

# Final Work Plan

## Central Tucson PFAS Project



Prepared by:

Arizona Department of Environmental Quality

Remedial Projects  
Safe Drinking Water  
Office of Environmental Excellence  
1110 W. Washington St.  
Phoenix, AZ 85007

August 2020

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Prepared by:



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Matt Narter, RG, PhD  
Associate Hydrogeologist  
Waste Programs Division

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8/19/2020

Date



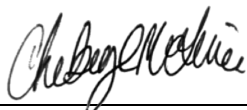
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Samara Taylor, MBA, PMP  
QA/QC Specialist  
Office of Environmental Excellence

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8/19/2020

Date



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Chelsey McGuire, MPH  
Technical Assistance Liaison  
Water Quality Division

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8/19/2020

Date

Reviewed by:



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Paula Panzino, MSE, EIT  
Chief Science Officer  
Office of Environmental Excellence

---

8/19/2020

Date



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Jeff Rackow, PE  
Principal Engineer  
Waste Programs Division

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8/19/2020

Date

# Table of Contents

<b>Acronyms .....</b>	<b>iv</b>
<b>1.0 Introduction .....</b>	<b>1</b>
1.1 Problem Definition .....	1
1.2 Scope and Objectives .....	1
1.3 Reporting .....	2
1.4 Community Involvement .....	2
1.5 Schedule .....	2
1.6 Project Organization and Responsibilities .....	3
<b>2.0 Background .....</b>	<b>4</b>
2.1 Regulatory Framework .....	4
2.1 Site History .....	4
2.2 Tucson Water PFAS Sampling .....	5
2.3 Additional Investigations .....	5
<b>3.0 Site Description .....</b>	<b>6</b>
3.1 Hydrogeology .....	6
3.2 Fate and Transport .....	7
3.2.1 Surface Water .....	7
3.2.2 Soils and Sediment .....	7
3.2.3 Groundwater .....	8
3.3 Conceptual Site Model .....	8
<b>4.0 Field Data Collection .....</b>	<b>10</b>
4.1 Personnel Qualifications .....	10
4.2 Sampling Consideration for PFAS .....	10
4.3 Surface Water and Sediment Sampling .....	10
4.4 Monitoring Well Installation .....	10
4.4.1 Monitoring Well Site Selection .....	10
4.4.2 Permits, Notifications, and Access .....	13
4.4.3 Drilling Methods .....	13
4.4.4 Borehole Sampling .....	14
4.4.5 Field Screening Decisions .....	15
4.4.6 Well completion .....	16

4.5	Well Sampling and Water Level Collection .....	16
4.6	Equipment Decontamination.....	18
4.7	IDW Management.....	18
4.8	Sample Identification .....	18
4.9	Data Management/Documentation .....	19
4.10	Quality Assurance/Quality Control .....	19
4.11	Health and Safety Requirements .....	19
<b>5.0</b>	<b>Data Evaluation and Remedy Assessment .....</b>	<b>20</b>
5.1	Modeling.....	20
5.2	Treatability Testing .....	21
5.3	Remedy Assessment .....	21
<b>6.0</b>	<b>References .....</b>	<b>22</b>

## Tables

Table 1.	Select Project Milestones.....	2
Table 2.	Key Points of Contact .....	3
Table 3.	Proposed Samples, Locations, and Quantities .....	11
Table 4.	Field-Screening Decision Matrix.....	16

## Figures

- Figure 1: Site Location Map
- Figure 2: Project Organizational Chart
- Figure 3: Tucson Water PFAS Sampling Results
- Figure 4: Preliminary Boring Locations

## Appendices

- Appendix A: DMAFB Select Figures
- Appendix B: Standard Operating Procedures

## Acronyms

A.A.C.	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AFFF	aqueous film forming foam
AMA	Active Management Area
amsl	above mean sea level
ASTM	ASTM International
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
Carollo	Carollo Engineers, Inc.
CAP	Central Arizona Project
CSM	Conceptual Site Model
DMAFB	Davis Monthan Air Force Base
EC	Electrical Conductivity
ESI	Environmental Simulations, Inc.
GAC	Granular Activated Carbon
HAL	Health Advisory Level
Hargis	Hargis and Associates, Inc.
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
IDW	Investigation-Derived Waste
IX	Ion Exchange
KERP	Kino Environmental Restoration Project
µg/kg	micrograms per kilogram
MCL	Maximum Contaminant Level
MRL	Minimal Risk Level
MS	Matrix Spike
MSD	Matrix Spike Duplicate
O&M	Operations and Maintenance
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PFAS	Per- and polyfluorinated alkyl substances
PFBS	Perfluorobutane sulfonic Acid
PFHpA	Perfluoroheptanoic Acid
PFHxS	Perfluorohexane sulfonic Acid
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane sulfonic Acid
PID	Photoionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
ppt	parts per trillion
PVC	polyvinyl chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control

ROW	Right of Way
RSL	Regional Screening Level
SI	Site Inspection
SOP	Standard Operating Procedure
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System

## 1.0 Introduction

### 1.1 Problem Definition

Polyfluoroalkyl substances (PFAS) have been detected in the regional aquifer near Davis Monthan Air Force Base (DMAFB) in Tucson, Arizona (Figure 1). Two of these compounds: perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), have been detected in groundwater at and downgradient of DMAFB at a combined concentration exceeding the US Environmental Protection Agency (USEPA) health advisory level (HAL) for PFOA+PFOS of 70 parts per trillion (ppt). Tucson Water, the primary drinking water service provider in the area, has set an internal operating target of 18 ppt for PFOA+PFOS+perfluorohexanesulfonic acid (PFHxS)+perfluoroheptanoic acid (PFHpA). Four Tucson Water drinking water production wells located near the base (C-007A, C-014B, C-036B and C-008B) have been removed from service because the concentration of PFOA+PFOS exceeds both Tucson Water's internal operating target and the USEPA HAL. If PFOA and PFOS continue to migrate downgradient, several additional drinking water production wells in Tucson Water's central wellfield will be impacted and removed from service, which will reduce the available water supply for the City of Tucson. The central wellfield has the potential to provide water to over 600,000 people, and is the sole alternate drinking water supply to the Central Arizona Project (CAP) for central Tucson.

The data collected through execution of this Work Plan and the associated Quality Assurance Project Plan (QAPP) will allow the Arizona Department of Environmental Quality (ADEQ) to design, construct, and operate a groundwater remedy before additional Tucson water supply wells can be impacted. The field-data collection activities will allow ADEQ to define the size and location of the PFOA+PFOS treatment area, determine the type of treatment technology, and establish the location and configuration of the chosen remedy.

### 1.2 Scope and Objectives

The primary objective of this study is to characterize the nature and extent of PFOA+PFOS exceeding the 70 ppt HAL in the regional aquifer near DMAFB. Data collected will be used to evaluate potential remedial alternatives and design a remedy capable of protecting Tucson Water's central wellfield from further PFOA+PFOS contamination above the EPA HAL of 70 ppt.

To accomplish the study objectives, several tasks will be completed concurrently:

- A groundwater model has been developed using the Arizona Department of Water Resources (ADWR) Tucson Active Management Area (AMA) regional groundwater flow model. This model will be further refined, calibrated, and updated with the results of forthcoming field characterization efforts. This modeling effort will inform decision making for fieldwork, remedial alternatives evaluation, and remedy design.
- Multi-media sampling will be conducted which may include the collection of soil, sediment, groundwater, and surface water samples. The data collected will be used to develop a detailed conceptual site model (CSM) and will inform the modeling effort, remedial alternatives evaluation, and remedy design.
- Data collected during field sampling will be used together with the results of treatability testing to assess alternatives for remedial action. Remedy design and construction will take place based on a thorough evaluation of feasible alternatives. Bench-, pilot-, and/or demonstration-scale tests

may be completed, where appropriate, to provide additional data for the design and construction of a remedial action.

### 1.3 Reporting

Deliverables generated during execution of this field deployment will likely include the following:

- ADEQ's field contractor will produce a Health and Safety Plan (HASP) prior to the start of field activities.
- Weekly field update reports will include information regarding progress, objectives met, data, and budget, and should be provided by the field manager to the ADEQ Program Manager and Project Manager. These reports should be single page email updates that can be shared with stakeholders when necessary.
- Investigation findings will be documented in a Site Characterization Report. This report will include, at a minimum, the field methodology and results of all sampling conducted, laboratory reports, Quality Assurance/Quality Control (QA/QC) documentation, boring logs and well construction diagrams, and field notes.
- The groundwater model should be documented in a Groundwater Modeling Report. The Groundwater Modeling Report should include a description of the model boundaries, model runs, the calibration process and outcomes.
- The Engineering Design Report and Plans (60% Design, 90% Design and Final Design Reports and Plans); this may also include the laboratory bench test or field pilot test design.
- A Construction Completion Report will be written to both document adherence to the engineering design plans and capture any changes to the construction of the design.
- An Operations and Maintenance (O&M) Manual will be required at a determined time.

### 1.4 Community Involvement

A project-specific community involvement plan is not currently planned for this investigation, but may be implemented if sufficient interest from the community is expressed. Prior to and during fieldwork, notifications will be distributed to homes and businesses that may be affected by performing site characterization activities (e.g. drilling, well construction, sampling, etc.).

### 1.5 Schedule

Table 1 summarizes the planned schedule for the completion of select project milestones. An aggressive timeline has been proposed in an effort to ensure the protection of the City of Tucson's water supply.

**Table 1. Select Project Milestones**

Date	Activity
6/30/2020	Draft Work Plan Available for External Review
August 2020	Final Work Plan Complete
September-October 2020	Field Work Implementation
October 2020	Additional Bench-Scale/Pilot Testing
December 2020	Site Characterization Report and Groundwater Modeling Report Complete
Spring 2021	Remedy Design
Spring - Summer 2021	Remedy Construction



## 1.6 Project Organization and Responsibilities

ADEQ has contracted with Hargis and Associates (Hargis) to assist in completing the scope of work for this project. Ms. Paula Panzino will be the ADEQ Program Manager, Dr. Matt Narter will be the primary ADEQ Project Manager (PM), and Dr. Leo Leonhart will be the Hargis Project Director. Ms. Panzino will provide general project oversight and interface with the ADEQ PM, Hargis Project Director, primary stakeholders, and with ADEQ leadership. Dr. Narter will manage the financial oversight, project schedule, and technical status of the work assignments. Dr. Leonhart will be the primary point of contact for the ADEQ PM and will manage both Hargis personnel and subcontractors, including Carollo Engineers, Inc. (Carollo), Environmental Simulations, Inc. (ESI), drillers, and analytical laboratory services. Ms. Samara Taylor will be the ADEQ QA/QC Specialist responsible for the development and execution of this QAPP. Key points of contact are included in Table 2. An organizational chart is provided as Figure 2.

**Table 2. Key Points of Contact**

Name	Organization	Project Role	Email	Phone
Paula Panzino	ADEQ	Program Manager	panzino.paula@azdeq.gov	602.771.6145
Matt Narter	ADEQ	Project Manager	narter.matthew@azdeq.gov	520.770.3128
Samara Taylor	ADEQ	QA/QC Specialist	Taylor.samara@azdeq.gov	602.771.4249
Chelsey McGuire	ADEQ	Drinking Water Specialist	mcguire.chelsey@azdeq.gov	602.771.4324
Leo Leonhart	Hargis	Project Director	lleonhart@hargis.com	520.308.6820
Mike Long	Hargis	Hydrogeology Peer Review Lead	mlong@hargis.com	480.345.0888
Chris Legg	Hargis	Groundwater Model Lead	clegg@hargis.com	480.999.5940
Chris Perkovic	Hargis	Field Work Lead	cperkovic@hargis.com	520.881.7300
George Maseeh	Carollo	Engineering Peer Review Lead	gmaseeh@carollo.com	520.230.4729
James Rumbaugh	ESI	Groundwater Model SME	jrumbaugh@groundwatermodels.com	610.670.3400

ESI = Environmental Simulations, Inc; SME = Subject Matter Expert

## 2.0 Background

### 2.1 Regulatory Framework

PFAS are a very large family of thousands of chemicals that vary widely in their chemical and physical properties, as well as their potential risks to human health and the environment (ITRC, 2020). Some PFAS have been widely detected in environmental media due to their persistence, mobility, and widespread use in certain firefighting foams, industrial processes, and consumer products (ITRC, 2020). Regulatory values for PFAS vary across state and federal agencies. Arizona has no regulatory standards for PFAS and the USEPA has not established Maximum Contaminant Levels (MCLs) for any PFAS under the Safe Drinking Water Act. However, the USEPA has established an HAL of 70 ppt for the combined concentration of PFOA+PFOS and has begun taking steps in its PFAS Action Plan to evaluate the need for MCLs. The Agency for Toxic Substances and Disease Registry (ATSDR) has established minimal risk levels (MRLs) for certain PFAS, which serve as screening levels to identify environmental exposures that might harm people's health (ASTDR, 2018). MRLs have been established for PFOA (78 ppt adult, 21 ppt child), PFOS (52 ppt adult, 14 ppt child), PFHxS (517 ppt adult, 140 ppt child), and perfluorononanoic acid (PFNA) (78 ppt adult, 21 ppt child).

### 2.1 Site History

PFAS have been historically used in the formulation of Aqueous Film-Forming Foam (AFFF), which has been used by airports and military installations for suppressing aircraft and other vehicle fires, and in aircraft hangar fire suppression systems. They have also been used extensively for fire training exercises. The use of AFFF by the United States Air Force (USAF) is documented to have begun in 1970 (HGL, 2015).

DMAFB is located in Pima County, Arizona, within the city limits of Tucson (Figure 1). The facility was established in 1925 and encompasses approximately 11,000 acres (AMEC, 2019a). A Preliminary Assessment (PA) was conducted at DMAFB in 2015 to document AFFF use at the base and determine the potential for PFAS releases to the environment. The PA identified numerous locations of AFFF use including former and current fire training areas, hangars equipped with AFFF fire suppression systems, fire stations, and locations of emergency response related to aircraft emergencies (HGL, 2015).

Based on the results of the PA, a Site Inspection (SI) was conducted at the base from October 2017 to January 2018 to evaluate the presence of PFAS in soil, groundwater, surface water, and sediment at three specific AFFF release areas identified during the PA (Figure A1 – Appendix A). The identified release areas included a former fire training area, the locations of four aircraft crashes, and a stormwater outfall. During sampling for the SI, PFAS were detected at several locations, primarily in surface soils. The USAF calculated a residential screening level of 126 micrograms per kilogram ( $\mu\text{g}/\text{kg}$ ) for PFOA+PFOS in soil, based on a total hazard quotient (THQ) of 1.0, using the USEPA Regional Screening Level (RSL) calculator (AMEC, 2019a). Concentrations of PFOA+PFOS exceeded the residential screening level in surface soil only at the former fire training area. The former fire training area was also the only area in which PFAS were detected below the surface, with PFOA+PFOS detected at a maximum concentration of 58.2  $\mu\text{g}/\text{kg}$  at 29 to 30 feet below ground surface (bgs) in soil boring MW01001. One groundwater well was installed near each of the three confirmed AFFF release locations. PFOA+PFOS was detected in only one well located at the north end of the airfield, downgradient from multiple aircraft crash locations (AMEC, 2019a). PFOA+PFOS was detected in this well at a concentration of 39.4 ppt (Figure 3).

In November 2017, the Air Force Civil Engineering Center (AFCEC) informed the SI consultant that PFOA+PFOS had been detected above the USEPA HAL in two Tucson Water production wells (C-007A and C-014B) located at the northern installation boundary, downgradient of the stormwater outfall (AMEC, 2019b). Based on this information, follow-on SI activities were completed in February 2019. Descriptions

of these activities are included in the Final Addendum 01 to the Site Inspection Report (AMEC, 2019b). The follow-on activities included the installation and sampling of two groundwater monitoring wells near the northern installation boundary. During installation of these two wells, PFOA+PFOS was detected in groundwater samples collected at various depth intervals during drilling, with maximum concentrations detected at the groundwater interface. PFOA+PFOS was detected at concentrations as high as 14,400 ppt, exceeding the USEPA HAL by more than two orders of magnitude. AFCEC is currently planning remedial investigation activities at the base.

## 2.2 Tucson Water PFAS Sampling

In 2016, Tucson Water began sampling for PFAS in municipal production wells located generally downgradient (north-northwest) of DMAFB (Figure 3). Several wells were sampled in the fourth quarter of 2016, including D-001A, C-016B, C-014B, C-046B, and C-051B. Samples were analyzed using USEPA drinking water method 537. PFAS were detected only in well C-014B, located approximately 600 feet from the northern boundary of the base. The concentration of PFOA+PFOS in C-014B was 79 ppt, exceeding the USEPA HAL. The well was subsequently removed from service by Tucson Water.

Since 2016, numerous additional wells in the area have been sampled and analyzed for PFAS using USEPA method 537. Six PFAS compounds have been detected in these wells, including PFOA, PFOS, PFHxS, PFNA, PFHpA, and perfluoro-1-butanesulfonic acid (PFBS). PFOA+PFOS has been detected above the USEPA HAL in four wells (C-007A, C-014B, C-036B, and C-008B). Each of these wells have been removed from service. Wells C-007A C-014B, C-036B are located within one mile of the northern installation boundary at DMAFB (Figure 3). Well C-008 is located approximately 800 feet north of the Kino Environmental Restoration Project (KERP). KERP is located approximately one mile west of DMAFB and receives water from an unlined drainage canal that, in turn, receives surface water runoff directly from the base (Figure 3).

Numerous Tucson Water municipal production wells are located downgradient of currently impacted wells (Figure 3). These wells make up a portion of Tucson Water's central wellfield, which has the potential to serve over 600,000 people. If PFAS continue to migrate in groundwater unabated, additional Tucson Water wells will be impacted.

## 2.3 Additional Investigations

In November 2019, ADEQ conducted an effort to identify and contact private well owners located within approximately two miles downgradient of DMAFB. Twenty-four potential private wells were identified in the area and notifications were sent to corresponding property owners that included information regarding PFOA and PFOS and a request that property owners contact ADEQ to confirm whether a well exists on their property. Four wells were identified, based on property owner responses, as being active and having a use that could potentially result in the ingestion of PFAS-contaminated water. The four wells were sampled from November 2019 to January 2020 (Figure 3). None of the four wells sampled had detectable concentrations of PFOA or PFOS (Hargis, 2020).

The Air Force conducted a survey of potential downgradient drinking water wells as part of SI activities at DMAFB. This survey identified 277 potential drinking water wells within a 4 mile-distance downgradient of the installation boundary (AMEC, 2019b). These wells include private wells, Tucson Water production wells, and a mobile home park supply well, and the University of Arizona well network. The Air Force plans to sample these wells in a phased-approach, beginning with wells located within one mile of the base (EA, 2020).

## 3.0 Site Description

### 3.1 Hydrogeology

DMAFB is located within the Tucson Basin, a broad 1,000 square mile area in the upper Santa Cruz River drainage basin. The basin receives relatively little precipitation (approximately 10 inches annually) and has a high evaporation rate (HGL, 2015). Surface streams and rivers are typically dry and convey water only during and immediately following precipitation events. Groundwater is recharged at the basin periphery and by streambed infiltration along the Santa Cruz River and its tributaries. The basin is drained by the Santa Cruz River, which flows generally from south to north in the western portion of the basin (ITS, 2012).

The Tucson basin is surrounded by mountain ranges including the Santa Rita Mountains to the south, Rincon Mountains to the east, Santa Catalina and Tortolita Mountains to the north, and the Tucson Mountains to the west. The basin-fill sediments that form the regional aquifer have been divided into upper basin-fill and lower basin-fill units based on their general hydrogeologic characteristics. The basin-fill has also been subdivided into stratigraphic units based on lithologic descriptions, structural relationships, and depositional history. In ascending order, the lower basin-fill unit is comprised of the Pantano Formation and the lower and middle Tinaja Beds. The upper basin fill unit is comprised of the upper Tinaja Beds, the Fort Lowell Formation, and surficial alluvial deposits, which include stream channel deposits (AECOM, 2010).

The Pantano Formation, the Tinaja Beds, and the Fort Lowell Formation comprise the aquifer beneath DMAFB and have an estimated combined thickness of more than 5,000 feet (HGL, 2015). The top of the Pantano Formation occurs at approximately 1,200 feet above mean sea level (amsl) (approximately 1,400 feet bgs) and is composed of silty sandstone, sand, and gravel. The Pantano Formation is overlain by the Tinaja Beds, which are composed of gravel and sand that grade into a thick sequence of gypsiferous clayey silt and mudstone in the center of the basin (HGL, 2015). Near DMAFB, the top of the Tinaja Beds occurs at approximately 2,400 feet amsl (approximately 300 feet bgs). Most wells in the area are completed within the Tinaja Beds (HGL, 2015). In the vicinity of DMAFB, the hydraulic conductivity of the Tinaja Beds ranges from 3 to 4.6 feet per day and the formation has specific yield of 0.1 where unconfined, with a specific storage of 0.000001, based on data inputs used in ADWR's Tucson AMA groundwater flow model (ADWR, 2013).

The Fort Lowell Formation overlies the Tinaja Beds and consists of gravel near the edge of the basin, grading to silt in the center. The top of the Fort Lowell Formation occurs at approximately 2,500 feet amsl at DMAFB (approximately 50-100 feet bgs). Overlying the Fort Lowell Formation is a thin layer of surficial deposits emplaced by the present surface drainage system. The formations that comprise the aquifer of the Tucson Basin generally act as a single hydrologic unit (HGL, 2015). In the vicinity of the site, the hydraulic conductivity of the Fort Lowell Formation ranges from 13 to 25 feet per day and has specific yield of 0.1 based on data inputs used in ADWR's Tucson AMA groundwater flow model (ADWR, 2013). Average groundwater flow velocities in the Fort Lowell formation are estimated to range from 0.6 feet per day to 0.8 feet per day based on preliminary particle tracking simulations using ADWR's Tucson AMA groundwater flow model.

Due to changes in topography, the water table near the northern boundary of DMAFB occurs from approximately 280 to 340 feet bgs (approximately 2,230 to 2,260 feet amsl) (Tucson Water, 2020).

Groundwater generally flows to the north-northwest in the area but can be locally influenced by pumping (Figure A2 – Appendix A). Water levels upgradient of and beneath DMAFB have been steadily declining for decades because groundwater withdrawals exceed the rate of recharge. However, water levels in many areas immediately north and west of the base have risen following decreased pumping from the central wellfield that occurred when Tucson began using Colorado River water from CAP. Water levels in some wells near the base have increased more than 50 feet in the last 20 years (Tucson Water, 2020). Average hydraulic gradients range from 0.009 ft/ft on the southern half of DMAFB to 0.004 ft/ft north of DMAFB, based on a groundwater elevation map prepared for the USAF in 2018, included as Figure A2 in Appendix A. The hydraulic gradient is generally steeper on the southern half of DMFB and appears to flatten on the north end of DMFB and downgradient to the north of the base.

### 3.2 Fate and Transport

The chemistry of AFFF is complex, which can lead to complex fate and transport processes. AFFFs are mixtures of many PFAS with some known as precursors because they can undergo abiotic and biotic transformation resulting in the production of dead-end compounds (AECOM, 2017). Dead-end compounds, which include PFOA and PFOS, are chemically and biologically stable in the environment and are resistant to the process of environmental degradation. As a result, these chemicals are persistent in the environment. PFAS can be found across multiple environmental media, including surface water, sediment, soil, and groundwater.

#### 3.2.1 Surface Water

Surface drainage at DMAFB has been modified by a series of ditches that empty into an ephemeral drainage canal at the northwest corner of the base (HGL, 2015). The drainage canal flows to KERF, a flood control basin located approximately 1 mile west of the base (Figure 3). Water from KERF flows through a series of ephemeral washes and ultimately discharges to the Santa Cruz River. During stormwater events, PFOA and PFOS may be present in surface water and sediment within the ditch systems, drainage canals and washes, and KERF due to historical releases of AFFF at the base. PFAS were detected during the SI in sediment samples within the drainage canal at DMAFB at a maximum concentration of 1.51 µg/kg, indicating potential contamination of surface water in this area.

#### 3.2.2 Soils and Sediment

AFFF releases to the environment at DMAFB have occurred at the surface due to its use in firefighting and fire suppression. However, PFAS have been detected in groundwater at approximately 300 feet bgs, indicating contaminant transport downward through the vadose zone to significant depth. During sampling for the SI, PFAS were detected at several locations, primarily in surface soils. PFOA+PFOS exceeded the calculated RSL of 126 ug/kg in surface soils only at the former fire training area. The former fire training area was also the only area in which PFAS were detected below the surface, with PFOA+PFOS detected at a maximum concentration of 58.2 ug/kg at 29 to 30 feet bgs, and at a maximum depth of 350 to 351 feet bgs.

Because PFAS are surfactants, they tend to accumulate at the air-water interface. Research has shown that transport of these compounds through the vadose zone may be significantly impeded due to the presence of air-water interfaces (e.g. Brusseau, 2018). Therefore, the vadose zone may represent a long-term source to groundwater.

### 3.2.3 Groundwater

During the initial installation of wells near the three confirmed AFFF release locations as part of the SI at DMAFB, PFAS were detected in only one well, near the location of a former plane crash. PFOA+PFOS was detected in this well at a concentration of 39.4 ppt. However, during additional well installation activities conducted near the stormwater outfall at the northern edge of the base, PFOA+PFOS was detected at concentrations up to 14,400 ppt. PFOA+PFOS has also been detected in municipal supply wells downgradient of the base. Maximum detected concentrations in these downgradient wells range from 2910 ppt in well C-007A near the boundary of the base to 131 ppt at C-036B approximately one mile north of the base. Wells located near the base are generally screened across the water table to depths of 700-800 feet bgs. PFOA+PFOS has also been detected at a concentration of 176 ppt in well C-008B located approximately one mile west of the base, where drainage from DMAFB discharges to KERF. Well C-008 is screened over three separate intervals from 240 feet bgs near the water table to 1180 feet bgs.

Within groundwater, PFAS are generally highly mobile due to their relatively low partition coefficient. Research has shown that retardation in groundwater is low compared to contaminants such as organic solvents and therefore these compounds likely migrate at velocities similar to the bulk groundwater (e.g. Brusseau, 2019). Specifics of the release mechanisms and release dates are unknown at this time and therefore it is difficult to estimate the extent of PFAS contamination downgradient of DMAFB.

### 3.3 Conceptual Site Model

CSM development is an iterative process that occurs over the project life cycle. The CSM for this site will be updated as information and data are obtained during site investigation and remedy design, implementation, and optimization. The following is a brief summary of the current CSM.

DMAFB is a currently operating Air Force Base located in Tucson, Arizona that began operation in 1925. The Air Force began using AFFF in 1970 and its use has been documented at DMAFB for firefighting training, hangar fire suppression, and emergency response to aircraft accidents. AFFF contains PFAS, which may be released to the environment during use. Two of these PFAS, PFOA and PFOS, have an established USEPA HAL of 70 ppt for their combined concentration.

Although numerous locations of AFFF use have been documented, three confirmed AFFF release areas were identified and investigated during the SI at the base. These include: a former fire training area (FT-03) which operated from 1970-1989; four plane crash locations where AFFF was used to extinguish fires; and a stormwater outfall that collects stormwater and other runoff from across the base. PFAS were detected in soil, sediment, and groundwater at several locations during the SI at DMAFB. PFOA+PFOS was detected in groundwater at concentrations as high as 14,400 ppt, exceeding the USEPA HAL, in a boring located downgradient of the stormwater outfall.

PFAS have migrated off-base within the regional aquifer, which occurs at depths between 280-340 feet bgs, and have been detected in several municipal production wells and monitoring wells located downgradient of DMAFB. PFOA+PFOS has been detected in these downgradient wells at a combined concentration high as 2,910 ppt in C-007A, which is located approximately 250 feet from the northern base boundary. PFOA+PFOS has been detected above the EPA HAL as far as approximately one mile downgradient of the base in C-036B, at a concentration of 131 ppt.

Surface water that discharges to a drainage canal at northwestern boundary of the base flows to KERF, a large stormwater infiltration basin located approximately one mile west of the base. From there, water

flows through a series of ephemeral washes into the Santa Cruz River, which is located approximately 3.5 miles from KERP. PFOA+PFOS has been detected at a combined concentration of 176 ppt in well C-008B located approximately 0.25 miles north of KERP. This indicates surface water runoff from DMAFB may be a source to groundwater in areas west of the base.

Numerous public and private groundwater wells exist downgradient of DMAFB. The SI identified up to 277 potential drinking water wells within four miles downgradient of the base. In this area, Tucson Water has removed four potable supply wells from service due to PFOA+PFOS concentrations greater than the USEPA HAL. Numerous additional Tucson Water supply wells are located downgradient of currently impacted wells and may be threatened by the continued migration of PFAS in groundwater. These supply wells make up part of Tucson Water's central wellfield, which has the potential to serve over 600,000 people. In 2019, ADEQ identified 24 potential private drinking water wells within approximately 2 miles of the base. Four of these wells were sampled and no PFAS were detected. However, continued PFAS migration may threaten these and other private wells in the area. Uncertainties in groundwater velocities, aquifer parameters and the extent of PFOA+PFOS impacts make estimation of current and future impacts to receptors difficult at this time.

## 4.0 Field Data Collection

A summary of initial proposed samples, locations, and quantities is provided in Table 3 below. The proposed sampling plan may be modified during the implementation of field work as data is collected and analyzed. Further details of field data collection activities are provided in the following sections.

### 4.1 Personnel Qualifications

All personnel mobilized to the site will meet applicable Occupational Safety and Health Administration (OSHA) training, including hazardous waste operations and emergency response (HAZWOPER) training. Additional information of training requirements and personnel qualifications are included the QAPP (ADEQ, 2020).

### 4.2 Sampling Consideration for PFAS

Due to the nature of PFAS and their prevalence in many consumer products, special precautions and procedures will be required during data collection, and for the handling, packaging, and shipment of samples analyzed for PFAS. These protocols are detailed in Standard Operating Procedure (SOP) #1 (Appendix B).

### 4.3 Surface Water and Sediment Sampling

Depending on final sample location selection and access considerations, surface water and sediment samples may be collected during site characterization activities. Surface water and sediment samples will be collected in accordance with SOPs #4 and #5 provided in Appendix B.

### 4.4 Monitoring Well Installation

#### 4.4.1 Monitoring Well Site Selection

Drilling activities will focus on defining the lateral and vertical extent of PFOA+PFOS that exceeds the USEPA HAL of 70 ppt in groundwater downgradient of DMAFB. Where possible, ADEQ and its contractors will follow the EPA Triad approach of systematic planning, dynamic work plans, and real-time measurement technologies. An estimated eight initial exploratory borings will be advanced throughout the investigation area to refine the horizontal and vertical extent of contamination (Figure 4). Samples collected from these borings will undergo expedited analysis to determine the need to step out at up to eight contingency locations. The preliminary locations for exploratory borings and potential step-out locations were selected based on:

- the current understanding of PFOA+PFOS distribution in groundwater based on water quality data from Tucson Water, DMAFB, and ADEQ (Figure 3);
- observed regional groundwater flow directions and gradients from several sources (e.g. Figure A2 – Appendix A; Tucson Water, 2020); and
- preliminary groundwater modeling and particle tracking simulations using the updated ADWR Tucson AMA groundwater flow model (Figure 4)

Proposed locations may be adjusted if warranted by evaluation of additional or new PFAS data prior to the start of field activities. The selection of final locations will also consider the ability to obtain access to City of Tucson right-of-ways (ROWS) or private property, utility locations, and other logistical issues.



**Table 3. Proposed Samples, Locations, and Quantities**

Sample Type	Analyte(s)	Method	Sample Purpose	Sample Locations	Sample Quantity
Surface Water and Sediment	PFAS <sup>1</sup>	EPA 537 MOD	Evaluation of potential continuing sources to groundwater	Select locations within surface water features near boring locations, as access and site conditions allow	One sediment sample will be collected from each viable location. Surface water samples will be collected if weather conditions allow.
Unsaturated Soil	PFAS <sup>1</sup>	EPA 537 MOD	Evaluation of potential continuing sources to groundwater	DMSB-01 and any other soil boring that may be located within 100 ft of a potential PFAS release location	Estimated up to 8 samples per well; samples will be collected at 5 feet bgs and approximately every 50 feet until groundwater is encountered.
Saturated Soil	Physical Parameters (porosity, bulk density, grain size distribution)	D422-98; API R40/ASTM D2937	Input to groundwater model and transport estimates	DMSB-01, DMSB-02, DMSB-03	Estimated 3-4 samples per soil boring; samples will be collected from within the saturated zone of each selected boring, targeting coarse-grain units. Additional samples may be collected from fine-grain units if they appear to be capable of inhibiting vertical transport.
Groundwater	PFAS <sup>1</sup>	EPA 537 MOD	Vertical and lateral PFOA+PFOS plume definition; treatability assessment	Each new boring and permanent wells <sup>2</sup> located within and adjacent to the PFAS plume	Estimated up to 10 samples per boring; samples will be collected approximately every 25 feet beginning at the water table  Where possible, three samples will be collected initially from the top, bottom, and middle of the screened interval in permanent wells.

