03.492224	TCLP Lab
Hotplate/Stirrer	IKA	RT15	3	1	03.503438	TCLP Lab

Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Microbiological Analysis <i>This table is subject to revision without notice</i>			
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Location</i>
Analytical Balance	Mettler Toleda	XSE1050DU	Microbiology Lab
Class "I" weights	(1 set) Troemner	000565	Microbiology Lab
Autoclave	Pelton and Crane	Validator 8	Microbiology Lab
Water Bath	Lindberg Blue	WB1130A	Microbiology Lab
Water Bath	Blue M	MW-1110A-1	Microbiology Lab
Oven	Fisher	655F	Microbiology Lab
Incubator	VWR	2030 22MFG	Microbiology Lab
Quantitray Sealer	IDEXX	2X	Microbiology Lab
Incubator	Thermo Scientific Precision	3759	Microbiology Lab
Colony Counter	Quebecor	3325	Microbiology Lab
pH Meter	Beckman	pH/Temp/mV/ISE	Microbiology Lab

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Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Microbiological Analysis <i>This table is subject to revision without notice</i>			
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Location</i>
Refrigerator	True	T-49	Microbiology Lab
Stereoscope (2)	Olympus	SZH-ILLD	Microbiology Lab
UV light; short and long wave	UVP		Microbiology Lab
Autoclave	SterileMax	Harvey	Microbiology Lab
Stereoscope	Olympus	SZX-ILLK100	Microbiology Lab
Water Purifier	ELGA Pure La	4LXXXSCM2	Microbiology Lab
Oven	VWR	13054U	Microbiology Lab
pH meter/Conductivity meter/LDO	Thermo Scientific Orion	VStar 02105	Aquatic Tox Lab

Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Mold/ BOD Analysis <i>This table is subject to revision without notice</i>				
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Serial #</i>	<i>Location</i>
Analytical Balance	Mettler	PL602-S	1125081657	Bacteriology Lab
Autoclave	Tuttnauer	2540EK	2906170	Bacteriology Lab
Biolog MicroStation	Biolog, Inc.	Microlog 3	342689	Bacteriology Lab
BOD SP Robotic Analyzer	Skalar	SP50	8123	BOD
BOD SP Robotic Analyzer	Skalar	SP50	8124	BOD
Class I BSC	AirFiltronix	AirFiltronix HS 4500	41031	Mold Lab
Class II BSC	Labconco	Labconco 36209	3076555	Bacteriology Lab
Class II BSC	Labconco	Labconco 36213	60554894	Mold Lab
COD Reactor	HACH	45600	900903221	BOD
DO meter	YSI	5000	081C101451	BOD
DO meter	YSI	5000	081C101450	BOD
Fisher Scientific Vortexq	Fisher Scientific		80109016	
Incubator	Precision Scientific	30M		Bacteriology Lab
Incubator	Fisher	Not Visible	100212	BOD
Incubator	Thermo Scientific Precision	3271	317217-1241	BOD
Incubator	Precision	818	35AK-10	BOD
Incubator	Labtronix	BOD2100D	21000010213	Mold Lab
Incubator	Precision Scientific	30M	9303590	Bacteriology Lab
Incubator	VWR	2030	802202	BOD
Incubator	Quincy Lab	10-100	I11-2454	Mold Lab
Microscope	NIKON	LABOPHOT	242008	Mold Lab
Microscope	NIKON	LABOPHOT	235267	Mold Lab
Microscope	Olympus	CH2	900216	Mold Lab
Microscope	Olympus	BH-2	708821	Mold Lab
Microscope	Leitz	Laborlux	512663	Mold Lab
Microscope	VWR Scientific	VWRC1	V167173	Mold Lab

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Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Mold/ BOD Analysis <i>This table is subject to revision without notice</i>				
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Serial #</i>	<i>Location</i>
pH meter	Thermo Scientific	Orion Star A211	X38960	BOD
Plate Reader	Biotek	ELX808BLG	203222	Bacteriology Lab
Refrigerator	Frigidaire	FRT17G4BW9	BA703306	Mold Lab
Refrigerator	Whirlpool	EL88TRRWS03	442001106	Mold Lab
Refrigerator	Whirlpool	EL7ATRMMQ07	EWR4973976	Mold Lab
Refrigerator	Whirlpool			Bacteriology Lab
Spectrophotometer	Hach	DR 2700	1388224	BOD
Stereoscope	VWR Scientific	VWRS1	V168430	Mold Lab
Stir Plate	Corning	PC-420D	23507102961	Bacteriology Lab
Stir Plate	IKA	Big Squid	102	Bacteriology Lab
Stir Plate	VWR	205	7852	BOD
Stir Plate	VWR	220	5031	BOD
Turbidimeter	Biolog, Inc.	21907	6093898	Bacteriology Lab
Vortex Genie2 Mixer	VWR	G-560	2-223236	Bacteriology Lab
Waterbath	Blue M-MagniWhirlpool	MW-1110A	14991	Bacteriology Lab
Waterbath	Precision	Circulating 260	21-AJ11	BOD

Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Protozoan Analysis <i>This table is subject to revision without notice</i>			
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Location</i>
Flow control valve	Plast-o-matic	FC050B	Protozoan Lab
Centrifugal pump	Jabsco	18610-0271	Protozoan Lab
Graduated container	Nalgene	20 Liter Carboy	Protozoan Lab
Laboratory shaker	Lab-Line	3587-4	Protozoan Lab
Laboratory shaker side arms	Lab-Line	3589	Protozoan Lab
1500 XG swinging bucket centrifuge	Damon/IEC Division	CRU-5000	Protozoan Lab
Sample mixer/rotator	DYNAL	Cat#: 947.01	Protozoan Lab
Magnetic Particle Concentrator	DYNAL	MPC-1	Protozoan Lab
Magnetic Particle Concentrator	DYNAL	MPC-S	Protozoan Lab
Magnetic Particle Concentrator	DYNAL	MPC-6	Protozoan Lab
Flat-sided sample tubes	DYNAL	Cat#: 740.03	Protozoan Lab
Epifluorescence/differential interference contrast microscope	Olympus	BX-40	Protozoan Lab
Excitation/band pass microscope for fluorescein isothiocyanate (FTIC)	C-Squared	UN3100	Protozoan Lab
Excitation/band pass filters for 4',6-diamidino-2-phenylindole (DAPI)	C-Squared	UN41001	Protozoan Lab
Masterflex pump	Cole Parmer	7553-50	Protozoan Lab
Balance	Denver Instrument	MXX-412	Protozoan Lab
Biosafety Cabinet	Labconco	Cat#: 36208043726	Protozoan Lab



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<i>Item</i>	<i>Manufacturer/ Model</i>	<i>Instrument Name</i>	<i>#</i>	<i>Serial #</i>	<i>Location</i>
Gas Chromatograph 2	HP 6890	svcompa	2	US00004397	SVOC
Gas Chromatograph 3	Agilent 6890	svcompo	3	US00002051	SVOC
Gas Chromatograph 7	Agilent 6890	svcompe	7	US10350064	SVOC
Gas Chromatograph 8	Agilent 6890	svcompp	8	DE00022534	SVOC
Gas Chromatograph 9	HP 6890	svcompj	9	US00029095	SVOC
Gas Chromatograph 10	Agilent 6890	svcompk	10	US00039655	SVOC
Gas Chromatograph 11	Agilent 6890	svcompn	11	US00040550	SVOC
Gas Chromatograph 12	Agilent 6890	Svcompaf	12	US00034155	SVOC
Gas Chromatograph 13	HP 6890	Svcomps	13	US00010364	SVOC
Gas Chromatograph 14	HP 6890	Svcompt	14	US00020581	SVOC
Gas Chromatograph 16	Agilent 6890	Svcompv	16	US10212071	SVOC
Gas Chromatograph 17	Agilent 6890	Svcompw	17	US10344078	SVOC
Gas Chromatograph 18	Agilent 6890	Svcompd	18	US10351038	SVOC
Gas Chromatograph 19	Agilent 6890	Svcompaa	19	CN10516070	SVOC
Gas Chromatograph 20	Agilent 6890	Svcompab	20	CN10543031	SVOC
Gas Chromatograph 21	Agilent 7890	Svcompae	21	CN 10730070	SVOC
Gas Chromatograph 22	Agilent 7890	svcompad	22	CN 10730081	SVOC
Gas Chromatograph 23	Agilent 6890	svcompag	23	CN 92174366	SVOC
Gas Chromatograph 24	Agilent 6890	svcompah	24	CN 92174369	SVOC
Gas Chromatograph 25	Agilent 7890	svcompaj	25	CN 10091009	SVOC
Gas Chromatograph 26	Agilent 7890	Svcompar	26	CN11501138	SVOC
Gas Chromatograph 27	Agilent 7890	Svcompas	27	CN11501139	SVOC
Gas Chromatograph 28	Agilent 7890	Svcompat	28	US11521018	SVOC
Gas Chromatograph 29	Agilent 7890	Svcompau	29	CN11521077	SVOC
Gas Chromatograph 30	Agilent 7890	svcompav	30	US11521020	SVOC
Gas Chromatograph 31	Agilent 7890	svcompba	31	CN13503096	SVOC
Gas Chromatograph 32	Agilent 7890	svcompbc	32	CN14423060	SVOC
Gas Chromatograph 33	Agilent 7890	svcompbd	33	CN15033026	SVOC
Gas Chromatograph 34	Agilent 7890	svcompbe	34	CN15033027	SVOC
Gas Chromatograph Detectors 2	FID Detector	svcompa	2	N/A	
Gas Chromatograph Detectors 3	NPD/NPD Detectors	svcompo	3	N/A	SVOC
Gas Chromatograph Detectors 7	FID Detector	svcompe	7	N/A	SVOC
Gas Chromatograph Detectors 8	FID Detector	svcompp	8	N/A	SVOC
Gas Chromatograph Detectors 9	FID Detector	svcompj	9	N/A	SVOC
Gas Chromatograph Detectors 10	FID Detector	svcompk	10	N/A	SVOC

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Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Semi-Volatiles Analysis
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<i>Item</i>	<i>Manufacturer/ Model</i>	<i>Instrument Name</i>	<i>#</i>	<i>Serial #</i>	<i>Location</i>
Gas Chromatograph Detectors 11	ECD/ECD Detectors	svcompn	11	F) U11750 B) U12481	SVOC
Gas Chromatograph Detectors 12	FPD/FPD Detectors	svcompaf	12	N/A	SVOC
Gas Chromatograph Detectors 13	Detectors	svcomps	13	N/A	SVOC
Gas Chromatograph Detectors 14	ECD/ECD Detectors	svcompt	14	F) U3113 B) U2620	SVOC
Gas Chromatograph Detectors 16	FID Detector	svcompv	16	N/A	SVOC
Gas Chromatograph Detectors 17	FID Detector	svcompw	17	N/A	SVOC
Gas Chromatograph Detectors 18	ECD/ECD Detectors	svcompd	18	F) U11613 B) U13988	SVOC
Gas Chromatograph Detectors 19	ECD/ECD Detectors	svcompaa	19	F) U6632 B) U8422	SVOC
Gas Chromatograph Detectors 20	ECD/ECD Detectors	svcompab	20	F) U13989 B) U0418	SVOC
Gas Chromatograph Detectors 21	FID Detector	svcompae	21	N/A	SVOC
Gas Chromatograph Detectors 22	ECD/ECD Detectors	svcompad	22	F)U12039 B) 12038	SVOC
Gas Chromatograph Detectors 23	ECD/ECD Detectors	svcompag	23	F) U2621 B) U8104	SVOC
Gas Chromatograph Detectors 24	ECD/ECD Detectors	svcompah	24	F) U8423 B) U12482	SVOC
Gas Chromatograph Detectors 25	FID Detector	svcompaj	25	N/A	SVOC
Gas Chromatograph Detectors 26	FID Detector	svcompar	26	N/A	SVOC
Gas Chromatograph Detectors 27	FID Detector	svcompas	27	N/A	SVOC
Gas Chromatograph Detectors 28	ECD/ECD Detectors	Svcompat	28	F) U26768 B) U26237	SVOC
Gas Chromatograph Detectors 29	ECD/ECD Detectors	svcompau	29	F) U20277 B) U20299	SVOC
Gas Chromatograph Detectors 30	ECD/ECD Detectors	svcompav	30	F) U20425 B) U20424	SVOC
Gas Chromatograph Detectors 31	FID Detector	svcompba	31	N/A	SVOC
Gas Chromatograph Detectors 32	FID Detector	svcompbc	32	N/A	SVOC
Gas Chromatograph Detectors 33	FID Detector	svcompbd	33	N/A	SVOC
Gas Chromatograph Detectors 34	FID Detector	svcompbe	34	N/A	SVOC
Gas Chromatograph/Mass Spectrometer 1	Agilent 6890GC 5973MSD	svcompf	1	GC CN10335001 MS US33220022	SVOC
Gas Chromatograph/Mass Spectrometer 2	Agilent 6890GC 5973MSD	svcompc	2	GC US10409048 MS US35120400	SVOC

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<i>Item</i>	<i>Manufacturer/ Model</i>	<i>Instrument Name</i>	<i>#</i>	<i>Serial #</i>	<i>Location</i>
Gas Chromatograph/Mass Spectrometer 4	Agilent 6890GC 5973MSD	svcomph	4	GC CN10403067 MS US35120308	SVOC
Gas Chromatograph/Mass Spectrometer 7	Agilent 6890GC 5973MSD	svcompm	7	GC ----- MS US03940745	SVOC
Gas Chromatograph/Mass Spectrometer 9	Agilent 6890GC 5973MSD	svcompx	9	GC CN10344042 MS US33220158	SVOC
Gas Chromatograph/Mass Spectrometer 10	Agilent 6890GC 5973MSD	svcompy	10	GC CN10340045 MS US33220183	SVOC
Gas Chromatograph/Mass Spectrometer 11	Agilent 6890GC 5975MSD	svcompac	11	GC CN10509031 MS US60532657	SVOC
Gas Chromatograph/Mass Spectrometer 12	Agilent 7890GC 5975MSD	svcompai	12	GC CN10728074/ MS 12-0706-1325	SVOC
Gas Chromatograph/Mass Spectrometer 13	Agilent 7890GC 5975MSD	svcompak	13	GC CN10301081/ MS US10313621	SVOC
Gas Chromatograph/Mass Spectrometer 14	Agilent 7890GC 5975MSD	Svcompal	14	GC: CN11031022 MS: US11093726	SVOC
Gas Chromatograph/Mass Spectrometer 15	Agilent 7890GC 5975MSD	Svcompam	15	GC: CN10301081 MS: US10313621	SVOC
Gas Chromatograph/Mass Spectrometer 16	Agilent 7890GC 5975MSD	Svcompan	16	GC: CN10301152 MS: US10313616	SVOC
Gas Chromatograph/Mass Spectrometer 17	Agilent 7890GC 5975MSD	Svcompao	17	GC: CN11191064 MS: US11363807	SVOC
Gas Chromatograph/Mass Spectrometer 18	Agilent 7890GC 5975MSD	Svcompap	18	GC: CN11401093 MS: US11403903	SVOC
Gas Chromatograph/Mass Spectrometer 19	Agilent 7890GC 5975MSD	Svcompaq	19	GC: CN11391051 MS: US11383838	SVOC
Gas Chromatograph/Mass Spectrometer 20	Agilent 7890GC 5975MSD	Svcompaw	20	GC: CN12031161 MS: US11503941	SVOC
Gas Chromatograph/Mass Spectrometer 21	Agilent 7890GC 5975MSD	Svcompax	21	GC: CN12031160 MS: US11513903	SVOC
Gas Chromatograph/Mass Spectrometer 22	Agilent 7890GC 5975MSD	Svcompay	22	GC: CN11521157 MS: US12023909	SVOC
Gas Chromatograph/Mass Spectrometer 23	Agilent 7890GC 5975MSD	Svcompaz	23	GC: CN12031114 MS: US11433926	SVOC
Gas Chromatograph/Mass Spectrometer 24	Agilent 7890GC 5977MSD	Svcompbb	24	GC:CN14163165 MS: US92043581	SVOC
Gas Chromatograph/Mass Spectrometer 25	Agilent 7890GC 5975MSD	Svcompbf	25	GC:CN10906031 MS: US11343905	SVOC
High Performance Liquid Chromatography (HPLC1)	Agilent 1100 Series DAD/FLD	hplc1	1	DAD de01608402 FLD de23904489	SVOC
High Performance Liquid Chromatography (HPLC2)	Agilent 1100 Series DAD/FLD	hplc2	2	DAD de30518420 FLD de92001880	SVOC
High Performance Liquid Chromatography	Agilent 1100 Series DAD	hplc3	3	DAD us64400711	SVOC
High Performance Liquid Chromatography	Agilent 1100 Series DAD	hplc4	4	DAD de43623013	SVOC
Analytical Balance	Mettler-Toledo MS1602S			B115130112	Ext. Lab
Analytical Balance	Mettler-Toledo MS1602S			B243464732	Ext. Lab
Analytical Balance	Mettler-Toledo XS204			1122411619	Ext. Lab
Analytical Balance	Ohaus			1202120814	Ext. Lab
Analytical Balance	Ohaus			B513752880	Ext. Lab

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Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Semi-Volatiles Analysis