Table 3 continued

Alkalinity as CaCO <sub>3</sub>	SM 2320B	General water quality parameters for treatment process evaluation	Permanent wells <sup>2</sup> within the plume where sample recovery is sufficient	One sample will be collected from each sampled well at approximately the middle of the screened interval or the area of highest PFAS concentration detected during depth-specific sampling.
Arsenic, Manganese	EPA 200.8			
Bromide	EPA 300.1B			
Calcium, Iron, Magnesium, Potassium, Sodium	EPA 200.7			
Chloride, Fluoride, Nitrate as N, Sulfate	EPA 300.0A			
Total Dissolved Solids	SM 2540C			
Total Hardness as CaCO <sub>3</sub>	SM 2340B			
Total Organic Carbon	SM 5310C			
Uranium	EPA 200.8	Evaluation of potential interferences with adsorption process	DMMW-01, DMMW-02, DMMW-03	One sample will be collected from each selected well at approximately the middle of the screened interval.
Hexavalent Chromium	EPA 218.6			
Perchlorate	EPA 331.0			
ORP	Field Meter	General water quality parameters for treatment process evaluation	Each new boring and permanent wells <sup>2</sup> located within and adjacent to the PFAS plume	These parameters will be measured in the field during the collection of each groundwater sample, where sample recovery allows.
Conductivity				
pH				
Temperature				
Turbidity				
Aquifer Parameters (transmissivity, hydraulic conductivity, and storage coefficients)	Pumping Test <sup>3</sup>	Input to groundwater model and transport estimates	Locations will be selected based on analysis of existing data	One pumping test will be conducted at each selected location.

<sup>1</sup>Samples will be analyzed for 28 PFAS as specified in the QAPP (ADEQ, 2020)<sup>2</sup>Permanent wells will include all monitoring wells installed by ADEQ as part of this work plan, and may also include Tucson Water production/ monitoring wells and existing private wells. Decisions to collect samples from a given well will be made based on the well characteristics (depth, screen interval, etc) and the ability to obtain legal access for sampling.<sup>3</sup>A standard operating procedure for pumping tests is provided in Appendix B

In general, the exploratory borings/monitoring wells will fall into three categories: exterior downgradient plume definition, exterior cross-gradient plume definition and interior plume definition. The exterior downgradient and exterior cross-gradient plume wells will be primarily used to define the horizontal extent of the plume that exceeds 70 ppt PFOA+PFOS. Monitoring wells constructed at these locations are expected to have, at the time of construction, PFOA+PFOS concentrations that are below the USEPA HAL of 70 ppt. The exterior downgradient and exterior cross-gradient wells will serve as sentinel wells to monitor PFOA+PFOS trends over time and to protect municipal supply wells. The interior plume definition borings/wells will be used to determine the vertical extent of the plume and monitor PFOA+PFOS concentrations exceeding 70 ppt, to optimize locations for remediation extraction wells, and assess remediation progress.

Due to potential PFOA+PFOS contributions from surface water infiltration west of DMAFB, it is possible that PFAS contamination exists west of the planned area of investigation proposed under this work plan. However, during a recent meeting with ADEQ, AFCEC conveyed their intent to investigate the north-western wash leading to KERF by installing groundwater monitoring wells. AFCEC also intends to collect sediment and surface water samples from the wash, weather permitting. ADEQ intends to maintain open communication with AFCEC and will share data collected under the current work plan with AFCEC and Tucson Water in an effort to assist in accuracy and thoroughness of subsequent investigations.

#### 4.4.2 Permits, Notifications, and Access

Where possible, drilling locations will be appropriately permitted and located within the City of Tucson ROW or other publicly-owned property. Coordination with an assigned inspector will be managed along with any necessary traffic control. In some instances, based on the CSM and groundwater modeling results, some borings may be optimally located and drilled on private property where access is granted to ADEQ by the property owner. For each proposed boring, all appropriate notifications will be filed with the ADWR to obtain necessary permits. Where possible, access will be obtained for all proposed step-out locations prior to commencement of field activities.

At all locations prior to drilling, utility clearance will be conducted by Hargis. Hargis or its drilling subcontractor will contact “Arizona 811”, the Arizona one-call utility clearance contractor. Private utility clearance may also be necessary in some locations. Additional details regarding utility clearance and other pre-drilling activities are included in SOP#9 (Appendix B).

#### 4.4.3 Drilling Methods

Each borehole will be advanced using sonic drilling technology. For the purposes of this work plan an estimated target depth of 500 feet bgs is assumed for each exploratory boring based on previous investigative work at conducted DMAFB using a roto-sonic drill rig. Sampling will be conducted in accordance with the policies and procedures of a qualified, certified drilling company.

The soil cores will be logged for lithological descriptions by a professionally registered field geologist using the Unified Soil Classification System (USCS) according to SOP#11 (Appendix B). Observations and measurements will be recorded on field forms and in a non-treated field logbook. Photographs will also be taken of the boring cores. At a minimum, depth interval, photoionization detector (PID) concentrations, moisture, relative density, color (using a Munsell soil color chart), and texture (using the USCS) will be recorded. Additional observations to be recorded may include groundwater or perched water depth, organic material, or cultural debris.

#### 4.4.4 Borehole Sampling

Where access for borehole locations may be secured very near or within potential source areas, soil samples may be collected at regular intervals with depth during drilling. Samples will be collected at approximately five feet bgs and every 50 feet thereafter until groundwater is encountered (up to 8 soil samples). The soil core recovered from the sonic drill casing will be split length-wise and a soil sample will be obtained from the center of the core to minimize effects from drilling. Samples will be collected into laboratory-supplied PFAS-free containers as specified in the QAPP (ADEQ, 2020). All soil cores recovered during drilling will be temporarily stored in a secure location so they may be available for further analysis, if necessary, after initial results are received. Soil sampling will follow the procedures outlined in SOP #6 (Appendix B). Where borings are advanced within the plume, downgradient of potential source areas, PFAS is not expected to be present within vadose zone soils. Therefore, soil samples will not be collected from the vadose during drilling at these locations.

Below the water table, groundwater samples will be collected from within the borehole using a sealed-screen sampler, such as a Hydropunch™, SimulProbe®, or similar sampler. Samples will be collected beginning at the water table (generally between 280-340 feet bgs) and approximately every 25 feet until the total borehole depth is reached (estimated up to 10 groundwater samples). As data is analyzed from each boring, the frequency of sampling will be evaluated to determine if less frequent sampling is appropriate for subsequent borings.

In the event that a groundwater sample cannot be retrieved from a specific depth due to a low yielding zone, the borehole will be advanced another two to five feet and a second attempt will be made to collect another sample. If the second attempt is unsuccessful then the boring will be advanced to the next 20-foot sample target. Groundwater samples will be collected into laboratory-supplied PFAS-free containers as specified in the QAPP (ADEQ, 2020). Samples will be submitted under appropriate chain-of-custody procedures to an off-site laboratory for expedited turn around for PFAS analysis. The expedited turn around will allow rapid decisions to be made on how to proceed with the field investigation. Samples will be analyzed for PFAS using EPA method 537 modified; details of analysis techniques, laboratory method detection limits, and QA/QC procedures are included in the QAPP (ADEQ, 2020).

Field duplicate, matrix spike (MS) and matrix spike duplicate (MSD) samples will be collected at the rate of 5% (one per 20 samples). One field reagent blank will be collected at each sample location and included with sample shipment for laboratory analysis. Due to the potential for cross-contamination, equipment blanks will also be collected and analyzed. All QA/QC samples will be analyzed for the same parameters as the accompanying samples. A temperature blank will be placed in each cooler to ensure that samples are preserved between zero and four degrees Celsius during shipment.

Where sample recovery is sufficient, groundwater from each depth-specific sampling location will be screened for water quality parameters using a handheld multi-meter according to SOP #15 (Appendix B). Water quality parameters will include pH, temperature, oxidation-reduction potential (ORP), electrical conductivity (EC), and turbidity.

Soil samples will also be collected below the water table for aquifer parameters including bulk density, porosity, and grain size distribution. Soil samples are proposed to be collected from exploratory borings AZSB-01, AZSB-02, and AZSB-03, which are oriented along the axis of the plume. At least three soil samples will be collected from the saturated zone at each boring by driving a sampler ahead of the drill casing to

collect and undisturbed sample. The soil sampling below the water table will target the larger coarse-grained units observed in the upper aquifer which are mostly likely to transport the bulk of PFAS mass. Additional soil samples may be collected from larger continuous fine-grain aquifer units that may act as aquitards, which inhibit significant vertical transport. The soil property data will be used to help refine the CSM and groundwater flow model.

#### 4.4.5 Field Screening Decisions

PFOA+PFOS analytical results for each exploratory boring will be used make decisions as field activities progress. As lithologic and analytical data is collected for a given boring, the project team will communicate to determine the total depth of the boring and if/how a well is to be constructed at that location or if the borehole should be abandoned. Efforts will be made to minimize drilling stand-by time while samples are being processed, however, some stand-by time is expected.

For each boring location, after the complete data set is received, the project team will meet to determine whether a step-out boring is necessary and exactly where the boring should be located. A representative of Tucson Water will be invited to participate in these decision-making discussions. The data collected for each boring will also be used to determine the most efficient frequency and depth of sampling for subsequent borings.

##### *Interior Plume Borings/Wells*

The PFOA+PFOS concentration data from each boring will be used to determine how deep each boring will be advanced. If PFOA+PFOS is detected above 70 ppt at the planned total depth of 500 feet, the exploratory boring will be advanced until the concentration of PFOA+PFOS is below 70 ppt. Exploratory borings in which PFOA+PFOS concentrations exceed 70 ppt in one or more zones of the aquifer will be considered for conversion to an interior plume monitoring well. The screen interval for these wells will be determined based on the vertical distribution of PFOA+PFOS and will generally extend across the zone(s) of the aquifer that exceed 70 ppt.

##### *Exterior Plume Definition Borings/Wells*

If concentrations of PFOA+PFOS are detected below 70 ppt throughout the vertical profile of an exploratory boring, a monitor well will be considered for construction at that location and will be identified as an exterior down-gradient or exterior cross-gradient plume definition well as discussed above. These monitoring wells will serve as sentinel wells around the plume perimeter. The screen interval for the sentinel wells will be determined based on the distribution of PFOA+PFOS in the exploratory boring; the lithologic data from the boring, data from other nearby upgradient monitoring wells, and the screen intervals of the nearest downgradient municipal supply wells.

In the event that the PFOA+PFOS concentration exceeds 70 ppt at an exploratory boring that was expected to be an exterior plume definition well, this boring will be considered for abandonment or turned in to an interior plume well. If supported by the data, a step-out boring will be advanced, preferably in a pre-determined, permitted location.

Table 4 provides a summary of potential decisions to be made during exploratory borehole advancement.

**Table 4. Field-Screening Decision Matrix**

Decision Question	Decision Point	Decision Criteria	Decision
1. Should borehole advancement continue?	Result is analyzed for a depth-specific sample(s) during drilling	Depth-specific sample with PFOA+PFOS >70 ppt	Yes, continue to advance the borehole to the next sampling depth
		At least two continuous depth-specific samples with PFOA+PFOS <70 ppt	No, stop drilling and move to decision question #2.
2. Should a well be constructed in the borehole?	Borehole advancement is complete	Analytical results indicate the boring defines the plume to PFOA+PFOS <70ppt	Yes, install a well that is screened based on lithologic/sampling data. Move to decision question #3
		PFOA+PFOS > 70ppt and boring provides useful/unique data for continued monitoring	Yes, install a well that is screened based on lithologic/sampling data. Move to decision question #3
		PFOA+PFOS > 70ppt and boring does not provide useful data for continued monitoring	No, backfill the boring and move to decision question #3.
3. Should a borehole be advanced in a step-out location?	Borehole advancement is complete	The highest depth-specific sample in a well >70 ppt	Yes, step out to the next alternative location downgradient and/or side-gradient, if available
		The highest depth-specific sample in a well <70 ppt	No, complete the well as an exterior plume definition well

#### 4.4.6 Well completion

Monitoring wells will be completed using 4-inch schedule 80 poly-vinyl chloride (PVC), flush-threaded 10-foot sections of riser, slotted well screen, and a threaded bottom cap. No Teflon-containing pipe tape, pipe dope, or other construction materials will be used for well construction. The location and length of the well screen will be determined based on analytical data and lithological characterization.

Wells will be constructed following procedures outlined in SOP #12. A filter pack of silica sand will be installed in the annulus around the well screen to a minimum of 5-feet above the well screen. Filter pack and screen slot size will be chosen based on observed lithology. A 2-foot thick bentonite seal will be placed above the filter sand and hydrated with distilled water. Cement-bentonite grout will be placed in the well annulus from the top of the bentonite seal to ground surface. A flush-mount well vault will be installed according to ADWR specifications. After completion, wells will be professionally surveyed to obtain accurate coordinate and elevation data. Wells will be developed according to the procedures outlined in SOP #13.

#### 4.5 Well Sampling and Water Level Collection

During plume characterization activities, it may be necessary or beneficial to sample existing monitoring wells, and private wells. The decision to sample existing wells will be dependent on initial site characterization efforts and access considerations. Monitoring wells may be sampled using PFAS-free Hydrasleeve (no-purge) samplers (SOP #2, Appendix B) or PFAS-free low flow pumps (SOP #3, Appendix B). The choice of sampling method will be based on well condition and whether a dedicated pump is present in the well.

If private wells are sampled, water will be collected directly from a spigot closest to the well. For private wells, not enough well construction information is typically known to calculate an appropriate purge volume prior to sampling. Instead, general guidelines from an EPA Region 4 guidance will be used for purging private wells (USEPA, 2013). If the pump operates continuously or nearly continuously, the sampling port will be opened and allowed to run for a few minutes prior to collecting a sample. If the pump operates intermittently or infrequently, field judgment should be used to determine the length of time that should be adequate to flush water from the piping and storage tanks that may be present. Fifteen to thirty minutes purging is typically adequate.

Following the construction and development of wells installed under this scope of work, wells will be sampled using PFAS-free Hydrasleeve (no-purge) samplers. The screens of new monitoring wells will be vertically profiled for PFAS distribution. In general, and depending on the length of the well screen, three depth discrete Hydrasleeve samples will be collected within the well screen; one in the upper third, one in the middle third, and one in the bottom third. The PFOA+PFOS data from these initial groundwater samples will be used to determine the depth(s) where future groundwater samples are collected and in most cases will be at the depth of the highest observed concentrations.

Groundwater samples from monitoring wells and private wells will be collected into method-appropriate laboratory-supplied PFAS-free containers as specified in the QAPP (ADEQ, 2020). Samples will be submitted under appropriate chain-of-custody procedures to a fixed based lab for standard turnaround analysis. Samples from each well will be analyzed for PFAS using EPA method 537 modified. Additionally, select wells will be sampled for constituents that may affect remedy performance, including metals, inorganic ions, and trace elements. A summary of proposed samples, analysis methods, and sample locations is included in Table 3; details of analysis techniques, laboratory method detection limits, and QA/QC procedures are included in the QAPP (ADEQ, 2020).

Field duplicate, MS, and MSD samples will be collected at the rate of 5% (one per 20 samples). One field reagent blank will be collected at each sample location and included with sample shipment for laboratory analysis. Due to the potential for cross-contamination, equipment blanks will also be collected and analyzed for any non-disposable sampling equipment used. All QA/QC samples will be analyzed for the same parameters as the accompanying samples. A temperature blank will be placed in each cooler to ensure that samples are preserved between zero and four degrees Celsius during shipment.

Groundwater from each sampling location will also be screened for water quality parameters (pH, temperature, ORP, EC, and turbidity) per SOP #15 (Appendix B). If a well is purged prior to sampling, field parameters will be recorded at regular intervals during purging. If necessary, aquifer testing will be conducted in select wells to evaluate aquifer properties including, transmissivity, and hydraulic conductivity and storage coefficients following the procedures outlined in SOP #14. This data will be used to refine the site CSM, refine the groundwater flow model, and will be used to help develop groundwater remediation strategies. If available, aquifer test data from Tucson Water and other sources will be reviewed to determine if additional testing may be necessary. Candidate wells for testing may include existing and new monitoring wells, Tucson Water wells, and any other wells to which ADEQ may be granted access.

After newly constructed monitoring wells are professionally surveyed, water levels in the vicinity of the plume will be measured using available wells as appropriate and as access allows (SOP #16, Appendix B).

Water levels should generally be collected during a single mobilization event to ensure data can be used to produce accurate water level contour maps.

#### 4.6 Equipment Decontamination

Equipment will be decontaminated following the standard procedures outlined in SOP#8 (Appendix B). Drilling equipment will be decontaminated before being brought to the work site and between each of the boring locations. Alconox detergent and a steam pressure washer will be used with clean water to decontaminate the drilling equipment. Preferably, water will be obtained from a known PFAS-free source. The final rinse will be conducted using verified PFAS-free water.

Where possible, sampling equipment will be disposable to avoid sample cross-contamination. All non-disposable sampling equipment will be decontaminated prior to use and after each use by using Alconox detergent and clean water. The final rinse will be conducted using verified PFAS-free water. All decontamination water will be containerized for off-site disposal.

#### 4.7 IDW Management

Investigation Derived Waste (IDW) generated during field activities (e.g., soil cuttings and decontamination /purge water) will be containerized in 55-gallon drums or roll-off containers and will be sampled and characterized for waste profiling. The IDW will be labeled and stored at a location to be determined based on access, until it is disposed of by a licensed disposal subcontractor. IDW will be managed in accordance with SOP #17 (Appendix B).

#### 4.8 Sample Identification

All samples collected will be properly labeled using designated PFAS-free labels and permanent ink. Sample labels will include, at a minimum, the unique sample identifier, sample location, date, and time. Sample identification numbers will consist of a designation related to the sample location, media type, and depth according to the following conventions:

Soil and groundwater samples collected during drilling: AZSB-ID-depth-medium

SB = Soil Boring

ID = consecutive number used as sample location identifier (e.g. 01, 02, etc)

Depth is recorded based on feet below ground surface

Medium = SOIL or GW (groundwater)

Installed Monitoring Wells: AZMW-ID

MW = Monitoring Well

ID = consecutive number used as sample location identifier (e.g. 01, 02, etc). The number should match that of the boring in which the well was installed.

Surface Water, Sediment, and Surface Soil Samples: AZ(medium)-ID

Medium = SW (surface water), SD (sediment), or SS (soil sample)

ID = consecutive number used as sample location identifier (e.g. 01, 02, etc)

All duplicate sample identification numbers will be followed with a "D".



#### 4.9 Data Management/Documentation

Field and analytical data collected during this project are critical to site characterization efforts and the establishment of an accurate CSM. Logbooks and field data sheets will be used to record data collection activities. Field and analytical data will be recorded and maintained for future use and reporting. Details of data collection and data management are included in the QAPP (ADEQ, 2020).

#### 4.10 Quality Assurance/Quality Control

Prior to the start of each workday, the field supervisor will ensure that all field instrumentation that will be used has been properly maintained and calibrated. Procedures for calibration of water quality meters are included in SOP#15 (Appendix B); all equipment will be calibrated following manufacturer specifications.

Data review and validation will be conducted on laboratory results by a Hargis chemist in accordance with procedures specified in the QAPP. Additional review will be conducted by the ADEQ QA/QC specialist using the checklist provided in the QAPP (ADEQ, 2020).

The quality of analytical data will be assessed through the collection and analysis of field and laboratory QC samples as specified in the QAPP (ADEQ, 2020). QC samples will be used to check the sampling methodology and analytical precision, accuracy, and representativeness.

#### 4.11 Health and Safety Requirements

Field personnel will wear PFAS-free clothing and Level D personal protective equipment (PPE). Job hazard analyses identifying the physical, chemical, and biological hazards that may be encountered at the site are included in the QAPP (ADEQ, 2020).

Detailed health and safety requirements will be included in a site-specific HASP to be completed prior to the start of field activities. Personnel and visitors who enter the site will be required to review the HASP, and site workers will be required to sign the daily tailgate safety meeting form. Safety issues that arise during implementation of site activities will be addressed during tailgate safety meetings held daily before the workday.

## 5.0 Data Evaluation and Remedy Assessment

Data used to achieve the project objectives will be collected from several sources, including historical investigations, fieldwork, groundwater modeling, and bench-scale/pilot testing. All data will be reviewed, verified, and/or validated according to the processes outlined in the QAPP (ADEQ, 2020). These data will be incorporated into a detailed, site-specific CSM to enhance the understanding of the site characteristics, PFAS fate and transport processes, potential receptors, and exposure pathways. The data will be used to assess potential remedial alternatives and design a remedy capable of protecting Tucson Water's central wellfield from additional PFAS impacts.

### 5.1 Modeling

ADEQ has obtained the latest model update for the Tucson AMA regional groundwater flow model available from ADWR. The model was first published in 2013 and was developed in an effort to provide the best tools possible for the long-term management of the water resources in the Tucson AMA (ADWR, 2013). The Tucson AMA covers 3,866 square miles in southern Arizona and includes portions of Pima, Pinal and Santa Cruz counties (ADWR 2020). ADWR has also provided ADEQ and its consultants with additional model files updated through 2017.

ESI, Inc, subcontractor to Hargis, has produced an updated version of the 2013 Tucson AMA regional flow model. The updated model has been used for preliminary modeling of groundwater flow and advective transport, including the generation of particle tracking simulations. Results of initial modeling efforts have been used to assist in planning field data collection. Efforts are underway to refine the model grid and conduct further calibration using the most recent aquifer data available. Any relevant data that may be provided from recent groundwater modeling efforts conducted for the DMAFB area by the Air Force will also be incorporated into future model updates.

The groundwater flow model will also be enhanced to allow for the simulation of contaminant transport. This model will incorporate analytical and physical data collected during field activities near DMAFB. Model simulations will be used to inform the CSM and evaluate remedial alternatives. During remedial design, the groundwater model may be used to determine locations of potential extraction and injection wells and to assess capture of the plume and evaluate remedy effectiveness.

All modeling conducted for this project will follow the latest standards for groundwater modeling, including the following:

ASTM D5447-17, Standard Guide for Application of a Numerical Groundwater Flow Model to a Site-Specific Problem, ASTM International, West Conshohocken, PA, 2017, [www.astm.org](http://www.astm.org)

ASTM D5490-93(2014)e1, Standard Guide for Comparing Groundwater Flow Model Simulations to Site-Specific Information, ASTM International, West Conshohocken, PA, 2014, [www.astm.org](http://www.astm.org)

ASTM D5718-13, Standard Guide for Documenting a Groundwater Flow Model Application, ASTM International, West Conshohocken, PA, 2013, [www.astm.org](http://www.astm.org)

ASTM D5981 / D5981M-18, Standard Guide for Calibrating a Groundwater Flow Model Application, ASTM International, West Conshohocken, PA, 2018, [www.astm.org](http://www.astm.org)

## 5.2 Treatability Testing

Carollo has conducted bench-scale treatability testing to evaluate the effectiveness of granular activated carbon (GAC) adsorption and ion exchange (IX) resin for the removal of PFAS from groundwater near DMAFB (Carollo, 2020). Treatment media effectiveness was evaluated using rapid small-scale column tests for groundwater collected from two contaminated Tucson Water wells in the vicinity of DMAFB and other Tucson-area locations. Relative performance of media and potential change-out frequencies were developed and may be used to help determine the cost-effectiveness of the treatment options.

Additional bench-, pilot-, and/or demonstration-scale tests may be completed to supplement the previously completed work by Carollo. These activities would be strategically developed and conducted to provide additional data for the design and construction of a remedial action.

The timing, nature, and objectives of further treatability testing depend on the following considerations:

- The extent of groundwater contamination.
- The range and distribution of contaminants, concentrations, and interfering constituents for the treatment processes.
- The approach for treated water management.
- The range of pump/treat/treated water management concepts that may be applicable.

## 5.3 Remedy Assessment

A primary objective of this project will be to design and construct a remedy that will address the current risk to public health by protecting the supply of water produced by Tucson Water's Central wellfield. A thorough analysis of potential remedial alternatives will be completed using all data collected for the project. Per Arizona Administrative Code (A.A.C.) R18-16-405(B), a remedial action will be chosen based on:

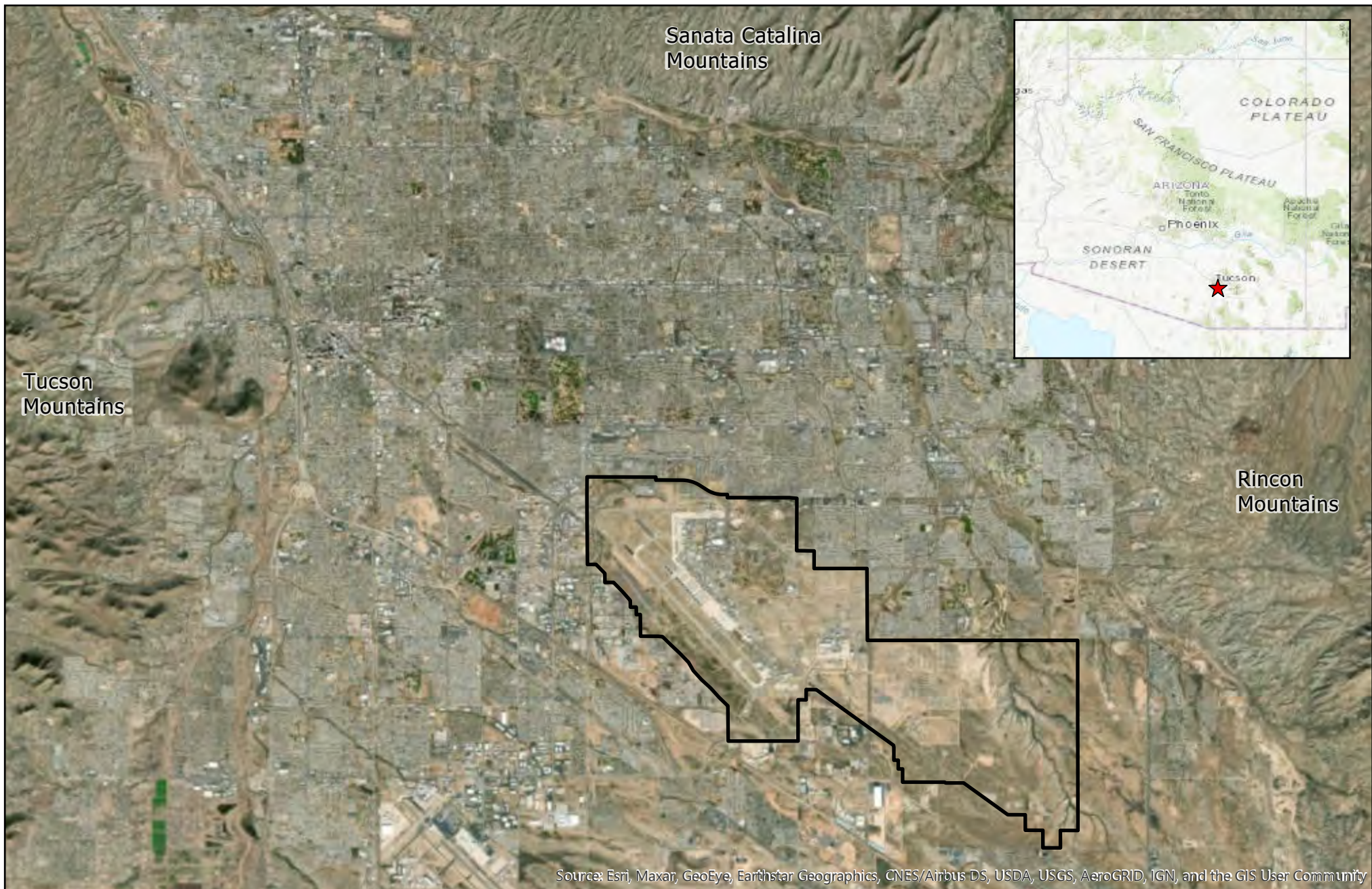
1. Best available data characterizing the site;
2. Best available scientific information concerning available remedial methods and technologies; and
3. Best available information regarding whether the technology or method could increase the scope or costs of possible remedies for the site or result in increased risk to public health or welfare or the environment.


## 6.0 References

- ADEQ, 2020. Quality Assurance Project Plan, Central Tucson PFAS. Arizona Department of Environmental Quality. June 2020.
- ADWR, 2013. Regional Groundwater Flow Model of the Tucson Active Management Area Model Update and Calibration.
- AECOM, 2010. Final water Resources Sustainability Analysis, Davis-Monthan Air Force Base, Pima County, Arizona. May 2010.
- AMEC, 2019a. Final Site Inspection Report, Site Inspection of Aqueous Film Forming Foam (AFFF) Release Areas, Environmental Programs Worldwide Installation, Davis-Monthan Air Force Base, Tucson, Arizona. AMEC Foster Wheeler Programs, Inc. February 2019
- AMEC, 2019b. Final Addendum 01 to the Final Site Inspection Report, Aqueous Film Forming Foam (AFFF) Release Areas, Environmental Programs Worldwide Installation, Davis-Monthan Air Force Base, Tucson, Arizona. AMEC Foster Wheeler Programs, Inc. July 2019
- ATSDR, 2018. ATSDR's Minimal Risk Levels (MRLs) and Environmental Media Evaluation Guides (EMEGs) for Perfluoroalkyls (PFAS). Agency for Toxic Substances and Disease Registry. November 2018.
- Brusseau, 2018. Assessing the potential contributions of additional retention processes to PFAS retardation in the subsurface. *Science Total Environ.*, 613-614, 176-185.
- Brusseau, 2019. The influence of molecular structure on the adsorption of PFAS to fluid-fluid interfaces: Using QSPSR to predict interfacial adsorption coefficients. *Water Research*, 152, 148-158.
- Carollo, 2020. Results of Rapid Small Scale Column Testing for Removal of PFAS from Tucson Water Wells. June 2020.
- EA, 2020. Final Uniform Federal Policy Quality Assurance Project Plan Addendum, Off-Base Drinking Water Site Inspection, Davis-Monthan Air Force Base, Arizona. EA Engineering, Science, and Technology, Inc. April 2020.
- Hargis, 2020. Results of Sampling Program for PFAS in Groundwater, Davis Monthan Air Force Base Vicinity, Tucson, Arizona. Hargis + Associates, Inc. March 2020.
- HGL, 2015. Final Preliminary Assessment Report for Perfluorinated Compounds at Davis-Monthan Air Force Base, Tucson, Arizona. HydroGeoLogic, Inc. September 2015
- ITS, 2012. Final Conceptual Site Model Site ST-35, Davis-Monthan Air Force Base, Arizona. March 2012.
- ITRC, 2020. Per- and Polyfluoroalkyl Substances (PFAS). Prepared by the Interstate Technology & Regulatory Council (ITRC) Per- and Polyfluoroalkyl Substances (PFAS) Team. April 2020.
- Tucson Water, 2020. Groundwater Maps, Tucson Water Technical Library. Accessed online at <https://www.tucsonaz.gov/water/groundwater-maps>. June 2020.
- USEPA, 2013. Groundwater Sampling. Prepared by United States Environmental Protection Agency Region 4. Number SESDPROC-301-R3. March 2013.