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<i>Item</i>	<i>Manufacturer/ Model</i>	<i>Instrument Name</i>	<i>#</i>	<i>Serial #</i>	<i>Location</i>
Analytical Balance	Ohaus ARA520			1202120618	Ext. Lab
Analytical Balance	Ohaus SP602			7132101108	Ext. Lab
Automated Soxhlet	Gerhardt Soxtherm			2951	Ext. Lab
Automated Soxhlet	Gerhardt Soxtherm			2952	Ext. Lab
Automated Soxhlet	Gerhardt Soxtherm			2953	Ext. Lab
Automated Soxhlet	Gerhardt Soxtherm			2954	Ext. Lab
Centrifuge	Sorvall ST-41			2225	Ext. Lab
Centrifuge	Sorvall ST-41			2227	Ext. Lab
Concentrator	Buchi			1461	Ext. Lab
Concentrator	Buchi			1462	Ext. Lab
Concentrator	Buchi			1463	Ext. Lab
Concentrator	Buchi			1464	Ext. Lab
Concentrator	Buchi			1465	Ext. Lab
Concentrator	Buchi			1466	Ext. Lab
Concentrator	Buchi			1467	Ext. Lab
Concentrator	Buchi			1468	Ext. Lab
Concentrator	Buchi			1469	Ext. Lab
Concentrator	Buchi			2302	Ext. Lab
Concentrator	Buchi			2303	Ext. Lab
Concentrator	Buchi			2304	Ext. Lab
Microwave	CEM MARS 6			MJ2518	Ext. Lab
Microwave	CEM MARS 6			MJ6367	Ext. Lab
Microwave	CEM MARS 6			MJZ868	Ext. Lab
O&G Solvent Evaporator	Horizon Speed-Vap III			04-2020	Ext. Lab
O&G Solvent Evaporator	Horizon Speed-Vap III			03-1001	Ext. Lab
O&G Solvent Evaporator	Horizon Speed-Vap III			2186	Ext. Lab
O&G Solvent Evaporator	Horizon Speed-Vap IV			15-0055	Ext. Lab
O&G Solvent Evaporator	Horizon Speed-Vap IV			15-0056	Ext. Lab
O&G SPE Extractor	Horizon SPE-DEX 3100			15-0113	Ext. Lab
O&G SPE Extractor	Horizon SPE-DEX 3100			15-0116	Ext. Lab
O&G SPE Extractor	Horizon SPE-DEX 3100			15-0117	Ext. Lab
O&G SPE Extractor	Horizon SPE-DEX 3100			15-0118	Ext. Lab
Oven	Fisher			00700127	Ext. Lab
Oven	Fisher			1000594	Ext. Lab
Ring & Puck Mill	SPEX ShatterBox 8530			10191	Ext. Lab
Sonicator	Misonix 4000			2016080588	Ext. Lab
Sonicator	Misonix 4000			2016080589	Ext. Lab
Sonicator	Misonix 4000			2016080594	Ext. Lab
Sonicator	Misonix 4000			2016080601	Ext. Lab
Sonicator	Qsonica Q700			92183M-16-16	Ext. Lab
Sonicator	Qsonica Q700			92186M-10-16	Ext. Lab
Sonicator	Qsonica Q700			92189M-10-16	Ext. Lab
Sonicator	Qsonica Q700			92193M-10-16	Ext. Lab
Water Bath	Branson			RPA040384175E	Ext. Lab

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Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Semi-Volatiles Analysis
This table is subject to revision without notice

<i>Item</i>	<i>Manufacturer/ Model</i>	<i>Instrument Name</i>	<i>#</i>	<i>Serial #</i>	<i>Location</i>
Water Bath	ThermoScientific			2033602-102	Ext. Lab

Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Volatiles Analysis
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<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Instrument Name</i>	<i>#</i>	<i>Serial #</i>	<i>Location</i>
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	1	3333A31215	Volatiles
Gas Chromatograph	Agilent	6890	VOCGC	2	CN10609095	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	3	2950A26786	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	4	3336A50614	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	5	3027A29678	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	6	2950A27895	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	7	3313A37610	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	13	2921A23548	Volatiles
Gas Chromatograph	Agilent	6890	VOCGC	10	US00022519	Volatiles
Gas Chromatograph	Agilent	6890	VOCGC	12	US00000410	Volatiles
Gas Chromatograph	Agilent	6890	VOCGC	14	CN10408054	Volatiles
Gas Chromatograph	Agilent	6890	VOCGC	15	US10232130	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5975 MSD	VOCMS	2	GCCN10641044 MSUS63234371	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973 MSD	VOCMS	6	GCCN10343037 MSUS44647141	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	4	GCUS00003465 MSUS82311257	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	7	GCUS00040221 MS05040022	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	8	GCUS00040221 MS03940725	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	13	GCCN103390006 MSUS91911078	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	14	GCUS00009794 MSUS63810153	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	16	GCUS00006479 MSUS82321899	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	18	GC CN10517046 MSUS03340424	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	19	GCCN10611062 MSUS60542638	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5975MSD	VOCMS	20	GCCN621S4367 MSUS469A4832	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5975MSD	VOCMS	21	GCCN621S4368 MSUS469A4833	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	22	GCCN10728074 MSUS71236615	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5975MSD	VOCMS	23	GCCN10728068	Volatiles

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Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Volatiles Analysis <i>This table is subject to revision without notice</i>						
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Instrument Name</i>	<i>#</i>	<i>Serial #</i>	<i>Location</i>
Spectrometer		5975MSD			MSUS71236616	
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	24	GCCN10151020 MSUS10223406	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	25	GCCN99205324 MSUS98003634	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	26	GCCN10301152 MSUS10313616	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	27	GCCN10301155 MSUS10313619	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	28	GCUS000034135 MSUS94240103	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	30	GCUS10208101 MSUS10442360	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	31	GCUS14453011 MSUS54441572	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	32	GCCN13113015 MSUS92013978	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	33	GCCN11351165 MSUS52440724	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	35	GCCN10849077 MSUS83131017	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975 MSD	VOCMS	36	GCCN11281031 MSUS50680017	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5977MSD	VOCMS	37	GCCN15333012 MSUS1534M407	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	38	GCCN11281031 MSUS83141150	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	INTUVO9000 GC/5977A MS	VOCMS	39	GCCN17040005 MSUS1417L240	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890B GC/5977A MSD	VOCMS	40	GCCN 15133171 MSUS1542L427	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890B GC/5977B MS	VOCMS	41	GCCN10940090 MSUS1705M027	Volatiles
Centurion Autosampler	(15) PTS/EST	Centurion				Volatiles
Autosampler	(19) Varian	Archon				Volatiles
Autosampler	(8) OI Analytical	4100				Volatiles
Purge and Trap	(21) OI Analytical	Eclipse 4660				Volatiles
Purge and Trap	(4) OI Analytical	Eclipse 4760				Volatiles
Purge and Trap	(12) PTS/EST	Encon				Volatiles
Purge and Trap	(9) PTS/EST	Evolution				Volatiles

Pace National-MT. MULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Wet Lab <i>This table is subject to revision without notice</i>					
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Instrument Name</i>	<i>Serial #</i>	<i>Location</i>
Analytical Balance	Mettler	XP205	Balance 3	1129420141	Wet Lab

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Pace National-MT. MULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Wet Lab
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<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Instrument Name</i>	<i>Serial #</i>	<i>Location</i>
Analytical Balance	Mettler Toledo	AG204	WetBal 1	1120381348	Wet Lab
Analytical Balance	Mettler Toledo	AT200	WetBal 6	L91221	Wet Lab
Analytical Balance	VWR	403B	WetBal 7	5262015102	Wet Lab
Autoanalyzer	OI Analytical	FS 3100	FS 3100-1	301831056 (NH3) 251833391 (CN)	Wet Lab
Autoanalyzer	OI Analytical	FS 3100	FS 3100-2	3168140781(NH3) 325833494 (CN)	Wet Lab
Autoanalyzer	OI Analytical	FS 3100	FS 3100-3	407831164 (NO2NO3) 403833925 (PHT)	Wet Lab
Autoanalyzer	Lachat	Quikchem 8000	Lachat 2	A83000-1027	Wet Lab
Autoanalyzer	Lachat	Quikchem 8000	Lachat 3	A83000-1638	Wet Lab
Autoanalyzer	Lachat	Quikchem 8500	Lachat 4	60900000341	Wet Lab
Autoanalyzer	Lachat	Quikchem 8500	Lachat 5	60900000342	Wet Lab
Autoanalyzer	Lachat	Quikchem 8500	Lachat 6	70500000452	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG1	100700000-982	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG1	1800-871	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG2	1000700000-982	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG2	1800-872	Wet Lab
Automated Titrator	SCP	TitrEC	SCP1	115-230V	Wet Lab
Automated titrator	Metrohm	855 titrosampler	Titrande	3256	Wet Lab
Balance	Ohaus	Scout Pro	WetBal 2	B146454764	Wet Lab
Balance	Mettler Toledo	PRB02	WetBal 4	1117223611	Wet Lab
Balance	Ohaus	Scout Pro	WetBal 5	7124350259	Wet Lab
Bomb Calorimeter	Parr	1108 Oxygen Bomb	Parr Bomb	5424	Wet Lab
Centrifuge	Thermo	ST40	Centrifuge	4119863	Wet Lab
Class "I" weights	Troemner	Serial #7944		4057	Wet Lab
COD Reactor	Environmental Express	B3000	COD Reactor	2016CODW101	Wet Lab
Conductivity Meter	ORION	MODEL 170	ATI Orion	32470051	Wet Lab
Conductivity Meter	Thermo Fisher	Orion VersaStar	Orion VS-2	V02971	Wet Lab
Discrete Analyzer	Seal	AQ400	Seal1	141032	Wet Lab
Distillation Unit - Cyanide	Environmental Express	Distillation 1	LMD1920-106	2270	Wet Lab
Distillation Unit - Cyanide	Environmental Express	Distillation 2	LMD1920-106	2271	Wet Lab
Distillation Unit - Cyanide	Environmental Express	Distillation 3	LMD1920-106	2272	Wet Lab
Distillation Unit - Phenol	Westco Scientific	Model EASY-DIST	Dist 1	1062	Wet Lab

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Pace National-MT. MULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Wet Lab <i>This table is subject to revision without notice</i>					
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Instrument Name</i>	<i>Serial #</i>	<i>Location</i>
Distillation Unit - Phenol	Westco Scientific	Model EASY-DIST	Dist 2	1198	Wet Lab
Drying Oven	VWR	1390 FM	103-105	501202	Wet Lab
Drying Oven	Shel Lab	FX28-2	178-182	12006713	Wet Lab
Drying Oven	Shel Lab	SM028-2	178-182	8041917	Wet Lab
Flash Point Tester	LAZAR Scientific	SETA-93	Automated	1038328	Wet Lab
Flash Point Tester	Koehler	Pensky-Martens K16200	Manual	R07002693B	Wet Lab
Flash Point Tester	Koehler	Pensky-Martens K16201	Manual	R070022328D	Wet Lab
Hot Block TDS	Environmental Express	TDS024	TDS Hot Block	2017TDSW101	Wet Lab
Hot Plate	Cole Parmer	HS19 C-P	Hot Plate	50000073	Wet Lab
Hot Plate	Thermo Fisher	Type 2200	Hot Plate	C1707140516473	Wet Lab
Hot Plate	Cole Parmer	HS19 CP	Hot Plate	50002676	Wet Lab
Hot Plate	Cole Parmer	HS19 CP	Hot Plate	50002447	Wet Lab
Hot Plate	Cole Parmer	HS19 CP	Hot Plate	50002557	Wet Lab
Ion Chromatograph	Dionex	ICS-2000	IC5	6050731	Wet Lab
Ion Chromatograph	Dionex	ICS 1500	IC6	8100010	Wet Lab
Ion Chromatograph	Dionex	ICS 2000	IC8	8090820	Wet Lab
Ion Chromatograph	Dionex	ICS 2100	IC9	10060822	Wet Lab
Ion Chromatograph	Dionex	ICS 2100	IC10	10091285	Wet Lab
Ion Chromatograph	Dionex	ICS 2100	IC11	11012204	Wet Lab
Ion Chromatograph	Dionex	ICS 2100	IC12	12020460	Wet Lab
Ion Chromatograph	Thermo Fisher	ICS 1600	IC13	13031204	Wet Lab
Ion Chromatograph	Thermo Fisher	ICS-2100	IC14	15030082	Wet Lab
Ion Chromatograph	Thermo Fisher	ICS-2100	IC15	15071973	Wet Lab
Ion Chromatograph	Thermo Fisher	ICS-2100	IC16	15071973	Wet Lab
Ion Chromatograph	Thermo Fisher	ICS-1600	IC17	15110462	Wet Lab
Ion Chromatograph	Thermo Fisher	ICS-2100	IC18	15120139	Wet Lab
Ion Chromatograph	Thermo Fisher	Integrion	IC19	16070510	Wet Lab
Ion Chromatograph	Thermo Fisher	Integrion	IC20	16090734	Wet Lab
Muffle Furnace	Thermolyne	(1) 30400	FURNACE	23231	Wet Lab
ORP Meter	YSI	ORP15	ORP	JC000114	Wet Lab
pH Meter	Fisher	AB15	AB15+	AB92329028	Wet Lab
pH Meter	Orion	410A	Orion	58074	Wet Lab
pH Meter	Thermo Fisher	Orion Versa Star	Orion VS-1	V00659	Wet Lab
pH Meter	Thermo Fisher	Orion Starfall 1	PH1	J13992	Wet Lab

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Pace National-MT. MULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Wet Lab <i>This table is subject to revision without notice</i>					
<i>Item</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Instrument Name</i>	<i>Serial #</i>	<i>Location</i>
Refrigerated Recirculator	Polyscience	Recirculator	Recirculator1	1282	Wet Lab
Refrigerated Recirculator	Polyscience	Recirculator	Recirculator2	1608	Wet Lab
SimpleDist	Env. Express	SC154	SimpDist1	8940CECW3871	Wet Lab
SimpleDist	Env. Express	SC155	SimpDist2	9062CECW3952	Wet Lab
SimpleDist	Env. Express	SC156	SimpDist3	9062CECW3955	Wet Lab
Spectrophotometer	Hach	DR6000	DR6000-1	1646676	Wet Lab
Spectrophotometer	Hach	DR6000	DR6000-2	1646781	Wet Lab
Spectrophotometer (UV/Vis)	Hach	DR 5000	DR5000-1	1381711	Wet Lab
TOC Analyzer	Shimadzu	Model TOC-VWS	TOC2	39830572	Wet Lab
TOC Analyzer	Shimadzu	TOC-VCPH	TOC3	H51304435	Wet Lab
TOC Analyzer	Shimadzu	TOC-L	TOC5	H54335232035	Wet Lab
TOC Analyzer	GE	Siemens M5310C	TOC7	16112058	Wet Lab
TOX Analyzer	Mitsubishi	AOX-200	AOX1	E7B00107	Wet Lab
TOX Analyzer	Mitsubishi	TOX-100	TOX2	1035	Wet Lab
TOX Analyzer	EST	TE Xplorer	TOX3	2015-184	Wet Lab
TOX Analyzer	EST	TE Xplorer	TOX4	2016202	Wet Lab
Turbidimeter	Hach	TL2300	TURB1	2017070C0008	Wet Lab
Turbidimeter	Hach	2100N	Turbidimeter1	94110000093	Wet Lab

Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Rad Lab <i>This table is subject to revision without notice</i>					
<i>Title</i>	<i>Quantity</i>	<i>Make</i>	<i>Model</i>	<i>Serial #</i>	<i>Location</i>
Chemchek KPA-11 Kinetic Phosphorescence Analyzer w/Gilson Sample Changer and Gilson Dilutor 401 Syringe Pump	2	Chemchek	KPA-11	1418986; 649025031; 91-5050024	Rad Lab
Canberra 2404 Alpha/Beta Counter	5	Canberra	2404	1090352; 988600/787196; 488584	Rad Lab
Packard Tri-Carb 2550TR Liquid Scintillation Counter	1	Packard	2550TR	103332	Rad Lab
Packard Tri-Carb 2200CA Liquid Scintillation Counter	1	Packard	2200CA	102180	Rad Lab
Canberra LB4100 Alpha/Beta Counter	3	Canberra	LB4100U2	13000001; 13000002; 13000000; 117	Rad Lab
Canberra Genie 2000 Alpha	2	Canberra	Genie 2000	See Description	Rad Lab

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Pace National-MT. JULIET LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Rad Lab <i>This table is subject to revision without notice</i>					
<i>Title</i>	<i>Quantity</i>	<i>Make</i>	<i>Model</i>	<i>Serial #</i>	<i>Location</i>
Spectrometer System					
Canberra Genie 2000 Gamma Spectrometer System	2	Canberra	Genie 2000	See Description	Rad Lab

Pace National-DECATUR LABORATORY EQUIPMENT LIST: BACTERIOLOGICAL/AQUATIC TOXICITY <i>This table is subject to revision without notice</i>			
Equipment Number	Description	Manufacturer	Serial Number
079	Conductivity Metter	Fisher	AB81208756
159	pH Meter Model AB15	Fisher Accumet	4117294P
0243	Dissolved Oxygen Meter, Model 5100	YSI	12B10202B
	Incubator (bacteriological samples) #2	Thermo Fisher model 51028066	41581913
	Incubator (bacteriological samples) #1	Thermo Fisher model 51028067	41583136