## FIGURES





 Davis Monthan Air Force Base (DMAFB) Installation Boundary

PFAS = per- and polyfluorinated alkyl substances

0 0.75 1.5 3 Miles



6/15/2020

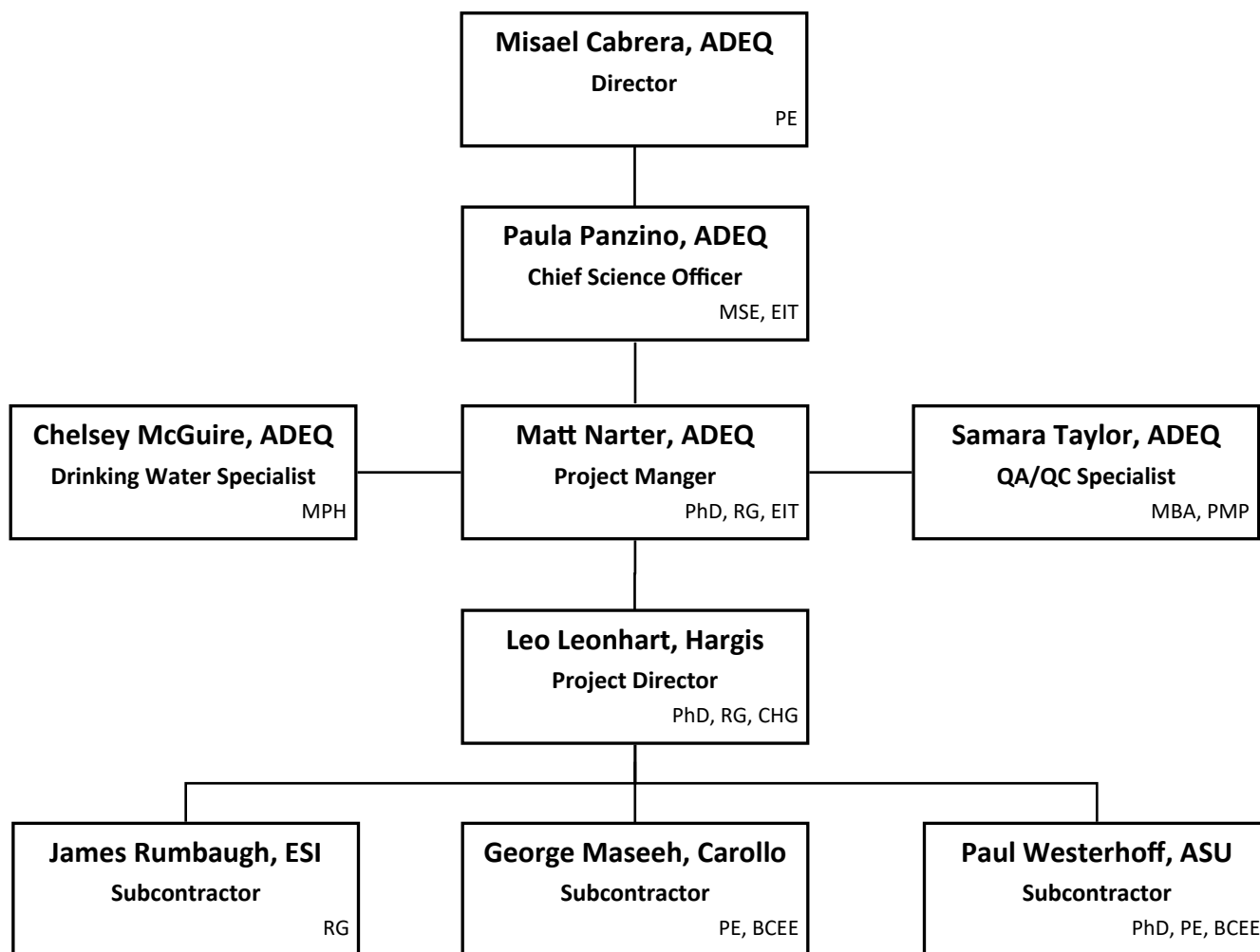
## Site Location Map

Central Tucson PFAS Project  
Work Plan

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**FIGURE 1**

**FIGURE 2**  
**PROJECT ORGANIZATION CHART**

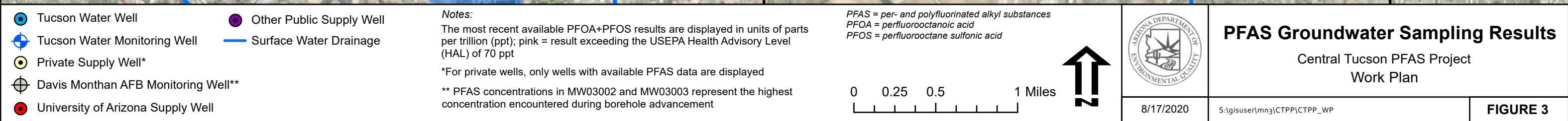


ADEQ—Arizona Department of Environmental Quality  
 ASU—Arizona State University  
 BCEE—Board Certified Environmental Engineer  
 CHG—Certified Hydrogeologist  
 EIT—Engineer in Training

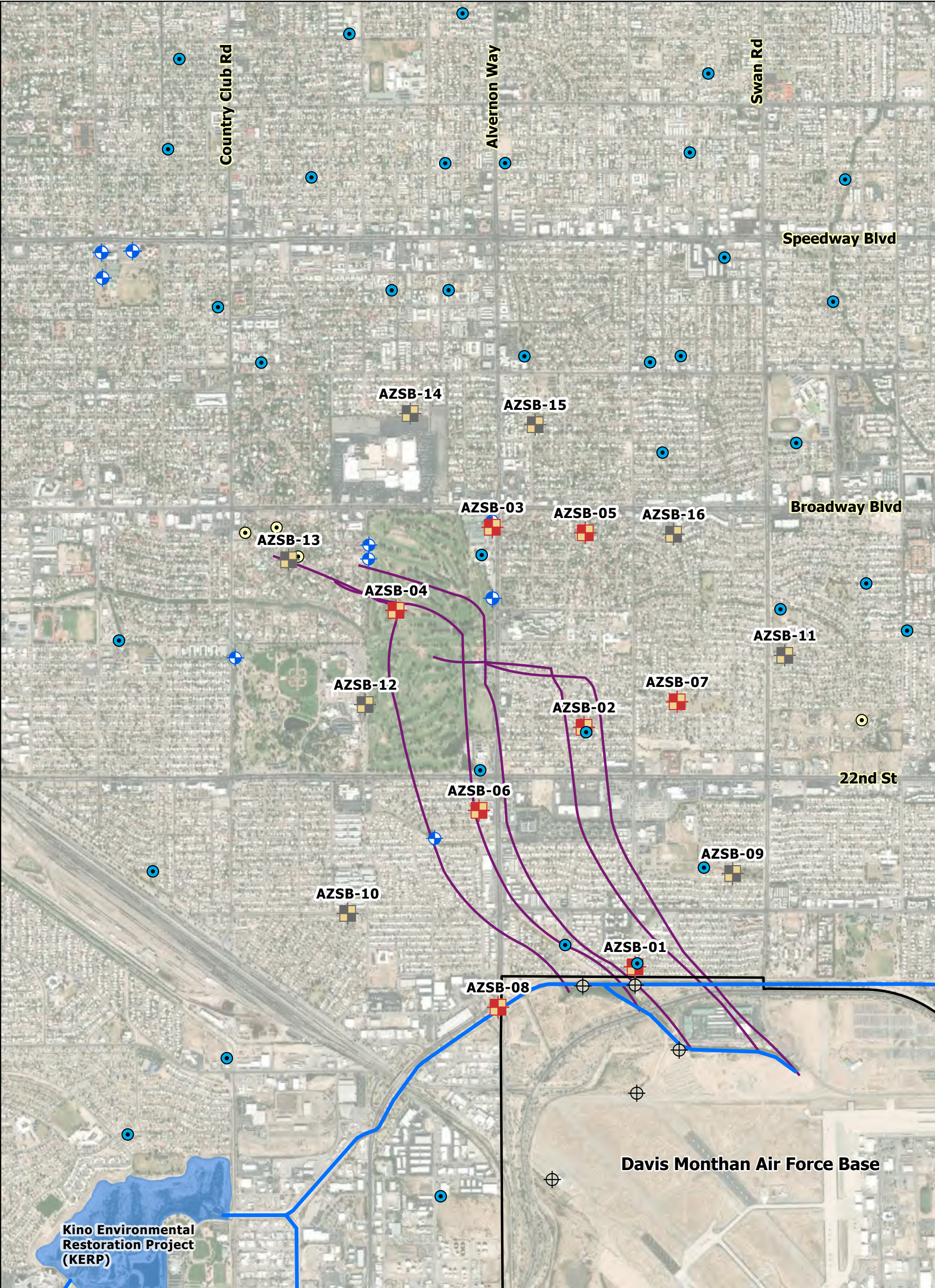
ESI—Environmental Simulations, Inc.  
 MBA—Master’s in Business Administration  
 MPH—Master’s in Public Health  
 MSE—Masters of Science in Engineering  
 PE—Professional Engineer

PhD—Doctor of Philosophy  
 PMP—Project Management Professional  
 QA/QC—Quality Assurance/Quality Control  
 RG—Registered Geologist









Proposed Soil Boring - Primary Location	Surface Water Drainage		<b>Proposed Boring Locations</b> Central Tucson PFAS Project Work Plan	
Proposed Soil Boring - Step-Out Location	Simulated Particle Paths**			
Tucson Water Supply Well	*For private wells, only wells with available PFAS data are displayed		8/17/2020	S:\gisuser\mn3\CTPP\CTPP_WP
Tucson Water Monitoring Well			<b>FIGURE 4</b>	
Private Supply Well*				
Davis Monthan AFB Monitoring Well				
PFAS = per- and polyfluorinated alkyl substances				





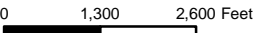


# APPENDIX A

## DMAFB SELECT FIGURES

**Figure A1.** *AFFF Release Areas, Davis Monthan Air Force Base.* Original Figure from Draft Final Site Inspection Report, Site Inspection of Aqueous Film Forming Foam (AFFF) Release Areas, Environmental Programs Worldwide Installation, Davis-Monthan Air Force Base, Tucson, Arizona. AMEC Foster Wheeler Programs, Inc. October 2018

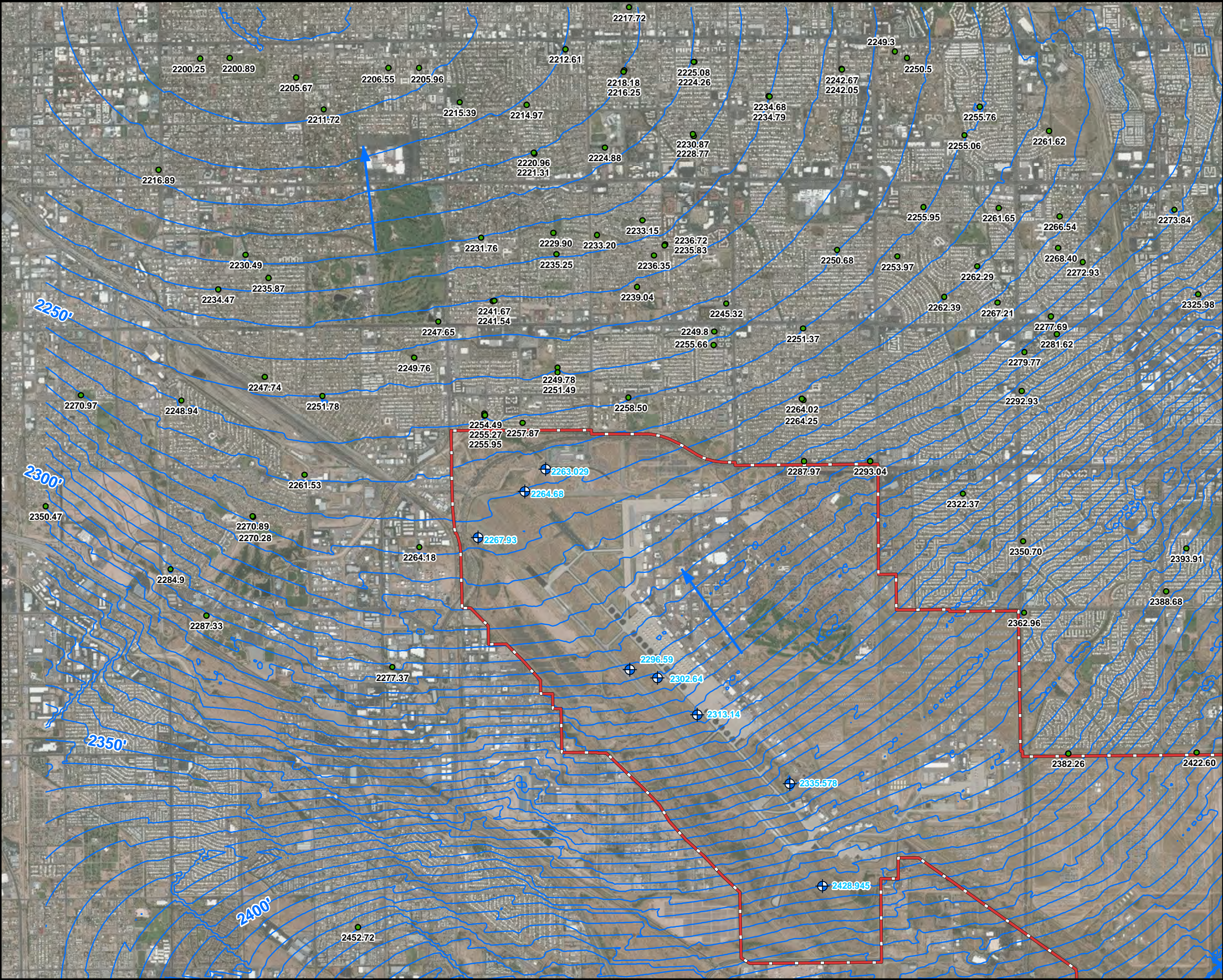


<b>Air Force Civil Engineer Center</b>  2261 Hughes Ave., Suite 163 JBSA Lackland, Texas 78236		<b>Symbol Key</b>  AFFF Release Area  Davis-Monthan AFB Installation Boundary	<b>FIGURE 2.3-1</b> <b>AFFF Release Areas</b> <b>Davis-Monthan AFB</b> <b>Tucson, Arizona</b>
<div> <div>  </div> <div>           Project: 775303101            By: EMK      Date: 8/10/2018         </div> <div>  </div> </div> <div> <div>           Disclaimer: For general reference purposes only.            This is not a survey product.            DO NOT USE to determine, certify, or verify            map features, scale and/or other information.         </div> <div>           Source: Esri, DigitalGlobe, GeoEye,            Earthstar Geographics, CNES/Airbus DS,            USDA, USGS, AeroGRID, IGN, and the            GIS User Community         </div> </div>			

Path: \\net1-151\projects\GIS\775303101\_AFFC\_PFCDavis-Monthan\Map\2.3-1\_AFFF\_Release\_Areas.mxd

**Figure A2.** *Regional Groundwater Elevation Map, Davis-Monthan Air Force Base, Tucson Arizona.* AMEC-Wood, November 2018.





**Regional Groundwater Elevation Map  
Davis-Monthan Air Force Base  
Tuscon, Arizona**

**Site Inspection of  
Aqueous Film Forming Foam (AFFF)  
Release Areas  
Environmental Programs Worldwide  
ISWPA 01**

**Air Force Civil Engineer Center**



2261 Hughes Ave., Suite 163  
JBSA Lackland, Texas 78236

- Symbol Key**
- DMAFB Monitoring Wells
  - 2302.64 February 2018 Groundwater Elevation
  - Off-Base Wells
  - 2277.37 December 2017-March 2018 Groundwater Elevation
  - Approximate Groundwater Flow Direction
  - 5-foot Groundwater Elevation Contours
  - Davis-Monthan AFB Installation Boundary



Project: 775303101

By: EMK Date: 11/20/2018

Disclaimer: For general reference purposes only.  
This is not a survey product.  
DO NOT USE to determine, certify, or verify  
map features, scale and/or other information.

Source: Esri, DigitalGlobe, GeoEye, Earthstar  
Geographics, CNES/Airbus DS, USDA,  
USGS, AeroGRID, IGN, and the GIS User  
Community

0 0.25 0.5 0.75 1 1.25  
Miles



# APPENDIX B

## STANDARD OPERATING PROCEDURES

This appendix contains standard operating procedures (SOP) relevant to the Central Tucson PFAS Work Plan. Where discrepancies may exist between an SOP and the Work Plan, procedures outlined in the Work Plan will supersede those included in the SOP. The document is organized as follows:

#### ACRONYMS AND ABBREVIATIONS

SOP #1 PFAS Field Sampling Procedures and Considerations

SOP #2 Groundwater Sample Collection

SOP #3 Groundwater Sampling Low Flow Method

SOP #4 Sediment Sampling

SOP #5 Surface Water Sampling

SOP #6 Subsurface Soil Sample Collection

SOP #7 Sampling Receiving, Handling and Storage

SOP #8 Equipment Decontamination

SOP #9 Pre-Drilling Procedures

SOP #10 - *This SOP was left intentionally blank*

SOP #11 Lithologic Logging

SOP #12 Monitor Well Construction

SOP #13 Monitor Well Development

SOP #14 Aquifer Testing

SOP #15 Field Water Quality Parameter Measurements

SOP #16 Water Level Measurement

SOP #17 Handling, Storage, Characterization, and Disposal of Investigation-Derived Waste

#### REFERENCES



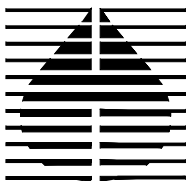
## ACRONYMS AND ABBREVIATIONS

ADWR	Arizona Department of Water Resources
ASTM	American Society for Testing and Materials
bls	Below land surface
C or °C	Centigrade
COC	Chain of Custody
CSWQCB	California State Water Quality Control Board
DI	De-ionized
DIS	Discrete interval samplers
DO	Dissolved oxygen
DOT	U.S. Department of Transportation
DTSC	Department of Substance Control
EC	Electrical conductivity
EPA	U.S. Environmental Protection Agency
ETFE	Ethylene-tetrafluoro-ethylene
FEP	Fluorinated ethylene propylene
FSP	Field sampling plan
FSSOP	Field Sampling and Standard Operating Procedures
H+A	Hargis + Associates, Inc.
HDPE	High Density Polyethylene
HSP or HASP	Health and Safety Plan
ID	Internal Diameter
LDPE	Low Density Polyethylene
ml	milliliter
MS/MSD	Matrix spike/matrix spike duplicate
ng/L	Nanograms per liter
PCTFE	Polychlorotrifluoroethylene
PDB	Passive diffusion bag
PFAS	Per- and polyfluoroalkyl substances
PID/FID	photoionization detector/flame ionization detector
PPE	Personal protective equipment

PPT	Parts per trillion
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl chloride
PVDF	Polyvinylidene fluoride
QA	Quality Assurance
QAPPs	quality assurance quality control plans
QC	Quality Control
RL	Reporting Limit
SAP	Sampling and Analysis plan
SOP(s)	Standard Operating Procedure(s)
uS/cm	Microsiemens per centimeter
USCS	Unified Soil Classification System
VOA	volatile organic analysis
WP	Work Plan

**JUNE 29, 2020**

**SOP 01**  
**PFAS FIELD SAMPLING**  
**PROCEDURES AND CONSIDERATIONS**



**HARGIS + ASSOCIATES, INC.**  
HYDROGEOLOGY • ENGINEERING

SOP 01  
PFAS FIELD SAMPLING  
PROCEDURES AND CONSIDERATIONS

TABLE OF CONTENTS

Section	Page
ACRONYMS AND ABBREVIATIONS.....	iii
1.0 INTRODUCTION.....	1
1.1 PURPOSE AND SCOPE.....	1
1.2 SUMMARY OF METHOD.....	1
1.3 HEALTH AND SAFETY WARNINGS.....	1
1.4 REFERENCES .....	2
2.0 GENERAL SAMPLING GUIDELINES.....	3
2.1 PERSONAL PROTECTIVE EQUIPMENT AND FIELD CLOTHING.....	3
2.2 PERSONAL HYGIENE, SUN AND BIOLOGICAL PROTECTION.....	3
2.3 FOOD PACKAGING .....	5
2.4 WET WEATHER .....	6
3.0 SAMPLING PROCEDURES.....	7
3.1 SAMPLING EQUIPMENT.....	7
3.2 GLOVES .....	8
3.3 PFAS FREE WATER.....	9
3.4 SAMPLING COLLECTION AND STORAGE .....	10
3.5 DECONTAMINATION.....	12
4.0 FIELD QUALITY CONTROL SAMPLES .....	13

TABLE OF CONTENTS (continued)

TABLES

Table

- 1 SUMMARY OF PROHIBITED AND ACCEPTABLE ITEMS FOR PFAS SAMPLING

ATTACHMENTS

Attachment

- A DAILY PFAS FIELD CHECKLIST



ACRONYMS AND ABBREVIATIONS

CSWQCB	California State Water Quality Control Board
ETFE	Ethylene-tetrafluoro-ethylene
FEP	Fluorinated ethylene propylene
H+A	Hargis + Associates
HASP	Health and Safety Plan
HDPE	High-density polyethylene
LDPE	Low density polyethylene
ng/L	Nanograms per liter
PPE	Personal Protective Equipment
PCTFE	Polychlorotrifluoroethylene
PFAS	Polyfluorinated alkyl substances
PPT	Parts per trillion
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl chloride
PVDF	Polyvinylidene fluoride
RL	Reporting Limit
SOP	Standard Operating Procedure

## SOP 01

### PFAS FIELD SAMPLING

### PROCEDURES AND CONSIDERATIONS

#### 1.0 INTRODUCTION

##### 1.1 PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to describe procedures and or considerations for the collection of soil, sediment, surface water, groundwater and potable water samples for the analysis of polyfluorinated alkyl substances (PFAS). Because of the high probability of false positives during PFAS sample collection, due to potential cross-contamination and low laboratory detection limits (nanograms per liter, ng/L; or parts per trillion, ppt), the presented procedures and considerations will help avoid potential PFAS cross-contamination.

This SOP applies to all Hargis + Associates (H+A) personnel and subcontractors who are involved in the collection and or otherwise handling of soil, sediment, surface water, groundwater, and potable water samples for analysis of PFAS. This SOP should be reviewed by all on-site personnel prior to implementation of field activities.

##### 1.2 SUMMARY OF METHOD

The SOP will help identify potential sources of PFAS cross-contamination and procedures to avoid cross-contamination during field activities.

##### 1.3 HEALTH AND SAFETY WARNINGS

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All PFAS-free proper personal protection clothing and equipment are to be worn.



#### 1.4 REFERENCES

California State Water Quality Control Board (CSWQCB), 2019. Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guidelines. March 20, 2019.

Amec Foster Wheeler, 2017. Field Sampling Protocols to Avoid Cross-Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS), SOP AFW-01 (PFAS). Rev. 3. February 7, 2017.

Michigan Department of Environmental Quality, 2018. General PFAS Sampling Guidance. October 16, 2018.



## 2.0 GENERAL SAMPLING GUIDELINES

### 2.1 PERSONAL PROTECTIVE EQUIPMENT AND FIELD CLOTHING

Any field planning and mobilization effort should address the physical, chemical, and biological hazards associated with each PFAS site. The mitigation of potential risks should be documented in a site-specific health and safety plan (HASP). The HASP should identify personal protective equipment (PPE) that is free of PFAS materials to avoid cross-contamination.

PFAS are used to coat various clothing and leather products to repel water, oil, and dirt. While preparing for sampling, attention should be paid on clothing that is advertised as having waterproof, water-repellant, or dirt and/or stain resistant characteristics. These types of clothing are most likely to have had PFAS used in their manufacturing.

There are many PPE items that may be required to be used during sampling events that have not been completely evaluated (e.g. including hard hats, safety glasses, and Tyvek®). If use of these items is required, they should be screened by reviewing the safety data sheets (if available) and/or collecting an equipment blank prior to use.

A summary of the prohibited and acceptable items for PFAS sampling is included in Table 1.

### 2.2 PERSONAL HYGIENE, SUN AND BIOLOGICAL PROTECTION

Field personnel will not use cosmetics, moisturizers, hand cream, or other related products as part of their personal cleaning/showering routine on the morning of a sampling event, unless the products are applied to a part of the body that will be covered by clothing. These products may contain surfactants and represent a potential source of PFAS.

For washroom breaks, field personnel will leave the exclusion zone and then remove gloves and overalls. Field personnel should wash as normal with extra time for rinsing with water after soap use. When finished washing, the use of a mechanical dryer and or air drying is preferred and the use of paper towel for drying is to be avoided (if possible).

Because biological hazards (sunburn, mosquitos, ticks, etc.) may be encountered during sampling, the elimination of specific clothing materials or PPE (sunscreens and insect repellants) could pose a health and safety hazard to staff. The safety of staff should not be compromised by fear of PFAS-containing materials without any scientific basis. Personal safety is paramount. Any deviation from this guidance, including those necessary to ensure the health and safety of field staff, should be recorded in field notes and discussed in the final report.

Prolonged sun exposure may require sunscreens, which may include PFAS in their manufacture. Protection against insects may require the use of insect repellent. The words “natural” and/or “organic” in a product name or used to describe it does not mean that it is PFAS-free. Below is a detailed list of sunscreens and insect repellants that have been analyzed and found to be PFAS-free. However, there is no guarantee that these products will always remain PFAS free.

- Allowable Insect Repellants:
  - o OFF Deep Woods
  - o Sawyer Permethrin
  - o Jason Natural Quit Bugging Me
  - o Repel Lemon Eucalyptus Insect repellent
  - o Herbal Armor
  - o California Baby Natural Bug Spray
- Allowable Sunscreens:
  - o Banana Boat Sport Performance Sunscreen Lotion Broad Spectrum SPF 30.
  - o Meijer Sunscreen Lotion Broad Spectrum SPF 30.
  - o Neutrogena Ultra-Sheer Dry-Touch Sunscreen Broad Spectrum SPF 30.

- o Banana Boat for Men Triple Defense Continuous Spray Sunscreen SPF 30
- o Banana Boat Sport Performance Coolzone Broad Spectrum SPF 30
- o Banana Boat Sport Performance Sunscreen Lotion Broad Spectrum SPF 30
- o Banana Boat Sport Performance Sunscreen Stick SPF 50
- o Coppertone Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50
- o Coppertone Sport High-Performance AccuSpray Sunscreen SPF 30
- o Coppertone Sunscreen Stick Kids SPF 55 • L'Oréal Silky Sheer Face Lotion 50+
- o Meijer Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50
- o Meijer Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70
- o Neutrogena Beach Defense Water + Sun Barrier Lotion SPF 70
- o Neutrogena Beach Defense Water + Sun Barrier Spray Broad Spectrum SPF 30
- o Neutrogena Pure & Free Baby Sunscreen Broad Spectrum SPF 60+

If none of the above sunscreens or insect repellents are available, an equipment blank sample must be collected to verify that it is PFAS-free.

A summary of the prohibited and acceptable items for PFAS sampling is included in Table 1.

### 2.3 FOOD PACKAGING

PFAS are known to be prevalent in food packaging, including paper plates, food containers, bags, and wraps. Although long-chain PFAS have been banned for use in the manufacturing of contact food materials in the United States, short-chain PFAS have not been banned.

Food packaging must not be in the sampling and staging areas during sampling due to the potential for PFAS cross-contamination. No food or drink shall be brought on-site, with the exception of bottled water and hydration drinks (i.e., Gatorade® and Powerade®), which will only be allowed to be brought and consumed within the staging area.

When staff requires a break to eat, they should remove their gloves, coveralls, and any other appropriate PPE, if worn, in the staging area and move to the designated area for food and beverage consumption. When finished, staff should wash their hands and put on a fresh pair of powderless nitrile gloves at the staging area, before returning to the sampling area.

A summary of the prohibited and acceptable items for PFAS sampling is included in Table 1.

## 2.4 WET WEATHER

Field sampling occurring during wet weather (e.g., rainfall and snowfall) should be conducted while wearing clothing that will not pose a risk for cross-contamination. Avoid fabric and or gear that has been treated with water-repellant finishes containing PFAS. Use rain gear made from polyurethane, vinyl, and wax or rubber-coated materials is acceptable.

All samples should be clearly labeled with a Sharpie® marker on laboratory provided sample labels or standard (non-weatherproof) Avery sample labels and should at a minimum include sample identification, site name, date, time, sampler's name or initials, analyses requested, and type of sample preservation. All required COC procedures should be followed.

The sample identification, date, time, location, exact sampling point, type of sample preservation, and name or initials of sampler should also be recorded in a field record log in ink. Analysis requested and type of preservative used will be indicated as appropriate.

Teams should consider the use of a gazebo tent, which can be erected overtop of the sample location and provide shelter from the rain. Because tent materials may be treated for water-proofing they should be handled as such; therefore, gloves should be worn when handling the tent (e.g. setting up, moving) and changed immediately afterwards.

A summary of the prohibited and acceptable items for PFAS sampling is included in Table 1.

### 3.0 SAMPLING PROCEDURES

The following are procedures/considerations to be made during field activities. A summary of the prohibited and acceptable items for PFAS investigation areas is included in Table 1. A checklist, provided as Attachment 1, shall be used by the Field Manager daily prior to the commencement of fieldwork to ensure that the field team is in compliance with this protocol. Visitors to the investigation area are asked to remain outside of the exclusion zone during sampling activities.

#### 3.1 SAMPLING EQUIPMENT

The actual list of PFAS-containing materials potentially encountered onsite will change based on the specific sampled media and site-specific sampling conditions. **Do not use any equipment that contains any known fluoropolymers** including, but not limited to:

- Polytetrafluoroethylene (PTFE), including the trademark Teflon® and Hostaflon®, which can be found in many items, including but not limited to ball check-valves on certain bailers, the lining of some hoses and tubing, some wiring, certain kinds of gears, lubricant, and some objects that require the sliding action of parts.
- Polyvinylidene fluoride (PVDF), including the trademark Kynar®, which can be found in many items, including but not limited to tubing, films/coatings on aluminum, galvanized or aluminized steel, wire insulators, and lithium-ion batteries.
- Polychlorotrifluoroethylene (PCTFE), including the trademark Neoflon®, which can be found in many items, including but not limited to valves, seals, gaskets, and food packaging.
- Ethylene-tetrafluoro-ethylene (ETFE), including the trademark Tefzel®, which can be found in many items, including but not limited to wire and cable insulation and covers, films for roofing and siding, liners in pipes, and some cable tie wraps.

- Fluorinated ethylene propylene (FEP), including the trademarks Teflon® FEP and Hostaflon® FEP, and may also include Neoflon®, which can be found in many items, including but not limited to wire and cable insulation and covers, pipe linings, and some labware.
- Low density polyethylene (LDPE) should not be used for any items that will come into direct contact with the sample media. LDPE can be found in many items, including but not limited to containers and bottles, plastic bags, and tubing.
- Glass or LDPE sample containers are not to be used due to potential loss of analyte through adsorption.

If reasonable alternate equipment is not available, equipment that contains PFAS materials such as Teflon coated parts can be used if the PFAS is internal to the equipment and does not contact the external environment. If in doubt about a product, collect and analyze an equipment blank sample.

Allowable materials include:

- High-density polyethylene (HDPE), polypropylene, silicone, stainless steel, nylon, PVC, acetate, and cotton.
- All samples should be collected in polypropylene or HDPE bottles. The screw cap will be made of polypropylene or HDPE and may be lined or unlined. However, if lined, the liner may not be made of Teflon® or contain PFAS.
- Acetate liners may be used as liners when collecting soil samples during direct-push technology or during conventional drilling and sampling methodologies.
- Groundwater samples may be collected using, PFAS-free hydrosleeves, PFAS-free bailers, a Grundfos RediFlo pump (or similar) and or dedicated pump.

A summary of the prohibited and acceptable items for PFAS sampling is included in Table 1.

### 3.2 GLOVES

Disposable nitrile gloves must be worn at all times. Further, a new pair of nitrile gloves shall be donned prior to the following activities at each sample location:

- Decontamination of re-usable sampling equipment.
- Prior to contact with sample bottles or water containers.
- Insertion of anything into the well (e.g., HDPE tubing, HydraSleeve, bailer, etc.).
- Insertion of silicon tubing into a peristaltic pump.
- Completion of monitor well purging, prior to sample collection.
- Handling of any quality assurance/quality control samples including field blanks; and,

After the handling of any non-dedicated sampling equipment, contact with non- decontaminated surfaces, or when judged necessary by field personnel.

### 3.3 PFAS FREE WATER

According to EPA Method 537 modified, water will be defined as being PFAS-free, if there are no target analyte detections at concentrations equal to or greater than one third of the reporting limit (RL). Target analyte detections at or greater than one third the RL will disqualify all the water in the associated batch from being used for equipment decontamination and field blanks.

The analytical laboratories will be responsible for providing PFAS-free water to use for field blanks. The laboratories must certify that each batch of deionized water is PFAS-free following the procedures specified below before shipment to the field. Procedures to be used for certification of the PFAS-free water are:

- 1) If the laboratory provides water from its internal ultrapure water system, that water must be used for the routine preparation of method blanks for PFAS analysis, and the laboratory must:
  - a. Provide copies of their control charts showing that PFAS concentrations in the method blanks are consistently less than the concentrations specified above with each shipment of water.
  - b. Fill a representative bottle from each manufacturer's lot of bottles/caps with the laboratory's PFAS-free water, and analyze an aliquot of water from that bottle to show that the water in the bottle meets the requirements above; and,
  - c. Provide documentation of the suitability of the PFAS-free water and sample containers.

- 2) If the laboratory provides purchased ultra-pure water for equipment decontamination and blanks, the laboratory must analyze an aliquot of each manufacturer's batch before the water is shipped. If target analytes are detected in the water at concentrations equal to or greater than the RL, the water must be considered contaminated, and it will not be shipped. The manufacturer name and batch or lot number will be used for purposes of maintaining traceability of purchased water.
- 3) If target analytes are not detected at concentrations equal to or greater than one third of the RLs, the water is suitable to be shipped. The laboratory must provide a certificate of analysis with results for the water batch before the water is shipped to the field.

The laboratory will maintain records and will chart results of the source water, and FRB analytical data.

This procedure will provide documentation that the source water used for equipment rinsing and blanks is PFAS-free, with PFAS levels less than less than one third of the RL. This will minimize concern about the PFAS-free water itself as a source of contamination and facilitate evaluation and identification of sources or actions that contribute to cross-contamination, so that the project team can adjust procedures if needed.

Due to the possibility of contamination, PFAS-free water should not be stored for future use. New water should be requested for each sampling event. Dispose any water remaining after the completion of the sampling event.

### 3.4 SAMPLING COLLECTION AND STORAGE

The laboratories providing analytical services should be informed that PFAS sample collection activities will be performed and that all provided collection supplies (e.g. sample labels, bottle ware, blank water, etc.) should be appropriate for PFAS sampling.

Any provided supplies potentially containing PFAS (e.g. bottle ware with Teflon® containing caps) should be identified by the laboratory and kept separate. All bottles used for PFAS sampling should come from the laboratory that will also be performing the PFAS analysis. For all environmental media, hands should be well washed before sampling. Clean powderless nitrile gloves must be put on before collecting samples, handling sample containers, and



handling sampling equipment. The sample container must be kept sealed and only open during the sample collection. The sampling container cap or lid should never be placed the ground, or on any other surface unless it is PFAS-free.

The following additional considerations should be taken during sample collection to prevent contamination:

- Regular/thick size markers (Sharpie® or otherwise) are to be avoided as they may contain PFAS.
- Do not use sticky notes (e.g. Post-it Notes®), plastic clipboards, binders, or spiral hard cover notebooks, or waterproof paper and notebooks in the sampling area. Loose papers secured on Masonite or aluminum clipboards using pen or pencil may be used.
- Fine and Ultra-Fine point Sharpie® markers are acceptable to label the empty sample bottle while in the staging area provided the lid is on the sample bottle and gloves are changed following sample bottle labeling.
- Ballpoint pens may be used when labeling sample containers. If ballpoint pens do not write on the sample container labels, preprinted non water-proof labels from the laboratory may be used. Alternately, preprinted standard (non-weatherproof) Avery sample labels may be used on sample containers.

Sample labels will be placed on containers after sampling is complete and container lids are in place to prevent possible cross contamination.

- Rite in the Rain® notebooks are acceptable to use in the staging area provided gloves are changed after note taking. Avoid plastic coatings or glue materials and do not use other brands of water-proof field books.
- Use HDPE or polypropylene sample bottles with Teflon®-free caps, provided by the laboratory.
- Chemical or blue ice should not be used.
- Samples and ice should be double bagged using LDPE bags (e.g. Ziploc®). Care should be taken to ensure that they are kept in the staging area, do not come into direct contact with the sample media, and gloves are changed after handling.

Samples must be chilled during storage and shipment and must not exceed 50°F (10°C) during the first 48 hours after collection.

### 3.5 DECONTAMINATION

For non-dedicated sampling equipment, the following materials and procedures must be used for decontamination:

- Do not use Decon 90®.
- Laboratory supplied PFAS-free deionized water is preferred for decontamination.
- Alconox®, Liquinox®, and Citranox® can be used for equipment decontamination.
- Sampling equipment can be scrubbed using a polyethylene or Polyvinyl chloride (PVC) brush to remove particulates.
- Decontamination procedures should include triple rinsing with PFAS-free water.
- Commercially available deionized water in an HDPE container may be used for decontamination if the water is verified to be PFAS-free.
- Municipal drinking water may be used for decontamination purposes if it is known to be PFAS free.

A summary of the prohibited and acceptable items for PFAS sampling is included in Table 1.

#### 4.0 FIELD QUALITY CONTROL SAMPLES

It is recommended to collect field quality control samples to evaluate if cross-contamination has occurred. The type and frequency of samples should be identified in the site-specific Quality Assurance Protection Program.

- Equipment blank samples are collected by passing laboratory-verified PFAS-free water over or through decontaminated field sampling equipment to assess the adequacy of the decontamination process and/or to evaluate potential contamination from the equipment used during sampling.
- Field blanks are prepared in the laboratory by placing an aliquot of PFAS-free water reagent water in a sample container and treating it as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The field blank sample is used to determine if method analytes or other interferences are present in the field environment.
- Trip blanks are a bottle of PFAS-free water that is prepared in the laboratory, travels from the laboratory to the site, and then get transported back to the laboratory without having been exposed to any sampling procedures. The trip blank sample is used to assess cross contamination introduced from the laboratory and during shipping procedures.
- Field duplicates are replicate or split samples collected in the field and submitted to the laboratory as two different samples. Field duplicates measure both field and laboratory precision.

Each analytical method provides instructions on how many blanks and duplicate samples are required per sampling event. Analytical test methods approved for use by the US EPA are found at: <https://www.epa.gov/measurements-modeling/collection-methods>.



To assist in evaluating potential PFAS cross contamination the following evaluations may be conducted.

- Products that will come into direct contact with field samples (e.g. drilling grease, sampling equipment, sample containers, and well construction materials), should not be used when sampling unless they are known to be PFAS-free, by collecting an equipment blank sample prior to use.
- Products that will not come into direct contact with samples but could be reasonably expected to contain PFAS may have their SDSs reviewed. To evaluate product SDS and/or manufacturing specs, check if the product contains anything with “fluoro” in the name or the acronyms TPE, FEP, ETFE, and/or PFA. If fluorinated compounds are not listed in the manufacturing specs and/or on the SDSs, product can be used.
- Products that will not come into direct contact with samples and are not expected to contain PFAS may have their SDSs reviewed and if no PFAS are indicated then they are appropriate to use.

TABLE

**TABLE 1**  
**SUMMARY OF PROHIBITED AND ACCEPTABLE ITEMS**  
**FOR PFAS SAMPLING**

FIELD EQUIPMENT	
Prohibited Items	Acceptable Items
Teflon® containing materials	High-density polyethylene (HDPE) and Low-density polyethylene (LDPE) materials.
LDPE sample containers	HDPE sample containers and acetate liners
Teflon® tubing	Silicon or HDPE tubing
Waterproof field books not manufactured by Rite in the Rain. Avoid plastic coatings or glue materials.	Rite in the Rain products or loose-leaf paper (non-waterproof)
Plastic clipboards, binders, spiral hard cover notebooks or waterproof paper or notebooks.	Loose paper, Aluminum or Masonite clipboards
Regular/thick size markers (Sharpie® or otherwise)	Fine and Ultra-Fine Sharpies®, pens for labeling. Not to use during sampling. Change gloves after use.
Labels: Waterproof labels	Preprinted standard (non-weatherproof) Avery sample labels; laboratory supplied labels.  Labels: To be applied after sampling and closure of container.
Sticky Notes (e.g. Post-It Notes)	
Chemical (blue) ice packs	Regular Ice
Excel Purity Paste TFW Multipurpose Thread Sealant Vibra-Tite Thread Sealant	Gasoids NT Non-PTFE Thread Sealant Bentonite
Equipment with Viton Components (need to be evaluated on a case by case basis, Viton contains PTFE, but may be acceptable if used in gaskets or O-rings that are sealed away and will not come into contact with sample or sampling equipment).	
Materials containing: <ul style="list-style-type: none"> <li>• Polytetrafluoroethylene (PTFE) / Teflon® and Hostaflon®,</li> <li>• Polyvinylidene fluoride (PVDF) /Kynar®</li> <li>• Polychlorotrifluoroethylene (PCTFE) / Neoflon®</li> <li>• Ethylene-tetrafluoro-ethylene (ETFE) / Tefzel®</li> <li>• Fluorinated ethylene propylene (FEP) / Teflon® FEP and Hostaflon® FEP, Neoflon®,</li> <li>• Items or materials containing fluoropolymers</li> <li>• Low density polyethylene (LDPE)</li> <li>• Perfluoroalkoxy alkane (PFA)</li> <li>• Thermoplastic elastomers (TPEs)</li> </ul>	Materials containing: <ul style="list-style-type: none"> <li>• High-density polyethylene (HDPE),</li> <li>• Polypropylene,</li> <li>• Silicone,</li> <li>• Stainless steel,</li> <li>• Nylon,</li> <li>• PVC,</li> <li>• Acetate,</li> <li>• Cotton.</li> <li>• Low density polyethylene (LDPE) if confirmed to be PFAs-free.</li> <li>• LDPE bags (e.g., Ziploc®) that do not come into direct contact with the sample media and do not introduce cross-contamination with samples may be used</li> </ul>

**TABLE 1**  
**SUMMARY OF PROHIBITED AND ACCEPTABLE ITEMS**  
**FOR PFAS SAMPLING**

FIELD CLOTHING AND PPE	
Prohibited Items	Acceptable Items
New unwashed clothing, waterproof, water/stain/dirt-resistant treated clothes (including, but not limited to, Gore-Tex™, Scotchgard™ Ruco®, etc).	Well-laundered (washed 6 or more times after purchase without fabric softener) synthetic or 100% cotton clothing (with most recent launderings not using fabric softeners).
Clothing laundered using fabric softener	No fabric softener
Clothes chemically treated for insect resistance and or ultraviolet protection.	Insect repellent listed on "Allowable Insect Repellents" table
Boots containing Gore-Tex™	Boots made with polyurethane and PVC, well-worn or untreated leather boots, leather boots with polypropylene, polyethane, or PVC boot covers.
Tyvek®	Reflective safety vests, cotton clothing, synthetic under clothing, body braces.
Latex gloves	Powderless nitrile gloves
For drying hands: (avoid) untreated paper towels. (prohibited) treated paper towels.	For drying hands: mechanical dryer or air drying.
Cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling, unless the products are applied to body parts that will be covered by clothing.	<b>Sunscreens</b> – See list of "Allowable Sunscreens" in Section 2.2. <b>Insect Repellents</b> – See list of "Allowable Insect Repellents" in Section 2.2 of PFAS Sampling Procedures.
Do not handle or apply and protective care products (PCPs) in the sampling area.	Move to the staging area and remove PPE if applying personal care products becomes necessary.
Do not handle or apply PCPs while wearing PPE that will be present during sampling.	Wash hands thoroughly after the handling or application of PCPs and, when finished, put on a fresh pair of powderless nitrile gloves.
SAMPLE CONTAINERS	
Prohibited Items	Acceptable Items
LDPE or glass containers	HDPE or polypropylene
Teflon®-lined caps	Lined or unlined HDPE or polypropylene caps
RAIN EVENTS	
Prohibited Items	Acceptable Items
Waterproof or resistant rain gear, except as noted to the right.	Waterproof clothing made of or with polyurethane, PVC, wax-coated fabrics, rubber, neoprene. Gazebo tent that is only touched or moved prior to and following sampling activities.

**TABLE 1**  
**SUMMARY OF PROHIBITED AND ACCEPTABLE ITEMS**  
**FOR PFAS SAMPLING**

EQUIPMENT DECONTAMINATION	
Prohibited Items	Acceptable Items
Decon 90 PFAS Treated Paper Towels	Alconox® and/or Liquinox® Untreated Paper Towels
Water from an on-site well	Municipal drinking water (verified PFAS free) Deionized water in HDPE (verified PFAS free) Laboratory supplied PFAS-free deionized water Alconox®, Liquinox®, and Citranox®
FOOD	
Prohibited Items	Acceptable Items
No food within sampling and staging areas.	Bottled water and hydration drinks (i.e. Gatorade® and Powerade®) to be brought and consumed only in the staging area

(avoid) = Item is not prohibited; however, alternate acceptable item is preferable.



ATTACHMENT A  
DAILY PFAS FIELD CHECKLIST

DAILY PFAS FIELD CHECKLIST

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_ Project Name/# \_\_\_\_\_

***Field Clothing and PPE:***

- ☐ Field crew in compliance with Tables 1 and 2, SOP AFW-01.
- ☐ Field crew has not used fabric softener on clothing.
- ☐ Field crew has not used cosmetics, moisturizers, hand cream, or other related products on exposed body parts this morning.
- ☐ Field crew has not applied unacceptable sunscreen or insect repellent.

***Field Equipment:***

- ☐ No Teflon® containing materials on-site.
- ☐ All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene.
- ☐ No waterproof field books on-site other than Rite in the Rain products.
- ☐ No plastic clipboards, binders, or spiral hard cover notebooks on-site.
- ☐ No adhesives (Post-It Notes) on-site.
- ☐ Coolers filled with regular ice only. No chemical (blue) ice packs in possession.

***Sample Containers:***

- ☐ All sample containers made of HDPE or polypropylene. Samples are not stored in containers made of LDPE.
- ☐ Caps are lined or unlined and made of HDPE or polypropylene.

***Wet Weather (as applicable):***

- ☐ For personnel in direct contact with samples and/or sampling equipment, wet weather gear made of vinyl, polyurethane, PVC, wax or rubber-coated materials only

***Equipment Decontamination:***

- ☐ "PFAS-free" water on-site for decontamination of sample equipment
- ☐ Alconox and Liquinox to be used as decontamination materials

***Food Considerations:***

- ☐ No food or drink on-site with exception of bottled water and/or hydration drinks (i.e., Gatorade and Powerade) that is available for consumption only in the staging area

PLEASE DESCRIBE ANY  
NONCOMPLIANCE ISSUES

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## SOP 02 GROUNDWATER SAMPLE COLLECTION

### GENERAL STATEMENT

Groundwater samples may be collected from monitor wells or other Site wells as part of site investigation activities. The following sections provide procedures used during groundwater sampling activities.

### OBJECTIVE

The objective of collecting and analyzing groundwater samples from monitor wells is to obtain data on the concentrations on some or all of the chemicals of concern. The resulting data will be used to assist in determining water quality conditions in the various water-bearing units at the Site, evaluate the areal extent of chemicals of concern, and potentially to monitor the changes in Site chemical conditions as a result of remedial activities. The target analytes and scope of groundwater sampling to be conducted are provided in the applicable Workplan. The scope and analytical schedule for future sampling events will be specified in the applicable workplan.

### PROCEDURES

Groundwater samples from monitor wells at the site will be conducted via the use of a no purge sampling method. No purge sampling methods that may be used include Passive Diffusion Bag (PDB) samplers, HydraSleeve™ samplers or discrete interval samplers (DIS). The following procedures will be used for the collection of groundwater samples:

- Measure depth to water in well to be sampled.
- Determine the casing volume of water in the well.
- For each event a PDB will be filled with deionized water, installed in the well at the specified depth or depths, and allowed to remain in the well at least 14 days prior to

sampling to allow water inside the sampler to attain equilibrium with the ambient groundwater. After 14 days, the bag is pulled to the surface and the contents are immediately transferred in the field to the 40-milliliter (ml) volatile organic analysis (VOA) vials using the manufacturer-supplied fill device. Field parameters are not collected at wells with PDB bags. Also with PDBs, four compounds will be omitted from the groundwater analyte list as these compounds do not migrate well through the membrane of the PDB sampler. These compounds include acetone, 2-butanone, 4-methyl-2-pentanone and methyl tert-butyl ether.

- The HydraSleeve™ samplers for each monitor well will be installed in the well at the specified depth or depths. The HydraSleeve™ is very thin and displaces very little water so it does not disturb the water column during deployment. In most cases the HydraSleeve™ can be recovered immediately or within a few hours of deployment. During recovery as the sleeve is pulled to the surface the check valve opens and water enters the sleeve. The check valve automatically closes when the sleeve is full. Continue pulling the sleeve to the surface and transfer the contents immediately in the field to 40-ml VOA vials using the manufacturer-supplied fill device. Water quality parameters may be collected during HydraSleeve™ sampling events.
- The DISs for each monitor well will be installed at the specified depth or depths for sample collection in the well per the manufacturer's instructions. The sample will be collected under hydrostatic pressure at the desired depth for one to three minutes. After the sample is obtained, the DIS will be repressurized and retrieved from the well. Once above ground surface, the groundwater sample is immediately transferred in the field to 40-ml VOA vials using the manufacturer-supplied fill device. Water quality parameters may be collected during DIS sampling events
- Record the following information on the field data sheet:
  - static depth to groundwater;
  - time of sample collection;
  - number of containers collected and analyses to be performed;
  - field parameter measurements at time of sampling, if collected; and
  - physical characteristics of the water including color, odor, turbidity, etc.
- Collect water samples in appropriate sample containers from the sampling device.
- Attach labels to sample containers immediately after samples are collected.

- Collect samples in accordance with laboratory instructions associated with each container type. If a container contains a preservative, do not rinse the container with discharge water prior to sample collection.
- Place samples in a resealable plastic bag and store on ice in an ice chest immediately after collection.
- Prepare split samples for ADEQ or other agencies during groundwater sampling, if required, by alternately filling agency and H+A sample containers in sequential order for each parameter until all containers are filled.
- If blank samples are required, handle blank water samples in a manner identical to other water samples.
- Record all pertinent data concerning each sample on the groundwater sampling information field data form (Table A-8).
- Record all pertinent data concerning each duplicate and blank sample on the groundwater sampling information field data form (Table A-8).
- Complete chain-of-custody record at each sample location prior to sampling at the next well (Table A-9)
- Finalize chain-of-custody record (Table A-9) at the completion of each sampling event.
- Samples will be delivered to the laboratories within laboratory required hold times for analyses.

Observations taken during sampling will be logged in project-specific forms in indelible ink. If a transcription error is made, the recorder will draw a single line through the incorrect entry, enter the corrected observation, and will initial and date the correction.

Groundwater grab samples may be collected in-situ at selected monitor well boring locations using a Hydropunch II™ type of sampler to identify the vertical extent of volatile organic compounds. The sampler is a 48-inch long by 1.75-inches diameter stainless steel tube containing a retracted and shielded stainless steel well screen with a drop-off expendable point. The sampler is threaded onto a 1.5-inches O.D. heavy duty probe rod and advanced directly into the aquifer in the shielded position with the direct push drilling method.

When the desired depth is reached, the probe rod is retracted approximately 48 inches. The expendable point drops off and the stainless steel sample screen is exposed. Ground water flows past the screen and into the void space of the sampler. Samples are then obtained using either a 1/2-inch O.D. (minimum) bailer or using a peristaltic pump and inert tubing.

#### EQUIPMENT DECONTAMINATION

Groundwater monitoring and sampling equipment requiring decontamination is limited to non-dedicated equipment including: water-level probes, portable wellhead sampling port assembly, non-dedicated pumps, and bailers. The water-level monitoring probes will be decontaminated by spray rinsing the probe after each use with DI water. The remaining equipment will be decontaminated as follows:

- Spray rinse and wash with a solution of phosphate-free detergent and water;
- Steam clean equipment using a portable washer unit, and pass solution through entire assembly;
- Spray rinse with DI water, and
- Air dry the equipment, if possible.

#### PARAMETERS AND ANALYTICAL METHODS

Groundwater samples, including trip blanks, equipment rinsate blanks, and duplicate samples will be analyzed for some or all chemicals of concern, or another approved analyte list specified in the applicable Workplan.

#### BOTTLE PREPARATION

Pre-cleaned and pre-preserved containers obtained from the laboratory will be used to collect project groundwater samples. All containers will be handled and packaged by the laboratory in a manner to ensure that they are free of all of the compounds to be analyzed.

## CHAIN-OF-CUSTODY

The Chain-of-Custody Record will be completed after the groundwater sample is collected (Table A-9). The COC form will accompany the groundwater samples through the sampling day and will be delivered to the laboratory. Upon delivery to the laboratory, the COC form will be relinquished to the laboratory representative accepting the groundwater samples. The laboratory then signs and takes control of the COC form and corresponding groundwater samples, and ensures that sample integrity is not compromised.

The COC form has check boxes allowing the laboratory to indicate the condition of the groundwater samples upon receipt. The following will be noted on the COC form:

- Number of sample containers is correct;
- Sample containers received in good condition, intact, and at the proper temperature, and
- Sample identifiers correspond to those listed on the COC form.

## SAMPLE HANDLING

Clean, pre-preserved sample containers will be provided by the laboratory prior to each sampling event or more frequently, if required. Each container will be labeled by the laboratory to indicate the type of preservative included in it. Sample containers will be kept in a clean, cool, and secure location until immediately prior to use.

Each groundwater sample will be labeled immediately upon collection; the label will be filled out with the sample identifier, the date and time of sample collection, initials of the sampler, analysis requested, project number, and client name (Table A-10). All information entered on the label will exactly match the information contained on the COC form.

After groundwater samples are collected, they will be placed in an ice chest maintained at 4° C using ice. A temperature blank will accompany the ice chest and groundwater samples. The ice chests containing groundwater samples will be kept in a secure location during the time between collection and delivery to the laboratory.

Groundwater samples will normally be hand-delivered to the laboratory at the end of each sampling day. If the groundwater samples cannot be hand-delivered the same day during regular business hours, then the coolers will be stored in a secure location until picked up by courier or shipment company or otherwise transported to the laboratory the next morning.

#### QUALITY ASSURANCE/QUALITY CONTROL

QC samples will be collected and analyzed to assess consistency and performance of groundwater sampling activities. QC samples for groundwater sampling will be specified in the applicable Workplan and the QAPP and include the collection and analysis of trip blanks, field duplicates, field blanks, and matrix spike/matrix spike duplicates (MS/MSD). In addition, an equipment rinsate blank will be collected if non-dedicated sample collection devices are used.

One trip blank will be collected for each day of groundwater sampling. The trip blanks will accompany the groundwater samples to the analytical laboratory within each cooler containing samples for VOC analyses. The trip blanks will be prepared by the analytical laboratory and remain unopened until analyzed with the field samples. Trip blanks will be analyzed for VOCs only.



## TABLES



**TABLE A-3**

**WATER LEVEL INDICATOR  
CALIBRATION DOCUMENTATION FORM**

PROJECT NUMBER: \_\_\_\_\_

DATE	TIME	WATER LEVEL INDICATOR TYPE	WATER LEVEL INDICATOR NUMBER	CALIBRATION METHOD	CALIBRATED BY (INITIALS)	REMARKS

## WATER LEVEL DATA FORM PROJECT:

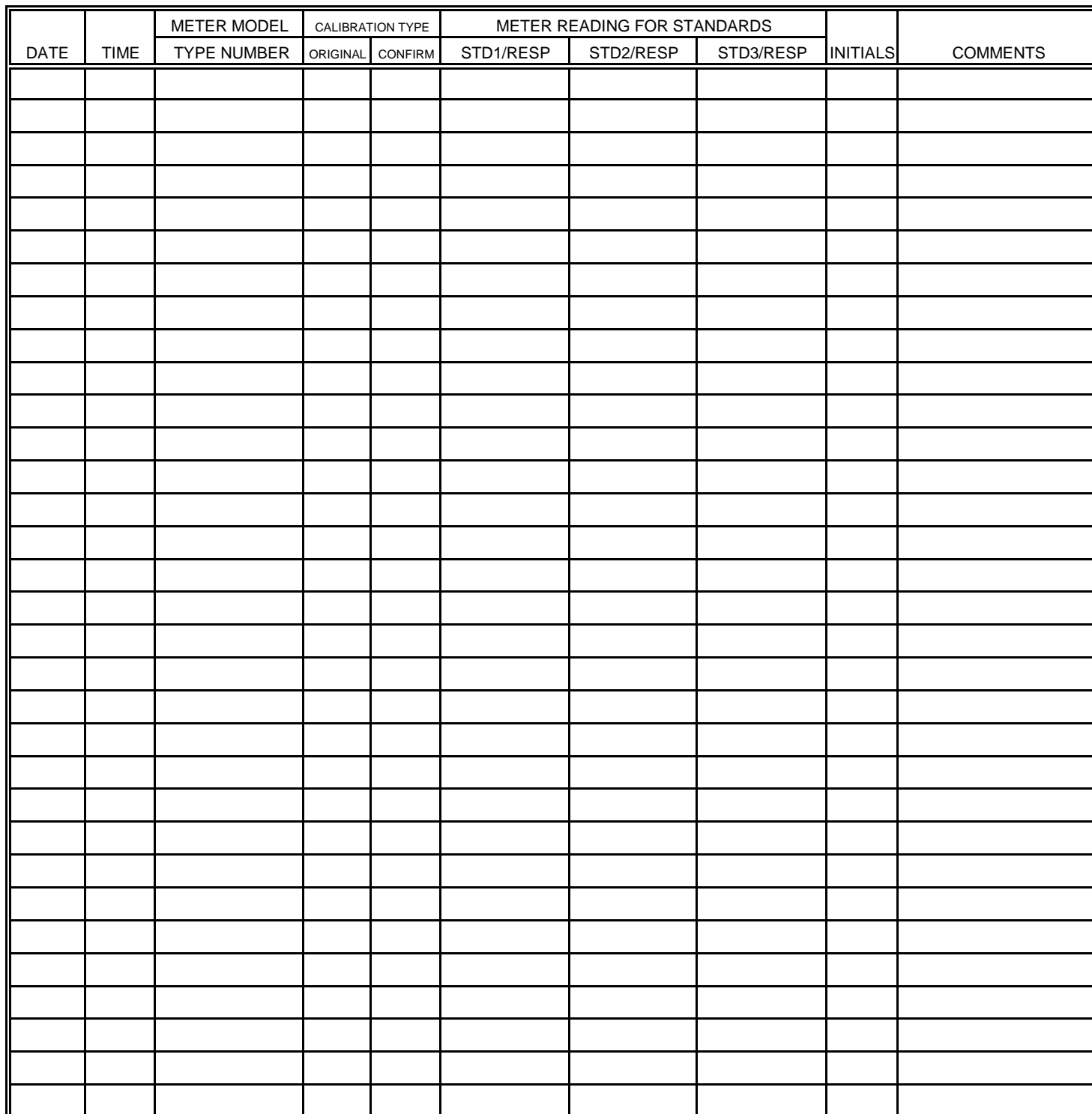
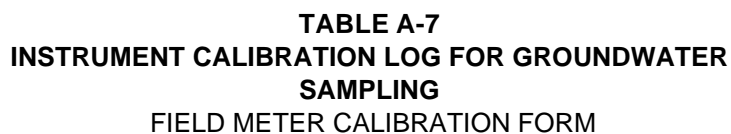


## WATER LEVEL DATA FORM PROJECT:

*Sounder No.*

[illegible]

Well Status: I = Injecting, P = Pumping, A = Abandoned



**GROUNDWATER SAMPLING DATA**  
**FORM PROJECT:**



Purge to \_\_\_\_\_ Stabilized Parameters  
(✓ one) \_\_\_\_\_ 3 CV  
\_\_\_\_\_ Dryness  
\_\_\_\_\_ No Purge

Total time pumped \_\_\_\_\_ minutes

TD = Total Depth;  
ft bmp = Feet below measuring point;  
CV = Casing volume;  
ft bls = Feet below land surface;  
gal/ft = Gallons per foot;  
PDB = Passive Diffusion Bag  
EC = Electrical Conductivity  
uS/cm = Micromhos per centimeter;  
D.O. = Dissolved oxygen;  
mg/L = Milligrams per liter;  
ORP = Oxidation reduction potential;  
mV = Millivolt;  
NTU = Nephelometric Turbidity Units;  
gpm = gallons per minute;  
REDOX = Oxidation reduction potential  
D.O. = Dissolved Oxygen



**TABLE A-9**  
**CHAIN-OF-CUSTODY AND ANALYSIS REQUEST FORM**

Date: \_\_\_\_\_  
Page \_\_\_\_\_ of \_\_\_\_\_

PROJECT NAME :  
TASK NO. :

Project Manager \_\_\_\_\_  
QA Manager \_\_\_\_\_  
Phone 480-345-0888

[illegible]

## Instructions

1. Fill out form completely and sign only after verified for completeness
2. Complete in ballpoint pen. Draw one line through error, initial and date correction
3. Indicate the number of sample containers in analytical request space; indicate choice with ✓ or ✕
4. Note applicable preservatives, special instructions, and deviations from typical environmental samples.
5. Consult project QA documents for specific instructions.

<input type="checkbox"/>	No. of containers correct
<input type="checkbox"/>	Received in good condition
<input type="checkbox"/>	Conforms to COC document

Temperature on receipt

Send Results to:  
Barbara A. Murphy  
1640 S. Stapley Drive  
Suite 209  
Mesa, AZ 85204  
Ph: 480-345-0888  
Fax: 480-730-0508  
[bmurphy@hargis.com](mailto:bmurphy@hargis.com)

**LAB - PLEASE EMAIL COC TO B. MURPHY UPON RECEIPT**

	
<b>HARGIS + ASSOCIATES, INC.</b>	
Stapley Center 1640 South Stapley Drive, Suite 209 Mesa, AZ 85204 Phone: 480-345-0888	
Client	Date
H+A Project No.	Sample ID
Initials	Time
Analyze for :	
Preservative/Special Instructions:	

TABLE A-10. SAMPLE IDENTIFICATION LABEL



## **SOP 03 GROUNDWATER SAMPLE COLLECTION – LOW FLOW METHOD**

### **SCOPE AND APPLICABILITY**

This SOP describes the Low-Stress (low flow) purge and sample method for groundwater sampling. Because methods draw groundwater from immediately adjacent to the pump intake, this method represents a depth-discrete sample rather than a composite sample of the entire saturated screen interval, which would be obtained by using the multiple casing volume method. Thus the pump set depth is an important consideration when using this method.

### **SUMMARY OF METHOD**

The Low-Flow purge and sample method extracts groundwater in a manner that minimizes stress (drawdown) to the extent practical taking into account established site sampling objectives (EPA 1996). Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology (EPA 1996). Water level drawdown provides the best indication of the stress imparted by a given flow-rate (EPA 1996). Once project specific parameter stabilization criteria have been met, typically include conductivity, pH, and temperature, sample collection can be performed. Sample collection generally includes:

- filling clean laboratory provided bottle ware,
- labeling samples,
- store samples on ice,
- preparing chain-of-custody documentation and
- transporting to the laboratory.

Because of the typically low flow rates involved, sample collection can be performed with no to minimal reduction of flow.

### **HEALTH AND SAFETY WARNINGS**

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn.

### **CAUTIONS**

The following cautions need to be considered when planning to collect groundwater samples if the below conditions occur:

- **DEGASSING:** If degassing is observed during purging and or sampling dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases and VOCs will need to be qualified. (EPA, 2017)
- **DEGASSING REACTION WITH PRESERVATIVE:** If a degassing reaction is observed when water contacts the preservative in a sample container (e.g. hydrochloric acid) dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases and VOCs will need to be qualified. Additionally, a second sample may be collected into an unpreserved container and labeled accordingly. (EPA, 2017)
- **AERATING:** When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump. (EPA, 2017)





- **DIRECT SUNLIGHT/HOT CONDITIONS:** Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater. (EPA, 2017)
- **WELL CONVECTION:** Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column which may cause the cooler water to sink to the bottom of the well and the warmer water to rise, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convectioning water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007). (EPA, 2017)
- **POOR INSTRUMENTATION:** Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected (EPA, 2017).

#### **INTERFERENCES**

Interferences may result from:

- contaminated equipment,
- cleaning materials,
- sample containers, and
- air conditions (e.g., truck/vehicle exhaust nearby).

All non-dedicated equipment should be clean and decontaminated prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Dedicated equipment may help eliminate or reduce cross contamination problems (EPA, 2017). The use of dedicated sampling equipment can reduce sampling time and promote consistency (e.g. intake depth). Cleaning materials should not be used if they contain compounds included in the testing program. Material Safety Sheets can be reviewed to help selecting cleaning materials. The laboratory will provide clean and proper sample containers for sample collection. Sample planning should include avoiding times when poor air conditions may interfere with sampling results (EPA, 2017).

#### **PERSONNEL QUALIFICATIONS /RESPONSIBILITIES**

All personnel collecting water samples should have the following minimum qualifications:

- First aid training;
- Medical clearance under the Hargis + Associates medical surveillance program; and
- Current respirator fit testing.

Personnel are responsible for reviewing the SOP, equipment operator manuals, and the project specific work plan (WP) and or sampling and analysis plan (SAP).



## **EQUIPMENT AND SUPPLIES**

A number of potentially suitable equipment and instrumentation options are available for purging and sampling. Common elements of these options include:

- Water level measuring device
- Submersible pump, discharge line and control box
- Bladder pump, discharge line and control box
- Power source (e.g. mobile generator)
- Parameter measurement equipment
- Laboratory provided storage bottles with preservatives and or filter as appropriate. Sample containers required for collection of water samples for chemical analysis are been specified in sampling and analysis plans (SAPs) and or quality assurance quality control plans (QAPPs).
- Water discharge storage container (e.g. drums, tanks)

All equipment should be made of chemically compatible materials suitable for environmental sample collection.

## **PROCEDURE**

**PURGING:** For each well to be sampled, field personnel will calculate and record the depth of the pump intake; the inner diameter and total length of the discharge tubing; and the total system volume for each system installation, which includes the sum of the volume of the pump, the volume of the discharge tubing, and the volume of the flow-through cell used to measure indicator parameters, compensated for the displacement volume of the parameter probes.

System volume will be recorded in the same units that discharge volume will be recorded during purging and sampling, generally milliliters or liters. To the extent practical, thick-walled discharge tubing will be used to minimize tubing/purge volumes. In no case will the purge volume at the time of sampling be less than twice the total system volume.

The overall goal when purging each well is to stabilize the flowrate as soon as possible to achieve the least amount of stress/turbulence and stabilize drawdown for purging and sampling, with a target drawdown on the order of about 0.1 meter (0.33 foot) or less. Purging will commence at the lowest flowrate possible to achieve and sustain continuous discharge at the surface, while simultaneously monitoring the water level to adjust flowrate downward to minimize drawdown. Measurements of discharge rate will be made using in-line flow meters and/or stop watches and graduated cylinders, beakers, or other calibrated small-volume containers sufficient for quantifying target flowrates that are typically on the order of about 100 ml/min to 500 ml/min. Drawdown will be calculated as the difference between the pumping water level and the pre-pumping static water level.