Pace National-DECATUR LABORATORY EQUIPMENT LIST: METALS <i>This table is subject to revision without notice</i>			
Equipment Number	Description	Manufacturer	Serial Number
0040	Thermometer -10 - +110C	Fisher	14-983-10B
0213	Optima 7300DV ICP	Perkin-Elmer	077C0062201
0221	Turbidimeter, 2100Q	Hach	10110C006457
R-9044	Gelex Secondary Stds Hach # 02890-00	Hach	Lot A1019
0235	Mercury Analyzer Model M-6100 CVAA & ASX-520 auto-sampler	CETAC Technologies	121104QT76 analyzer, 091198A520 autosampler
0242	Hot Block, SC 100	Environmental Express	145CEC0183
0240	Hot Block, SC 191 stirrer	Environmental Express	8016CEP1163
0295	Nexion 350 D ICP-MS + Auto-sampler + Chiller + FAST system +computer	Perkin-Elmer	Nexion SN: 85DN6091401, Chiller 5U1680020, Lenovo computer SMJ04FLNU, FAST PC3 X4DXX-A-160622

Pace National-DECATUR LABORATORY EQUIPMENT LIST: INORGANICS <i>This table is subject to revision without notice</i>			
Equipment Number	Description	Manufacturer	Serial Number
0023	COD heating block with timer	Hach	980500017667
0068	Spectrophotometer	Genesys 20 Model 4001/4	35GD353002
0067	BOD Auto EZ reader	Thermo	A0061
0077	pH meter model 420A & Triode probe	Orion 9107BN	30179

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Pace National-DECATUR LABORATORY EQUIPMENT LIST: INORGANICS <i>This table is subject to revision without notice</i>			
Equipment Number	Description	Manufacturer	Serial Number
0095	pH/ISE Meter, Model 920A	Orion	1447
0101	Muffle Furnace	Fisher Scientific, Model 550-126	s/n 305N0030
0211	Distillation unit/auto - titrator	Buchi/Titrino	Buchi s/n 1000040018 Type-K-360, Titrino Titrator s/n 10109, part# 1.719.0010, type-719S
0216	Oven	Blue M model OV-472-2	OV3 24471 38
0226	Phosphorus digestion unit	Tecator	
0232	Genesys 10S Vis Spectrophotometer	ThermoFisher	2D9P076001
0236	Distillation unit/auto - titrator	Buchi/Titrino	Buchi s/n 1000116430 Type-K-360, Titrino Titrator s/n 17147, part# 1.719.0010, type-719S
0245	FS3100 Cyanide Analyzer (avail)	OI Analytical	149831195
0246	FS3100 Cyanide Analyzer (total)	OI Analytical	302831498
0247	BOD Incubator	Thermo Scientific Model 3721	162118-2982
0249	TKN Digestor	Buchi Model K-439	1000150618
0250	TKN scrubber	Buchi Model B-414Bas	1000112608
0251	COD Digestor	Hanna Instruments HI839800-01	1147924
0282	DO meter	YSI model 5100-115v	14J101552
0283	Versastar meter (multi-function)	Thermo Orion	V03535
0286	Forced Air Oven	Fisher Scientific, Model 8921	s/n 610855-263
0287	BOD Incubator, model 3721	Thermo Scientific Model 3721	111972-2468
0293	BOD 200 apparatus	SCP	BDX0115500011
0294	BOD 200 apparatus	SCP	BDX0115500012
0298	Forced Air Oven, Labstrong CT002712	North Central Laboratories	27160500002
0300	Muffle Furnace	Fisher Scientific, Model 750-14	412N0004
089	Ion Chromatograph DX120 & Ion Chromatograph Autosampler	Dionex	1031375, 970 60607
0198	Ion Chromatograph ICS 1600 RFIC & Autosampler	Dionex	9070013
0239	TOC Analyzer TOC -L, CPH E100; auto-sampler ASI-L	Shimadzu	TOC-L H54215000551; A/S H57114900467

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Pace National-DECATUR LABORATORY EQUIPMENT LIST: INORGANICS <i>This table is subject to revision without notice</i>			
Equipment Number	Description	Manufacturer	Serial Number
0284	TOC Analyzer TOC -L, CPN ; auto-sampler	Shimadzu	TOC-L H54315232013 CS; A/S H57415200591

Pace National-DECATUR LABORATORY EQUIPMENT LIST: ORGANICS <i>This table is subject to revision without notice</i>			
Equipment Number	Description	Manufacturer	Serial Number
080	Water Bath	NESLAB	101242027
0175	Muffle Furnace	Vulcan A-550	9493306 / AKV9725-101
0195	Gas Chromatograph model 7890A (FID/NPD) model G3440A	Agilent	CN10827119
0212	Volatiles Gas Chromatograph - Mass Spectrometer 7890A/5975C	Agilent	US10143111 (MS) CN10021075 (GC)
0244	Q500 Sonicator	Qsonica	72898AD+-01-13
0254	7890A GC/ 5977 MS (semi-volatiles)	Agilent	CN13483185 (GC) US1349M227 (MS)
0281	7890A GC/ 5977 MS (volatiles)	Agilent	US1451L418; CN14513033; US14330003
0301	Q500 Sonicator	Qsonica	93364AQ-01-17

Pace National-DAVIS LABORATORY EQUIPMENT LIST: VOLATILES <i>This table is subject to revision without notice</i>				
Equipment Number	Description	Model	Manufacturer	Serial Number
19MSV4	Autosampler	Varian	Dynatech Archon	13104
19MSV4	Concentrator	3100 P&T	Tekmar	US02150010
19MSV4	GC/MS	6890 GC/ HP5973 MS	HP	US00028923 & US91922612
19MSV6	Autosampler	Varian	Dynatech Archon	13500
19MSV6	Concentrator	3100 P&T	Tekmar	US01064003
19MSV6	GC/MS	6890 GC / HP5973 MS	HP	US00040666 & US10360129
19MSV9	Autosampler	Varian	Dynatech Archon	13499
19MSV9	Concentrator	3100 P&T	Tekmar	US02081006
19MSV9	GC/MS	6890 GC / HP5973 MS	HP	US00042860 & US10460538
19MSVC	Autosampler	Centurian	ENCON	CENTS365041414
19MSVC	Concentrator	ENCON EV	ENCON	EV591051214
19MSVC	GC/MS	6890 GC / HP5973 MS	HP	US10207007 & US10462118
19MSVD	Autosampler	Centurian	ENCON	CENTW544122315
19MSVD	Concentrator	ENCON EV	ENCON	EV659030515
19MSVD	GC/MS	7820A GC / 5977B MS	Agilent	CN15522023 & US1602R003
19MSVB	Autosampler	Varian	Dynatech Archon	13754
19MSVB	Concentrator	3100 P&T	Tekmar	2141003
19MSVB	GC/MS	6890 GC / HP5973	HP	US10207086 &

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3. Administrative	020303	Contract Review
4. Administrative	020304	Protection and Transfer of Laboratory Records
5. Administrative	020305	Laboratory Communications Regarding Sample Analysis
6. Administrative	020306	Business Continuity and Disaster Preparedness Plan
7. Administrative	020307	Pennsylvania Department of Environmental Protection (PA DEP) Drinking Water Maximum Contaminant Level (MCL) Violation Reporting
8. Administrative	030209	Subcontracting
9. Administrative	030210	Materials Procurement for Analytical Processes
10. Administrative	030223	Report Revision
11. Administrative	030224	Sample Re-Analysis
12. Administrative	030230	Standards Logger - Tree Operation
13. Administrative	060105	Sample Receiving
14. Administrative	060106	Sample Storage, Disposal and Sample Control Technicians
15. Administrative	060108	Return Sample Shipping by Common Carrier
16. Administrative	060110	Sample Shipping
17. Administrative	060111	Total Solids (SM 2540G)
18. Administrative	060112	Cold Storage Management
19. Air	330367	Measurement of Volatile Organic Compounds and Gasoline Range Components in Ambient Air by Gas Chromatography/Mass Spectrometry (EPA TO-15 and EPA Method 18-Modified)
20. Air	330367 OH	VOCs in Ambient Air by TO15/8260B
21. Air	330369 OH	VOCs in Air by GCMS 8260 for the Ohio VAP Program
22. Air	330370	Method for the Determination of Methane, Ethane, Ethene, Propane, and Acetylene (Based on RSK-175)
23. Air	330371	Canister Cleaning, Certification and Storage of Air Sampling Equipment
24. Air	330371 OH	Cleaning, Certification and Storage of Air Sampling Equipment for Ohio EPA/VAP
25. Air	330372	The Analysis of Fixed Gases and Helium Tracer Gas from Passivated Canisters or Pump-Assisted Bag Samples Using Gas Chromatography Thermal Conductivity Detection (ASTM D1946, ASTM D5314)
26. Air	330373	Method for the Determination of Methanol and Ethanol - MEETAC (Based on EPA 8015C)
27. Air	330378	Measurement of VOCs in Ambient Air by GC/MS (EPA TO-17 and Method 325b)
28. Bioassay	340303	Biochemical Oxygen Demand (SM 5210B)
29. Bioassay	340312	Dissolved Oxygen Membrane Electrode and Optical Based Sensing Method
30. Bioassay	350301	Fathead Minnow, Pimephales promelas, Larval Survival and Growth Test (EPA Method 1000.0)
31. Bioassay	350302	Cladoceran, Ceriodaphnia dubia, Chronic Survival and Reproduction Test (EPA Method 1002.0)

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32. Bioassay	350303	Pimephales promelas Acute Toxicity Testing
33. Bioassay	350303 NC	North Carolina Pimephales promelas Acute Toxicity Testing
34. Bioassay	350304	Ceriodaphnia dubia Acute Toxicity Testing
35. Bioassay	350304 NC	North Carolina Ceriodaphnia dubia Acute Toxicity Testing
36. Bioassay	350305	Fecal Coliform - Membrane Filter Technique (SM 9222D)
37. Bioassay	350315	Fecal Coliform Determination in Biosolids: Membrane-Filter Technique (SM 9221B/9221F/9222D)
38. Bioassay	350315 A	Fecal Coliforms (Class A and Class B) in Sewage Sludge (Biosolids) by MPN using A-1 Medium (EPA Method 1681)
39. Bioassay	350316	Total Coliform and E. coli Membrane-Filter Technique (SM 9222B, SM9221B/F)
40. Bioassay	350317	Reference Toxicant Testing
41. Bioassay	350318 NC	North Carolina Mini Chronic Whole Effluent Toxicity Test Procedure for Ceriodaphnia dubia (EPA Method 1002.0)
42. Bioassay	350320	Acceptability Test of New Food Batches for WET Testing
43. Bioassay	350321	Pocket Colorimeter Chlorine Tester Maintenance and Calibration
44. Bioassay	350322	Dissolved Oxygen Meter Maintenance and Calibration
45. Bioassay	350323	Fluke Thermometer Operation and Maintenance
46. Bioassay	350324	Digital Light Meter Maintenance and Operation
47. Bioassay	350325	pH Meter Maintenance and Calibration
48. Bioassay	350326	Thermometer and Chart Recorder Operation, Maintenance and Verification Procedure
49. Bioassay	350327	Bottle Top Dispensor Maintenance and Method of Operation
50. Bioassay	350328	Conductivity Meter Maintenance and Calibration
51. Bioassay	350329	Taxonomic Verification/Identification of Pimephales promelas - Fathead Minnow
52. Bioassay	350330	Taxonomic Verification/Identification of Ceriodaphnia dubia
53. Bioassay	350332	Laboratory Maintenance of Bacteria Reference Cultures
54. Bioassay	350333	Quality Control and Quality Assurance of Microbiological Equipment and Testing Materials
55. Bioassay	350343	Total Coliform and E. coli Enumeration by the Enzyme Substrate Method (SM 9223B)
56. Bioassay	350345	Receipt and Maintenance of Pimephales promelas (Fathead Minnow)
57. Bioassay	350346	Ceriodaphnia dubia Culture Maintenance, Food Preparation, and Food Maintenance
58. Bioassay	350348	Enterococci Enumeration by the Defined Substrate Method Enterolert (ASTM 6503-99)
59. Bioassay	350354	Heterotrophic Plate Count - Pour Plate Method (SM 9215B)
60. Bioassay	350355	Technical Training and Personnel Qualifications for Biomonitoring - Aquatic Toxicity, Mold, and Microbiology
61. Bioassay	350356	Waterbath and Incubator Temperature Stability and Load Testing
62. Bioassay	350359	Calibration and Maintenance of Autoclaves

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64. Bioassay	350364 NC	North Carolina Phase II Chronic Whole Effluent Toxicity Test Procedure for Ceriodaphnia dubia (Modified EPA Method 1002.0)
65. Bioassay	350369	Sterilization, Sanitization and Residue Testing of Microbiological Glassware and Equipment
66. Bioassay	350380	Class "A" MPN Fecal Coliform Analysis (SM 9221E & C)
67. Cryptosporidium	350401	Isolation & Identification of Giardia and/or Cryptosporidium in water
68. Cryptosporidium	350402	Method 1622/1623 Field-Filtering Sample Collection and Laboratory Delivery
69. Cryptosporidium	350403	Method 1622/1623 Bulk Sample Collection and Laboratory Delivery
70. Cryptosporidium	350404	Method 1622/1623 Sample Receiving
71. Cryptosporidium	350405	Training Protocol for Method 1622/1623
72. Cryptosporidium	350406	Data Collection and Verification for Method 1622/1623
73. Cryptosporidium	350407	Microscope Analyst Verification
74. Cryptosporidium	350408	Biosafety Guidelines for the Cryptosporidium Laboratory
75. Cryptosporidium	350409	IPR, OPR and MS Spiking Procedures and Corrective Actions
76. Cryptosporidium	350410	IEC CRU-5000 Centrifuge Operation and Maintenance
77. Cryptosporidium	350411	Lab-Line Multi-Wrist Shaker Operation and Maintenance
78. Cryptosporidium	350412	Cryptosporidium Laboratory Equipment Cleaning
79. Cryptosporidium	350413	Olympus BX40 Microscope Operation and Maintenance
80. Cryptosporidium	350414	SteamScrubber® Dishwasher Operation and Maintenance
81. Field Sampling	060303	Wastewater Sampling
82. Field Sampling	060304	Groundwater Sampling
83. General	030214	Storage of Consumables/Supplies
84. General	030220	Sample Homogenization and Sub-Sampling
85. General	030222	Volume Verification for Volumetric Ware (ASTM E 542-01)
86. General	030227	Data Review
87. General	030227 OH	Data Review
88. General	030228	General Analytical Balance Operation and Verification in the Laboratory
89. General	030229	Verification of Automatic Temperature Compensation Probes on Laboratory pH Meters
90. General	030234	Temperature Calibration for CEM Microwaves using Intelli-Temp Calibrator
91. General	030401	Instrument Transport
92. General	030701	Glassware Cleaning
93. Information Technology	040601	Information Technology Processes
94. Information Technology	041102	Electronic Data Deliverables
95. Metals	340384 A	Mercury in Aqueous/Liquid Samples (Cold-Vapor Technique)(EPA Methods 7470A and 245.1)
96. Metals	340384 A OH	Mercury IN LIQUID (Cold-Vapor Technique)

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98. Metals	340384 B OH	Mercury in Solid waste (Cold-Vapor Technique)
99. Metals	340386	Determination Metals and Trace Elements in Various Matrices by ICP-AES (EPA Methods 6010B, 6010C, 6010D [ICP-OES], and 200.7) Including Hardness (EPA Methods 200.7 and 6010B/C/D and SM 2340B)
100. Metals	340386 OH	Determination Metals by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICPAES) (SW-846 6010B)
101. Metals	340390	Determination of Metals by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) (EPA Methods 6020, 6020A, 6020B & 200.8)
102. Metals	340390 OH	ICPMS 6020/200.8
103. Metals	340393	Trivalent Chromium by Calculation (EPA Methods 6010B/C, 6020/A, 7196A, 7199, and 3060A, SM 3500Cr B & C)
104. Metals Prep	340354 A	Turbidity - Metals Drinking Water Screen Only (EPA Method 180.1)
105. Metals Prep	340358	Toxicity Characteristic Leaching Procedure (EPA Method 1311)
106. Metals Prep	340363	Extraction Procedure Toxicity Test (EPA Method 1310B)
107. Metals Prep	340364	Muliple Extraction Procedure
108. Metals Prep	340380	Digestion of Metals and Trace Elements in Drinking Water and Wastes for ICP-AES and ICPMS by Microwave and Hot Block Digestion (EPA Method 200.2)
109. Metals Prep	340388	Acid Digestion of Sediments, Sludges, Soils, and Oils (3050B, 3051, and 3051A)
110. Metals Prep	340388 OH	Acid Digestion of Sediments, Sludges, Soils, and Oils (3050B/3051)
111. Metals Prep	340389	Acid Digestion of Aqueous Samples and Extracts, including Total Recoverable and Dissolved Metals (EPA Methods 3005A, 3010A, 3015, & 3015A)
112. Metals Prep	340389 OH	Acid Digestion of Aqueous Samples and Extracts, 3010A/3015
113. Metals Prep	340392	Sodium Adsorption Ratio/Ex. Sodium Percentage
114. Metals Prep	340704	Synthetic Precipitation Leaching Procedure (EPA Method 1312)
115. Metals Prep	340705	California Waste Extraction Test (CAL WET)(California Code of Regulations, Title 22, Chapter 11, Appendix II)
116. Mold	350306	Preparation, Processing, and Analysis of Spore Traps
117. Mold	350307	Processing of Fungal Andersen Samples for Quantification
118. Mold	350308	Fungal Quantification
119. Mold	350309	Processing RODAC Fungal & Bacterial Plates for Quantification
120. Mold	350310	Preparation, Processing and Analysis of Swabs and Tape Lifts for Direct Exam
121. Mold	350311	Viable Mold Spore ID from Culture Plates
122. Mold	350312	Mold QA/QC
123. Mold	350313	Mold Laboratories' Safety and Housekeeping
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126. Mold	350334	Microscope Usage
127. Mold	350335	Non-viable Fungal Spore Identification
128. Mold	350342	Processing of Water from Sprinkler Systems, Water and Petroleum Wells for Presence/Absence and Determination of Potential Iron Related Bacteria, Sulfate Reducing Bacteria, Slime Forming Bacteria, and Acid Producing Bacteria by BART(TM) Testing
129. Mold	350347	Processing of Bacterial Swabs, Bulk, Dust and Water Samples for Quantification
130. Mold	350349	Bacterial Identification Using Biolog
131. Mold	350352	Anaerobic Plate Count: Pour Plate Method (SM 9215B Modified)
132. Mold	350367	LabConco Flaskscrubber Operation and Maintenance
133. Mold	350370	Preparation of Culture Media
134. Mold	350371	Operation, Calibration, and Maintenance of the Autoclave in the Mold Laboratory
135. Mold	350379	Laboratory Maintenance of Bacterial and Fungal Reference Cultures in the Mold Laboratory Maintenance
136. Organic Extractions	330702	Separatory Funnel Liquid-Liquid Extraction (EPA Methods 3510C & 625)
137. Organic Extractions	330702 A	Separatory Funnel Liquid-Liquid Extraction for Wisconsin/Minnesota Samples (EPA Method 3510C, SW-846 Update III, Revision 3, Dec. 1996)
138. Organic Extractions	330702 B	Reduced Volume Separatory Funnel Liquid-Liquid Extraction (EPA Methods 3510C, 625, 608, FL PRO)
139. Organic Extractions	330702 B OH	RV Separatory Funnel Liquid-Liquid Extraction 3510C
140. Organic Extractions	330702 OH	Separatory Funnel Liquid-Liquid Extraction 3510C
141. Organic Extractions	330707	Microwave Extraction (EPA Method 3546)
142. Organic Extractions	330707 OH	Microwave Extraction (3546)
143. Organic Extractions	330708	Buchi Syncore Concentration System
144. Organic Extractions	330708 OH	Buchi Syncore Concentration System
145. Organic Extractions	330709	Microextraction Procedure (3511)
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152. Organic Extractions	330754	Waste Dilution for Semivolatile Analysis (EPA Method 3580A)
153. Organic Extractions	330755	PCBs in Oil for Progress Energy
154. Organic Extractions	330770 A	TPH/O&G- Soxhlet extraction using Hexane
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164. Quality	030205	Technical Training and Personnel Qualifications
165. Quality	030206	Method Detection Limits (MDL), Limits of Detection (LOD) and Limits of Quantitation (LOQ)
166. Quality	030207	Generation of Control Limits
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170. Quality	030215	Manual Integration
171. Quality	030215 OH	Manual Integration Procedure
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174. Quality	030225	Use of Accreditation Symbols
175. Quality	030226	Requirements for Suppliers Providing Calibration Services
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177. Quality	030233	Significant Figures and Rounding of Data
178. Quality	030235	Sample Dilution Policy
179. Radioactivity	360401	Radioactive Sample Receiving, Handling, and Shipping
180. Radioactivity	360402	Survey Meter Source Checking
181. Radioactivity	360403	Radiation and Contamination Surveys
182. Radioactivity	360404	Sample Control of Licensed Material for WET Analyses
183. Radioactivity	360501	Basic Radiation Safety Training
184. Safety	030217	Emergency Management Plan
185. Safety	030218	Fume Hood Usage
186. Safety	030219	Spill Prevention and Control
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200. Semivolatiles	330319	THAA's
201. Semivolatiles	330320	Chlorinated Herbicides by Gas Chromatography (Methods 8151A, 615 & 1658)
202. Semivolatiles	330320 OH	Chlorinated Herbicides by Gas Chromatography (Method 8151A)
203. Semivolatiles	330322	Polynuclear Aromatic Hydrocarbons by HPLC (EPA 8310, EPA 610, SM 6440B)
204. Semivolatiles	330323	Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC) - EPA Methods 8330A & 8330B
205. Semivolatiles	330343	Polychlorinated Biphenyls (PCBS) by Gas Chromatography (Soil, Water & Oil) (EPA Methods 608, 8082, & 8082A, SM 6431B)
206. Semivolatiles	330343 OH	8082 PCB's
207. Semivolatiles	330344	Pesticides by Gas Chromatography (EPA Methods 608, 8081A, 8081B, SM 6630C)
208. Semivolatiles	330344 OH	Pesticides and PCBS by Gas Chromatography (608 and 8081A)
209. Semivolatiles	330345	Semi-volatile Organics by Gas Chromatography/Mass Spectrometry using Capillary Column (EPA Methods 8270C, EPA 8270D, EPA Method 625, SM 6410B), Including Provisions for Analysis in SIM Mode
210. Semivolatiles	330345 OH	Semi-volatile Organics by GC/MS using Capillary Column
211. Semivolatiles	330346	EDB and DBCP by GC/ECD (EPA Methods 504.1 & 8011)
212. Semivolatiles	330346 OH	EDB and DBCP by GC/ECD (EPA Method 8011)for Ohio VAP
213. Semivolatiles	330348	507 NP Pesticides in Drinking Water by GC NPD
214. Semivolatiles	330350 A	Diesel Range Organics/Total Petroleum Hydrocarbons (C10 to C28) by Gas Chromatography With #2 Diesel Fuel (EPA Methods 8015B/C/D)
215. Semivolatiles	330352	Method for Determination of Extractable Petroleum Hydrocarbons BY GC/FID With 1:1 Diesel/Motor Oil – Modified 8015B, 8015C & 8015D with provisions for: AZ, CA, IN (ERO), ND (TEH/TEM – client specific), OH, TN, and Waste Oil Analysis
216. Semivolatiles	330352 OH	Extractable Petroleum Hydrocarbons - Ohio
217. Semivolatiles	330353	Method for the Determination of Extractable Petroleum Hydrocarbons (EPH)(Based on MA EPH for NC, LA, MT, CT, NJ, and WA)
218. Semivolatiles	330355	Analysis of Petroleum Range Organics by GC-FID (FL PRO, CT ETPH Methods)
219. Semivolatiles	330356	Texas Natural Resource Conservation Commission - Total Petroleum Hydrocarbons (TNRCC 1005 and 1006)
220. Semivolatiles	330358	Method for the determination if Extractable Petroleum Hydrocarbons by GC/FID (IDNR OA-2 and NWTPH-Dx, Including HCID by Modified EPA Method 8015)
221. Semivolatiles	330359	AK102/AK103
222. Semivolatiles	330360	Analysis of Wisconsin/Minnesota Petroleum-Range Organics by GC-FID
223. Semivolatiles	330361	Glycols by GC/FID (EPA Method 8015B/C/D-Modified)
224. Semivolatiles	330376	Kansas Method for Determination of MRH and HRH

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226. Volatiles	330351	BTEX (Method 8021B, 602, SM6200C 2th) and Gasoline Range Organics (Methdo 8015B, 8015C, 8015D) by GC (with provisions for Calif-Lo, NWTPH-Gx, OA1, WI GRO (synthetic), Wyoming LAUST Req., GRO Luoisiana, AK101 GRO)
227. Volatiles	330351 OH	BTEX and Gasoline Range Organics by Gas Chromatography - Oh VAP
228. Volatiles	330354	Method for the Determination of Volatile Petroleum Hydrocarbons (VPH) (Based on MA VPH for NC, LA, CT, MT, and KS)
229. Volatiles	330357	Volatile Organic Compounds (GRO by GCMS) (EPA Methods 8260B, 8015B, 8015C, 8015D)
230. Volatiles	330363	Volatile Organic Compounds by GC/MS (EPA 8260B, 8260C, 624, and SM 6200B)
231. Volatiles	330363 OH	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry 8260A/B Ohio VAP
232. Volatiles	330364	Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry (EPA Method 524.2, Supplement III, Revision 4.1, Aug. 1995)
233. Volatiles	330365	Volatile Organic Compounds Screening using the RAE Systems Photoionization Gas Detector Model MiniRAE 3000
234. Volatiles	330751	Closed System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples (EPA Method 5035A)
235. Volatiles	330751 OH	5035 Closed System Purge and Trap and Extraction for VOC's in Soil for Ohio VAP
236. Volatiles	330752	Purge and Trap for Aqueous Samples (EPA 5030B, SW846 Update III)
237. Volatiles	330752 OH	5030B Purge and Trap for Ohio VAP
238. Wet Chemistry	340300	Acidity (SM 2310B)
239. Wet Chemistry	340301	Total Alkalinity, Manual and Automated (Titration)(SM 2320B)
240. Wet Chemistry	340302	Alkalinity (Methyl Organge) in Surface and Waste Waters - Lachat Quick Chem 8500 (EPA Method 310.2)
241. Wet Chemistry	340305	Total (Residual) or Free Chlorine (DPD) (SM4500-Cl-G)
242. Wet Chemistry	340307 A	Cyanide- All Forms, Colorimetric, Automated UV using Lachat FIA (EPA Methods 9010C, 9012B, 9013, 9013A, 335.4 and SM 4500-CN C, E, G, I)
243. Wet Chemistry	340307 A OH	Total Cyanide, Colorimetric, Automated UV using Lachat FIA (EPA Method 9012B)
244. Wet Chemistry	340307 C	Cyanide- OI Method
245. Wet Chemistry	340309	Chemical Oxygen Demand
246. Wet Chemistry	340310	Color by Visual Comparison (SM2120B)
247. Wet Chemistry	340313	Density (Specific Gravity)
248. Wet Chemistry	340317	Total Hardness (mg/l as CaCO3) - (Titrimetric)
249. Wet Chemistry	340317 A	Total Hardness by Lachat Method 130.1
250. Wet Chemistry	340318 B	Hexavalent Chromium (Colorimetric) Water 7196A
251. Wet Chemistry	340318 B OH	Hexavalent Chromium (Colorimetric) Water 7196A

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253. Wet Chemistry	340319	Determination of Elements in Water and Solids by Ion Chromatography (EPA Methods 300.0, 300.1, 9056, 9056A, and SM 4110B)
254. Wet Chemistry	340319 OH	Ion Chromatography - Anions OH VAP
255. Wet Chemistry	340325	MBAS (Methylene Blue Active Substances)
256. Wet Chemistry	340327 A	Ammonia, Phenolate (Lachat)
257. Wet Chemistry	340327 B	Ammonia, Phenolate (OI)
258. Wet Chemistry	340328	Organic Nitrogen
259. Wet Chemistry	340331	Threshold Odor Test (EPA Method 140.1, Standard Methods 2150B)
260. Wet Chemistry	340333 A	Nitrate/Nitrite (OI Autoanalyzer)
261. Wet Chemistry	340334	Paint Filter Liquids Test (EPA Method 9095B)
262. Wet Chemistry	340335	pH, Manual or Automated (EPA Methods 150.1, 9040B, 9040C, 9045C and 9045D; SM 4500H+ B) Including Corrosivity for Solids and Liquids using these Methods
263. Wet Chemistry	340336 A	Total Phenol - 4AAP (Lachat) SM5530D, EPA Methods 420.1, 420.2, & 9066
264. Wet Chemistry	340336 A OH	Phenol - 4AAP (Lachat Autoanalyzer)
265. Wet Chemistry	340338 A	Total Phos.(361.2,4500P-B/F) Colorimetric
266. Wet Chemistry	340338 A OH	Total Phos.(361.2,4500P-B/F) Colorimetric
267. Wet Chemistry	340338 B	Orthophosphate (365.2,4500P-E) Colorimetric
268. Wet Chemistry	340338 C	Total Phosphorus in Groundwater/Wastewater (EPA 365.4) (Colorimetric/Block Digestor)
269. Wet Chemistry	340339	Water Reactivity (SW-846, Chapter 7, Section 7.3 & 40 CFR 261.23)
270. Wet Chemistry	340342	Specific Conductance, Manual (Conductivity) (EPA Methods 120.1 & 9050A and SM2510B)
271. Wet Chemistry	340344 A	Sulfide (Colorimetric Methylene Blue) (376.2)
272. Wet Chemistry	340344 B	Sulfide Acid-soluble, and acid-insoluble Method 9034
273. Wet Chemistry	340345	Sulfite
274. Wet Chemistry	340346	Settleable Solids
275. Wet Chemistry	340347	Total Dissolved Solids (EPA Method 160.1, SM 2540C)
276. Wet Chemistry	340348	Total Suspended Solids (SM 2540D)
277. Wet Chemistry	340349	Total Solids and/or Percent Moisture (SM 2540B & 2540G)
278. Wet Chemistry	340350	Total Volatile Solids
279. Wet Chemistry	340352 A	Total Kjeldahl Nitrogen by Flow Injection Analysis Colorimetry (EPA Method 351.2, SM4500-Norg A/C/D)
280. Wet Chemistry	340354	Turbidity
281. Wet Chemistry	340356 A	Total Organic Carbon (TOC) & Total Inorganic Carbon (TIC) Using Shimadzu 5000A (EPA Methods 415.1 & 9060A, SM 5310B) – Groundwater and Wastewater Only
282. Wet Chemistry	340356 B	TOC for Drinking Water only
283. Wet Chemistry	340356 C	Total Organic Carbon In Soils (loss of weight on ignit.

ATTACHMENT V- LABORATORY SOP LIST (CONTINUED)



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284. Wet Chemistry	340357	Ignitability
285. Wet Chemistry	340359	Ultraviolet Absorbing Organic Constituents (SM 5910B)
286. Wet Chemistry	340360	Total Organic Halides (TOX) (EPA Methods 9020B & 450.1, SM 5320B)
287. Wet Chemistry	340361	Ferrous Iron, SM-3500-Fe-B
288. Wet Chemistry	340362	Heat of Combustion
289. Wet Chemistry	340365	Particles Not Otherwise Regulated, Total (PNOR) NIOSH 0500
290. Wet Chemistry	340366	Oxidation Reduction Potential
291. Wet Chemistry	340367	Extractable Organic Halides (EOX) (EPA Method 9023)
292. Wet Chemistry	340368	Total Organic Carbon in Soil (Walkley-Black)
293. Wet Chemistry	340369	Carbon Dioxide by Calculation
294. Wet Chemistry	340370	Perchlorate in DW
295. Wet Chemistry	340371	Chlorine in Oil (ASTM D808-00)
296. Wet Chemistry	340372	Hexavalent Chromium in Water by IC (EPA Methods 7199, 218.6 and 218.7, SM 3500Cr C/E)
297. Wet Chemistry	340372 A	Hexavalent Chromium in Soil by IC (EPA Methods 7199 and 3060A)
298. Wet Chemistry	340373	Organic Matter (FOM) and Fractional Organic Carbon (FOC) (ASTM D2974-07A)
299. Wet Chemistry	340374	Total Volatile Dissolved Solids (TVDS)
300. Wet Chemistry	340376	Total Organic Halides in Oil (EPA 9076)
301. Wet Chemistry	340377	Manual Nitrocellulose Analysis (US Army Bioengineering Research and Development Lab, Document #ADA0670871) - Modified
302. Wet Chemistry	340378	Volatile Suspended Solids
303. Wet Chemistry	340379	Guanidine Nitrate by Ion Chromatography (EPA Methods 9056, 9056A-Mod)
304. Wet Chemistry	340381	Ash in Petroleum Products (ASTM D482-07)
305. Wet Chemistry	340394	Salinity

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ATTACHMENT VI- PACE NATIONAL-MT. JULIET LABORATORY CERTIFICATION LIST
SCOPE AND APPLICATION CERTIFICATES ARE MAINTAINED AND FILED IN THE LOCAL QUALITY
DEPARTMENT