The actual flowrate and the minimal drawdown goal may be difficult to achieve under some circumstances due to hydraulic properties of the geologic formation within the screened interval. Adjustments may be required based on Site- and/or well-specific conditions, equipment, and/or personal experience. If the minimal drawdown cannot be maintained, the actual drawdown and flowrate will be monitored and documented on the field data documentation forms (SOP-E, SOP-F).



In addition to drawdown and flowrate, indicator parameters will be continuously monitored during purging and sampling. Indicator parameters will be monitored using a flow-through cell of known volume and calibrated meters and probes. Frequency of monitoring for these parameters is a function of the total system volume and purge rate. Indicator parameter monitoring will commence after purging a minimum of one complete total system volume. The minimum time interval between subsequent indicator parameter readings will be equal to or greater than the time required to replace the internal volume of the flow-through cell plus the measurement/reading equilibration time, generally expected to be on the order of every 3 to 5 minutes. Indicator parameter stabilization will be defined as 3 consecutive readings after the initial system volume is removed that meet the following stabilization criteria as further detailed in the Guidance (DTSC, 2008; EPA, 2002).

INDICATOR PARAMETER	STABILIZATION CRITERIA
Drawdown	Generally <0.1 meter (<0.33 foot)
Flowrate	Generally 100 to 500 ml/min
Temperature	± 0.2 degree Celsius or ± 3% of reading
pH	± 0.1 pH units
EC	± 3% of reading (mS/cm)
DO	± 0.3 mg/l
Turbidity	1 NTU or ± 10% when turbidity is >10 NTUs
ORP	± 10mV

< = Less than; mS/cm = milliSiemens per centimeter; mg/l = milligrams per liter; NTU = nephelometric turbidity unit; > = Greater than; mV = millivolts; ± = plus or minus

Minimal flowrate, minimal drawdown, and indicator parameter stabilization will be confirmed as soon as possible after commencing purging. Documentation will be maintained in a detailed and well-organized format on the appropriate field data documentation forms (SOP-E, SOP-F, SOP-J)

#### **SAMPLE COLLECTION AND HANDLING.**

- Record the following information on the field data sheet:
  - Static depth to groundwater.
  - Time that pumping started.
  - Time of sample collection.
  - Number of containers collected and analyses to be performed.
  - Field parameter measurements for each purge volume.
  - Field parameter measurements at time of sampling.
  - Physical characteristics of the water including color, odor, turbidity, etc.
  - Total gallons/liters removed at time of sampling.
  - Total gallons/liters removed at end of sampling.
- Collect water samples in appropriate sample containers from the pump discharge.



- Attach labels to sample containers immediately after samples are collected.
- General sample collection statements:
  - If sample bottles for analytes specified in field sampling plan (FSP) contain preservatives or are sterile, do not rinse bottles; otherwise, triple-rinse unpreserved (not sterile) bottles prior to sample collection.
  - If samples are to be cooled, store on ice in ice chest immediately after collecting.
- Specific sample collection statements:
  - Collect headspace free water samples for volatile organic compound (VOC) analysis in pre-acidified 40 milliliter (ml) glass sample vials preserved with hydrochloric acid. Do not rinse the glass vials with discharge water prior to sample collection. To avoid aeration, hold the glass vial at an angle so the stream of water flows down the side. To eliminate any air bubbles, fill the vial until it forms a meniscus and replace the Teflon lined cap. Turn the vial upside down and tap it to check for air bubbles. If there is any headspace in samples collected for VOC analyses, discard the original vial and use a new pre acidified vial. Repeat this procedure until a sample without headspace is obtained. Collect three 40 ml vials for each VOC analysis for each well sampled. Place samples in a resealable plastic bag and store on ice in an ice chest immediately after collection.
  - If water samples are to be analyzed for constituents that require filtration and acidification (for example, for priority pollutant metals), the samples can be collected filtered in the field or filtered in the laboratory as follows:
    - Field filtered samples: Filter water samples in the field prior to collection in pre-acidified bottles. Collect water samples for constituents in pre-acidified bottles as specified in the FSP. In some cases, it may be possible to combine different constituents that require filtration and the same preservative from the same well into one bottle if the laboratory confirms adequate volume of water is available in the respective bottle (e.g., cations and priority pollutant metals). Do not rinse sample bottles with discharge water prior to sample collection. Store on ice in an ice chest immediately after collection.
    - Laboratory filtered samples: Collect water samples for constituents in unpreserved (non-acidified) bottle (same size and material as specified in FSP). Triple-rinse unpreserved sample bottles with sample water prior to sample collection. Instruct laboratory to filter and acidify immediately upon receipt. Store on ice in an ice chest immediately after collection.
  - If coliform bacteria analysis is conducted, wear gloves when collecting samples. Do not rinse the bottles. The bottles are sterile, so care must be taken not to contaminate the bottle or cap. Once the distribution line is flushed and the flow reduced, quickly open the bottle (but do not set the cap down), hold the cap by its outside edges only, and fill the sample bottle to just above the 100 ml line leaving 1 inch of headspace. Cap the bottle immediately and place it into a cooler with ice for delivery or overnight shipment to the laboratory.
- Collect one field duplicate sample for every 10 samples collected during the sampling event. Analyze duplicate samples for the same compounds as original samples. Send duplicate samples along with the original samples to the primary laboratory. The location for duplicate sample collection will be determined prior to each sampling round.
- Collect one field blank sample daily or for every 10 samples collected during the sampling event, whichever is more frequent. Analyze field blank samples for VOCs. The field blank



will be prepared at a sampling location by the field personnel using reagent-free deionized water obtained from the primary analytical laboratory.

- If nondedicated sampling equipment is used, collect one rinsate blank sample daily or for every 10 samples collected during the sampling event, whichever is more frequent. Analyze field blank samples for organic constituents. The field blank will be prepared at a sampling location by the field personnel using reagent-free deionized water obtained from the primary analytical laboratory.
- Include one trip blank sample containing reagent-free deionized water for VOC analysis to accompany each ice chest shipped each day for these analyses. The trip blanks will be prepared by the primary analytical laboratory, using reagent-free deionized water.
- Prepare split samples for EPA or other agencies during groundwater sampling, if required, by alternately filling agency and project sample containers in sequential order for each parameter until all containers are filled.
- Handle duplicate, trip blank, and field blank water samples in a manner identical to other water samples.
- Record all pertinent data concerning each sample on the groundwater sampling information field data form (Table Low Flow Groundwater Sampling Form).
- Record all pertinent data concerning each duplicate, split, and blank sample on the appropriate field data log forms (Table QA QC Sample Log Form).
- Complete chain of custody record at each sample location prior to sampling at the next sample location.
- Prepare chain of custody record (Table Chain-of-Custody) at the completion of each sampling event.
- Package, store, and transport the samples to the laboratory at the conclusion of each sampling day. Samples will be delivered to the laboratories as quickly as possible, via laboratory courier, if available.

**SAMPLE CONTAINERS, PRESERVATION, AND TRANSMITTAL:** A list of the types and volumes of sample containers used for groundwater sampling has been prepared (refer to FSP). The laboratory will prepare the 40 ml glass vials and septa used to collect samples for VOC analysis. The vials will be washed with detergent, rinsed with reagent free deionized water, and dried 1 hour at 105 degrees Celsius. Vials to be used for VOC analysis will be preserved with hydrochloric acid. These vials will not be rinsed with sample water prior to collection of samples.

Upon collection, all samples will be sealed with custody seals, labeled, and stored on ice in ice chests until received by the laboratory. Sample shipments will contain completed chain of custody records stored in resealable plastic bags for shipment to the laboratory (Table Chain-of-Custody). Each ice chest containing samples will be clearly labeled and sealed to prevent tampering. Standard sample control and chain of custody procedures will apply.

**EQUIPMENT DECONTAMINATION AND DISPOSAL:** Non-dedicated downhole equipment will be decontaminated between monitor wells to be sampled during the Work Area activities by using a non-phosphate detergent wash, followed by a potable water rinse and a final, distilled water rinse. Water generated during decontamination procedures will be containerized and stored onsite. Spent health and safety equipment will be containerized and stored onsite.



Purge water from monitor wells will be contained at the wellhead and transported to an on Site storage tank or other designated purge water storage container. Disposal of purge water practices will be consistent with the SOP for handling, storage, characterization, and disposal of IDW.

#### **DATA AND RECORDS MANAGEMENT**

**FIELD ACTIVITY LOG:** Field activities will be recorded on the appropriate field logs (attached tables) by the on-site field staff. All field data entries in the field notebook will be signed, dated, and kept as a permanent record. The field notebook will be the responsibility of the field team leader. Erroneous entries will be corrected by crossing a line through the error and entering the correct information. Corrections will be initialed by the person making the re-entry. Documented information may include:

- Project name and number;
- A description of field activities performed (e.g. procedures, field measurements, calibrations)
- Date and location of field activities
- Field Personnel
- Sub-contractors names and provided services
- Deviations from the work plan and or SOP.
- Miscellaneous remarks and comments (e.g. weather conditions, significant events)

Completed field sheets and or scanned copies of completed field sheets will be maintained in the project file.

**SAMPLE DOCUMENTATION:** Sample identification documents will be prepared so that sample identification and chain of custody are maintained and sample disposition is controlled. The following sample identification documents are to be used:

- Sample identification label (SOP-Q)
- Chain of custody and analysis request forms (SOP-D)

**SAMPLE IDENTIFICATION LABEL:** Preprinted adhesive sample labels will be secured to the sample containers by field personnel. Sample labels will be completed with waterproof ink, and contain the following information:

- Sample location/identifier
- Depth at which sample was collected, if applicable
- Date and time sample was collected
- Analyses to be performed
- Preservation instructions
- Project number
- Sampler's initials
- Any other pertinent information
- Any special instructions to laboratory personnel

**CHAIN-OF-CUSTODY:** The chain of custody will be maintained and documented from the time of sample collection until the validation of analytical results. The chain of custody record is the document that records the transfer of sample custody and also serves to cross reference the sample identifier assigned by the QA Manager with the sample identifier assigned by the laboratory. Copies of the chain of custody will be retained by the samplers and sent directly



to the QA Manager designated for the project. The chain of custody record includes the following information:

- Sample location/identifier
- Project number
- Sampling date
- Sampling personnel
- Shipping method
- Sample description
- Sample volume
- Number of containers
- Sample destination
- Preservatives used
- Analyses to be performed
- Special handling and reporting procedures
- The identity of personnel relinquishing and accepting custody of the samples

The sampling personnel will be responsible for the samples and will sign the chain of custody record to document sample transferal or transport. Samples will be packaged in sealed containers for transport and dispatched to the appropriate laboratory for analysis with a separate chain of custody record accompanying each shipment. The method of transport, courier name(s), and other pertinent information will be entered on the chain of custody record. During transport, samples will be accompanied by the chain of custody record.

Once received at the laboratory, laboratory custody procedures apply. It is the laboratory's responsibility to acknowledge receipt of samples and verify that the containers have not been opened or damaged. It is also the laboratory's responsibility to maintain custody and sample tracking records throughout sample preparation and analysis.

## **QUALITY CONTROL AND QUALITY ASSURANCE**

Quality Control and Quality assurance (QC/QA) during sampling will be accomplished by following this SOP. Laboratory QA procedures are specified in the laboratory's QA Manual, and evaluation of laboratory QA documentation is described in the QAPP. In addition, the Supervising Professional Geologist will review all documentation to ensure conformity with this SOP. In addition, the following field QC methods will be implemented during sample collection:

- Wells should be sampled in order of increasing contamination.
- If multiple sampling methods are being compared (e.g. Low-Flow purging versus PDB) both sample collections should be performed on the same day.
- Collect one field duplicate sample for every 10 samples collected during the sampling event. Send duplicate samples along with original samples to the primary laboratory. The purpose of the duplicate sample is to determine the precision of field sampling and laboratory analysis techniques. Field duplicate samples will be laboratory blind duplicates. A false well identifier will be assigned for the sample identifier and recorded on the sample label and chain-of-custody record along with a false sample collection time. The actual sample location, sample time, and corresponding false sample identifier and sample time will be recorded on the duplicate sample log form (Table QA QC sample Log Form).
- Collect one equipment rinsate blank sample each day or for every 10 samples collected, whichever is more frequent, if nondedicated sampling equipment is used in one or more wells. Equipment rinsate samples will be analyzed for organic constituents. If laboratory



analysis of the equipment rinsate sample indicates inadequate decontamination procedures, corrective action will be taken as detailed in the QAPP. Record blank sample preparation on the appropriate field form (Table QA QC sample Log Form).

- Collect one field blank sample each day during the sampling event or for every 10 samples collected, whichever is more frequent. Sampling personnel will prepare the field blanks at a predetermined sample location using reagent-free deionized water obtained from the analytical laboratory. The purpose of the field blank is to identify possible contamination associated with sample collection and transport. Record blank sample preparation on the appropriate field form (Table QA QC sample Log Form).
- Include one trip blank sample containing reagent-free deionized water for VOC analyses to accompany each ice chest shipped each day for these analyses. The trip blanks will be prepared by the analytical laboratory using reagent-free deionized water. The purpose of the trip blank is to identify possible contamination associated with container preparation and sample transport.
- Prepare split samples for EPA or other agencies during groundwater sampling, if required, by alternately filling agency and primary sample containers in sequential order for each parameter until all containers are filled.
- Identify duplicates and blank samples in the same manner as all other samples. Identifiers will be determined prior to the sampling round and will be indicated in the sampling memorandum issued to field sampling personnel prior to the start of sampling activities.
- Prior to the start of each sampling round, the field staff under the supervision of a licensed geologist will determine the sampling locations for field blank preparation and duplicate sample collection. Additionally, the field staff in consultation with the QA Manager will specify labeling procedures for these samples. This information will be contained in a sampling memorandum issued to field sampling personnel prior to the start of sampling activities.

## REFERENCES

U.S. Environmental Protection Agency (EPA), 1996. Ground Water Issue – Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. OSWER, EPA540/S-95/504. April 1996.

U.S. Environmental Protection Agency Region I (EPA) 2017. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells EQASOP GW4. Date: July 30, 1996 Revised: September 19, 2017.

## ATTACHMENTS

- TABLE Chain\_of\_Custody
- TABLE Field Observations Form w lines
- TABLE GW Sampling Form
- TABLE Low Flow Groundwater Sampling Form
- TABLE QA QC Sample Log Form
- TABLE SAMPLE LABEL





**TABLE A-9**  
**CHAIN-OF-CUSTODY AND ANALYSIS REQUEST FORM**

Date: \_\_\_\_\_  
Page \_\_\_\_\_ of \_\_\_\_\_

PROJECT NAME :  
TASK NO. :

Project Manager \_\_\_\_\_  
QA Manager \_\_\_\_\_  
Phone 480-345-0888

[illegible]

## Instructions

1. Fill out form completely and sign only after verified for completeness
2. Complete in ballpoint pen. Draw one line through error, initial and date correction
3. Indicate the number of sample containers in analytical request space; indicate choice with ✓ or ×
4. Note applicable preservatives, special instructions, and deviations from typical environmental samples.
5. Consult project QA documents for specific instructions.

<input type="checkbox"/>	No. of containers correct
<input type="checkbox"/>	Received in good condition
<input type="checkbox"/>	Conforms to COC document

Temperature on receipt

Send Results to:  
Barbara A. Murphy  
1640 S. Stapley Drive  
Suite 209  
Mesa, AZ 85204  
Ph: 480-345-0888  
Fax: 480-730-0508  
[bmurphy@hargis.com](mailto:bmurphy@hargis.com)

**LAB - PLEASE EMAIL COC TO B. MURPHY UPON RECEIPT**



**FIELD OBSERVATIONS**

PROJECT NAME / LOCATION: \_\_\_\_\_

PROJECT NO.: \_\_\_\_\_ DATE: \_\_\_\_\_ INITIALS: \_\_\_\_\_

<div>-</div> <div></div>
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## GROUNDWATER SAMPLING INFORMATION

DATE: \_\_\_\_\_

**TASK:** \_\_\_\_\_

WELL ID: \_\_\_\_\_

Time _____ Static DTW (ft below reference point)  Casing Total Depth (ft below reference point)  Water Column (feet)  Casing Capacity (Diameter    " ) (gallons per foot)		Casing Volume (CV) (gallons) _____ 3 CV (gallons) _____	<u>Weather Conditions</u>	<b>Initials</b>
		Purging Device _____ Sampling Device _____	Time _____ Temp. _____	Begin Purge _____ End Purge _____
		Pump: Depth (ft brp) _____ Type _____ Voltage _____ HP _____	Skies _____	Gallons Purged _____ CVs Purged _____
		Monitor Well Recharge Rate: Slow _____ Fast _____	Wind (mph) _____ From _____	DTW (ft brp) _____ Time _____

[illegible]



## LOW-FLOW GROUNDWATER SAMPLE FORM

**DATE:** \_\_\_\_\_

**TASK:** \_\_\_\_\_

WELL ID: \_\_\_\_\_

SELECT TUBING SPECS		Calculate System Volume		Initial Measurements		Purge Summary      Initials: _____	
TUBING DIAMETER	TUBING CAPACITY	Length of tubing: _____ ft x Capacity of Tubing: _____ mL/ft		Static Depth to water: _____ ft brp		Begin Purge: _____ End Purge: _____	
3/8" X 1/2"	22 mL/ft	Tubing Volume = _____ L		Well Total Depth: _____ ft brp		Tot. Vol Purged: _____ L SVs purged: _____	
1/4" X 3/8"	9.7 mL/ft	+ Vol of flow-thru cell: _____ L		Screened Interval : _____ to _____ ft brp		Weather Conditions      Time: _____	
0.17"ID	4.5 mL/ft	+ Vol of pump: _____ L		Pump Intake : _____ ft brp		Temp. _____ 'F      Skies _____	
Total Vol of System = _____ L x 2 = <b>Min. Purge Volume</b> = _____ L				brp description (circle one): TOC   LS   other		Wind _____ mph      From _____	

**Pump Type (circle one) :** Bladder pump or Peristaltic Pump

Time	Flow Controller Settings	Depth to Water (ft brp)	Flow Rate (mL/min)	Volume Purged (L)	System Volumes Purged	....FIELD PARAMETERS....						COMMENTS
						Temp. (°___)	Ph units	EC (___S/cm)	O.R.P. (mV)	D.O. (mg/L)	Turbidity (NTU)	
						+/- 3%	+/- 0.1 unit	+/- 3%	+/- 10 mV	+/- 0.3mg/L	+/- 10% (if > 10NTU)	

SAMPLE COLLECTION

SAMPLE TIME

ANAYSIS

QUANTITY

TYPE

AIR MONITORING PID/FID ppm: VAULT BKGD BREATHING ZONE DISCHARGE WATER

NOTES (Color, odor, sand and silt content, factors possibly affecting samples, condition of vault, wellhead, sampling apparatus, etc.)

DUPLICATES / BLANKS?

Y

N

If yes, complete appropriate forms.

Acronyms and Abbreciations:

SVs = System Volumes; bmp = below measurment point; mL = milliliters; gal = gallons; L = liters; DTW = depth to water; TD = total depth



## QA/QC SAMPLE LOG FORM

### (Duplicates, Splits and Blanks)

PROJECT NAME: \_\_\_\_\_

PROJECT NUMBER: \_\_\_\_\_

MONTH/YEAR: \_\_\_\_\_

[illegible]



HARGIS + ASSOCIATES, INC.

**FIGURE SOP-Q  
SAMPLE IDENTIFICATION LABEL**



**HARGIS + ASSOCIATES, INC.** Phone: 858.455.6500  
9171 Towne Centre Drive, Suite 375, San Diego, CA 92122

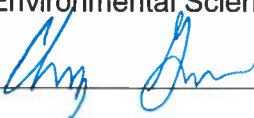

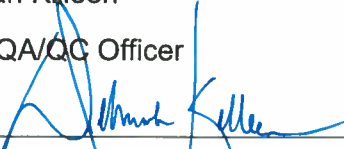

Client	H+A Project No.	Initials
--------	-----------------	----------

Sample ID	Date / /	Time
-----------	-------------	------

Analyze for:

Preservative/Special Instructions:

## STANDARD OPERATING PROCEDURE APPROVAL AND CHANGE FORM

Scientific, Engineering, Response and Analytical Services 2890 Woodbridge Avenue Building 209 Annex Edison New Jersey 08837-3679	
<b>STANDARD OPERATING PROCEDURE</b>	
Title: Sediment Sampling	
Approval Date: 07/31/2016	
Effective Date: 07/31/2016	SERAS SOP Number: 2016, Rev 1.0
<b>Authors</b>	
Name Christopher Gussman	
Title SERAS Environmental Scientist (Biologist)	
Signature 	Date 7/31/16
Name	
Title	
Signature	Date
<b>Approvals</b>	
Name Richard Leuser	
Title SERAS Deputy Program Manager	
Signature 	Date 7/31/16
Name Deborah Killeen	
Title SERAS QA/QC Officer	
Signature 	Date 7/31/16
Name Kevin Taylor	
Title SERAS Program Manager	
Signature 	Date 7/31/16

The top row of this table shows the most recent changes to the controlled document. For previous revision history information, archived versions of this document are maintained by the SERAS QA/QC Officer on the SERAS local area network (LAN).

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# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 1 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

### CONTENTS

1.0	SCOPE AND APPLICATION
2.0	METHOD SUMMARY
3.0	SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE
4.0	INTERFERENCES AND POTENTIAL PROBLEMS
5.0	EQUIPMENT/APPARATUS
6.0	REAGENTS
7.0	PROCEDURES
7.1	Preparation
7.2	Sample Collection
7.3	Sediment Sampling Methods and Operational Instructions
7.3.1	Sampling Surface Sediment with a Scoop/Trowel
7.3.2	Sampling Surface Sediment with a Bucket/Tube Auger
7.3.3	Sampling Deep Sediment with a Bucket/Tube Auger
7.3.4	Sampling Surface Sediment with a Mechanical Dredge
7.3.5	Sampling Sediment with a Core Device
7.3.6	Diver-Assisted Sediment Sampling
7.3.7	Vibracore® Sampling
7.3.8	Volatile Organic Sampling
7.3.8.1	En Core® Sampling
7.3.8.2	Terra Core® Sampling
8.0	CALCULATIONS
9.0	QUALITY ASSURANCE/QUALITY CONTROL
10.0	DATA VALIDATION
11.0	HEALTH AND SAFETY
12.0	REFERENCES
13.0	APPENDICES

A - Figures

SUPERCEDES: SOP #2016, Rev. 0.0, 11/02/01, U.S. EPA Contract 68-C99-223

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# STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 2 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

### 1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes general and specific procedures to be used by Scientific, Engineering, Response and Analytical Services (SERAS) personnel when collecting representative sediment samples. For the purposes of this SOP, sediment is defined as organic or inorganic material that is broken down by the processes of weathering and erosion and deposited/transported by the action of water. Some examples of sediments include: weathered rock, naturally occurring organic material, and secretions from organisms (e.g. Calcite). The methodologies discussed in this SOP are applicable to the sampling of sediment located adjacent to and underneath the surface of water bodies. Sediment samples are most typically collected to determine the following:

- chemical analysis
- contaminant toxicity
- bioassays
- the presence of benthic biota
- delineate the type, extent and concentration of contamination/impact
- to identify contaminant migration pathways and sources
- disposal of contaminants
- grain size distribution of contamination
- depositional environment/ambient conditions
- sediment type

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure the methods used are adequate to satisfy the data quality objectives listed in the site-specific QAPP.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

### 2.0 METHOD SUMMARY

Various techniques, methods and equipment have been developed for the collection of sediment samples and their use is subject to site conditions and project goals. Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed), contaminants present, sediment type, and analyses required.

Sediment is collected from beneath an aqueous layer either directly, using a hand-held device such as a scoop, trowel, or auger, or indirectly, using a remotely activated device such as an Ekman or Ponar dredge. Following collection, sediment is transferred from the sampling device to a sample container of appropriate size and construction for the analysis(es) requested. If composite sampling techniques are employed, multiple grabs are placed into a container constructed of an inert material (e.g. stainless steel bowl, aluminum pan, or re-sealable plastic bag), homogenized, and transferred to the sample container(s) appropriate for the analysis(es) requested. The homogenization procedure should not be used if the sample analysis includes volatile organic compounds (VOCs). In this case, sediment, or multiple grabs of sediment, should be transferred directly from the sample collection device or homogenization container to the sample container.



# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 3 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

Cores may also be collected directly into an acetate or polyvinyl chloride (PVC) sleeve that serves as the sample container for undisturbed samples.

### 3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is generally not recommended. Cooling to less than or equal to ( $\leq$ ) 6 degrees Celsius ( $^{\circ}\text{C}$ ) is usually the best approach, supplemented by the appropriate holding time for the analyses requested.

Wide-mouth glass containers with Teflon lined caps are utilized for sediment samples. The sample volume is a function of the analytical requirements and will be specified in the QAPP.

The amount of sample collected, along with the proper sample container type (i.e. glass, plastic), chemical preservation, and storage requirements are dependent upon the matrix sampled and analysis performed. For further information, refer to the SERAS SOP #2003, *Sample Storage, Preservation and Handling*, and/or the QAPP. Preservation of sediment samples is dependent on the analytical method chosen for analysis. Use of sodium bisulfate for VOCs creates low pH conditions that may deteriorate certain target compounds. Samples preserved with methanol can only be analyzed by the medium level method; thereby, elevating reporting limits (RLs).

Additional Quality Assurance/Quality Control (QA/QC) samples should be collected as outlined in the QAPP for each specific site. Further information on QA/QC Samples can be found in SERAS SOP #2005, *Quality Assurance/Quality Control Samples*.

Samples are packed and shipped in accordance with SERAS SOP #2004, *Sample Packing and Shipping*.

### 4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Sediments occur in a wide variety of environments such as streams, wetlands, rivers, lakes and oceans. Some of these environments can be difficult and possibly hazardous to sample. It is common to find material that may be too large to sample such as cobbles and gravel. In addition, dense clays, silts and organic material may also be found. The appropriate sampling equipment must be assigned, prior to field work, for the collection of the materials anticipated to be encountered.

When working in areas deeper than wading depth, a vessel would be required. SERAS maintains a wide range of vessels (from small zodiacs, pontoon boat for inland projects to a 41-survey vessel capable of working in the open ocean). Appropriate health and safety measures must be applied to the collection methods chosen.

The potential of introducing contamination by a sampling device or technique poses a limitation in sediment sampling. Sometimes, the material that sample containers are made of can interfere with the contaminants that a sample will be analyzed for (i.e. plastics absorb pesticides, metal devices may corrode, etc.). When selecting the samples bottles, consider the contaminants of concern which are to be analyzed.

Substrate particle size and organic matter content are a direct consequence of the physical characteristics of a water body and the watershed. Contaminants are more likely to be concentrated in sediment typified by fine particle size and high organic matter. This type of sediment is most likely to be collected from depositional zones. In contrast, coarse sediment with low organic matter does not typically concentrate



# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 4 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

contaminants and are generally found in erosional zones. The selection of a sampling location can, therefore, greatly influence the analytical results and should be justified and discussed in the QAPP.

Sediments may contain very light particulate matter. For undisturbed samples, all efforts must be made to protect these light sediments from being lost during sampling due to current, agitation, or other methods. Care must be taken when decanting standing water from a sediment sample to minimize the loss of these fine particulates.

### 5.0 EQUIPMENT/APPARATUS

The equipment required for collection of sediment samples mainly depends on the environment where the sampling is going to take place and the contaminants that are being analyzed. In general, the equipment listed below may be required to perform sediment sampling:

- Maps/Navigational charts
- Personal protective equipment (PPE)
- Compass
- Global positioning system (GPS) receiver
- Tape measure
- Survey stakes, flags, buoys and anchors
- Digital camera
- Bucket, plastic or stainless steel
- Sample bottles
- Ziploc® plastic bags of various sizes
- Field logbook/Sampling data sheets
- Sample labels
- COC records
- Custody seals
- Cooler(s)
- Wet ice
- Decontamination equipment and supplies
- Scoops (plastic or stainless steel)
- Trowels (plastic or stainless steel)
- Bucket auger, with T-handle and extensions
- Tube auger, with T-handle and extensions
- Pipe wrenches
- "T" handle for Volatile Organic Compound (VOC) sampling and "T" handle for sampling with auger bucket/tube
- Ekman™ dredge
- Ponar™ dredge
- Van Veen Sampler or Young-Modified Van Veen Sampler
- Nylon™ rope line or steel cable
- Winch
- Power drill
- Photo-Ionization Detector (PID)/Flame-Ionization Detector (FID)
- Tools and toolbox, multi-use
- SCUBA/dive gear

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# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 5 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

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- Laptop computer with Scribe™ software
- Portable printer
- Printer paper
- Power strip (s)
- Extension cords
- Vessel
- Hacksaw
- En Core®/Terra Core® samplers
- Trash bags
- Coring device
- Acetate/Polycarbonate/PVC sleeves
- Cutting shoes
- Core catchers
- Hook blade razor knife
- Geoprobe® liner cutting tool
- Hip and chest waders
- Over boots
- Ice
- Bowls, stainless steel, for homogenizing sample

### 6.0 REAGENTS

Decontamination solutions are specified in the SERAS SOP #2006, *Sampling Equipment Decontamination*. In addition, these solutions are included in the site-specific Health and Safety Plan (HASP).

### 7.0 PROCEDURES

#### 7.1 Preparation

1. Determine the project objectives and extent of the sampling event.
2. Perform a general site survey prior to commencement of field activities, in accordance with the site-specific HASP.
3. Prepare schedules, coordinate with staff and subcontractors, and communicate with the regulatory agency.
4. Determine the type of equipment and supplies required based on the site characteristics and project objectives.
5. Identify, obtain and calibrate the required air monitoring equipment (e.g. PID/FID), if required by the health and safety plan (HASP).
6. Confirm that the sampling equipment is working and ready to use.
7. Decontaminate all non-dedicated sampling equipment in accordance with SERAS SOP #2006, *Sampling Equipment Decontamination*.

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# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 6 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

8. Identify and mark all potential sampling locations with stakes, flags, and/or buoys, if appropriate. A GPS may be used to identify preselected sampling locations or to record sampling locations. When selecting sampling locations, consider the site's specific physical characteristics including, but not limited to, water flow, topography, depth of the overlying aqueous layer, sediment type, contaminant source, and the extent and nature of contamination. In addition, consider on-site access and property boundaries.

### 7.2 Sample Collection

The selection of a sampling device is mainly contingent upon the:

- physical characteristics of the sediment to be sampled,
- type of sample needed,
- analytical parameters to be studied,
- amount of sediment needed,
- contaminant(s) contained in the sediment,
- depth of water above the sampling location, and
- possible interferences or contamination introduced by the sampling device.

If analysis of sediment from a discrete depth or location is desired, sediment is transferred directly from the sampling device to a labeled sample container(s) of appropriate size and construction for the analysis (es) requested. Transfer is accomplished with a stainless steel or plastic lab spoon or equivalent.

If composite sampling techniques or multiple grabs are employed, equal portions of sediment from each location or collocation are deposited into a decontaminated stainless steel, plastic, aluminum pan or other appropriate container (e.g., Teflon). The sediment is homogenized thoroughly to obtain a mixture representative of the area sampled. The composite sediment sample is transferred to a labeled container(s) of appropriate size and construction for the analysis (es) requested. Transfer of sediment is accomplished with a stainless steel or plastic lab spoon or equivalent. Samples for VOC analysis must be transferred directly from the sample collection device or pooled from multiple areas in the homogenization container prior to mixing. This is done to minimize the loss of contaminant due to volatilization during homogenization.

All non-dedicated sampling devices should be decontaminated prior to use, then wrapped in aluminum foil. The sampling device should remain wrapped until needed. Dedicated sampling devices should be used for each sample. Disposable sampling devices for sediment are generally impractical due to cost and the large number of sediment samples which may be required. Sampling devices should be cleaned in the field using the decontamination procedure described in (SERAS) SOP #2006, *Sampling Equipment Decontamination*.

Once samples have been collected, the following procedures must be followed:

1. Transfer the sample(s) into suitable, labeled sample containers specific for the analyses to be performed.
2. Preserve the sample, if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.



# STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 7 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

3. Cap the container securely, place in a resealable plastic bag, and cool to  $\leq 6^{\circ}\text{C}$ , if required by the analytical method.
4. Record all pertinent data in the site logbook and/or on field data sheets.
5. Enter all sampling information into Scribe.
6. Generate a Chain of Custody (COC) record, place inside a plastic sleeve and tape to the top of the inside of the cooler.
7. Attach custody seals to cooler prior to shipment.

### 7.3 Surface Sediment Sampling Methods and Operational Instructions

The main purpose of sediment sampling is to collect a sample of a deposited material. In performing this task, proper sampling equipment and precautions are required to be taken. Several techniques have been developed to sample sediment material from different surface water environments. In general, the main techniques are sampling with scoops, bucket/tube augers, coring devices and mechanical grabs.

Scoops cause the greatest degree of sediment disturbance. Cores and mechanical grabs cause the least disturbance in the water-sediment interface. The main sediment sampling procedures are discussed below.

#### 7.3.1 Sampling Surface Sediment with a Scoop/Trowel

In shallow, slow moving water representative surficial sediment samples may be collected with plastic or stainless steel scoops or trowels.