State/Agency	Certificate Number	Expiration Date/Status	Certified Programs	Approved Programs ⁶	Cert.Type	Cert. Authority
Alabama	40660	6/30/2018	DW, DW-Rad	WW, RCRA, UST	Reciprocity	TN
Alaska	UST-080	1/11/2018	UST	UST	AK	AK
Arizona	AZ0612	6/25/2018	AIR, SDW, WW, SW, SDW-Rad, WW-Rad, SW-Rad, SDW-Crypto, SDW-Micro		Audit	AZ
Arkansas	88-0469	1/21/2018	NPW, SCM, Aquatic Toxicity		NELAP	NJ
California	2932	8/31/2018	NPW, HW		NELAP	NJ
Colorado	None	3/31/2018	DW, DW-Micro	WW, RCRA, UST	Reciprocity	TN
Connecticut	PH-0197	9/30/2019	DW, NPW, SCM(RCRA)		Reciprocity	NJ
Florida	E87487	6/30/2018	DW, Crypto, NPW, Aquatic Toxicity, SCM, Air, NPW-Micro		NELAP	NJ
Georgia DW	923	10/23/2018	DW, Crypto, Micro		Reciprocity	TN
Georgia	None	6/30/2018	NPW, SCM, Air, Aquatic Toxicity, NPW-Micro, Rad		NELAP	NJ
Idaho	TN00003	6/30/2018	DW	WW, RCRA, UST	NELAP	NJ
Illinois	200008	11/30/2017	DW, NPW, SCM		NELAP	NJ
Indiana	C-TN-01	6/16/2019	DW	WW, RCRA, UST	Reciprocity	TN
Iowa	364	5/1/2018	SDWA, WW, UST, SW/CS, SDWA-Rad, WW-Rad		Audit	IA
Kansas	E-10277	10/31/2017	DW, NPW, Aquatic Toxicity, SCM, DW-Rad, NPW-Rad, SCM-Rad		NELAP	NJ
Kentucky DW	90010	12/31/2017	DW, DW-Rad, DW-Micro, Crypto	RCRA	Reciprocity	TN
Kentucky UST	16	11/30/2017	UST		Audit	A2LA
Kentucky WW	90010	12/31/2017	WW, WW-Micro, WW-Rad		Reciprocity	NJ
Louisiana	Agency ID 30792	6/30/2018	NPW, SCM, Air, Aquatic Toxicity, NPW-Rad, SCM-Rad		NELAP	NJ
Louisiana DW	LA150002	12/31/2017	DW		NELAP	NJ
Maine	TN0002	7/5/2019	DW, NPW, Crypto, Air, SCM		Reciprocity	TN, NJ
Maryland	324	12/31/2017	DW		Reciprocity	TN
Massachusetts	M-TN003	6/30/2018	DW, NPW	RCRA, UST	Reciprocity	TN
Michigan	9958	6/16/2019	DW	WW, RCRA, UST	Reciprocity	TN
Minnesota	047-999-395	12/31/2017	NPW, SCM, Air		Audit	MN
Mississippi	None	6/16/2019	DW	WW, RCRA, UST	Reciprocity	NJ
Missouri	340	6/16/2019	DW	WW, RCRA, UST	Reciprocity	NJ
Montana	CERT0086	1/1/2018	DW	WW, RCRA, UST	Reciprocity	TN
Nebraska	NA	6/30/2018	DW	WW, RCRA, UST	Reciprocity	TN
Nevada	TN-03-2002-34	7/31/2018	WW, DW, SCM, Crypto, Aquatic Toxicity		NELAP	NJ
New Hampshire	2975	5/20/2018	DW, Air, Crypto, NPW, SCM, DW-Micro, DW-Rad, NPW-Rad		NELAP	NJ
New Jersey - NELAP	TN002	6/30/2018	DW, NPW, SCM, Air, Crypto, Aquatic Toxicity, DW-Micro, NPW-Micro, DW-Rad, NPW-Rad, SCM-Rad		NELAP	NJ
New Mexico	None	Renewal		WW, RCRA, UST	NELAP	NJ
New York	11742	4/1/2018	DW, WW, SCM, Air		NELAP	NJ

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North C. Aquatic Tox	41	11/1/2018	Aquatic Toxicity		Audit	NC
North Carolina DW	DW21704	7/31/2018	DW, DW-Micro, Crypto		Audit	NC
North Carolina	Env375	12/31/2017	WW, WW-Micro		Audit	NC
North Dakota	R-140	6/30/2018	DW, WW, RCRA, DW-Rad, NPW-Rad, SCM-Rad		Reciprocity	TN, WI
Ohio EPA/VAP	CL0069	6/26/2019	DW, WW, SCM		Audit	OH
Oklahoma	9915	8/31/2018	NPW, SCM, Air, DW-Rad, NPW-Rad, SCM-Rad		NELAP	NJ
Oregon	TN200002	1/15/2018	DW, WW, SCM		NELAP	NJ
Pennsylvania	68-02979	12/31/2017	DW, DW-Micro, NPW, SCM, Air, Aquatic Toxicity, Crypto, DW-Rad, NPW-Rad, SCM-Rad		NELAP	NJ
Rhode Island	221	12/30/2017	DW, Crypto, DW-Micro, NPW, SCM, Aquatic Toxicity	WW, RCRA, UST	Reciprocity	TN
South Carolina	84004	6/30/2018	DW, NPW		NELAP	NJ
South Dakota	Pending	1/0/1900	0			
Tennessee DW	2006	6/16/2019	DW, DW-Rad	WW, RCRA, UST	Audit	TN
Tennessee DW Micro	2006	10/23/2018	DW Micro		Audit	TN
Texas - Env.	T 104704245-07-TX	10/31/2018	DW, DW-Micro, NPW, NPW-Micro, SCM, Air, Aquatic Toxicity, DW-Rad, NPW-Rad, SCM-Rad		Reciprocity	NJ
Texas - Mold	LAB0152	3/10/2019	MOLD		NA	TX
Utah	6157585858	7/31/2018	Air, DW, NPW, SCM, Aquatic Toxicity, DW-Rad, NPW-Rad, SCM-Rad		NELAP	NJ
Vermont	VT2006	1/5/2018	DW	WW, RCRA, UST	Reciprocity	TN
Virginia VELAP	460132	6/14/2018	Air, DW, Crypto, DW-Micro, NPW, NPW-Micro, SCM, Aquatic Toxicity, Crypto, DW-Rad, NPW-Rad, SCM-Rad		NELAP	NJ
Washington	C1915	8/19/2018	Air, DW, NPW, SCM, Aquatic Toxicity		Audit	A2LA
West Virginia	233	2/28/2018	NPW, SCM, Aquatic Toxicity		Audit	WV
West Virginia Crypto	9966 M	12/31/2017	DW		Reciprocity	NJ
Wisconsin	998093910	8/31/2018	NPW, SCM		Audit	WI
Wyoming	A2LA	11/30/2017	WW, RCRA, UST	WW, RCRA	Audit	A2LA
A2LA ¹	1461.01	11/30/2017	DW, WW, SCM, KY-UST, WY-STR, AIR, Micro, Aquatic Toxicity, Mold, Rad		Audit	A2LA
AIHA-LAP ²	100789	8/1/2018	EMLAP ⁴		Audit	AIHA
DOD	1461.01	11/30/2017	NPW, SCM, Air, Aquatic Toxicity, Micro, Rad		Audit	A2LA
EPA ⁸	TN00003	None	Cryptosporidium		Audit	EPA
EPA ⁸ Region 8		6/16/2019	Drinking Water		Reciprocity	TN
USDA ⁵	S-67674	9/3/2018	Quarantine Permit		Audit	USDA

(1) A2LA = American Association for Laboratory Accredited.

(2) AIHA-LAP = American Industrial Hygiene Association Lab Accredited. Program

(3) NELAP = National Environmental Laboratory Accredited. Program

(4) EMLAP = Environmental Microbiology Laboratory Accreditation Program

(5) USDA = United States Department of Agriculture

(6) Approved Programs = The state does not have a formal certification program.

(7) Pending = The state is processing our application.

(8) EPA = Environmental Protection Agency

ATTACHMENT VI- PACE NATIONAL-DECATUR LABORATORY CERTIFICATION LIST

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State/Agency	Certificate Number	Expiration Date/Status	Certified Programs	Cert.Type	Cert. Authority
Alabama	40160	2/28/2019	DW-Metals, Inorganics, Disinfection Byproducts & Bacteria	Audit	AL
Florida	E871078	6/30/2018	DW-Metals, Inorganics, Disinfection Byproducts & Bacteria	NELAP	FL
L.A.B.	L2239	2/3/2020	DW-Metals, Inorganics, Disinfection Byproducts & Bacteria	Audit	L.A.B.

ATTACHMENT VI- PACE NATIONAL-DAVIS LABORATORY CERTIFICATION LIST
SCOPE AND APPLICATION CERTIFICATES ARE MAINTAINED AND FILED IN THE LOCAL QUALITY DEPARTMENT

State/Agency	Certificate Number	Expiration Date/Status	Certified Programs	Cert.Type	Cert. Authority
California	2961	12/31/2018	NPW-Volatiles, HW-Volatiles	Audit	CA
Minnesota	006-999-465	12/31/2017	NPW-Volatiles, HW-Volatiles	Reciprocity	OR
North Dakota	R-214	1/29/2018	NPW-Volatiles, HW-Volatiles	Reciprocity	OR
Oregon	CA300002	1/29/2019	NPW-Volatiles, HW-Volatiles	NELAP	OR
Washington	C926	11/6/2018	NPW-Volatiles, HW-Volatiles	Reciprocity	OR

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ATTACHMENT VII- METHOD HOLD TIME, CONTAINER AND PRESERVATION GUIDE

THE HOLDING TIME INDICATED IN THE CHART BELOW IS THE MAXIMUM ALLOWABLE TIME FROM COLLECTION TO EXTRACTION AND/OR ANALYSIS PER THE ANALYTICAL METHOD. FOR METHODS THAT REQUIRE PROCESSING PRIOR TO ANALYSIS, THE HOLDING TIME IS DESIGNATED AS ‘PREPARATION HOLDING TIME/ANALYSIS HOLDING TIME’.

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Acid Base Accounting	Sobek	Solid	Plastic/Glass	None	N/A
Acidity	SM2310B	Water	Plastic/Glass	≤ 6°C	14 Days
Acid Volatile Sulfide	Draft EPA 1629	Solid	8oz Glass	≤ 6°C	14 Days
Actinides	HASL-300	Water	Plastic/Glass	pH<2 HNO ₃	180 Days
Actinides	HASL-300	Solid	Plastic/Glass	None	180 Days
Alkalinity	SM2320B/310.2	Water	Plastic/Glass (NY requires separate bottle filled to the exclusion of air)	≤ 6°C	14 Days
Alkylated PAHs		Water	1L Amber Glass	≤ 6°C; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved
Alkylated PAHs		Solid	8oz Glass	≤ 10°C	1 Year/40 Days
Anions (Br, Cl, F, NO ₂ , NO ₃ , o-Phos, SO ₄ , bromate, chlorite, chlorate)	300.0/300.1/SM4110 B	Water	Plastic/Glass	≤ 6°C; EDA if bromate or chlorite run	All analytes 28 days except: NO ₂ , NO ₃ , o-Phos (48 Hours); chlorite (immediately for 300.0; 14 Days for 300.1). NO ₂ /NO ₃ combo 28 days.
Anions (Br, Cl, F, NO ₂ , NO ₃ , o-Phos, SO ₄ , bromate, chlorite, chlorate)	300.0	Solid	Plastic/Glass	≤ 6°C	All analytes 28 days except: NO ₂ , NO ₃ , o-Phos (48 hours); chlorite (immediately). NO ₂ /NO ₃ combo 28 days.
Anions (Br, Cl, F, NO ₂ , NO ₃ , o-Phos, SO ₄)	9056	Water/ Solid	Plastic/Glass	≤ 6°C	48 hours
Aromatic and Halogenated Volatiles (see note 1)	8021	Solid	5035 vial kit	See note 1	14 days
Aromatic and Halogenated Volatiles	602/8021	Water	40mL vials	pH<2 HCl; ≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	14 Days (7 Days for aromatics if unpreserved)

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Asbestos	EPA 600/R-93/116	Solid	Plastic/Glass; bulk- 2'' square; popcorn ceiling- 2tbsp; soil- 4oz	None (handling must be done in HEPA filtered fume hood; drying may be required)	N/A
Bacteria, Total Plate Count	SM9221D	Water	Plastic/WK	≤ 6°C; Na ₂ S ₂ O ₃	24 Hours
Base/Neutrals and Acids	8270	Solid	8oz Glass	≤ 6°C	14/40 Days
Base/Neutrals and Acids	625/8270	Water	1L Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	7/40 Days
Base/Neutrals, Acids & Pesticides	525.2	Water	1L Amber Glass	pH<2 HCl; ≤ 6°C; Na sulfite if Cl present	14/30 Days
Biomarkers		Water	≤ 6°C; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved	≤ 6°C; pH<2 1:1 HCl (optional)
Biomarkers		Solid	≤ 10°C	1 Year/40 Days	≤ 10°C
BOD/cBOD	SM5210B	Water	Plastic/Glass	≤ 6°C	48 hours
Boiling Range Distribution of Petroleum Fractions	ASTM D2887-98	Product	10mL glass vials	≤ 6°C	N/A
BTEX/Total Hydrocarbons	TO-3	Air	Summa Canister	None	28 Days
BTEX/Total Hydrocarbons	TO-3	Air	Tedlar Bag or equivalent	None	72 Hours
Carbamates	531.1	Water	Glass	Na ₂ S ₂ O ₃ , Monochloroacetic acid pH <3; ≤ 6°C	28 Days
Carbamates	8318	Water	Glass	Monochloroacetic acid pH 4-5; ≤ 6°C	7/40 Days
Carbamates	8318	Solid	Glass	≤ 6°C	7/40 Days
Carbon Specific Isotope Analysis (CSIA)	AM24	Water	40mL clear VOA vial with TLS	≤ 6°C, trisodium phosphate or HCl	N/A
Cation/Anion Balance	SM1030E	Water	Plastic/Glass	None	None
Cation Exchange	9081	Solid	8oz Glass	None	unknown
Cations (Ferrous Iron, Ferric Iron, Divalent Manganese)	7199 modified	Water	40mL clear VOA vials with mylar septum	≤ 6°C; HCl	48 Hours
Chloride	SM4500Cl-C,E	Water	Plastic/Glass	None	28 Days
Chlorinated Hydrocarbons in Vapor	AM4.02	Vapor	20cc vapor vial with flat septum	None	N/A
Chlorine, Residual	SM4500Cl-D,E,G/330.5/Hach 8167	Water	Plastic/Glass	None	15 minutes



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Chlorophyll	SM10200H	Water	Opaque bottle or aluminum foil	$\leq 6^{\circ}\text{C}$	48 Hours to filtration
COD	SM5220C, D/410.4/Hach 8000	Water	Plastic/Glass	$\text{pH} < 2 \text{ H}_2\text{SO}_4; \leq 6^{\circ}\text{C}$	28 Days
Coliform, Fecal	SM9222D	Water	100mL Plastic	$\leq 10^{\circ}\text{C}; \text{Na}_2\text{S}_2\text{O}_3$	8 Hours
Coliform, Fecal	SM9222D	Solid	100mL Plastic	$\leq 10^{\circ}\text{C}; \text{Na}_2\text{S}_2\text{O}_3$	24 Hours
Coliform, Fecal	SM9221E	Water	100mL Plastic	$\leq 10^{\circ}\text{C}; \text{Na}_2\text{S}_2\text{O}_3$	8 Hours
Coliform, Fecal	SM9221E	Solid	100mL Plastic	$\leq 10^{\circ}\text{C}; \text{Na}_2\text{S}_2\text{O}_3$	24 Hours
Coliform, Total	SM9222B	Water	100mL Plastic	$\leq 10^{\circ}\text{C}; \text{Na}_2\text{S}_2\text{O}_3$	8 Hours
Coliform, Total	SM9221B	Solid	100mL Plastic	$\leq 10^{\circ}\text{C}; \text{Na}_2\text{S}_2\text{O}_3$	8 Hours
Coliform, Total, Fecal and E. coli	Colilert/ Quanti-tray	Water	100mL Plastic	$\leq 10^{\circ}\text{C}; \text{Na}_2\text{S}_2\text{O}_3$	8 Hours
Coliform, Total and E. coli	SM9223B	Drinking Water	100mL Plastic	$\leq 10^{\circ}\text{C}; \text{Na}_2\text{S}_2\text{O}_3$	30 Hours
Color	SM2120B,E	Water	Covered Plastic/Acid Washed Amber Glass	$\leq 6^{\circ}\text{C}$	48 Hours
Condensable Particulate Emissions	EPA 202	Air	Solutions	None	180 Days
Cyanide, Reactive	SW846 chap.7	Water	Plastic/Glass	None	28 Days
Cyanide, Reactive	SW846 chap.7	Solid	Plastic/Glass	None	28 Days
Cyanide, Total and Amenable	SM4500CN-A,B,C,D,E,G,I,N/9010/9012/335.4	Water	Plastic/Glass	$\text{pH} \geq 12 \text{ NaOH}; \leq 6^{\circ}\text{C}; \text{ascorbic acid if Cl present}$	14 Days (24 Hours if sulfide present-applies to SM4500CN only)
Diesel Range Organics- Alaska DRO	AK102	Solid	8oz Glass	$\leq 6^{\circ}\text{C}$	14/40 Days
Diesel Range Organics- Alaska DRO	AK102	Water	1L Glass	$\text{pH} < 2 \text{ HCl}; \leq 6^{\circ}\text{C}$	14/40 Days
Diesel Range Organics- TPH DRO	8015	Solid	8oz Glass Jar	$\leq 6^{\circ}\text{C}$	14/40 Days
Diesel Range Organics- TPH DRO	8015	Water	1L Amber Glass	$\leq 6^{\circ}\text{C}; \text{Na}_2\text{S}_2\text{O}_3 \text{ if Cl present}$	7/40 Days
Diesel Range Organics- TPH DRO	8015	Tissue	1L Amber Glass	$\leq - 10^{\circ}\text{C}$	1 Year if frozen/40 Days
Diesel Range Organics- TPH DRO	TO-17	Air	Thermal desorption tubes via SKC Pocket Pumps or equivalent	$\leq 6^{\circ}\text{C}$ but above freezing	28 Days
Diesel Range Organics- NwTPH-Dx	Nw-TPH-Dx	Solid	8oz Glass Jar	$\leq 6^{\circ}\text{C}$	14/40 Days

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Diesel Range Organics- NwTPH-Dx	Nw-TPH-Dx	Water	1L Amber Glass	pH <2 HCl; ≤ 6°C	14/40 Days; 7 Days from collection to extraction if unpreserved
Diesel Range Organics- Wisconsin DRO	WI MOD DRO	Solid	Tared 4oz Glass Jar	≤ 6°C	10/47 Days
Diesel Range Organics- Wisconsin DRO	WI MOD DRO	Water	1L Amber Glass	≤ 6°C; pH <2 HCl	14/40 Days
Dioxins and Furans	1613B	Solid	8oz Glass	≤ 6°C	1 year
Dioxins and Furans	1613B	Water	1L Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	1 year
Dioxins and Furans	1613B	Fish/Tissue	Aluminum foil	≤ 6°C	1 year
Dioxins and Furans	8290	Water	1L Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	30/45 Days
Dioxins and Furans	8290	Solid	8oz Glass	≤ 6°C	30/45 Days
Dioxins and Furans	8290	Fish/Tissue	Not specified	< -10°C	30/45 Days
Dioxins and Furans	TO-9	Air	PUF	None	7/40 Days
Diquat/Paraquat	549.2	Water	Amber Plastic	≤ 6°C; Na ₂ S ₂ O ₃	7/21 Days
EDB/DBCP (8011) EDB/DBCP/1,2,3-TCP (504.1)	504.1/8011	Water	40mL vials	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	14 Days
Endothall	548.1	Water	Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃	7/14 Days
Enterococci	EPA 1600	Water	100mL Plastic	≤ 10°C	8 Hours
Enterococci	Enterolert	Water	100mL Plastic	≤ 10°C; Na ₂ S ₂ O ₃	8 Hours
Explosives	8330/8332	Water	1L Amber Glass	≤ 6°C	7/40 Days
Explosives	8330/8332	Solid	8oz Glass Jar	≤ 6°C	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	NJ EPH	Water	1L Amber Glass	pH < 2 HCl; ≤ 6°C	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	NJ EPH	Solid	4oz Glass Jar	≤ 6°C	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	MA-EPH	Water	1L Amber Glass	pH<2 HCl; ≤ 6°C	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	MA-EPH	Solid	4oz Glass Jar	≤ 6°C	7/40 Days
Fecal Streptococci	SM9230B	Water	100mL Plastic	≤ 10°C; Na ₂ S ₂ O ₃	8 Hours
Ferrous Iron	SN3500Fe-D; Hach 8146	Water	Glass	None	Immediate



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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Flashpoint/ Ignitability	1010	Liquid	Plastic/Glass	None	28 Days
Florida PRO	FL PRO DEP (11/1/95)	Liquid	Glass, PTFE lined cap	$\leq 6^{\circ}\text{C}$; pH <2 H ₂ SO ₄ or HCl	7/40 Days
Fluoride	SM4500Fl-C,D	Water	Plastic	None	28 Days
Gamma Emitting Radionuclides	901.1	Water	Plastic/Glass	pH<2 HNO ₃	180 days
Gasoline Range Organics	8015	Water	40mL vials	pH<2 HCl	14 Days
Gasoline Range Organics	8015	Solid	5035 vial kit	See note 1	14 days
Gasoline Range Organics (C3-C10)	8260B modified	Water	40mL vials	$\leq 6^{\circ}\text{C}$; HCl	14 Days
Gasoline Range Organics (C3-C10)	8260B modified	Solid	4oz Glass Jar	$\leq 6^{\circ}\text{C}$	14 Days
Gasoline Range Organics- Alaska GRO	AK101	Solid	5035 vial kit	See 5035 note*	28 Days if GRO only (14 Days with BTEX)
Gasoline Range Organics- Alaska GRO	AK101	Water	40mL vials	pH<2 HCl; $\leq 6^{\circ}\text{C}$	14 Days
Gasoline Range Organics- NwTPH-Gx	Nw-TPH-Gx	Water	40mL vials	pH<2 HCl; $\leq 6^{\circ}\text{C}$	7 Days unpreserved; 14 Days preserved
Gasoline Range Organics- NwTPH-Gx	Nw-TPH-Gx	Solid	40mL vials	$\leq 6^{\circ}\text{C}$; packed jars with no headspace	14 Days
Gasoline Range Organics- Wisconsin GRO	WI MOD GRO	Water	40mL vials	pH<2 HCl; $\leq 6^{\circ}\text{C}$	14 Days
Gasoline Range Organics- Wisconsin GRO	WI MOD GRO	Solid	40mL MeOH vials	$\leq 6^{\circ}\text{C}$ in MeOH	21 Days
Glyphosate	547	Water	Glass	$\leq 6^{\circ}\text{C}$; Na ₂ S ₂ O ₃	14 Days (18 Months frozen)
Grain Size	ASTM D422	Solid	Not specified	Ambient	N/A
Gross Alpha (NJ 48Hr Method)	NJAC 7:18-6	Water	Plastic/Glass	pH<2 HNO ₃	48 Hrs
Gross Alpha and Gross Beta	9310/900.0	Water	Plastic/Glass	pH<2 HNO ₃	180 Days
Gross Alpha and Gross Beta	9310	Solid	Glass	None	180 Days
Haloacetic Acids	552.1/552.2	Water	40mL Amber vials	NH ₄ Cl; $\leq 6^{\circ}\text{C}$	14/7 Days if extracts stored $\leq 6^{\circ}\text{C}$ or 14/14 Days if extracts stored at $\leq -10^{\circ}\text{C}$
Hardness, Total (CaCO ₃)	SM2340B,C/130.1	Water	Plastic/Glass	pH<2 HNO ₃	180 Days
Heterotrophic Plate Count (SPC/HPC)	SM9215B	Water	100mL Plastic	$\leq 10^{\circ}\text{C}$; Na ₂ S ₂ O ₃	8 Hours
Heterotrophic Plate Count (SPC/HPC)	SimPlate	Water	100mL Plastic	$\leq 10^{\circ}\text{C}$; Na ₂ S ₂ O ₃	8 Hours

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Herbicides, Chlorinated	8151	Solid	8oz Glass Jar	≤ 6°C	14/40 Days
Herbicides, Chlorinated	8151	Water	1L Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	7/40 Days
Herbicides, Chlorinated	515.1/515.3	Water	1L Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	14/28 Days
Hexavalent Chromium	7196/218.6/ SM3500Cr-B, C, D	Water	Plastic/Glass	≤ 6°C	24 Hours (see note 4)
Hexavalent Chromium	218.6/SM3500Cr-B, C, D	Water	Plastic/Glass	Ammonium Buffer pH 9.3-9.7	28 Days (see note 4)
Hexavalent Chromium	218.6/218.7	Drinking Water	Plastic/Glass	Ammonium Buffer pH >8	14 Days (see note 4)
Hexavalent Chromium	7196 (with 3060A)	Solid		≤ 6°C	30 Days from collection to extraction and 7 days from extraction to analysis
Hydrocarbons in Vapor	AM4.02	Vapor	20cc vapor vial with flat septum	None	N/A
Hydrogen by Bubble Strip	SM9/AM20Gax	Water	20cc vapor vial with stopper septum	None	14 Days
Hydrogen Halide and Halogen Emissions	EPA 26	Air	Solutions	None	6 Months
Ignitability of Solids	1030	Non-liquid Waste	Plastic/Glass	None	28 Days
Lead Emissions	EPA 12	Air	Filter/Solutions	None	6 Months
Light Hydrocarbons by Bubble Strip	SM9/AM20Gax	Water	20cc vapor vial with stopper septum	None	14 Days
Light Hydrocarbons in Vapor	AM20Gax	Vapor	20cc vapor vial with flat septum	None	14 Days
Lipids	Pace Lipids	Tissue	Plastic/Glass	≤ -10°C	1 Year if frozen
Mercury, Low-Level	1631E	Solid	Glass	None	28 Days
Mercury, Low-Level	1631E	Water	Fluoropolymer bottles (Glass if Hg is only analyte being tested)	12N HCl or BrCl	48 Hours for preservation or analysis; 28 Days to preservation if sample oxidized in bottle; 90 Days for analysis if preserved

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Mercury, Low-Level	1631E	Tissue	Plastic/Glass	$\leq -10^{\circ}\text{C}$	28 Days if frozen
Mercury	7471	Solid	8oz Glass Jar	$\leq 6^{\circ}\text{C}$	28 Days
Mercury	7470/245.1/245.2	Water	Plastic/Glass	pH<2 HNO ₃	28 Days
Mercury	7471/245.6	Tissue	Plastic/Glass	$\leq -10^{\circ}\text{C}$	28 Days if frozen
Metals (GFAA)	7000/200.9	Water	Plastic/Glass	pH<2 HNO ₃	180 Days
Metals (ICP)	NIOSH 7300A/7303	Air	Filters	None	180 Days
Metals (ICP/ICPMS)	6010/6020	Solid	8oz Glass Jar	None	180 Days
Metals (ICP/ICPMS)	6010/6020/200.7/200.8	Water	Plastic/Glass	pH<2 HNO ₃	180 Days
Metals (ICP/ICPMS)	6020	Tissue	Plastic/Glass	$\leq -10^{\circ}\text{C}$	180 Days if frozen
Methane, Ethane, Ethene	8015 modified	Water	40mL vials	HCl	14 Days
Methane, Ethane, Ethene	RSK-175; PM01/AM20GAx	Water	20mL vials	HCl; or trisodium phosphate or benzalkonium chloride and $\leq 6^{\circ}\text{C}$	14 Days; 7 Days unpreserved
Methane, Ethane, Ethene	EPA 3C	Air	Summa Canister	None	28 Days
Methane, Ethane, Ethene	EPA 3C	Air	Tedlar Bag or equivalent	None	5 Days
Methanol, Ethanol	8015 modified	Water	40mL vials	$\leq 6^{\circ}\text{C}$	14 Days
Methanol, Ethanol	8015 modified	Solid	2oz Glass	$\leq 6^{\circ}\text{C}$	14 Days
Methyl Mercury	1630	Water	Teflon/ fluoropolymer	Fresh water- 4mL/L HCl; Saline water- 2mL/L H ₂ SO ₄ (must be preserved within 48 hours of collection)	6 months
Methyl Mercury	1630	Tissue	2-4oz glass jar	$\leq 0^{\circ}\text{C}$	28 Days; ethylated distillate 48 hours
Nitrogen, Ammonia	SM4500NH3/350.1	Water	Plastic/Glass	pH<2 H ₂ SO ₄ ; $\leq 6^{\circ}\text{C}$	28 Days
Nitrogen, Total Kjeldahl (TKN)	351.2	Solid	Plastic/Glass	$\leq 6^{\circ}\text{C}$	28 Days
Nitrogen, Total Kjeldahl (TKN)	SM4500-Norg/351.2	Water	Plastic/Glass	pH<2 H ₂ SO ₄ ; $\leq 6^{\circ}\text{C}$	28 Days
Nitrogen, Nitrate	SM4500-NO3/352.1	Water	Plastic/Glass	$\leq 6^{\circ}\text{C}$	24 Hours preferred
Nitrogen, Nitrate & Nitrite combination	353.2	Solid	Plastic/Glass	$\leq 6^{\circ}\text{C}$	28 Days
Nitrogen, Nitrate & Nitrite combination	SM4500-NO3/353.2	Water	Plastic/Glass	pH<2 H ₂ SO ₄ ; $\leq 6^{\circ}\text{C}$	28 Days
Nitrogen, Nitrite or Nitrate separately	SM4500-NO2/353.2	Water	Plastic/Glass	$\leq 6^{\circ}\text{C}$	48 Hours
Nitrogen, Organic	SM4500-Norg/351.2	Water	Plastic/Glass	pH<2 H ₂ SO ₄ ; $\leq 6^{\circ}\text{C}$	28 Days
Non-Methane Organics	EPA 25C	Air	Summa Canister	None	28 Days

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Non-Methane Organics	EPA 25C	Air	Tedlar Bag or equivalent	None	72 Hours
Odor	SM2150B	Water	Glass	≤ 6°C	24 Hours
Oil and Grease/HEM	1664A/SM5520B/9070	Water	Glass	pH<2 H ₂ SO ₄ or HCl; ≤ 6°C	28 Days
Oil and Grease/HEM	9071	Solid	Glass	≤ 6°C	28 Days
Oil Range Organics	8015	Solid	Glass	≤ 6°C	14/40 Days
Oil Range Organics	8015	Water	Glass	≤ 6°C	7/40 Days
Organic Matter	ASA 29-3.5.2	Solid	Plastic/Glass	None; samples air-dried and processed prior to analysis	N/A
Oxygen, Dissolved (Probe)	SM4500-O	Water	Glass	None	15 minutes
Oxygenates on Product (GCMS SIM)	1625 modified	Product	10mL glass vial	≤ 6°C	14 Days (7 Days from extraction)
PBDEs	1614	Water	1L Amber Glass	≤ 6°C	1 Year/1 Year
PBDEs	1614	Solid	Wide Mouth Jar	≤ 6°C	1 Year/1 Year
PBDEs	1614	Tissue	Aluminum Foil	≤ -10°C	1 Year/1 Year
PCBs and Pesticides, Organochlorine (OC)	TO-4/TO-10	Air	PUF	None	7/40 Days
PCBs and Pesticides, Organochlorine (OC)	608	Water	1L Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	Pest: 7/40 Days; PCB: 1 Year/1 Year
PCBs, Pesticides (OC), Herbicides	508.1	Water	Glass	Na ₂ SO ₃ ; pH<2 HCl; ≤ 6°C	14/30 Days
PCBs, total as Decachlorobiphenyl	508A	Water	1L Glass, TFE lined cap	≤ 6°C	14/30 Days
Perchlorate	331	Water	Plastic/Glass	≥0-6°C, field filtered with headspace	28 Days
Permanent Gases (O ₂ , N ₂ , CO ₂)	RSK-175; PM01/AM20Gax	Water	40mL vials	benzalkonium chloride and ≤ 6°C	14 Days
Permanent Gases by Bubble Strip	SM9/AM20Gax	Water	20cc vapor vial with stopper septum	None	14 Days
Permanent Gases in Vapor	AM20Gax	Vapor	20cc vapor vial with flat septum	None	14 Days
Pesticides, Organochlorine (OC)	8081	Water	1L Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	7/40 Days
Pesticides, Organochlorine (OC)	8081	Solid	8oz Glass Jar	≤ 6°C	14/40 Days
Pesticides, Organochlorine (OC)	8081	Tissue	8oz Glass Jar	≤ -10°C	1 Year if frozen/40 Days
Pesticides, Organophosphorous (OP)	8141	Solid	8oz Glass Jar	≤ 6°C	14/40 Days

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Pesticides, Organophosphorous (OP)	8141	Water	1L Amber Glass	pH 5-8 with NaOH or H ₂ SO ₄ ; ≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	7/40 Days
PCBs (Aroclors)	8082	Water	1L Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	1 Year/1 Year
PCBs (Aroclors)	8082	Solid	8oz Glass Jar	≤ 6°C	1 Year/1 Year
PCBs (Aroclors)	8082	Tissue	Plastic/Glass	≤ -10°C	1 Year if frozen/1 Year
PCB Congeners	1668A	Water	1L Amber Glass	≤ 6°C but above freezing	1 Year/1 Year
PCB Congeners	1668A	Solid	4-8oz Glass Jar	≤ 6°C but above freezing	1 Year/1 Year
PCB Congeners	1668A	Tissue	4-8oz Glass Jar	≤ -10°C	1 Year/1 Year
Paint Filter Liquid Test	9095	Water	Plastic/Glass	None	N/A
Particle Size	ASA 15-5 modified	Solid	Plastic/Glass (100g sample)	None	N/A
Particulates	PM-10	Air	Filters	None	180 Days
Permanent Gases	EPA 3C	Air	Summa Canister	None	28 Days
Permanent Gases	EPA 3C	Air	Tedlar Bag or equivalent	None	5 Days
pH	SM4500H+B/9040	Water	Plastic/Glass	None	15 minutes
pH	9045	Solid	Plastic/Glass	None	7 Days
Phenol, Total	420.1/420.4/9065/9066	Water	Glass	pH<2 H ₂ SO ₄ ; ≤ 6°C	28 Days
Phosphorus, Orthophosphate	SM4500P/365.1/365.3	Water	Plastic	≤ 6°C	Filter within 15 minutes, Analyze within 48 Hours
Phosphorus, Total	SM4500P/365.1/365.3/365.4	Water	Plastic/Glass	pH<2 H ₂ SO ₄ ; ≤ 6°C	28 Days
Phosphorus, Total	365.4	Solid	Plastic/Glass	≤ 6°C	28 Days
Polynuclear Aromatic Hydrocarbons (PAH)	TO-13	Air	PUF	None	7/40 Days
Polynuclear Aromatic Hydrocarbons (PAH)	TO-17	Air	Thermal desorption tubes via SKC Pocket Pumps or equivalent	≤ 6°C but above freezing	28 Days
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Solid	8oz Glass Jar	≤ 6°C	14/40 Days
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Water	1L Amber Glass	≤ 6°C; Na ₂ S ₂ O ₃ if Cl present	7/40 Days
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Tissue	Plastic/Glass	≤ -10°C	1 Year if frozen/40 Days
Purgeable Organic Halides (POX)	9021	Water	Glass; no headspace	≤ 6°C	14 Days
Radioactive Strontium	905.0	Water	Plastic/Glass	pH<2 HNO ₃	180 days