1. Collect the desired thickness and volume of sediment from the marked sampling location causing minimal disturbance of the water-sediment interface with a scoop.
2. Place the sample into a homogenization container or a specified sampling bottle. (If sampling for VOCs, do not homogenize; transfer the sample directly into the container). See section 7.3.8 for more information on collecting VOC samples.
3. Label the sample bottle and store in a cooler with wet ice.

#### 7.3.2 Sampling Surface Sediment with a Bucket/Tube Auger

In shallow water, representative surficial sediment samples may be collected with a bucket or tube auger. Bucket and tube augers are sampling devices that consist of a bucket or tube with a series of extensions and a handle in the shape of the letter "T" (commonly known as "T" handle). Refer to Figure 1, Appendix A)

1. Attach the bucket/tube auger to the required length of extensions and attach the "T" handle to the upper extension.
2. If the study objectives and characteristics of the sediment or water body warrant, an acetate sleeve may be inserted into the tube auger prior to sampling.
3. Insert the bucket/tube auger onto the sediment at a  $90^{\circ}$  vertical angle.





# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 8 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

4. Begin sampling by rotating the auger into the sediment with downward pressure until the desired depth is reached.
5. Slowly retrieve the auger containing the sample. The auger should be examined to determine if significant amounts of sediment are lost due to the thin, wet nature of some sediments. If significant losses have occurred, an alternate method of sampling should be performed, such as coring.
6. Carefully decant the surface water contained in the auger.
7. Collect VOC samples directly from the bucket/tube auger using methods discussed in section 7.8.3.
8. Place the sediment sample in a container to homogenize, and then transfer the sediment sample into the appropriate sample bottle.
9. Label the sample bottle and store in a cooler with wet ice.

### 7.3.3 Sampling Deep Sediment with a Bucket/Tube Auger

In some instances Bucket/Tube Augers may also be used to collect subsurface sediment samples in a dry creek bed. Typically this method is not practical due to difficulties keeping boreholes open to desired depth.

1. Attach the auger bucket/tube to the required length of extensions and attach the handle to the upper extension.
2. If using a tube auger, insert an acetate sleeve prior to sampling.
3. Insert the bucket/tube auger into the sediment at a 90° vertical angle.
4. Rotate the auger into the sediment with downward pressure until the desired depth is reached.
5. Begin augering while periodically removing any accumulated sediment (i.e. cuttings) from the auger bucket/tube. The cuttings should be temporarily stored on plastic sheeting at a distance of at least two (2) feet from the sampling area, to prevent cross-contamination.
6. After reaching the upper range of the desired depth, carefully retrieve the bucket/tube auger from the boring.
7. Advance the auger down the borehole carefully avoiding contact with the borehole sides to prevent cross-contamination. Gradually push down the auger into the sediment at sampling location to reach the desired depth.
8. Retrieve the auger from the borehole.



# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 9 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

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9. Carefully decant the surface water contained in the auger.
10. Collect VOC samples directly from the bucket/tube auger using methods discussed in section 7.8.3.
11. Place the sediment sample in a homogenization container, homogenize, and then transfer into the appropriate sample bottle.
12. Label the sample bottle and store in a cooler with wet ice.
13. Dispose the cuttings in accordance with the site-specific QAPP.

### 7.3.4 Surface Sediment Sampling with a Mechanical Dredge

The Ekman, Van Veen, and the Ponar™ dredges are recommended for sampling in deeper water (water that is too deep to use scoops or augers) or for when relatively large amounts of sediments are required. In general, dredges are devices with jaws that are forced shut by weights, level arms, springs, cables or cords. The Ekman™ dredge is mainly used to sample fine sediments (e.g. mud, silt, and other soft and unconsolidated materials) whereas the Ponar™ dredges can be used to sample a wider range of grain sizes (clay to small gravel). Listed below are the assembly and operation instructions for both devices (Figures 2 and 3, Appendix A)

#### Sampling using an Ekman™ Dredge

1. Attach a dredge head to the bracket on the base of the extension pole with machine bolts.
2. Engage the jaws in a way that they are in the open position by placing trip cables over the release studs. Ensure that the hinged doors on the top of the dredge open freely to grab a sample.
3. Lower the dredge above the sampling location and hold.
4. Using the extension pole, push the dredge head into the sediments to the desired depth.
5. Trigger the jaw by depressing the button on the upper end of the extension pole.
6. Raise the sampler and slowly decant the water contained in the device through the top opening of the sampler.
7. Open the dredge jaws and place the sediment into a container for homogenization or directly into appropriate sample containers.
8. Label the sample bottle and store in a cooler with wet ice.



# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 10 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

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### Sampling using a Ponar™ or Van Veen Dredge

**NOTE: Special care should be taken when using these types of dredges. The steel arms act in such a way as to cause significant pinch hazards.**

1. Attach a nylon rope (at least 1/4") or a steel cable (at least 1/8") to the ring located on top of the dredge.
2. Arrange the dredge with the jaws in the open position, setting the trip bar or spring pin so the sampler remains open when lifted from the top.
3. Slowly lower the sampler to just above the sediment surface and drop the sampler into the sediment.
4. Raise the dredge to the surface and slowly decant the water through the screens on top of the dredge.
5. Open the dredge jaws and place the sediment into a container for homogenization or directly into appropriate sample containers.
6. Label the sample container and store in a cooler with wet ice.

### 7.3.5 Sampling Sediment with a Coring Device

This method is ideal for collecting intact sediment core samples. By utilizing this technique the original layering of the sediment deposited will be preserved. In general, core samplers are elongated tubes composed of an acetate sleeve, a "T" handle, a core catcher, drive hammer and a cutting shoe (Figure 4, Appendix A).

1. Assemble the coring device and insert a PVC sleeve into the sampling tube.
2. Insert the core catcher, if needed, into the lower end of the sampling tube with the convex surface positioned inside the acetate sleeve.
3. Screw the cutting shoe onto the lower end of the sampling tube, securing the acetate sleeve and core catcher.
4. Attach the sampling device to the required length of extensions; then attach the "T" handle or the drive hammer onto the upper extension.
5. Place the sampler 90° over the location to be sampled.
6. If the "T" handle is used, place downward pressure on the device until the desired depth is reached. After the desired depth is reached, slowly retrieve the sampler from the sediment. Some samplers may be equipped with a ball valve at the top of the core to aid in retrieving wetter samples. This valve should be closed before retrieving the sampler from the bottom.



# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 11 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

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7. Carefully remove the coring device from the water sampling location.
8. Unscrew the cutting shoe and remove the core catcher.
9. Slide the PVC sleeve out of the bottom of the sampler tube. Decant surface water, using care to retain the fine sediment fraction. The sample may be left in the PVC sleeve, collected directly from the sleeve, or placed in a container for homogenization prior to transferring to sample containers. Cores should always be stored in an upright position until the overlying water has been drained, the PVC cores cut to remove any overlying air spaces, and capped on both ends. To drain the overlying water, the PVC core should cut at various levels starting near the top of the core and proceeding to just above the top of the sediments. Water should be drained at a rate slow enough to minimize turbulence and disturbance to the sediment. Indicate on the PVC tube the orientation of the sediment core using a waterproof marker.
10. Label the sample and store in a cooler with wet ice.

### 7.3.6 Diver-Assisted Sediment Sampling

For sampling in deep water environments where dredge methods cannot be used or core samples are required, a diver-assisted sediment sampling may be utilized. This technique may be used in biological and chemically-contaminated environments at depths up to 130 feet sea water (fsw) and is performed by trained EPA-certified scientific divers. All divers performing these activities are required to adhere to the SERAS SOP # 3019, *Dive Operation Safety*. Divers collecting sediment samples should have experience with equipment/methodology required to collect sediment.

1. Prepare two teams: a surface team (surface support) and a dive team (sampling team). The dive team will sample all locations and will remain in constant communication and supported by the surface team.
2. The surface control team will provide the diver team with an acetate or polyvinyl chloride (PVC) sampling tube, and two plastic end caps. A metal cap and a sledge hammer may be used in stiffer sediments to achieve the required sample depth.
3. The diver(s) will move to the sampling location.
4. Once at the sampling location, the diver(s) communicate to the surface team; the depth of water and the site/sediment conditions.
5. The diver(s) will manually advance the sample tube into the sediment or place the metal cap on top of the sleeve and hammer the sleeve vertically into the sediment until the desired depth is reached.
6. Remove the metal cap from the top of the core (if used) and replace with an end cap.
7. The core will then be slowly pulled from the sediment. The diver should reach the sediment and place a bottom cap on the core as soon as possible.



# STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 12 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

8. The diver will carry core vertically to the surface and give it to a member of the surface support team.
9. The surface support team will secure the end caps to the core with duct tape and document the sample location, sample depth and sample orientation (top of core/bottom of core). Cores are then transported and stored in an upright position.
10. The sample may be left in the sleeve, sampled directly from the core, or placed in a container for homogenization or compositing. Cores should always be stored in an upright position until the overlying water has been drained.
11. If intact cores are to be used for analysis or transported off the site, they should be cut and recapped after removing all overlying water/air space in the core. To drain the overlying water, the acetate core should cut at various levels starting near the top of the core and proceeding to just above the top of the sediment. Water should be drained at a rate slow enough to minimize water turbulence and disturbance to the sediment. After the water has been drained from the core, the core should be cut at the top of the sediment and recapped.
11. Label the sample and store in a cooler with wet ice.

### 7.3.7 Vibracore Sampling

When sampling in deep water or where significant sample volume or depth are required, Vibracoring techniques may be used. Use of the Vibracore obtains sediment samples by vibrating a metal core barrel into the sediment. Penetration success is dependent upon the lithology of the formation.

Vibracores are generally composed of a stainless steel tube, detachable metal-cutting nose, stainless steel core catcher and the Vibracore drilling head. In general, Vibracores are operated by a team of two or more people from a vessel or on a structure extending over the water surface. Vibracoring should be conducted in accordance with subcontractor's SOPs and industry methodology standards.

Vibracoring uses vibration to achieve penetration into the sediments. If undisturbed cores are required, alternate sampling methods should be evaluated (Figure 5, Appendix A).

1. After allowing the sediments in the core to settle, all standing water should be drained from the core by cutting small holes above the sediment line. Water should be drained slowly so as not to re-entrain fine sediments.
2. Put the core sleeve on the soil identification table.
3. Use a Vibracore™ sleeve cutting tool (electric sheet metal cutter) and cut the full length of the sleeve. Then position the cutting tool roughly 4 inches to the left or right of the first cut and cut the entire length of the sleeve again.
4. Separate the sample core into the pre-determined sampling intervals.



# STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 13 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

5. Screen the sample core with the appropriate air monitoring device and record all readings in a site log book.
6. Perform soil identification/description activities.
7. Collect Terra Core samples for VOC's first. Then, transfer the remainder of the interval to a mixing bowl and homogenize.
8. Transfer the samples into the appropriately labeled sample containers and then store in a cooler with wet ice to maintain a temperature of  $\leq 6^{\circ}\text{C}$ .

### 7.3.8 Volatile Organic Compound Sampling

#### 7.3.8.1 En Core® Sampler Method

The En Core® sampler is designed to collect sediment samples to be analyzed for VOC's. The En Core® sampler is comprised of an inert composite polymer (coring body) and a stainless steel "T" handle. This method reduces the open-air handling of soil samples in the field, minimizing the loss of VOC's. The following procedures are used for collecting sediment samples using an En Core® sampler (Figure 6, Appendix A).

1. Assemble the coring body, plunger rod and "T" handle.
2. Turn the "T" handle with the T-up and the coring body down and push the sampler into the sediment until the coring body is completely full (coring on sampler seen in the bottom hole of the sampler for 5 grams, and the top hole of the sampler for 25 grams) with minimal disturbance of the sample. Remove the sampler from the sediment.
3. Cap the coring body while it is still on the "T" handle. Push the cap over the flat area of the ridge. Ensure that the cap is seated properly to seal the sampler. Push cap to lock arm in place. Rotate the cap 90 degrees ensuring the cap is locked.
4. Remove the capped sampler by depressing the locking lever on the "T" handle while twisting and pulling the sampler from the "T" handle.
5. Using the hole located on the En Core® "T" handle, insert the core plunger, twist and lock the plunger of the core body.
6. Attach the label to the coring body cap, place it back into the En Core® sample bag and seal the bag.
7. This process will be conducted a total of three times for each field sample, six times for a sample and a field duplicate and nine times for a sample that has been chosen for the Matrix Spike/Matrix Spike Duplicate (MS/MSD) as outlined in the UFP-QAPP.



# STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 14 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

8. Store the sample in a cooler with wet ice at  $\leq 6^{\circ}\text{C}$ .
9. Decontaminate the En Core® "T" handle according to SERAS SOP #2006, *Sampling Equipment Decontamination*.

### 7.3.8.2 Terra Core® Sampler Method

A Terra Core® sampler is a single-use device designed to collect sediment samples to be analyzed for VOCs. The Terra Core® sampler is made of an inert composite polymer and reduces the open-air handling of sediment samples in the field. The following procedures are used for collecting sediment samples using a Terra Core® sampler (Figure 7, Appendix A).

1. Assemble the Terra Core® sampler by inserting the plunger portion into the "T" handle. Snap the plunger into the sampler.
2. Push the Terra Core® sampler into the sediment, ensuring that the Terra Core® sampler is completely full with sediment. Remove sampler from the sediment.
3. Unclip the plunger, rotate  $90^{\circ}$  and push the sample out of the sampler into a pre-weighted 40-milliliter (mL) vial containing a stirring bar. Refer to the analytical method if preservation is required. Label sample and store on wet ice.
4. This process will be conducted 3 times for the collection of a sample, 6 times for a duplicate and 9 times for an MS/MSD as outlined in the UFP-QAPP.

## 8.0 CALCULATIONS

This section is not applicable to this SOP.

## 9.0 QUALITY ASSURANCE/QUALITY CONTROL

Specific QA/QC activities that apply to the implementation of these procedures will be listed in the Quality Assurance Project Plan QAPP prepared for the applicable sampling event. The following general QA procedures will also apply:

1. All sample collection data, including sample collection methods, times of collection, analyses required, and decontamination procedures (if any) must be documented on site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer or instrument-specific SOPs, unless otherwise specified in the QAPP. Equipment check out and calibration is necessary prior to purging and sampling and must be done according to the instruction manuals supplied by the manufacturer.
3. Each field sampler's level of competency must be documented for each type of equipment used.





# STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 15 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

## SEDIMENT SAMPLING

### 10.0 DATA VALIDATION

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. These data are essential to providing an accurate and complete final deliverable. The SERAS Task Leader (TL) is responsible for completing the UFP-QAPP verification checklist for each project.

### 11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health Administration (OSHA) and SERAS health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs must be implemented prior to sampling the first well. The site's health and safety plan (HASP) should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and other PPE.

When conducting sediment sampling activities, physical hazards must be identified and adequate precautions are required to be taken to prevent any hazards. If sampling is conducted from a shore or bank adjacent to a water body, the sampler should be alert for bank collapse. The person performing the sampling should be on a lifeline and wearing the appropriate PPE [including a personal flotation device (PFD)]. If sampling from a vessel, samplers are required to take all appropriate protective measures and wear a PFD or mustang suit. Further information on personal protective equipment can be found in SERAS SOP # 3016, *Personal Protective Equipment Program*.

All diver assisted sampling should also follow SERAS SOP# 3019, *Diver Operation Safety*. Any sampling that is being conducted from a vessel should follow both safety and operation requirements.

### 12.0 REFERENCES

Barth, D.S. and B.J. Mason. 1984. *Soil Sampling Quality Assurance User's Guide*. EPA-600/4-84-043.

de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. 1980. *Samplers and Sampling Procedures for Hazardous Waste Streams*. EPA-600/2-80-018.

Mason, B.J. 1983. *Preparation of Soil Sampling Protocol: Technique and Strategies*. EPA-600/4-83-020.

Murdoch, Alena and S.D. MacKnight. 1991. *Handbook of Techniques for Aquatic Sediments Sampling*. CRC Press.

U.S. Environmental Protection Agency. 1984. *Characterization of Hazardous Waste Sites - A Methods Manual, Available Sampling Methods*. 2<sup>nd</sup> Ed. Vol. II. EPA-600/4-84-076.

U.S. Environmental Protection Agency. 1991. *Compendium of ERT Surface Water and Sediment Sampling Procedures*. EPA/5404/P-91/005.



## STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 16 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

### SEDIMENT SAMPLING

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US Environmental Protection Agency. 1996. *Guidance Document for the Implementation of the United States Environmental Agency Method 5035: Methodologies for Collection, Preservation, Storage, and Preparation of Soils to be Analyzed for Volatile Organic Compounds*. Revision 0.

U.S. Environmental Protection Agency. 1985. *Sediment Sampling Quality Assurance User's Guide*. EPA/600/4-85/048.

U.S. Environmental Protection Agency. 1982. *Sampling Protocols for Collecting Surface Water, Sediment, Bivalves, and Fish for Priority Pollutant Analysis*. Final Report. EPA-68-01-6195. D748.

#### 13.0 APPENDICES

##### A - Figures

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## STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 17 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

### SEDIMENT SAMPLING

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APPENDIX A  
Figures  
SETAS SOP #2016  
July 2016

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## STANDARD OPERATING PROCEDURES

SOP: 2016

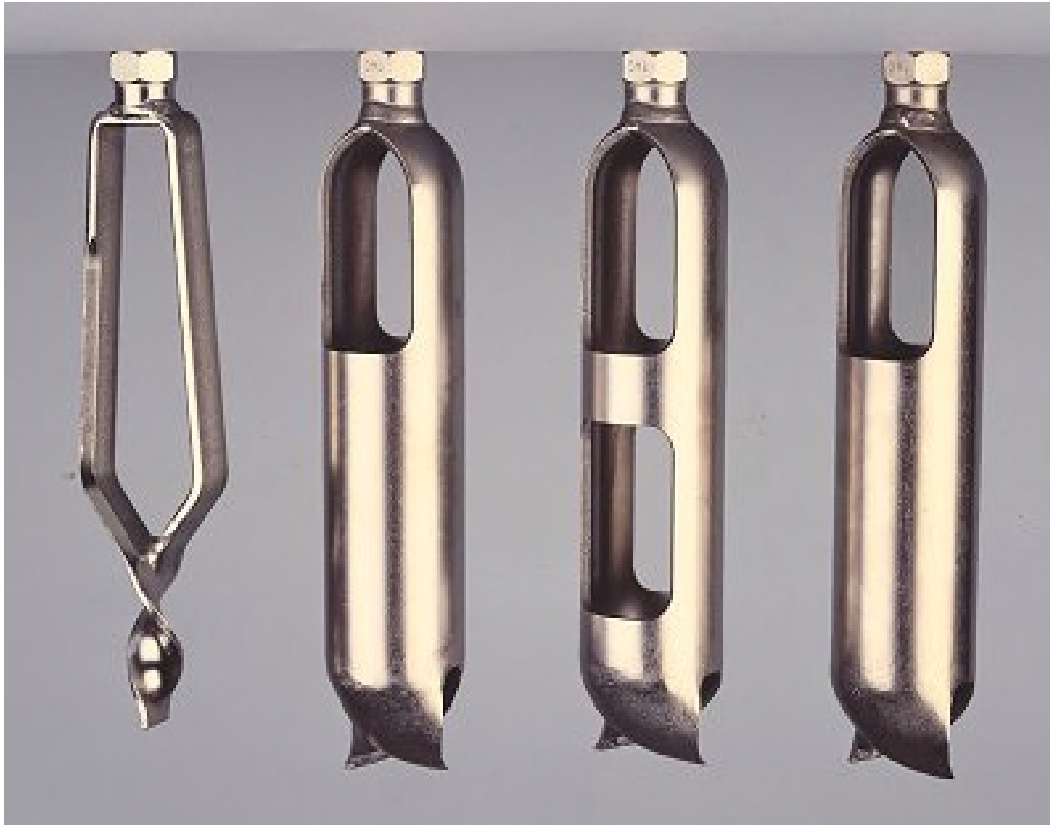
PAGE: 18 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

### SEDIMENT SAMPLING

FIGURE 1 - Example of Sampling Augers



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## STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 19 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

### SEDIMENT SAMPLING

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FIGURE 2 - Example of an Ekman™ Dredge



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## STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 20 of 24

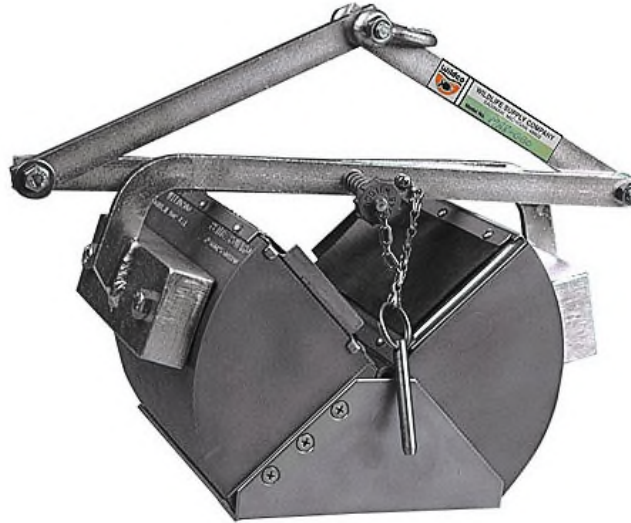
REV: 1.0

EFFECTIVE DATE: 07/31/16

### SEDIMENT SAMPLING

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FIGURE 3 - Example of a Ponar™ Dredge



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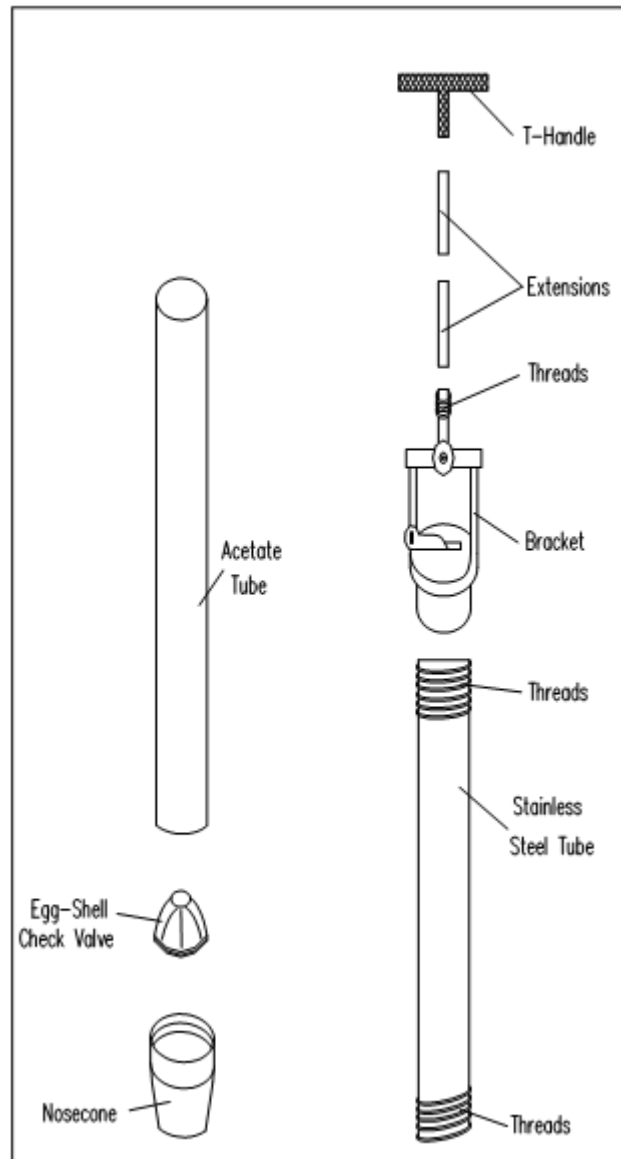


## STANDARD OPERATING PROCEDURES

SOP: 2016  
PAGE: 21 of 24  
REV: 1.0  
EFFECTIVE DATE: 07/31/16

### SEDIMENT SAMPLING

Figure 4 - Example of a Sampling Coring Device



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## STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 22 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

### SEDIMENT SAMPLING

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Figure 5 - Example of Vibracoring



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## STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 23 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

### SEDIMENT SAMPLING

Figure 6 - Example of an Encore Sampler



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## STANDARD OPERATING PROCEDURES

SOP: 2016

PAGE: 24 of 24

REV: 1.0

EFFECTIVE DATE: 07/31/16

### SEDIMENT SAMPLING

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Figure 7 - Example of a Terracore Sampler



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# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 1 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

---

### CONTENTS

1.0	SCOPE AND APPLICATION
2.0	METHOD SUMMARY*
3.0	SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE
4.0	INTERFERENCES AND POTENTIAL PROBLEMS
5.0	EQUIPMENT/APPARATUS*
6.0	REAGENTS
7.0	PROCEDURES
7.1	Preparation
7.2	Representative Sampling Considerations
7.2.1	Sampler Composition
7.3	Sample Collection
7.3.1	Kemmerer Bottle*
7.3.2	Van Doren Sampler*
7.3.3	Bacon Bomb Sampler*
7.3.4	Dip Sampler
7.3.5	Direct Method
8.0	CALCULATIONS
9.0	QUALITY ASSURANCE/QUALITY CONTROL*
10.0	DATA VALIDATION
11.0	HEALTH AND SAFETY
12.0	REFERENCES*



# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 2 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

---

### CONTENTS (cont)

#### 13.0 APPENDICES\*

##### A - Figures\*

\* These sections affected by Revision 0.0.

SUPERSEDES: SOP #2013; Revision 0.0; 11/17/94; U.S. EPA Contract EP-W-09-031.



# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 3 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

---

### 1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative surface water samples from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

### 2.0 METHOD SUMMARY

Sampling situations vary widely; therefore, no universal sampling procedure can be recommended. However, surface water sampling is generally accomplished through the use of one of the following samplers or techniques:

- Kemmerer bottle
- Van Doren sampler
- Bacon bomb sampler
- Dip sampler
- Direct method

These samplers and sampling techniques will result in the collection of representative samples from the majority of surface waters and impoundments encountered.

### 3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Once samples have been collected, the following procedures should be followed:

1. Transfer the sample(s) into suitable, labeled sample containers specific for the analyses to be performed.
2. Preserve the sample, if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.
3. Cap the container securely, place in a resealable plastic bag, and cool to 4°C.
4. Record all pertinent data in the site logbook and/or on field data sheets.
5. Complete the Chain of Custody record.
6. Attach custody seals to cooler prior to shipment.



# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 4 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

---

7. Decontaminate all non-dedicated sampling equipment prior to the collection of additional samples.

### 4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems associated with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated or disposable sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to ERT/SERAS SOP #2006, *Sampling Equipment Decontamination*.
2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed or non-representative area.

Following proper decontamination procedures, minimizing disturbance of the sample site, and careful selection of sampling locations will eliminate these problems. Proper timing for the collection of samples must be taken into consideration due to tidal influences and low or fast-flowing streams or rivers.

### 5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of surface water samples may include (depending on technique chosen):

- Kemmerer bottles
- Van Doren sampler
- Bacon bomb sampler
- Dip sampler
- Line and messengers
- Peristaltic pump
- Tygon tubing
- 0.45 micron ( $\mu\text{m}$ ) filters
- Sample bottles/preservatives
- pH paper
- Resealable plastic bags
- Ice
- Coolers, packing material
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment/supplies
- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film





# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 5 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

---

- Logbook/waterproof pen
- Sample bottle labels
- Paper towels
- Disposable pipets
- Hydrolab

### 6.0 REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed and are summarized in ERT/SERAS SOP #2003, *Sample Storage, Preservation and Handling*. Decontamination solutions are specified in ERT/SERAS SOP #2006, *Sampling Equipment Decontamination*.

### 7.0 PROCEDURES

#### 7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan (HASP).
6. Use stakes, flags, or buoys to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and obstructions.

#### 7.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics of a stream, river, pond, lake or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Water quality data should be collected in ponds, lakes and impoundments to determine if stratification is present. Measurements of dissolved oxygen, pH, conductivity, oxidation-potential, temperature and turbidity can indicate if strata exist that would affect analytical results. Measurements should be collected at one-meter intervals from the surface to the bottom using the appropriate instrument (i.e., a Hydrolab or equivalent). These water quality measurements can assist in the interpretation of analytical data, and the selection of sampling sites and depths when



# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 6 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

---

surface water samples are collected.

Factors that contribute to the selection of a sampling device used for sampling surface waters in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

- Width, depth, flow and accessibility of the location being sampled
- Whether the sample will be collected onshore or offshore

### 7.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, polyvinyl chloride (PVC) or PFTE (Teflon) should be based upon the suspected contaminants and the analyses to be performed.

## 7.3 Sample Collection

### 7.3.1 Kemmerer Bottle

A Kemmerer bottle (Figure 1, Appendix A) may be used in most situations where site access is from a boat or structure, such as a bridge or pier, and where samples at specific depths are required. Sampling procedures are as follows:

1. Use a properly decontaminated Kemmerer bottle. Set the sampling device so that the upper and lower stoppers are pulled away from the body, allowing the surface water to enter tube.
2. Lower the pre-set sampling device to the predetermined depth. Avoid disturbance of the bottom.
3. When the Kemmerer bottle is at the required depth, send the weighted messenger down the suspension line, closing the sampling device.
4. Retrieve the sampler and discharge the first 10-20 milliliters (mL) from the drain to clear potential contamination from the valve. This procedure may be repeated if additional sample volume is needed to fulfill analytical requirements. Subsequent grabs may be composited or transferred directly to appropriate sample containers.

### 7.3.2 Van Doren Sampler

A Van Doren sampler (Figure 2, Appendix A) is used to collect surface water from a very specific sampling depth or from a shallow water body. Since the sampler is suspended horizontally, the depth interval sampled is the diameter of the sampling tube. The sampling procedure is as follows:

1. Use a properly decontaminated Van Doren sampler. Set the device so that the end stoppers are pulled away from the body allowing surface water to enter the





# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 7 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

---

tube.

2. Lower the pre-set sampling device to the predetermined depth. Avoid disturbance of the bottom.
3. When the Van Doren is at the required depth, send the weighted messenger down the suspension line, closing the sampling device.
4. Retrieve the sampler and discharge the first 10-20 milliliters (mL) from the drain to clear potential contamination from the valve. This procedure may be repeated if additional sample volume is needed to fulfill analytical requirements. Subsequent grabs may be composited or transferred directly to appropriate sample containers.

### 7.3.3 Bacon Bomb Sampler

A bacon bomb sampler (Figure 3, Appendix A) may be used in situations similar to those outlined for the Kemmerer bottle. Sampling procedures are as follows:

1. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut. This will allow the sampler to fill.
2. Release the trigger line and retrieve the sampler.
3. Discharge the first 10-20 milliliters (mL) from the drain to clear potential contamination from the valve. This procedure may be repeated if additional sample volume is needed to fulfill analytical requirements. Subsequent grabs may be composited or transferred directly to appropriate sample containers.

### 7.3.4 Dip Sampler

A dip sampler (Figure 4, Appendix A) is useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.
2. Extend the device to the sample location and collect the sample by dipping the sampler into the water.
3. Retrieve the sampler and transfer the sample to the appropriate sample container(s).

### 7.3.5 Direct Method



# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 8 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

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For streams, rivers, lakes, and other surface waters, the direct method may be utilized to collect water samples directly into the sample container(s). Health and safety considerations must be addressed when sampling lagoons or other impoundments where specific conditions may exist that warrant the use of additional safety equipment. These issues must be addressed in the site-specific HASP.

Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface while avoiding surface debris and the boat wake.

When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

### 8.0 CALCULATIONS

This section is not applicable to this SOP.

### 9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.
3. To avoid the incidental inclusion of disturbed sediment in the sample, surface water should be collected from a downstream to upstream direction and upstream of any activity that may disturb the sediment (i.e., wading).
4. While collecting surface water using the direct method, the sample container should be held below the surface to avoid the collection of floating debris.
5. Water quality data should be collected to detect the presence of stratified layers or other site-specific characteristics that would affect the sample.

### 10.0 DATA VALIDATION

This section is not applicable to this SOP.

### 11.0 HEALTH AND SAFETY



# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 9 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

---

When working with potentially hazardous materials, follow U.S. EPA, Occupational Health and Safety (OSHA) and corporate health and safety procedures.

More specifically, when sampling lagoons or surface impoundments containing known or suspected hazardous substances, adequate health and safety and boating precautions must be taken to ensure the safety of sampling personnel.

### 12.0 REFERENCES

Wilde, F.D., D.B. Radtke, J. Gibbs and R.T. Iwatsubo. 1998. National Field Manual for the Collection of Water-Quality Data - Selection of Equipment for Water Sampling. U.S. Geological Survey Techniques of Water - Resources Investigations, Book 9, Chap. A2, variously paged.