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Radium-226	903.0/903.1	Water	Plastic/Glass	pH<2 HNO ₃	180 days
Radium-228 (see note 3)	9320/904.0	Water	Plastic/Glass	pH<2 HNO ₃	180 days
Radium-228 (see note 3)	9320	Solid	Plastic/Glass		
Residual Range Organics- Alaska RRO	AK103	Solid	8oz Glass	≤ 6°C	14/40 Days
Saturated Hydrocarbons		Water	≤ 6°C; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved	≤ 6°C; pH<2 1:1 HCl (optional)
Saturated Hydrocarbons		Solid	≤ 10°C	1 Year/40 Days	≤ 10°C
Silica, Dissolved	SM4500Si-D	Water	Plastic	≤ 6°C	28 Days
Solids, Settleable	SM2540F	Water	Glass	≤ 6°C	48 Hours
Solids, Total	SM2540B	Water	Plastic/Glass	≤ 6°C	7 Days
Solids, Total	SM2540G	Solid	Plastic/Glass	≤ 6°C	7 Days
Solids, Total (FOC, OM, Ash)	ASTM D2974	Solid	Plastic/Glass	≤ 6°C	7 Days
Solids, Total Dissolved	SM2540C	Water	Plastic/Glass	≤ 6°C	7 Days
Solids, Total Suspended	SM2540D/USGS I-3765-85	Water	Plastic/Glass	≤ 6°C	7 Days
Solids, Total Volatile	160.4/SM2540E	Water	Plastic/Glass	≤ 6°C	7 Days
Solids, Total Volatile	160.4	Solid	Plastic/Glass	≤ 6°C	7 Days
Specific Conductance	SM2510B/9050/120.1	Water	Plastic/Glass	≤ 6°C	28 Days
Stationary Source Dioxins and Furans	EPA 23	Air	XAD Trap	None	30/45 Days
Stationary Source Mercury	EPA 101	Air	Filters	None	180 Days, 28 Days for Hg
Stationary Source Metals	EPA 29	Air	Filters	None	180 Days, 28 Days for Hg
Stationary Source PM10	EPA 201A	Air	Filters	None	180 Days
Stationary Source Particulates	EPA 5	Air	Filter/Solutions	None	180 Days
Sulfate	SM4500SO4/9036/9038/375.2/ASTM D516	Water	Plastic/Glass	≤ 6°C	28 Days
Sulfide, Reactive	SW-846 Chap.7	Water	Plastic/Glass	None	28 Days
Sulfide, Reactive	SW-846 Chap.7	Solid	Plastic/Glass	None	28 Days
Sulfide, Total	SM4500S/9030	Water	Plastic/Glass	pH>9 NaOH; ZnOAc; ≤ 6°C	7 Days
Sulfite	SM4500SO3	Water	Plastic/Glass	None	15 minutes
Surfactants (MBAS)	SM5540C	Water	Plastic/Glass	≤ 6°C	48 Hours
Total Alpha Radium (see note 3)	9315/903.0	Water	Plastic/Glass	pH<2 HNO ₃	180 days
Total Alpha Radium (see note 3)	9315	Solid	Plastic/Glass	None	180 days



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Total Inorganic Carbon (TIC)	PM01/AM20GAx	Water	40mL VOA vial with mylar septum	≤ 6°C	14 Days
Total Organic Carbon (TOC)	SM5310B,C,D/9060	Water	Glass	pH<2 H ₂ SO ₄ or HCl; ≤ 6°C	28 Days
Total Organic Carbon (TOC)	9060/Walkley Black/Lloyd Kahn	Solid	Glass	≤ 6°C	14 Days
Total Organic Halogen (TOX)	SM5320/9020	Water	Glass; no headspace	≤ 6°C	14 Days
Total Petroleum Hydrocarbons (aliphatic and aromatic)	TPHCWG	Water	40mL vials	pH<2 HCl, no headspace, ≤ 6°C	7 Days
Total Petroleum Hydrocarbons (aliphatic and aromatic)	TPHCWG	Solid	Glass	≤ 6°C	14 days
Tritium	906.0	Water	Glass	None	180 days
Turbidity	SM2130B/180.1	Water	Plastic/Glass	≤ 6°C	48 Hours
Total Uranium	908.0/ASTM D5174-97	Water	Plastic/Glass	pH<2 HNO ₃	180 days
UCMR Metals	200.8	Water	Plastic or glass	pH<2 HNO ₃	28 Days
UCMR Hexavalent Chromium	218.7	Water	HDPE or propylene	Na ₂ CO ₃ /NaHCO ₃ /(NH ₄) ₂ SO ₄ ; pH>8	14 Days
UCMR Chlorate	300.1	Water	Plastic or glass	EDA	28 Days
UCMR Perfluorinated Compounds	537	Water	Polypropylene	Trizma	14 Days
UCMR 1, 4 Dioxane	522	Water	Glass	Na ₂ SO ₃ , NaHSO ₄ ; pH<4	28 Days
UV254	SM5910B	Water	Glass	≤ 6°C	48 Hours
Vermiculite	EPA 600/R-93/116	Solid	Plastic/Glass	None (handling must be done in HEPA filtered fume hood; drying may be required)	N/A
Volatile Fatty Acids	AM21G	Water	40mL clear VOA vials	≤ 6°C	21 Days
Volatile Fatty Acids (low level)	AM23G	Water	40mL clear VOA vials	≤ 6°C with benzalkonium chloride	14 Days
Volatile Petroleum Hydrocarbons (aliphatic and aromatic)	MA-VPH	Water	40mL vials	pH<2 HCl; ≤ 6°C	14 Days preserved
Volatile Petroleum Hydrocarbons (aliphatic and aromatic)	MA-VPH	Solid	4-8oz Glass Jar	≤ 6°C; packed jars with no headspace	7/28 Days
Volatiles	TO-14	Air	Summa Canister	None	28 Days

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Volatiles	TO-14	Air	Tedlar Bag or equivalent	None	72 Hours
Volatiles	TO-15	Air	Summa Canister or Tedlar Bag	None	5 days or 72 hr depending on regulatory requirement
Volatiles	TO-17	Air	Thermal desorption tubes via SKC Pocket Pumps or equivalent	$\leq 6^{\circ}\text{C}$ but above freezing	28 Days
Volatiles	TO-18/8260	Air	Tedlar Bag or equivalent	None	72 Hours
Volatiles	8260	Solid	5035 vial kit	See note 1 (analyze for acrolein and acrylonitrile per local requirements)	14 days
Volatiles	8260	Water	40mL vials	pH<2 HCl; $\leq 6^{\circ}\text{C}$; $\text{Na}_2\text{S}_2\text{O}_3$ if Cl present (preserve and analyze for acrolein and acrylonitrile per local requirements)	14 Days
Volatiles	8260	Conc. Waste	5035 vial kit or 40mL vials	$\leq 6^{\circ}\text{C}$	14 Days
Volatiles	624	Water	40mL vials	pH<2 HCl; $\leq 6^{\circ}\text{C}$; $\text{Na}_2\text{S}_2\text{O}_3$ if Cl present (or unpreserved if run within 7 days of collection) (preserve and analyze for acrolein and acrylonitrile per local requirements)	14 Days (7 Days for aromatics if unpreserved)
Volatiles (see note 2)	524.2	Water	40mL vials (in duplicate)	pH<2 HCl; $\leq 6^{\circ}\text{C}$; Ascorbic acid or $\text{Na}_2\text{S}_2\text{O}_3$ if Cl present ²	14 Days
Whole Oil	ASTM D3328 (prep); ASTM D5739	Product	10mL glass vials	$\leq 6^{\circ}\text{C}$	N/A

¹ **5035/5035A Note:** 5035 vial kit typically contains 2 vials water, preserved by freezing **or**, 2 vials aqueous sodium bisulfate preserved at 4°C , **and** one vial methanol preserved at $\leq 6^{\circ}\text{C}$ **and** one container of unpreserved sample stored at $\leq 6^{\circ}\text{C}$.

² Method 524.2 lists ascorbic acid as the preservative when residual chlorine is suspected, unless gases or Table 7 compounds are NOT compounds of interest and then sodium thiosulfate is the preservative recommended.

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³ Methods 9315 and 9320 both state that if samples are unpreserved, the samples should be brought to the lab within 5 days of collection, preserved in the lab, and then allowed to sit for a minimum of 16 hours before sample preparation/analysis.

⁴ The holding time for hexavalent chromium may be extended by the addition of the ammonium buffer listed in EPA 218.6 per the 2012 EPA Method Update Rule. Although Method 218.6 stipulates a different pH range (9.0 to 9.5) for buffering, this method requirement was modified in the Method Update Rule to a pH range of 9.3 to 9.7. For non-potable waters, adjust the pH of the sample to 9.3 to 9.7 during collection with the method required ammonium sulfate buffer to extend the holding time to 28 days. For potable waters, addition of the buffer during collection will extend the holding time for 14 days per EPA 218.7 and the EPA UCMR program.

APPENDIX C
ATC FIELD REPORT FORM

APPENDIX D

ATC STANDARD OPERATING PROCEDURES



ATC STANDARD OPERATING PROCEDURE INDOOR AIR QUALITY (IAQ) SAMPLE COLLECTION

Field personnel should refrain from wearing perfume, aftershave or any personal care products containing alcohol or other fragrances when using the SUMMA canister samplers as these products will impact the sample. Use only regular ink pens for note taking, not Sharpies or other markers.

The SUMMA canister is placed in the area of interest where there is moderate airflow around the canister and four to six feet above the floor surface. Do not place in a corner or against equipment. The regulator is then placed on the canister or opened if already placed. If the regulator must be screwed on and opened, ensure that the canister valve is closed and remains closed prior to attaching the regulator. The canister valve nut should be removed and the regulator should be delicately tightened into place using a wrench. Do not over-tighten. Once the regulator is securely attached, the canister valve may be opened. Some regulators attach using a quick-release. For these units, there is no valve on the canister. Once the regulator is attached using the quick release, sample collection has begun. For all samples, record the initial vacuum pressure displayed on the pressure gauge on the sampling form.

The regulator will be set by the analytical laboratory for the specified sample collection period. This period may range from eight to 24 hours on a normal basis and is dependent upon the sampling strategy. The container will be left in place throughout the sampling time period. Do not allow the canister to sit open for a prolonged period beyond the specified sampling time. Ideally, the canister is placed where it will not be impacted by human activity. Perfumes and other personal care products will bias the sample as will common office supplies such as dry-erase markers, Sharpie markers and cleaning fluids.

The sample is complete when the regulator reaches "0" or equilibrium with atmospheric pressure. At the conclusion of the sample period, the regulator is removed to stop sample collection if it is a quick release type. If it is a valve canister, the canister valve is closed BEFORE removing the regulator. The regulator is then removed and the canister valve nut is replaced. If the designated sample period has passed and the regulator does not read "0", record the final vacuum pressure on the sampling form.

The canister should be uniquely labeled and information regarding sample number, vacuum pressure readings and time of sample collection is entered on the chain of custody form. If directed to do so, field personnel will collect information on the temperature and relative humidity of the sample area and enter that information on the chain of custody. The sealed canister and regulator is then returned to the analytical laboratory for analysis.



ATC STANDARD OPERATING PROCEDURE SOIL VAPOR WELL INSTALLATION AND SAMPLING

Preliminary Activities

Prior to the onset of field activities at the site, ATC obtains the appropriate permit(s) from the governing agencies. Advance notification is made as required by the agencies prior to the start of work. ATC marks the borehole locations and contacts the local one call utility locating service at least 48 hours prior to the start of work to mark buried utilities. Borehole locations may also be checked for buried utilities by a private geophysical surveyor. Prior to drilling, the borehole location is cleared in accordance with the client's procedures. Fieldwork is conducted under the advisement of a registered professional geologist and in accordance with an updated site-specific safety plan prepared for the project, which is available at the job site during field activities.

Soil Vapor Well Construction

The borehole is advanced to the desired depth using either a direct-push rig, hand auger, or air vacuum rig. Lithologic conditions are recorded on a boring log during borehole advancement, and select soil matrix sampling may be conducted based on soil characteristics.

Each soil vapor sampling (SVS) well is constructed using inert screen material attached to 1/8- to 1/4-inch outer diameter inert tubing. A gas-tight vacuum fitting or valve is attached to the top of each length of tubing using a female compression fitting. Each screen is set within a minimum of a 12-inch thick appropriately sized sand pack, with a minimum of three inches of sand pack above the top of the screen. A minimum of four inches of dry granular bentonite is set above each screen and associated sand pack. In SVS wells with multiple and separate casings and screens, the annular space between the top of the dry granular bentonite above the deep screen and the bottom of the sand pack associated with the shallow screen is sealed with a minimum of 18 inches of hydrated bentonite. The remainder of the annular space of the well is sealed with hydrated bentonite to one foot below ground surface. Wellheads are finished with traffic-rated well boxes set in concrete flush with the surrounding grade. No glues, chemical cements, or solvents are used in well construction.

A boring log is completed with the construction details for each well, including the materials of construction, depth of the borehole, screen length, and annular seal thickness.

Soil Vapor Sampling

Samples are collected using a soil vapor purging and sampling manifold consisting of a flow regulator, vacuum gauges, vacuum pump, shroud, and laboratory-prepared, gas-tight, opaque containers such as Summa™ canisters. Samples may also be collected using a syringe and analyzed by a mobile laboratory. Prior to use, Summa™ canisters are checked to ensure they are under the laboratory induced vacuum between 31 and 25 inches of mercury (in. Hg). New inert tubing is used to purge and sample each well. Prior to purging and sampling each SVS well, the sampling manifold is connected to the gas-tight vacuum fitting or valve at the wellhead, and the downstream tubing and fittings are vacuum tested at approximately 24 to 28 in. Hg. Purging and sampling are conducted only on SVS wells when the tubing and fittings hold the applied vacuum for five minutes per vacuum gauge reading.

When required, ATC conducts a purge volume versus constituent concentration test on at least one SVS well prior to purging and sampling activities. The purge volume test well is selected based on the location of the anticipated source of chemical constituents at the site and on the location of anticipated maximum soil vapor concentrations based on lithologic conditions. If the SVS well has been in place for more than one week, it is assumed that soil vapor in the sand pack has equilibrated with the surrounding soil, and only the screen and tubing volumes are included in the purge volume calculation. If the SVS well has been in place for less than one week, the volume of the sand pack around the screen is included in the purge volume calculation. A photoionization detector (PID) or on-site mobile laboratory is used to evaluate concentrations of chemical constituents in the vapor stream after one, three, and 10 volumes of vapor have been purged from the SVS well.

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(Soil Vapor Well Installation and Sampling SOP – continued)

Purging is conducted at a rate of 100 to 200 milliliters per minute (ml/min). The purge volume exhibiting the highest concentration is the volume of vapor purged from each SVS well prior to sampling. If the three separate purge volumes produce equal concentrations a default of three purge volumes is extracted prior to sampling.

Prior to sampling, a leak test is performed at each SVS well, including a summa canister and its fittings, to check for leaks in the SVS annulus. Typically helium or 1,1-difluoroethane (DFA) are utilized as the leak check compound (LCC). To assess the potential for leaks in the SVS well annulus when using helium as the LCC, a shroud is placed over the SVS well and summa canister and the shroud is filled with a measured amount of helium. Helium screening is performed in the field by drawing soil gas into a Tedlar bag via a lung-box and screening the contents of the Tedlar bag with a helium meter. The concentration of helium in the sample divided by the concentration of helium in the shroud provides a measure of the proportion of the sample attributable to leakage. A leak that comprises less than 5% of the sample is insignificant. When DFA is utilized as the LCC, a rag infused with DFA is placed in near the sampling train during the sample intake period. Helium and DFA screening are performed using laboratory analysis of the contents of the summa canister. Sampling is conducted at approximately the same rate of purging, at 100 to 200 ml/min. Soil vapor samples are submitted under chain of custody protocol for the specified laboratory analyses.

At a minimum, weather conditions (temperature, barometric pressure and precipitation), the sampling flow rate, the purge volume, the helium leak detection percentage results, the sample canister identification number, the method of sample collection, and the vacuum of the sampling canister at the start and end of sample collection (if applicable) are recorded on a log for each SVS well purged and sampled.

Decontamination Procedures

If soil samples are collected, ATC or the contracted driller decontaminates the soil sampling equipment between each sampling interval using a non-phosphate solution, followed by a minimum of two tap water rinses. De-ionized water may be used for the final rinse. Downhole drilling equipment is steam-cleaned or triple-rinsed prior to advancing each borehole.

Waste Treatment and Disposal

Soil cuttings generated from the well installation are stored on site in labeled, Department of Transportation-approved, 55-gallon drums or other appropriate storage container. The soil is removed from the site and transported under manifest to a client- and regulatory-approved facility for recycling or disposal. Decontamination water is stored on site in labeled, regulatory-approved storage containers, and is subsequently transported under manifest to a client- and regulatory-approved facility for disposal or treated with a permitted mobile or fixed-base carbon treatment system.



ATC STANDARD OPERATING PROCEDURE HAND AUGER DRILLING AND SOIL SAMPLING

Soil borings are advanced utilizing a stainless steel hand-operated auger tool. The subsurface lithology will determine the type of auger bucket head used: a regular solid-body bucket is best for dry to slightly damp, light to medium density soils; a sand auger bucket is designed to retain soils comprised primarily of sand; and a mud auger bucket (windowed bucket) is best suited for wet silt and clays with high plasticity. Auger buckets are 3.25-inches in diameter, although 2.25-inch diameter and smaller, custom designs can be utilized depending on the lithology. ATC attempts to advance the hand auger by gently rotating the hand auger into the soil, allowing it to pull itself into the ground. Once the bucket is 3/4 full of cuttings, it is lifted out of the hole and emptied by shaking the bucket vertically. Using this technique, the boring is advanced to the desired sample depth. Extensions can be added to increase the length of the tool.

Sample collection is achieved by one of two methods. The soil extracted from the desired sample depth can be removed from the auger bucket head and placed directly in a laboratory supplied container appropriate for the proposed analysis. The collected sample container is appropriately sealed, marked for identification and stored in an ice chest cooled to approximately four degrees Celsius with wet ice for delivery to a State certified laboratory. Chain of custody records are maintained as samples are collected and accompany the samples to the laboratory.

The second method utilized for sample collection with hand-operated tools involves the use of a slide hammer and a two-inch diameter split core sampler (six-inches in length). The split core sampler is generally loaded with a decontaminated metal sleeve (brass or stainless steel), which is fitted with extensions to reach the bottom of the auger-advanced boring. At the surface, a hand-operated slide hammer is utilized to drive the split core sampler into the subsurface soils. After the sampler is driven, the tools are extracted from the boring and the split core sampler is disassembled to obtain the representative soil sample. The sample tube will be visually inspected to insure that the tube is completely filled with soil, and no headspace exists in samples submitted for laboratory analysis. The collected brass sample tube will be sealed at each end with Teflon® liner squares followed by aluminum foil liners, capped with plastic end-caps, sealed with Teflon® tape, marked for identification, and stored in an ice chest cooled to approximately four degrees Celsius with wet ice for delivery to a State certified laboratory. Alternatively, soil samples for volatile organic compound analysis are extracted in the field using laboratory-provided extraction kits. This sampling technique minimizes the sample exposure to the atmosphere (a potential for loss of volatile organic compounds). Chain of custody records are maintained as samples are collected and accompany the samples to the laboratory.

When utilizing hand auger for soil borings, selected cuttings are emptied into a sealable plastic bag for field soil vapor monitoring and soil classification purposes. Soil samples are logged by an ATC Field Scientist in general accordance with American Society of Testing and Materials (ASTM) Method D 2488 and boring logs maintained.

To minimize the potential for cross-contamination, a new pair of disposable gloves are worn when preparing a sample for laboratory analysis. Additionally, all downhole sampling equipment is washed in an Alconox® or Liquinox® and tap water solution, rinsed with tap water and rinsed again with distilled water prior to each sampling event. Decontamination water and soil boring cuttings are stored in separate, labeled 55-gallon drums which remain on-site pending disposal.



STANDARD OPERATING PROCEDURE FIELD SOIL VAPOR AND METALS MONITORING

Soil Vapor

The MiniRAE 2000 (or equivalent) photoionization detector (PID) is calibrated on-site at the commencement of each work day to zero and to 100-parts per million by volume (ppmV) using isobutylene-in-air span gas (equivalent to benzene). An appropriate PID lamp is selected based on the ionization potential of the primary chemical(s) of concern relevant to the investigation.

A representative soil sample is collected from each sample location and placed in a sealable plastic bag. The soil sample identifier is marked on the bag above the top of the bag seal. The bag is sealed and the soil disaggregated. At least ten minutes is allowed for the soil to be heated by direct sunlight and for any volatile organic compounds in the soil to accumulate in the headspace of the bag. In cool weather (e.g. below 60 degrees Fahrenheit) or darkness, the soil sample bag is warmed for at least ten minutes inside a heated vehicle.

Volatile gases are then monitored by inserting the probe of the PID into the bag. The PID is equipped with a lamp which is capable of detecting volatile organic compounds at concentrations of 0.1 to 9,999 ppmV. The PID probe remains inside the bag for a period of time sufficient to allow the reading to peak and stabilize. The peak reading is recorded on the soil boring log.

Metals

Soil samples subject to x-ray fluorescence (XRF) analyzer screening are retained in the sealable plastic bag which is wiped clean of debris. The contents of the bag are packed so that the soil in the bag is a minimum of one inch thick below the XRF analyzer window. The XRF analyzer is calibrated to known standards and programmed to measure target metals concentrations in soil. The XRF analyzer window is placed over the packed soil sample and the x-ray trigger engaged for 60 seconds. After 60 seconds, the analysis is terminated and the metals constituent concentrations of interest are recorded along with the unique sample identifier in the field notes (all data are also recorded in the XRF's data logger and are available for later download).



ATC STANDARD OPERATING PROCEDURE ROTONSONIC DRILLING AND SOIL SAMPLING

The rotonsonic drill rig employs the use of high-frequency, resonant energy to rotationally advance a 6-inch inside diameter (ID) by 7-inch outside diameter (OD) core barrel within a nominal 7-inch ID by 9-inch OD overshot casing to construct an approximate 9 $\frac{1}{8}$ -inch diameter borehole. This dual-string assembly allows advancement of the overshot casing with the inner core barrel used to collect samples. The core barrel is driven ahead of the overshot casing and is used to collect a representative continuous core sample in approximate 10-foot lengths. Once the core barrel is advanced to the required depth, the drill head (attached to the drill rig) is disconnected from the core barrel and reconnected to the overshot casing. The overshot casing is then driven down over the core barrel. The overshot casing prevents the hole from collapsing when the core barrel is extracted for sample retrieval. Attached to the tip of both the core barrel sampler and the overshot casing are hardened steel casing shoe-type bits. The drill bits have several carbide buttons around the tip and outer edge that cut through the formation as the drill string is vibrated and rotated.

Following core sample retrieval, the soil is emptied into plastic bags in approximate two-foot lengths and labeled for depth. Soil samples are logged by an ATC Field Scientist in general accordance with American Society for Testing and Materials Method D 2488 and field boring logs maintained.

Soil samples are collected by driving a laboratory-provided sample container into the core sample. The container is visually inspected to insure it is completely filled with soil, and no headspace exists in samples submitted for laboratory analysis. The sample container is sealed with a Teflon[®] lined cap, marked for identification and stored in an ice chest cooled to approximately four degrees Celsius with wet ice for delivery to a State-certified laboratory. Alternatively, soil samples for volatile organic compound analysis are extracted in the field using laboratory-provided extraction kits. Chain of custody records are maintained as samples are collected and accompany the samples to the laboratory.

To minimize the potential for chemical exposure, a new pair of disposable gloves are worn when logging. All downhole drilling and sampling equipment is washed in an Alconox[®] or Liquinox[®] and tap water solution, rinsed with tap water and rinsed again with distilled water prior to each drilling event. Excess drill cuttings are placed in 55-gallon drums or a rolloff-type container and remain on-site pending disposal. Alternatively, soil cuttings may be spread onsite depending on project-specific requirements. Borings are typically backfilled with grout (or other materials deemed acceptable by the permitting agency) if no well is installed.



ATC STANDARD OPERATING PROCEDURE IN-SITU SOIL VAPOR, SOIL AND GROUNDWATER SAMPLER

In-situ soil vapor, soil and groundwater sample collection can be accomplished utilizing a downhole sampling device (commonly referred to as a Simulprobe or Hydropunch) operated by a variety of drilling methods (direct-push, hollow-stem auger, rotosonic and air rotary). The downhole sampler tool (generally provided and operated by the drilling contractor) is designed to collect soil vapor, soil and/or groundwater (or other liquids) just ahead of the drill string. At the pre-selected depth, the sampler is set-up in the correct sampling mode (soil vapor, soil or groundwater) and lowered to the bottom of the boring. At the bottom of the boring the sampler is driven up to 21 inches into undisturbed soil using the down-hole hammer for soil sample collection. The sample is retrieved by recovering and disassembling the sampler device. In the soil vapor sample collection mode, the sampler is driven into undisturbed soil four- to six-inches and the external sheath is pulled back exposing a screen section to allow a soil vapor sample to be collected at the surface by applying a vacuum to the tubing line that was lowered with the sampler. To collect a groundwater sample, the sampler is assembled by the driller into the groundwater mode with an internal water canister and the sampler is lowered to the bottom of the boring and driven four- to six-inches into native soil. The protective sheath is then pulled back to expose the screen interval of the sampler allowing groundwater to enter into the water canister. A top and bottom check valve assembly prevent the loss of the sample as it is transported to the surface.

Samples are collected from the sample device and transferred directly into laboratory provided containers. The containers are then labeled, entered onto a chain of custody form and placed into an iced cooler for transport to the analytical laboratory.

Decontamination (typically conducted by the drilling contractor) is a non-phosphate soap and water wash with a two stage distilled water rinse.



ATC STANDARD OPERATING PROCEDURE GROUNDWATER MONITOR WELL INSTALLATION AND DEVELOPMENT

Prior to drilling, ATC completes an applicable permit from the regulating agency (varies by state and locality). Copies of the original permits are on-site during drilling operations.

Following completion of each well boring, wells are constructed using two- or four-inch nominal diameter, Schedule 40, 0.020-inch machine slotted, polyvinylchloride (PVC) well screen from the bottom of the borehole to 10 feet above the static depth to groundwater to account for seasonal water level fluctuations. The remaining well string is constructed of Schedule 40 blank PVC casing. Actual well construction specifications are determined on a site-specific basis.

The bottom of the perforated interval is capped with a flush-threaded PVC cap or riveted cap and the monitor well casing is assembled and lowered into the open end of the drill pipe. No PVC cement or other solvents or glues are used in construction of the monitor well. All well casing and screen material is delivered to the site in factory-sealed containers.

The annulus of the well is backfilled with clean #3 Monterey or 8/12 sand (or equivalent) filter pack to approximately three feet above the top of the well screen. In general, the sand filter pack extends to a height above the top of the well screen equivalent to approximately 10% of the well screen length. The top of the filter pack is direct measured with a weighted tape. A minimum 1.5-foot thick layer of bentonite pellets or chips is placed on top of the filter pack and hydrated to form an annular seal. The bentonite pellets are hydrated by adding approximately one gallon of water for each linear foot of bentonite. The remaining annular space to the surface is filled with cement grout. Well construction details are recorded in the boring logs. The well is completed at the ground surface with a watertight, flush-mounted, traffic rated vault.

The well vault lid or surface completion is typically marked with the permit registration number and unique well identifier. The geographic position and elevation of the well is recorded using a handheld global positioning system unit. A permanent mark is made on the north side of the well casing, and this point surveyed for location and elevation. All subsequent groundwater level measurements are recorded from this surveyed point.

A minimum of 24 hours after well completion, the groundwater monitor well is developed to remove sediment and to stabilize the filter pack by a combination of surging, bailing and/or pumping groundwater from the well. Bailing or purging continues until movement of the fine sediment stabilizes or ceases and turbidity stabilizes. Groundwater purged from the well is contained in 55-gallon drums and remains on-site pending the waste profile sample analytical results and subsequent disposal.



ATC STANDARD OPERATING PROCEDURE DEPTH-SPECIFIC PNEUMATIC SAMPLER

The pneumatic sampling device utilizes air pressure to keep fluid from entering the sample vessel until it is released. Prior to using a pneumatic sampling device, field personnel review the manufacturer's instructions regarding assembling, pressurizing, de-pressurizing, transferring the sample and decontaminating the sampling device.

Sample collection is achieved by slowly lowering the pressurized sampling vessel, hose and supporting cable to the proscribed depth and opening (de-pressurizing) the device to allow groundwater to enter the sample chamber. The sample is retained in the sample chamber with a check valve. The sampling vessel is then retrieved to the surface and the collected groundwater sample is then transferred to the appropriate laboratory glassware. As each sample is collected and transferred to a laboratory supplied container, the container is labeled, entered on to a chain of custody form and then stored in a hard-sided cooler with ice. Samples collected for volatile organic compounds analysis are transferred to the laboratory supplied glassware in a manner to avoid aerating the samples during the transfer process. At the direction of the ATC Project Manager or Technical Leader, the field crew will record temperature, conductivity, pH, dissolved phase oxygen and oxidation-reduction potential of the portion of the groundwater sample not prepared for laboratory analysis.

Subsequent to sample collection the pneumatic sampler is then dis-assembled, decontaminated and re-assembled in accordance with the manufacturer's instructions.



ATC STANDARD OPERATING PROCEDURE LOW-FLOW PURGING AND GROUNDWATER SAMPLING

EQUIPMENT

Pumps: Adjustable rate, positive displacement pumps (e.g., low flow-rate submersible centrifugal or bladder pumps constructed of stainless steel or Teflon). The pump should be easily adjustable and capable of operating reliably at lower flow rates. Adjustable rate peristaltic pumps may be used with caution. Bailers are inappropriate for use in this procedure.

Tubing: Tubing used in purging and sampling each well must be dedicated to that individual well. Once properly located, moving the pump in the well should be avoided. Consequently, the same tubing should be used for purging and sampling. Teflon or Teflon-lined polyethylene tubing must be used to collect samples for organic analysis. For samples collected for inorganic analysis, Teflon or Teflon lined polyethylene, PVC, Tygon or polyethylene tubing may be used. The tubing wall thickness should be maximized ($\frac{3}{8}$ to $\frac{1}{2}$ inch) and the tubing length should be minimized (i.e. do not have excess tubing outside of the well). Pharmaceutical grade (platinum-cured polyethylene, or equivalent) tubing should be used for the section around the rotor head of the peristaltic pump to minimize gaseous diffusion.

Water level measuring device, 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).

Flow measurement supplies (e.g., graduated cylinder and stop watch).

Power source (e.g., generator, located downwind; car battery; nitrogen tank; etc). The generator should not be oversized for the pump.

In-line flow-through cell containing purge criteria parameter monitoring instruments for pH, specific conductance, temperature, oxidation-reduction potential (ORP) and dissolved oxygen (DO). The in-line device should be bypassed or disconnected during sample collection.

Decontamination supplies: distilled water, scrub brushes, Liquinox® soap and three five-gallon buckets are required for three-stage decontamination (Liquinox®/water wash and two distilled water rinse cycles).

Sample Bottles: It is recommended that preservatives are added to sample bottles by the laboratory prior to field activities to reduce potential error or introduction of contaminants.

Sample tags or labels, chain of custody.

Well construction data, location map, field data from last sampling event.

PROCEDURE

1. Measure and record the depth to water (to 0.01 foot) in all wells to be sampled before installing the pump or tubing. Care should be taken to minimize disturbance to the water column and to any particulate matter attached to the sides or at the bottom of the well.
2. Attach and secure the tubing to the low-flow pump. Slowly lower the pump into the well and secure the safety drop cable, tubing, and electrical lines to each other using nylon stay-ties. For peristaltic pump operation, lower only the Teflon-lined tubing into the well and attach pharmaceutical-grade polyethylene tubing to the portion to be attached to the pump rotor.
3. Pump, safety cable, tubing and electrical lines should be lowered slowly into the well to a depth corresponding to the center of the saturated screen section of the well (by default), or at a location determined to either be a preferential flow path or zone where contaminants are present. The pump intake should be kept a minimum of two feet, if possible, above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well. Secure the pump and tubing to the well casing to prevent slippage of the tubing into the well during purging and sampling.
4. Measure the water level again with the pump in the well before starting the pump. Start the pump at the lowest rate possible (100 milliliters per minute [mL/min]) while measuring drawdown continuously. Avoid

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(Low-Flow Purging and Groundwater Sampling SOP – continued)

surging water from the well. Observe air bubbles displaced from discharge tube to assess progress of steady pumping until water arrives at the surface. Adjust the pumping rate such that there is little or no water level drawdown in the well (less than 0.3 foot) and the water level should stabilize. If the minimum drawdown that can be achieved exceeds 0.3 foot, but remains stable, continue purging until indicator parameters stabilize without dewatering the well screen, if possible. Water level measurements should be made continuously. Pumping rate changes (both time and rate) should be recorded on the field logs. Precautions should be taken to avoid pump suction loss or air entrainment. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to avoid pumping the well dry and ensure stabilization of indicator parameters. If the recharge rate of the well is very low, purging should be interrupted so as not to cause the drawdown within the well to advance below the pump intake but the operator should attempt to maintain a steady flow rate with the pump to the extent practicable. In these low-yielding wells, where 100 mL/min exceeds the entrance rate of groundwater into the well, it is important to avoid complete dewatering of the well screen interval. In these cases, the pump should remain in place and the water level should be allowed to recover repeatedly until three well volumes have been purged and there is sufficient volume in the well to permit collection of samples (up to four hours). Samples may then be collected even though the indicator field parameters have not stabilized.

5. While purging the well, monitoring of in-line water quality indicator parameters should include specific conductance, pH, DO, temperature and ORP, which must be collected every three to five minutes until all of the parameters have stabilized. Stabilization is achieved when three successive readings are within:
 - ± 0.1 for pH;
 - $\pm 3\%$ for conductivity and temperature;
 - ± 10 mV ORP; and,
 - $\pm 10\%$ for DO

A minimum subset of these parameters that can be used to determine stabilization during purging in this procedure is pH, specific conductivity and DO. DO is typically the last parameter to stabilize. Stabilization of indicator parameters is used to indicate that conditions are suitable for sampling to begin.

If, after one hour of purging, indicator field parameters have not stabilized, one of three optional courses of action may be taken:

- Continue purging until stabilization is achieved;
 - Discontinue purging, do not collect any samples, and record in the logbook that stabilization could not be achieved (the documentation must describe attempts to achieve stabilization); or
 - If three well volumes have been evacuated from the well and parameter stabilization has not been achieved, discontinue purging, collect samples, and provide a full explanation of attempts to achieve stabilization in the logbook.
6. Once stabilization has been documented, volatile organic compounds (VOC) and gas sensitive (e.g., Fe^{+2} , CH_4) parameter samples should be immediately collected directly into pre-preserved sample containers. All sample containers should be filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence. Samples requiring pH adjustment should have their pH checked to assure that the proper pH has been obtained. For VOC samples, this will require that a test sample be collected to determine the amount of preservative required to be added to the sample containers prior to sampling.
 7. Filtered metal samples are to be collected with an in-line filter. A high capacity, in-line 0.45-micron particulate filter must be pre-rinsed according to the manufacturer's recommendations, or with approximately one liter of groundwater following purging and prior to sampling. After the sample is filtered it must be preserved immediately.

As each sample is collected, the sample should be labeled and placed into a cooler with proper temperature control. After collection of the samples, the tubing from the pump should be properly discarded or dedicated to the well for re-sampling by hanging the tubing inside the well. When finished, secure the well (close and lock it up).