<http://water.usgs.gov/owq/FieldManual/index.html> and  
<http://water.usgs.gov/owq/FieldManual/mastererrata.html>

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

### 13.0 APPENDICES

A - Figures



# STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 10 of 14  
REV: 0.0  
DATE: 02/15/02

## SURFACE WATER SAMPLING

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APPENDIX A  
Figures  
SOP #2013  
February 2002



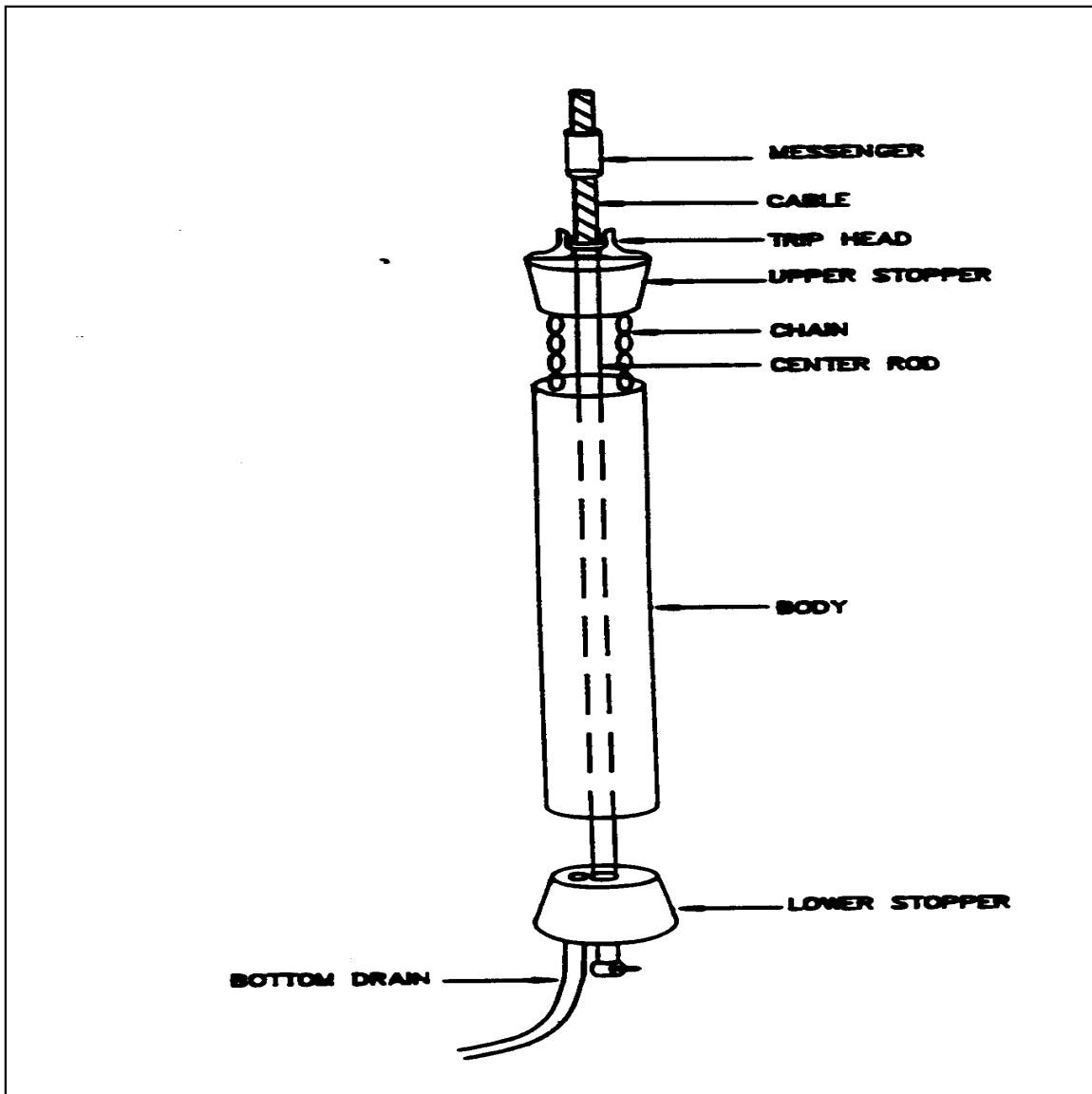
## STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 11 of 14  
REV: 0.0  
DATE: 02/15/02

### SURFACE WATER SAMPLING

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FIGURE 1. Kemmerer Bottle





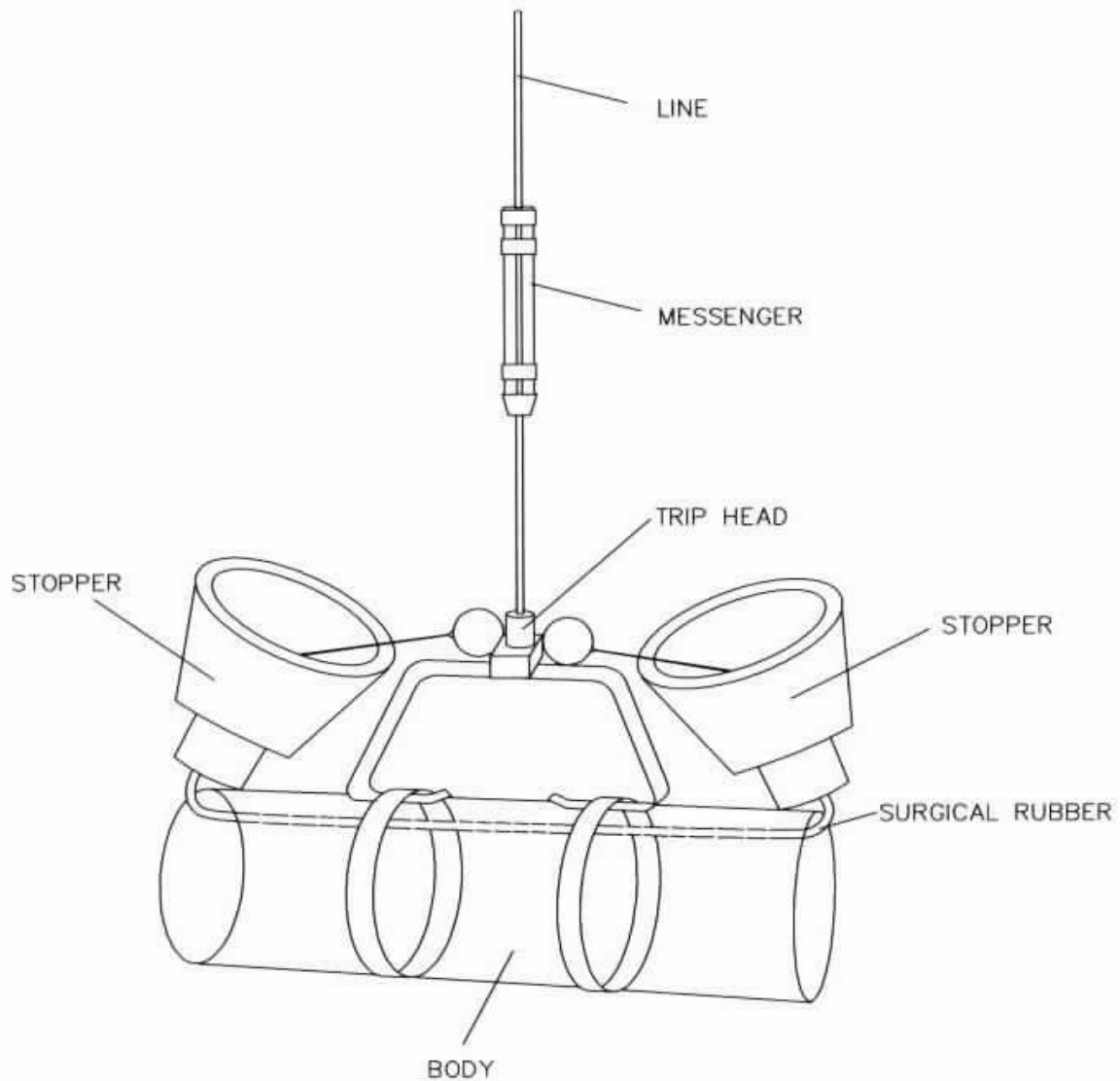
## STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 12 of 14  
REV: 0.0  
DATE: 02/15/02

### SURFACE WATER SAMPLING

---

FIGURE 2. Van Doren Sampler





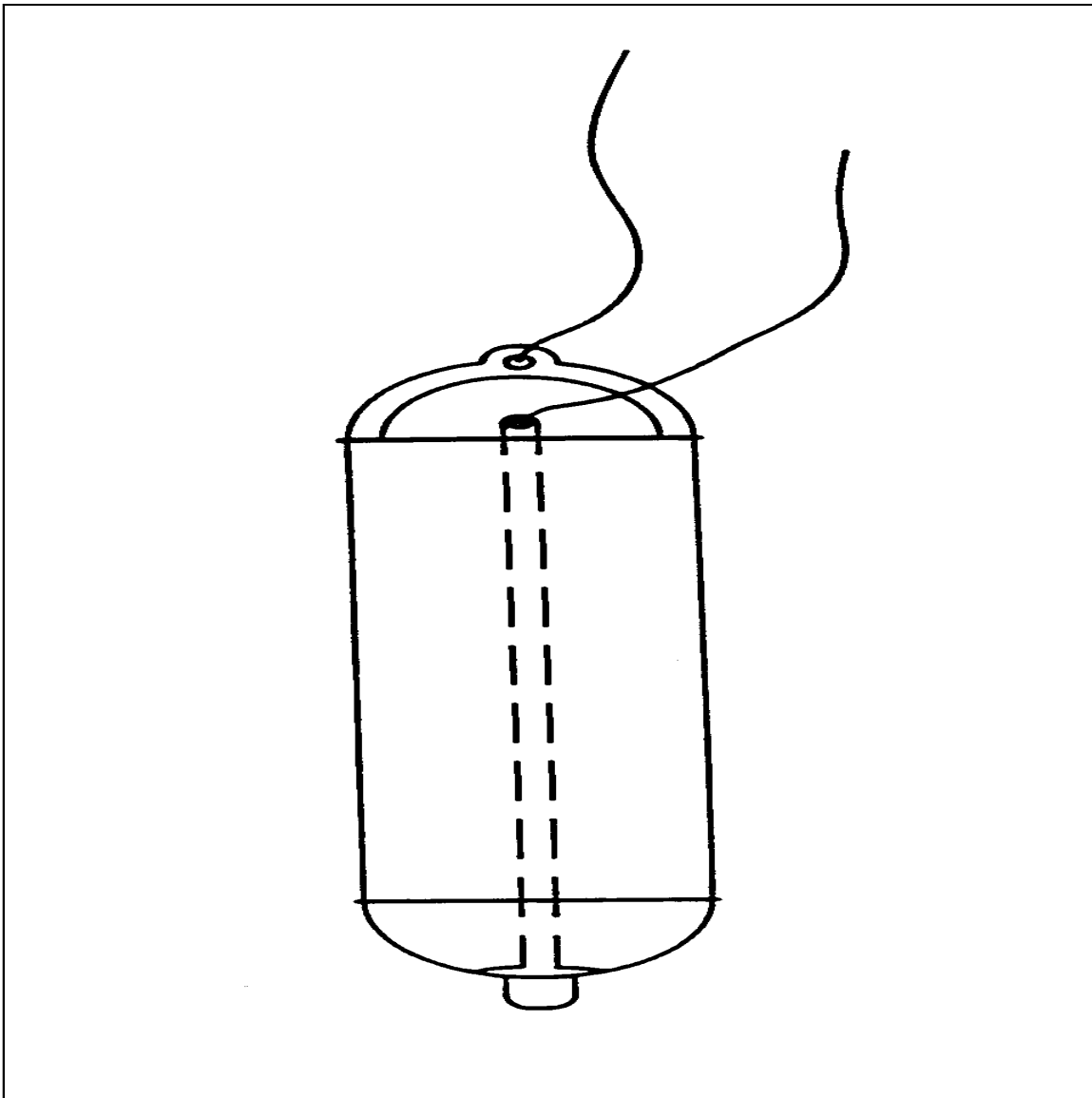
## STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 13 of 14  
REV: 0.0  
DATE: 02/15/02

### SURFACE WATER SAMPLING

---

FIGURE 3. Bacon Bomb Sampler





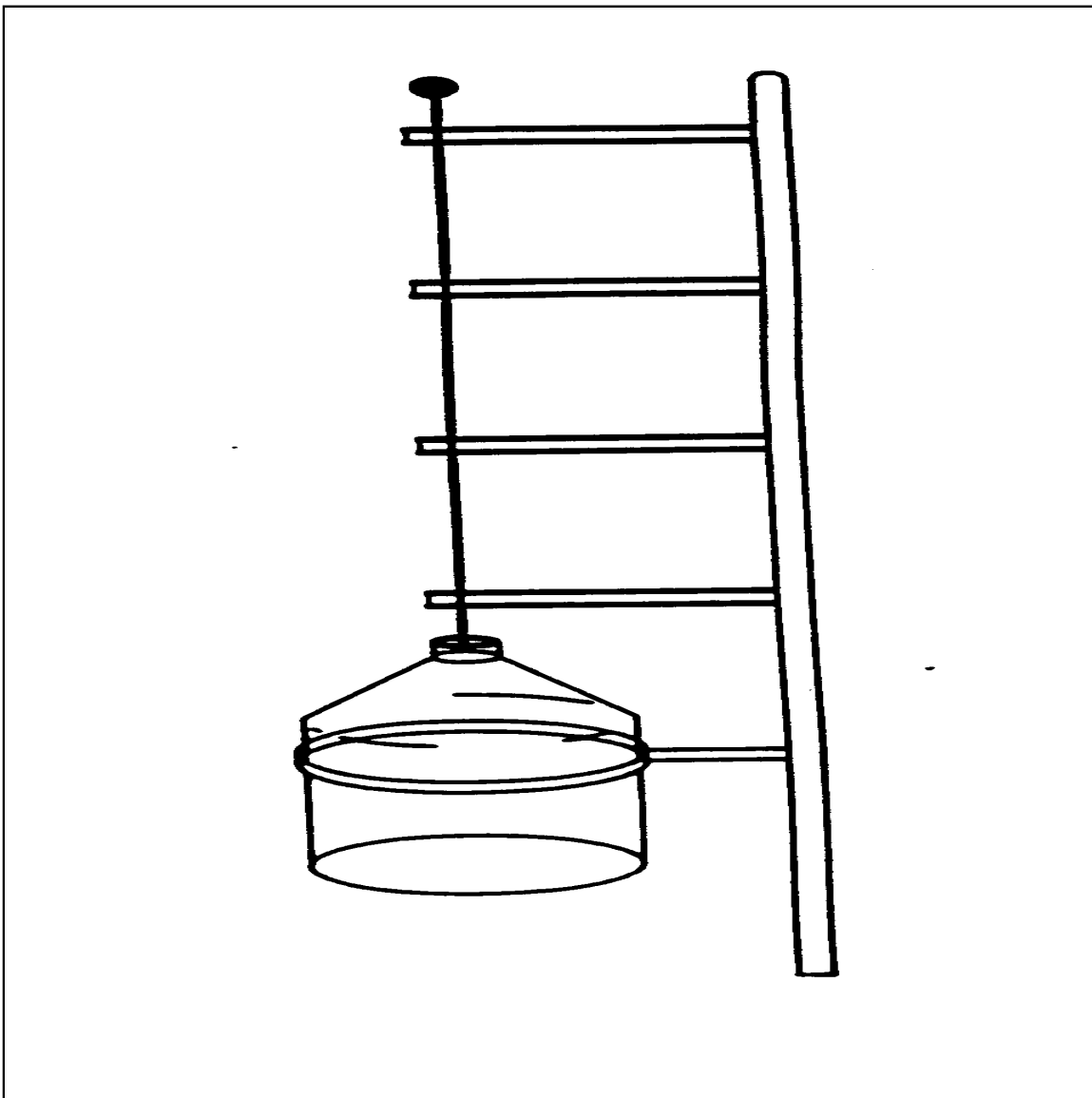
## STANDARD OPERATING PROCEDURES

SOP: 2013  
PAGE: 14 of 14  
REV: 0.0  
DATE: 02/15/02

### SURFACE WATER SAMPLING

---

FIGURE 4. Dip Sampler





SOP 06  
SUBSURFACE SOIL SAMPLE COLLECTION

GENERAL STATEMENT

Subsurface soil samples may be collected during drilling of borings for monitor wells as required by the applicable Workplan.

OBJECTIVE

The objective of soil sampling is to provide sufficient information to choose the appropriate screened interval for the well. The cuttings will be screened with a combination photoionization detector/flame ionization detector (PID/FID) to help with selection of the soil sampling interval.

EQUIPMENT AND/OR INSTRUMENTATION

Equipment used during sample collection will be determined by the type of drilling rig or direct-push equipment used by the drilling contractor, and potentially includes roto sonic drilling rod, core barrel, or stainless steel sampling tubes. Alternate sampling equipment may be used depending on site conditions encountered or discussion with ADEQ if project requirements change.

PREPARATION

The following procedures will be used in preparation for subsurface soil sample collection after all appropriate subsurface utility location work has been completed:

- Review applicable permits, insurance requirements, contractual requirements, and site access procedures;
- Obtain all appropriate underground utility clearances necessary;

- Review health and safety procedures with all personnel;
- Review appropriate sections of the work plan, the pertinent SOP and the task and project objectives and identify sites to be drilled with all personnel;
- Review sampling locations, inspect sampling equipment and supplies. Note and discuss any unusual or different sampling methods that may need to be employed at selected locations, and
- Inform the laboratory of the number of samples to be shipped and the timing of expected sample shipments.

## PROCEDURES

The procedures that will be used during subsurface soil sample collection include observations and screening of soil core collected during drilling, including:

- Direct visual observation;
- Lithologic logging of subsurface materials;
- Screening the core with a combination PID/FID; and
- Collection and transport of soil matrix samples.

Soil samples will be collected from depth ranges specified for each boring or monitor well proposed in the applicable Workplan.

Sample collection:

- Immediately after recovering a soil core, it will be cut lengthwise, inspected visually, and lithologically logged.
- As soon as possible after cutting the core, a screening sample of the soil core comprising approximately one linear inch of core collected every two feet to five feet will be removed from the core liner and placed in a re-sealable freezer bags. The bag will be sealed while allowing air to remain inside the bag with the soil. The soil core fragment will be broken up by hand after the bag is sealed. Air in the bag will

be screened using the PID/FID after allowing the soil to de-gas for approximately 5 to 10 minutes after sealing the bag. The PID/FID reading for each interval will be recorded on the lithologic log form and/or in the field notebook.

- Immediately after recovering a soil core and performing the visual inspection and field screening described above, if observed, collection of a sample for VOCs using the Encore sampling method as described by EPA Method 5035a will be performed in accordance with the applicable Workplan. Soil samples collected for any non-volatile analytes will be performed using stainless steel sampling tubes hand driven into the freshly exposed soil surface or a decontaminated stainless steel trowel. The appropriate containers will be used for each sample and analyte(s) in accordance with the applicable Workplan and with the soil sample handling protocol.
- For sampling using lined core barrels, sufficient tubes or liner for each sample and analyte is cleanly cut. The exposed soil is then covered with a clean Teflon sheet, and the ends are capped and secured with parafilm or tape, and the core samples are sealed in Ziplok or similar resealable plastic bags.
- The samples will be labeled per the procedures outlined below, and
- The sample will be immediately stored in an ice chest at approximately 4 degrees Centigrade ( $^{\circ}$  C) and delivered to the analytical laboratory under chain of custody (COC) procedures.

#### SAMPLE CONTAINERS, PERSERVATION, AND TRANSMITTAL

Subsurface soil samples for analysis will be collected in the appropriate sampling device, sample tubes or preserved glass vials pursuant to SW-846, labeled, and immediately stored on ice in an ice chest. These samples will be chilled for preservation and will be transported to the laboratory on ice in plastic ice chests containing a COC form. Samples will be hand delivered to the analytical laboratory at the end of each sampling day, or picked up by the lab courier.

## EQUIPMENT, DECONTAMINATION, AND DISPOSAL PROCEDURES

All equipment used for subsurface soil samples will be decontaminated between sample collection locations. Equipment rinsate blanks will be collected in accordance with the applicable Workplan requirements.

The level of effort for decontamination is a site- and task-specific issue as detailed in the applicable Workplan. Prior to use in the field, decontamination of all down-hole or non-dedicated equipment must be performed following specific decontamination procedures. However, dedicated or disposable equipment is preferable since it eliminates any possible cross-contamination pathway that incomplete decontamination may cause.

Before use, and between each site, all down-hole or non-dedicated equipment and other non-sampling equipment will be decontaminated with high pressure steam, or scrubbed with a non-phosphate detergent and rinsed with water from the approved water source. As with other procedures documented in this SOP, decontamination procedures may be determined by the client or regulatory agency involved in the project. Decontamination of field equipment and personnel will consist of the procedures provided below.

### Equipment

Equipment will be decontaminated on site in the established decontamination area.

1. Wash and scrub with detergent (non-phosphate). Typically a laboratory-grade detergent such as Alconox™ is used.
2. Rinse with tap water.
3. Triple rinse with de-ionized (DI) water.
4. Air dry.
5. Protect from fugitive dust and vapors. Field equipment will be covered in to protect it from the elements.

If equipment is highly contaminated, it may be rinsed with reagent-grade isopropanol alcohol or methanol and allowed to air dry prior to Step 2 above. Additional solvent and/or acid rinses may be added to the procedure, depending on the Site sampling objectives.

1. Wash and scrub with detergent (laboratory-grade, non-phosphate detergent).
2. Rinse with tap water.
3. Rinse with methanol (pesticide-grade).
4. Rinse with DI water.
5. Rinse with 1:1 nitric acid.
6. Rinse with DI water.
7. Air dry.
8. Protect from fugitive dust and vapors.

Materials Safety Data Sheets must be obtained for any hazardous chemical used for decontamination and approved by the Project Manager prior to bringing the chemical to the worksite.

Decontamination fluids will be handled by the drilling company disposal at an appropriate facility.

## DOCUMENTATION

Documentation of the subsurface soil sampling activities will include entries on the Lithologic Log Form, the field notebook, sample identification documents, and custody documentation to the laboratory.

The following information will be recorded each time a subsurface soil sample is collected:

- sample location/identifier;
- depth at which sample was collected;
- date and time sample was collected;

- sample lithologic description;
- percent recovery, if appropriate, and
- other pertinent information, including difficulties in sample collection or unusual occurrences during drilling.

Sample identification documents will be prepared so that sample identification and COC are maintained and sample disposition controlled. The sample identification documents to be used are:

- sample identification labels; and
- COC record.

Standard sample identification labels and COC forms will be used to record all information. Sample documentation forms and labels will be completed with waterproof ink. The sample documentation forms will accompany the samples to the laboratory. Copies of the sample documentation forms will be retained by the field samplers.

Adhesive sample labels will be secured to the sample containers by field personnel. The following information will be recorded on the sample label:

- sample location/identifier;
- depth at which sample was collected;
- date and time sample was collected;
- analyses to be performed;
- project number;
- sampler's initials;
- any other pertinent information, including any difficulties in sampling or unusual occurrences, and
- any special instructions to laboratory personnel.

Official custody of samples will be maintained and documented from the time of sample collection until the validation of analytical results. The COC record is the document that records the transfer of sample custody. The COC record includes the following information:

- sample location/identifier;
- project code;
- sampling date;
- sampling personnel;
- shipping method and date;
- sample description;
- sample volume;
- number of containers;
- sample destination;
- preservatives used;
- analyses to be performed;
- special handling procedures, and
- the identity of personnel relinquishing and accepting custody of the samples.

The sampling personnel will be responsible for the samples and will sign, or will designate personnel to sign, the COC record to document sample transfer or transport. Samples will be packaged in sealed containers for transport and dispatched to the appropriate laboratory for analysis with a separate COC record accompanying each shipment. The method of transport, courier name(s), and other pertinent information will be entered on the COC record.

Once received at the laboratory, laboratory custody procedures apply. It is the laboratory's responsibility to acknowledge receipt of samples and verify that the containers have not been opened or damaged. It is also the laboratory's responsibility to maintain custody and sample tracking records throughout sample preparation and analysis.

## QUALITY ASSURANCE

QA for subsurface soil sample collection will be accomplished by following these SOPs and the project QAPP for collection, handling, preservation, and decontamination. All sampling documentation will be reviewed and approved by the Project Manager.



## STANDARD OPERATING PROCEDURE APPROVAL AND CHANGE FORM

Scientific, Engineering, Response and Analytical Services  
2890 Woodbridge Avenue Building 209 Annex  
Edison New Jersey 08837-3679

### STANDARD OPERATING PROCEDURE

Title: Sample Receiving, Handling and Storage

Approval Date: 12/09/2015

Effective Date: 12/09/2015

SERAS SOP Number: 1008, Rev 2.1

#### Authors

Name Lawrence Martin

Title SERAS Sample Receiving Technician/Hazardous Waste Coordinator

Signature 

Date 12/7/15

Name

Title

Signature

Date

#### Approvals

Name Jay Patel

Title SERAS Analytical Support Leader

Signature 

Date 12/7/15

Name Deborah Killeen

Title SERAS QA/QC Officer

Signature 

Date 12/9/15

Name Kevin Taylor

Title SERAS Program Manager

Signature 

Date 12/9/15

The top row of this table shows the most recent changes to the controlled document. For previous revision history information, archived versions of this document are maintained by the SERAS QA/QC Officer on the SERAS local area network (LAN).

History	Effective Date
Added Section 3.1.2 for sample acceptance/rejection criteria	12/09/15
Added Sample Receipt Report and Nonconformance Memo to Attachments	12/09/15
Added that freezer maintenance in the Biology lab is the responsibility of the Risk Maintenance Task Leader	12/09/15
Removed references to freezers in Section 3.4	12/09/15



# STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 1 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

## SAMPLE RECEIVING, HANDLING AND STORAGE

---

### CONTENTS

- 1.0 OBJECTIVE
- 2.0 APPLICABILITY
- 3.0 DESCRIPTION
  - 3.1 Sample Receiving
    - 3.1.1 Procedures during Regular Hours
    - 3.1.2 Sample Acceptance/Rejection Criteria
    - 3.1.3 After Hours Procedures
    - 3.1.4 Potential Problems
  - 3.2 Sample Storage
    - 3.2.1 Normal Conditions
    - 3.2.2 Overload Conditions
    - 3.2.3 Labeling, Storage and Maintenance of Samples
    - 3.2.4 Emergency SRU and Freezer Malfunction Conditions
  - 3.3 Sample Disposal
  - 3.4 Sample Security
- 4.0 RESPONSIBILITIES
  - 4.1 Sample Receiving Technician
  - 4.2 Task Leaders
  - 4.3 Analytical Support Leader
  - 4.4 QA/QC Officer
  - 4.5 Laboratory Personnel
- 5.0 APPENDICES
  - A - Attachments

SUPERSEDES: SOP #1008; Revision 2.0; 12/07/12; U.S. EPA Contract EP-W-09-031

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# STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 2 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

## SAMPLE RECEIVING, HANDLING AND STORAGE

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### 1.0 OBJECTIVE

The purpose of this Standard Operating Procedure (SOP) is to define routine procedures for sample receiving, logging and storing of samples submitted to the Environmental Response Team/Scientific, Engineering, Response and Analytical Services (ERT/SERAS) Laboratory for analysis.

### 2.0 APPLICABILITY

This SOP applies to all samples submitted to the ERT/SERAS Laboratory, whether the samples are to be subcontracted to or analyzed at the ERT/SERAS Laboratory.

### 3.0 DESCRIPTION

#### 3.1 Sample Receiving

Sample receiving, log-in and custody procedures to be followed during regular working hours and after hours are described in this section.

##### 3.1.1 Procedures during Regular Hours

1. The SERAS Task Leader (TL) will complete a Projected Work Assignment/Analytical Services Resource Requirements (PWA/ASRR) (Attachment 1, Appendix A) prior to initiation of field activities. The PWA provides a preliminary indication of the number of samples to be collected, matrix, and types of analyses requested, approximate field sampling dates and requested analytical data requirements for preliminary data and final analytical reports. This is subject to change due to unpredictable field events. The PWA will be transmitted to the PWA distribution list and the Work Assignment Manager (WAM) of the project to facilitate coordination of laboratory activities.

During field activities, the TL will notify the Sample Receiving Technician (SRT) of the number of samples being shipped, the types of analyses requested, and when and how the samples are being shipped to the SERAS facility by directly calling the SRT, by leaving a detailed message on the SRT's voicemail (609)-865-9306 or sending the SRT an email. The SRT, in turn, will inform the Analytical Support Leader (ASL).

2. If shipped via commercial carrier, sample shipments will be received in the shipping/receiving area. The shipping/receiving clerk will notify the SRT that samples have arrived. The samples will be kept in the designated sample receiving area until the SRT is available. Alternatively, the SRT will receive directly any samples delivered to SERAS by returning sampling personnel. The TL will telephone the SRT to confirm the samples have arrived intact and complete.
3. The SRT will move the sample shipping containers to the sample receiving area where the containers will be opened under a hood and examined for physical integrity. The samples in the shipping container will be compared with those listed on the enclosed Chain of Custody (COC) record (Attachment 2, Appendix A). The SRT will measure and document the internal cooler temperature using a calibrated thermometer on the COC record, sign the "Received By" section along with the date and time received.

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## STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 3 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

### SAMPLE RECEIVING, HANDLING AND STORAGE

---

Any problems with the shipment will be addressed to the TL by the SRT.

4. For samples to be analyzed at SERAS, samples will be logged into the laboratory data system, Element, and given an Element tracking number. The Element sample number is indexed to each work order coming into the laboratory and will have the following format: Rymmxxx-ss where y is the last digit for the year, mm is the month, xxx is a sequential number assigned to each work order received for the month and ss is a sequential number assigned to each sample with the first sample on the COC typically assigned -01. Samples with multiple containers are given a letter designation, in alphabetical order, for each container. For example: Element number R208005-07 is interpreted as the year 2012, the month of August, the 5<sup>th</sup> work order received in August and sample 7 on COC record. The Element number is written on the sample labels affixed to the sample containers. A sample receiving report (Attachment 4, Appendix A) is filled out and stored in the SRT's files for each work order.

After the samples have been logged into Element and labeled, the SRT will transfer custody of the samples to the laboratory. The samples will be delivered by the SRT to the appropriate laboratory along with the COC record. A representative from the appropriate laboratory will sign the COC record to acknowledge transfer of the samples. Additional copies of the COC record will be given to the SERAS Program Manager, Quality Assurance/Quality Control (QA/QC) Officer, ASL, TL, and QA/QC Group. The location of the samples is updated in Element to the receiving laboratory by the SRT.

In the event of the receipt of samples with quick turn-around requirements, samples may be delivered directly to the laboratory prior to assignment of Element numbers and entry into the Element data base. The COC will be used to document the transfer of the samples to the laboratory. Element numbers will be assigned at the earliest possible time by the SRT, the sample labels will be updated and the laboratory will update the analytical records with the respective Element numbers.

As each group is finished with the sample(s), they are transferred within the lab to any additional groups for analysis, as required. The COC is used to document the internal transfer of the sample to each group and the location of the sample is updated in Element.

After the representatives from each group have signed the original COC acknowledging receipt and custody of the samples, the original COC is delivered to the QA/QC Group for incorporation into the final report.

After samples are transferred to the various laboratory groups, the samples will be stored in the respective laboratory's sample storage refrigerators in preparation for analysis. After completion of all the required analyses, the SRT will regain custody of any remaining samples by having a representative from the laboratory group sign the COC record; thereby, relinquishing possession of the samples. The SRT will remove the relinquished samples from the laboratory's sample storage refrigerators and place them in the Sample Refrigeration Units (SRU) or the Risk Maintenance freezer (tissue samples), as appropriate, for storage or in preparation for disposal. The

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## STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 4 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

### SAMPLE RECEIVING, HANDLING AND STORAGE

---

location of the sample needs to be updated in Element from the laboratory to the SRU or other appropriate area.

5. Samples transferred to an outside laboratory should be packed in separate shipping containers and shipped directly from the site to the outside laboratory. If the shipping container is received at the SERAS facility, and the COC record inside the cooler indicates that the entire shipment of samples is to be subcontracted, the SRT will take the shipping container to the sample receiving area. The SRT will open the shipping container under the hood and visually examine the samples for physical integrity. The number of samples in the shipping container will be compared with those listed on the COC record to verify the number of samples and types of analyses. The SRT will note the approximate internal cooler temperature on the COC, sign the "Received by" section with the date and time received. The SRT will then repack the samples, as outlined in SERAS SOP #2004, *Sample Packaging and Shipment*, add additional ice if necessary to maintain the temperature, and sign the COC record relinquishing custody of the samples. The shipping containers will be sealed as outlined in the above referenced SOP, and shipped to the subcontracted laboratory.

When part of a shipment of samples arriving at the SERAS facility is to be subcontracted, all samples will first be logged into Element, as in step 4. The SRT will complete a new COC record for the samples to be subcontracted, sign the COC record relinquishing custody of the samples, and pack the samples as per SERAS SOP #2004, *Sample Packaging and Shipment* for shipping. The new COC record will reference the original COC record for traceability. The location of the samples in Element will be changed to "Other" and the SRT will make a note (in Element) where the samples were shipped.

Samples returning from an outside laboratory will be treated the same as samples being sent in from the field. If the samples already have a work order #, the location of the samples needs to be updated in Element and the samples can be handled as per COC.

#### 3.1.2 Sample Acceptance/Rejection Criteria

Samples received at SERAS will only be rejected at the request of the TL. If the TL is not available, their manager or the WAM can act as an alternate. Upon discovery of a nonconforming sample, the SRT will contact the TL (or alternate) and provide them details about the samples condition. The sample will be held until a resolution is provided by the TL (or alternate). The SRT will fill out a nonconformance memo (Attachment 3, Appendix A) providing details about the samples condition, reason for rejection, and resolution. The nonconformance memo will be turned into the SERAS QA/QC Officer. A copy of the nonconformance memo will be provided to the ASL and a copy will be retained by the SRT.

#### 3.1.3 After Hours Procedures

1. If samples are to be delivered after hours and the SRT is not available, the TL or their designee will obtain the key for SRU No. 2 from the SRT or the Analytical Support Leader. SRU No. 2 has a locked inner door that prevents unauthorized access to

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## STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 5 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

### SAMPLE RECEIVING, HANDLING AND STORAGE

---

samples currently under custody.

2. Upon delivery, the TL or designee will place the sample shipping containers inside SRU No. 2.
3. At the beginning of the next work day, the TL or designee will inform the SRT that the shipping container has been placed inside the SRU. The SRT will follow the procedures detailed in section 3.1.1.

#### 3.1.4 Potential Problems

1. Discrepancy in number of samples - If there is a discrepancy between the number of samples in the shipping container and those listed on the COC record, the SRT will note the discrepancy on the COC record and notify the TL. If the TL is unavailable, their immediate supervisor should be notified immediately. A non-conformance form must be filled out and submitted to the immediate supervisor.
2. Broken/damaged sample bottles - If any of the sample bottles received are broken, damaged or leaking, the SRT will note the problem on the COC record and notify the TL immediately. If the TL is unavailable, their immediate supervisor should be notified immediately. A non-conformance form must be filled out and submitted to the immediate supervisor.
3. Documentation errors - If there are any documentation errors, the SRT will note the problem on the COC record and notify the TL to initiate corrections. If the TL is unavailable, their immediate supervisor should be notified immediately. The SRT is not authorized to change or correct the COC record unless written authorization from the TL is received. The COC records will also be reviewed by the QA/QC Group during the verification process.

#### 3.2 Sample Storage

Procedures for sample storage under routine and overload conditions are described in this section. Procedures for inventory are also outlined in this section.

##### 3.2.1 Normal Conditions

All samples, except tissue samples, will be stored in the SRUs in labeled crates. Tissue samples will be stored in the freezer maintained by the risk maintenance group. Samples will be transferred to the appropriate laboratories for analysis by the SRT as described in section 3.1.1. After analysis is completed, custody of the samples will be transferred back to the SRT, and the samples stored in the SRU or as appropriate.

##### 3.2.2 Overload Conditions

In the event that all the space in both of the SRUs is occupied, the samples will be stored in coolers or crates stacked on the floors of the SRUs. In the event that all floor space in the SRUs is occupied, the samples will be packed in ice, to maintain the temperature at  $\leq 6^{\circ}\text{C}$ , and stored in coolers. The coolers will be stacked in the sample receiving area or in the laboratories. The temperature of the coolers will be maintained at  $\leq 6^{\circ}\text{C}$  by adding more ice as needed. A log will be maintained of the daily ice replenishment and maintenance check of the coolers. The log will be reviewed daily and initialed by the ASL.

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## STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 6 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

### SAMPLE RECEIVING, HANDLING AND STORAGE

---

NOTE: Samples that are to be analyzed for Volatile Organic Compounds (VOCs) will be stored separately from all other samples due to the potential for contamination.

#### 3.2.3 Labeling, Storage and Maintenance of Samples

The SRT will maintain, in a bound logbook or electronic spreadsheet, a listing of location of all samples in the SRUs.

#### 3.2.4 Emergency SRU and Freezer Malfunction Conditions

Refer to SERAS SOP #1009, *Operation of Sample Refrigeration Units*, in the event of malfunction of the SRU or freezers for emergency sample handling and alternate storage.

#### 3.3 Sample Disposal

The inventory database will be reviewed monthly by the SRT. Samples may be returned to the site or designated for disposal as soon as the SERAS TL or ERT WAM determines that the samples are no longer needed. Samples will automatically be destined for disposal or returned to the site six months after collection unless requested to be held by the SERAS TL or EPA/ERT WAM.

Prior to designating samples for disposal, the SRT/Hazardous Waste Coordinator (HWC) must determine the extent of contamination of the samples. Samples analyzed by ERT/SERAS or a subcontracted laboratory will have analytical data available. Data may be accessed from preliminary data or final data, if available.

The analytical data are checked to ensure that the samples results correspond to the actual samples to be disposed. Many projects have identical sample numbers from one sampling event to the next. Care must be taken to verify the collection date and when possible, the location code. The samples can then be consolidated and the data summarized. Water samples are typically consolidated into 5-gallon jerry cans. The bottles are triple rinsed with a 10 percent (%) volume of water for a quantitative transfer. Additional rinses are performed if sediment or particulates remain in the original bottle. The pH of the consolidated water samples is recorded on the pail and the hazardous waste description form. Soil samples are typically kept in their original containers and packed into a 5-gallon open head polyethylene pail. The highest concentration of each constituent is noted on the hazardous waste description form. Consolidated samples destined for disposal are considered waste and are handled in accordance with SERAS SOP #1501, *Hazardous Waste Management*.

#### 3.4 Sample Security

The sample receiving area and the walk-in SRUs will be locked at all times. The SRT and Analytical Support Leader are the only individuals who possess a key to the sample receiving area and SRUs. All transfer of samples in and out of the SRU or sample receiving area will be done by the SRT. In the event that the SRT is unavailable, his designee may perform the functions of the SRT.

Each individual is responsible for the security of samples transferred to their laboratory groups for analyses and alternate storage.

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# STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 7 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

## SAMPLE RECEIVING, HANDLING AND STORAGE

---

### 4.0 RESPONSIBILITIES

#### 4.1 Sample Receiving Technician

The SRT is responsible for the following functions:

- Ensure that every sample is entered into Element according to the COC record, assigned an Element number, and delivered to the appropriate laboratory departments. Record the internal temperature of the sample shipping container on the COC record.
- Fill out the COC record and ship samples to an outside laboratory, if the samples are to be subcontracted and currently in the SRT's custody.
- Responsible for maintaining a record of all samples transferred to laboratories and retrieving samples when analysis is completed or alternate storage is no longer required.
- Ensure that the SRUs and the sample receiving area are locked and secure at all times when samples are present.
- Contact the ASL in the event of any observable malfunction of the SRUs.
- Maintain the dedicated logbook(s) for the SRUs and freezer temperatures (if the freezer is being used by SRT), the bound logbook for alternate storage of samples, documentation of all samples transferred to the laboratories for analysis or storage, and an inventory of samples in the SRUs.
- Inspect and maintain the cleanliness of the SRUs.

#### 4.2 Task Leaders

Task Leaders are responsible for the following functions:

- Inform the SRT and ASL of anticipated sample(s) by filling out a PWA/ASRR, prior to initiation of field activities.
- Complete a COC record and notify the SRT of the total number of samples and types of analyses requested prior to shipping the samples, or the day before samples are scheduled to arrive at SERAS. Inform the SRT of any changes to the PWA. Notify the SRT if sample delivery is expected after hours.
- Contact the SRT after the shipment of samples to confirm sample receipt and condition.

#### 4.3 Analytical Support Leader

The ASL is responsible for the following functions:

- Resolve any problems that arise as expeditiously as possible. Evaluate information from

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## STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 8 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

### SAMPLE RECEIVING, HANDLING AND STORAGE

---

the SRT or laboratory personnel as to the nature and magnitude of any malfunctions, and initiate procedures for "alternate" storage as outlined in Section 3.2.3 of this SOP, if required.

- In the absence/unavailability of the SRT, security will be the responsibility of the ASL or designated individual.
- The ASL is responsible for expeditiously resolving problems, as they arise and for updating this SOP as necessary.

#### 4.4 QA/QC Officer

The QA/QC Officer is responsible for the review of this SOP and for periodically checking the implementation of this SOP.

#### 4.5 Laboratory Personnel

Samples will be handled only by personnel who have passed all requirements for working in the laboratory. Laboratory requirements include, but are not limited to, safe handling of hazardous materials in the laboratory; proper use of personal protective devices; fit testing and proper use of respiratory protection; location and use of laboratory safety equipment; safe handling of compressed gases; location and use of fire equipment; proper cleanup of spills; segregation and identification of hazardous wastes, Federal Hazard Communications Training (Right-To-Know) and chemical hygiene safety training established under OSHA Title 29 Code of Federal Regulations Part 1910 (29CFR1910).

The sample containers will be kept in a well ventilated area.

Latex gloves, safety glasses, steel-toed boots, laboratory coat and/or Tyvek overalls will be worn while handling samples and heavy containers.

#### 5.0 APPENDICES

##### A – Attachments

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## STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 9 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

### SAMPLE RECEIVING, HANDLING AND STORAGE

---

APPENDIX A  
Attachments  
SOP #1008  
December 2015

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## STANDARD OPERATING PROCEDURES

SOP: 1008  
PAGE: 10 of 13  
REV: 2.1  
EFFECTIVE DATE: 12/09/15

### SAMPLE RECEIVING, HANDLING AND STORAGE

#### ATTACHMENT 1. SERAS Projected Work Assignment/Analytical Services Resource Requirements (PWA/ASRR)

WA #: SERAS-XXX

WA Name:

TL:

WAM:

Date:

#### ANALYTICAL WORK REQUESTED

Number of Samples by Matrix					Analytical Schedule		
Analysis	Soil	Water	Air	Shipment Date(s)	Laboratory Prelim(BD)	Laboratory Final (BD)	Validated Report (BD)

Additional Requirements:

#### ANALYTICAL RESOURCE REQUIREMENTS

Estimated Hours or Cost by Matrix or Function					
Analysis	Number of Samples	Water	Soil/ Sediment	Air	Data Validation/ Report Writing

#### ANALYTICAL LABORATORIES (estimated cost or hours)

Analysis	SERAS	Subcontract Laboratory

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# STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 11 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

## SAMPLE RECEIVING, HANDLING AND STORAGE

### ATTACHMENT 2. Sample Chain of Custody Record

CHAIN OF CUSTODY RECORD										No: SC-12/30/08-0055
SERAS Edison, NJ				Soil Sampling				Lab: SERAS VOA Lab		
EPA Contract # EP-W-00-032				Contact Name:						
				Contact Phone:						
Lab #	Sample #	SUMMA #	Analyses	Pressure	Collected	Numb Cont	Container/Preservative	Site Name	WAF	
	2006-0002	P2	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0003	P3	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0004	P4	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0005	P5	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0006	P6	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0007	P7	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0008	P8	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0009	P9	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0010	P10	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0011	P11	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0012	P12	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0013	P13	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0014	P14	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0015	P15	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0016	P16	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0017	P17	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0018	P18	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	
	2006-0019	P19	Volatiles (VOAs)	Soil	10/10/2012	1	8oz Jar	SOP Example	011	

Special Instructions: Soil Samples						SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #					
Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished By	Date	Received by	Date	Time

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## STANDARD OPERATING PROCEDURES

SOP: 1008  
PAGE: 12 of 13  
REV: 2.1  
EFFECTIVE DATE: 12/09/15

### SAMPLE RECEIVING, HANDLING AND STORAGE

#### ATTACHMENT 3. Nonconformance Memo

---

Number: \_\_\_\_\_  
Date Received: \_\_\_\_\_  
(To Be Filled in by QA/QC Officer)

---

**LABORATORY NONCONFORMANCE MEMO**

Work Assignment Number: \_\_\_\_\_ Filed By: \_\_\_\_\_  
Parameter (s): \_\_\_\_\_ Date: \_\_\_\_\_  
Sample (s) Affected: \_\_\_\_\_

Area (check one): Sample Receiving ☐ Metals ☐ VOC Lab ☐ BNA Lab ☐  
Central Lab ☐ GC Lab ☐ Tissue Lab ☐ Mobile Lab ☐

NONCONFORMANCE (Check appropriate item(s)):

<input type="checkbox"/> Not enough sample received for analysis	<input type="checkbox"/> Incorrect preparation/analysis procedure used
<input type="checkbox"/> Sample received	<input type="checkbox"/> Sample concentrations exceeded linear range;
<input type="checkbox"/> Broken/Leaking	Reanalysis not conducted
<input type="checkbox"/> Without proper preservative	<input type="checkbox"/> Incorrect/incomplete data reported to client
<input type="checkbox"/> Improper container	<input type="checkbox"/> Blank contamination; no prep of associated samples
<input type="checkbox"/> Incomplete paperwork	done or possible
<input type="checkbox"/> Holding time exceeded	<input type="checkbox"/> Reporting limits higher than specified in:
<input type="checkbox"/> At receipt	<input type="checkbox"/> Method <input type="checkbox"/> QAPP due to:
<input type="checkbox"/> Sample lost during extraction/analysis;	<input type="checkbox"/> Matrix <input type="checkbox"/> Insufficient sample
no prep or reanalysis possible	<input type="checkbox"/> Instrumentation <input type="checkbox"/> Other _____
<input type="checkbox"/> QC data reported to client outside of:	
<input type="checkbox"/> Method <input type="checkbox"/> QAPP	
<input type="checkbox"/> Other _____	

**CORRECTIVE ACTION:**

☐ Client informed in writing on \_\_\_\_\_ by \_\_\_\_\_  
☐ Client informed verbally on \_\_\_\_\_ by \_\_\_\_\_  
☐ Samples processed As is. Comments \_\_\_\_\_  
☐ Further action required (list details) \_\_\_\_\_

Corrective action performed by: \_\_\_\_\_ Date: \_\_\_\_\_

QC Concurrence: ☐ Nonconformance ☐ Deficiency

Corrective Action Verification ☐ Verified ☐ Cannot verify. Reason: \_\_\_\_\_

Verified by: \_\_\_\_\_ Date: \_\_\_\_\_

Lockheed Martin Information Systems and Global Services  
Environmental Services/SERAS  
2890 Woodbridge Ave, Building 209 Annex  
Edison, NJ 08837-3679  
Telephone: 732-321-4200 Facsimile: 732-494-4021

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# STANDARD OPERATING PROCEDURES

SOP: 1008

PAGE: 13 of 13

REV: 2.1

EFFECTIVE DATE: 12/09/15

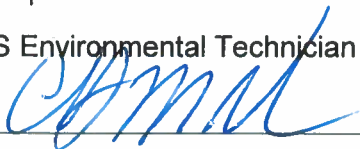


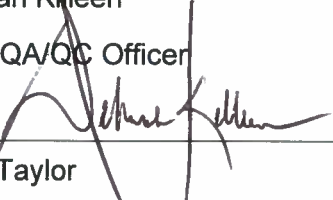

## SAMPLE RECEIVING, HANDLING AND STORAGE

### ATTACHMENT 4. Sample Receipt Report

Date/Time Received:			<b><u>Shipping Container Details</u></b>	
Received By:			Container	of
Delivered By: Left in SRU#2 Walk-In Fed-Ex/UPS Other			<b>Remarks:</b>	
Work Assignment #:				
Work Order #:				
<b><u>Receiving Criteria</u></b>	<b>Yes</b>	<b>No</b>	<b><u>Comments/Resolution</u></b>	
1. Outer shipping container intact?				
2. Custody Seals Intact?				
3. Shipping Papers/Information available?				
4. Chain of Custody (COC) present?				
5. COC properly filled out?				
6. All samples received intact?				
7. Samples packaged according to SOP 2004?				
8. Custody is relinquished to SERAS Lab?				
9. Received on Ice? Temperature at <6°C w/o freezing?			<b>Temp °C =</b>	
10. Sample labels and COC match?				
11. Samples received within method specified hold time?				
12. Volatiles free of headspace and in airtight container?				
13. Was the proper sample container used?				
14. Was a Trip Blank received with the shipment?				
15. Is a PWA available? How was SRT notified of the shipment?				
16. Does this require a non-conformance memo?				
<b>Comments:</b>				

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## STANDARD OPERATING PROCEDURE APPROVAL AND CHANGE FORM

Scientific, Engineering, Response and Analytical Services 2890 Woodbridge Avenue Building 209 Annex Edison New Jersey 08837-3679	
<b>STANDARD OPERATING PROCEDURE</b>	
Title: Sampling Equipment Decontamination	
Approval Date: 12/28/2015	
Effective Date: 12/28/2015	SERAS SOP Number 2006, Rev 1.0
<b>Authors</b>	
Name Christopher French	
Title SERAS Environmental Technician	
Signature 	Date 12/28/15
Name Christopher Gussman	
Title SERAS Phytoremediation Scientist	
Signature 	Date 12/28/15
<b>Approvals</b>	
Name Richard Leuser	
Title SERAS Deputy Program Manager	
Signature 	Date 12/28/2015
Name Deborah Killeen	
Title SERAS QA/QC Officer	
Signature 	Date 12/23/15
Name Kevin Taylor	
Title SERAS Program Manager	
Signature 	Date 12/28/15



The top row of this table shows the most recent changes to the controlled document. For previous revision history information, archived versions of this document are maintained by the SERAS QA/QC Officer on the SERAS local area network (LAN).

History	Effective Date
Supersedes: SOP #2006, Revision 0.0, 08/11/94	12/28/15
Complete Rewrite - Updated all sections of the SOP	12/28/15



# STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 1 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

## SAMPLING EQUIPMENT DECONTAMINATION

---

### CONTENTS

1.0	SCOPE AND APPLICATION
2.0	METHOD SUMMARY
3.0	SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE
4.0	INTERFERENCES AND POTENTIAL PROBLEMS
5.0	EQUIPMENT/APPARATUS
5.1	Decontamination Tools/Supplies
5.2	Health and Safety Equipment
5.3	Waste Disposal
6.0	REAGENTS
7.0	PROCEDURES
7.1	Decontamination Methods
7.1.1	Abrasive Cleaning Methods
7.1.2	Non-Abrasive Cleaning Methods
7.2	Field Sampling Equipment Decontamination Procedures
7.2.1	Decontamination Setup
7.2.2	Decontamination Procedures
7.2.3	Post Decontamination Procedures
7.3	Decontamination of Earth Moving Equipment/Drilling Equipment and accessories
7.3.1	Decontamination Setup
7.3.2	Decontamination Procedures
7.3.3	Post Decontamination Procedures
8.0	CALCULATIONS
9.0	QUALITY ASSURANCE/QUALITY CONTROL
10.0	DATA VALIDATION
11.0	HEALTH AND SAFETY

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 2 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

#### CONTENTS (cont'd)

12.0 REFERENCES

13.0 APPENDICES

A - Tables  
B - Figures

SUPERSEDES: SOP #2006, Rev. 0.0, 08/11/94; US EPA Contract EP-W-09-031

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# STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 3 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

## SAMPLING EQUIPMENT DECONTAMINATION

### 1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe the methods for preventing or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during environmental investigations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure the methods used are adequate to satisfy the data quality objectives.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

### 2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the possibility of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances. Some equipment may have specific decontamination procedures that do not follow this SOP. Refer to the user manual for each piece of equipment before utilizing this SOP.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes and high and low pressure water cleaning.

The first step is the physical removal of gross contamination on sampling equipment which may include steam or a high pressure water wash. The second step is a soap and water wash that removes the remainder of visible material and residual oils and grease. The third step involves a potable water rinse to remove any detergent, followed by a distilled/deionized water rinse.

For the removal of metals, an acid rinse with a 10% nitric acid solution is used prior to the final distilled/deionized water rinse. For the removal of organics, pesticide grade acetone, methanol or hexane, depending on the specific contaminant of concern, will be applied prior to the final distilled/deionized rinse. Acetone is typically chosen because it is excellent at removing organics, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern or if Target Compound List analysis (which includes acetone) is to be performed, another solvent such as methanol will need to be substituted.

Hexane should be used when the contaminant of concern is polychlorinated biphenyls (PCBs) or in oily media. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

A generalized decontamination procedure is:

1. Physical removal
2. Non-phosphate detergent wash with potable water
3. Potable water rinse
4. Solvent rinse (acetone, hexane, etc.)

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 4 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

5. Air dry
6. 10% nitric acid solution rinse
7. Distilled/deionized water rinse
8. Air dry

In instances in which sampling equipment is being used to collect samples for biological pathogens, the acid is replaced with a 10% bleach solution. Modifications to the standard procedure are required to be documented in the site-specific QAPP, field log book and subsequent reports. All decontamination water is replaced daily at a minimum. If at any point throughout the day the water becomes too dirty, then it is no longer suitable for cleaning and is required to be replaced. All sampling equipment is required to be decontaminated before collecting samples on-site and after use of each piece of sampling equipment.

Waste materials generated from the decontamination processes are referred to as Investigation-Derived Waste (IDW). Management of this waste should be in coordination with SOP#2049, *Investigative-Derived Waste Management*.

#### 3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample collected, along with the proper sample container type (i.e. glass, plastic), chemical preservation, and storage requirements are dependent upon the matrix sampled and analysis performed. For further information, refer to SERAS SOP #2003, *Sample Storage, Preservation and Handling*.

Sample collection and analysis of decontamination waste generated on-site may be required prior to disposal of decontamination liquids and solids. This should be determined prior to initiation of site activities or as soon as possible thereafter. For more information on handling of IDW, refer to SOP#2049, *Investigative-Derived Waste Management*.

#### 4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Acetone is an excellent solvent since it is miscible with water; however, if volatile organic compounds (VOCs) are to be analyzed, the use of an alternate solvent (methanol, hexane) should be considered since acetone is a compound on the Target Compound List (TCL).

The use of deionized (distilled if only option) water is required for decontamination of sampling equipment. In addition, that water is required to be lab certified, analyte free (specifically for the contaminants of concern). The deionized water must be secured prior to field activities as it is not commonly found local to the site.

The use of solvents and acids on sensitive sampling equipment may cause damage. It is important avoid damaging the equipment. If acids or solvents are utilized, follow health and safety, and waste disposal guidelines.

When decontaminating equipment when temperatures are below freezing, water will freeze in pump spray hoses lines, tanks and in buckets/pails, etc. Additionally, equipment will require longer drying times.

Do not store sampling equipment or reagents used for decontamination near gasoline or any exhaust emissions. Improperly cleaned and prepared sampling equipment can lead to misinterpretation of analytical data due to cross contamination.

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 5 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

Make sure that the decontamination station is set up as not to compromise a clean environment.

#### 5.0 EQUIPMENT/APPARATUS

Decontamination equipment is selected based on the type of equipment to be cleaned and anticipated contaminants to be removed. For example, soft-bristle scrub brushes or long-handled bottle brushes are used to remove contaminants. Large galvanized wash tubs, stock tanks, buckets, or children's wading pools hold wash and rinse solutions. Large plastic garbage cans or other similar containers lined with plastic bags help segregate contaminated equipment. Drums are used to store liquid and solid site derived waste.

The following standard materials and equipment are recommended for decontamination activities:

- 
- 5.1 Decontamination Tools/Supplies
  - Long and short handled brushes
  - Bottle brushes, composed of nonmetallic material such as nylon
  - Plastic sheeting
  - Paper towels
  - Plastic or galvanized tubs or buckets
  - Pressurized sprayers filled with potable water
  - Spray bottles
  - Aluminum foil
  - Pressure washer
  - Garden hose
  - Electrical cords
  - Work lights (if working in the dark)
  - Generator (if using a submersible pump or lights)
  - Water tank
  - Sump pump

#### 5.2 Health and Safety Equipment

The use of personal protective equipment (PPE), (i.e. safety glasses or splash shield, Tyvek® suits, nitrile gloves, aprons or coveralls, steel toe boots, etc.), is required. Refer to the site-specific Health and Safety Plan (HASP) for site-specific requirements.

#### 5.3 Waste Disposal

- Trash bags
- 55-gallon drums (open and closed top types)
- Metal/plastic buckets/containers for storage and disposal of decontamination solutions

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# STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 6 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

## SAMPLING EQUIPMENT DECONTAMINATION

---

### 6.0 REAGENTS

Table 1 (Appendix A) lists solvents recommended for the elimination of particular chemicals. In general, solvents typically utilized during the decontamination process are:

- 10% Nitric Acid ( $\text{HNO}_3$ ), typically used for inorganic compounds such as metals
- Acetone (pesticide grade)
- Hexane (pesticide grade)
- Methanol (pesticide grade)
- Deionized/Distilled Water that meets ASTM Type II specifications
- Non-Phosphate Detergent
- Potable Water

### 7.0 PROCEDURES

A decontamination area should be set up prior to sampling. Weather conditions (i.e. hot, cold, rain, snow, etc.) play an important role in the decontamination process. In hot, cold, rainy or snowy conditions, a tent or canopy may be erected around and over the decontamination area. In cold environments, the decontamination may need to occur inside a building or portable heaters may be needed to warm the area under the tent or canopy. In addition, in cold environments the potable and deionized water may freeze. Plan accordingly and consider your working conditions prior to field sampling activities.

A decontamination plan needs to be implemented and includes:

- The number, location, and layout of decontamination stations
- Decontamination equipment
- Selection of appropriate decontamination methods
- Methods of disposal of all investigative derived waste (i.e. PPE, solid and liquid waste, etc.)
- Work practices that minimize contact with potential contaminants.
- Protection procedures for monitoring and sampling equipment (i.e. covering with plastic, etc.)
- Considerations related to weather conditions
- The use of disposable sampling equipment, when possible

#### 7.1 Decontamination Methods

All samples and equipment removed from site must be decontaminated, removing all contamination that may have adhered to the equipment. Various decontamination methods remove contaminants by washing with water and another physical cleaning action. In addition, solvents and/or acids may be used to decontaminate the equipment.

Physical decontamination methods are grouped into two categories, abrasive and non-abrasive methods, and are listed below:

##### 7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. It involves the use of metal or nylon brushes. The amount and type of contaminants removed will vary with the brush type, length of time brushed,

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 7 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

degree of brush contact, degree of contamination, nature of the contaminant and surface being cleaned.

#### 7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with water pressure (i.e. sprayer or pressure washer).

##### Low-Pressure Water

This method consists of a pressure sprayer filled with water. The user pumps air into the sprayer tank to create pressure. The water is then discharged through a slender nozzle and hose, cleaning the equipment. Scrubbing with a brush is typically used in conjunction with this method.

##### High-Pressure Water

This method consists of the use of a pressure washer. The operator controls the directional nozzle which is attached to a high-pressure hose. Operating pressure usually ranges from 400 – 600 pounds per square inch (PSI). Scrubbing with large brushes can be used to aid in the decontamination process.

##### Rinsing

Contaminants and any remaining solvents and/or acids are removed by thorough rinsing. The rinsing is done either by the use of a sprayer or a pressure washer depending on the equipment being cleaned.

##### Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps attached to a fence, placed on a drum, or equipment protected by plastic or some other material are not likely to become heavily contaminated.

A damp cloth is used to wipe off any contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set. The use of a different cleaning cloth for each piece of equipment is required. Upon completion, dispose of all cloths with the site derived waste.

#### 7.2 Field Sampling Equipment Decontamination Procedures

##### 7.2.1 Decontamination Setup

The decontamination area is set up by laying out a section of plastic sheeting large enough for the type and amount of equipment to be decontaminated and for the equipment drop and equipment air drying areas.

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# STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 8 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

## SAMPLING EQUIPMENT DECONTAMINATION

---

Stage brushes, pressure sprayers, spray bottles (w/appropriate solvents, acids and deionized water), 5-gallon buckets, plastic/galvanized wash tubs, pressure washer (if required) and detergent. Figure 1 (Appendix B) shows the decontamination area overall layout. Section 7.2.2 discusses the decontamination procedures depending on the contaminants of concern for a Site.

Stage the appropriate amount and type of sample bottles and a cooler, for the collection of rinsate samples. For specific rinsate sample information, refer to SERAS SOP #2005, *Quality Assurance/Quality Control Samples*.

### 7.2.2 Decontamination Procedures

There are various stations of the cleaning process in which the equipment move through that are designed to remove all visible contamination. Stations 1 and 2 are designed to remove all visible contamination. Additional stations after 1 and 2 remove materials that require dissolution and a final rinse. Once the equipment has passed through all stations, it is laid out to air dry.

#### Decontamination Process for Metals

**Station 1** - Place the sampling equipment into the soapy water solution and thoroughly scrub with brushes or pressure washer. When there is no visible residue remaining, transfer to Station 2.

**Station 2** - Rinse the equipment in the bucket/tub with potable water. Then remove from the bucket/tub and rinse with the pressure sprayer. When satisfied with the cleanliness of the sampling equipment, transfer to Station 3.

**Station 3** - Apply the acid solution and air dry on the plastic sheeting, behind Station 3. Once equipment has fully dried, transfer to Station 4.

**Station 4** - Rinse the equipment with the pressure sprayer filled with deionized water. When satisfied the rinsing process is complete, transfer to the equipment drying area. After drying, the equipment should be wrapped in aluminum foil to prevent contamination of the equipment.

#### Decontamination Process for Organics

**Station 1** - Place the sampling equipment into the soapy water solution and thoroughly scrub with brushes. When there is no visible residue remaining, transfer to Station 2

**Station 2** - Rinse the equipment in the bucket/tub with potable water. Then remove from the bucket/tub and rinse with the pressure sprayer. When satisfied with the cleanliness of the sampling equipment, transfer to Station 3.

**Station 3** - Apply the appropriate solvent or solvents and air dry on the plastic sheeting, behind Station 3. Once equipment has fully dried, transfer to Station 4.

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 9 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

**Station 4** - Rinse the equipment with the pressure sprayer filled with deionized water. When satisfied the rinsing process is complete, transfer to the equipment drying area.

#### Decontamination process for Metals and Organics

**Station 1** - Place the sampling equipment into the soapy water solution and thoroughly scrub with brushes. When there is no visible residue remaining, transfer to Station 2.

**Station 2** - Rinse the equipment in the bucket/tub with potable water. Then remove from the bucket/tub and rinse with the pressure sprayer. When satisfied with the cleanliness of the sampling equipment, transfer to Station 3.

**Station 3** - Apply the acid solution and transfer to Station 4.

**Station 4** - Rinse the equipment with the pressure sprayer filled with deionized water. When satisfied the rinsing process is complete, transfer to Station 5.

**Station 5** - Apply the solvent or solvents and air dry on the plastic sheeting behind Station 5. Once equipment has fully dried, transfer to Station 6.

**Station 6** - Rinse the equipment with the pressure sprayer filled with deionized water. When satisfied the rinsing process is complete, transfer to the equipment drying area. After drying, the equipment should be wrapped in aluminum foil to prevent contamination of the equipment.

#### 7.2.3 Post Decontamination Procedures

1. Fill out the appropriate labels for the all the various wastes and affix the labels to the drums and/or containers.
2. Clean up the entire work area. Collect solid waste (i.e. nitrile gloves, plastic sheeting, etc.) and store in an appropriate DOT certified drum.
3. Return any remaining unused solvents or acid solutions to their respective labeled containers and properly store.
4. Transfer potable water rinse waste into an appropriate Department of Transportation (DOT) certified drum or container.
5. Transfer the solvent and acid solution rinse water waste into the appropriately labeled DOT certified drums or containers.
6. Using a pressure sprayer, rinse the basins/buckets.
7. Transfer liquid generated from this process into the potable water rinse waste container.
8. Transfer the decontamination brushes into the solid waste container.

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 10 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

9. Empty the pressure sprayer filled with potable water onto the ground.
10. Return all equipment into their carrying cases or shipping containers.
11. Make arrangements for the pickup of all liquid and solid waste.

For further information on waste disposal, refer to SERAS SOP 2049, *Investigation Derived Waste Management*.

#### 7.3 Decontamination of Earth Moving Equipment/Drilling Equipment and Accessories

The decontamination of earth moving and/or drilling equipment and their accessories will require the use of a pressure washer. In addition, an on-site water supply will need to be available. If an on-site water supply is not available, a water tank along with a pump, hoses and a generator will be required. Finally, a designated area on-site needs to be designated as a decontamination area. Some sites already have a concrete pad set-up for this very purpose. If this is not the case, work with the Work Assignment Manager (WAM) to assign a location for these activities to take place on-site.

An area for decontamination can be built with 4x4 lumber or hay bales, heavy duty plastic sheeting and a sump pump. The area will need to extend at least 4 feet beyond the outer dimensions of the equipment being cleaned. Either slope the decontamination area down to one corner or dig a small hole about 2 feet by 2 feet square and about 2 feet deep to allow for the collection of the decontamination water. Cover the decontamination area with plastic sheeting, wrapping the sides around and under the 4 x 4 lumber or bales of hay. If equipment being decontaminated includes equipment with tracks that might tear through the plastic sheeting, appropriate surfaces need to be included for the equipment to drive on. Finally, place a sump pump into this area and periodically empty the water as necessary, into the appropriately labeled liquid waste drum.

##### 7.3.1 Decontamination Set-up Procedures:

1. Move the equipment into the decontamination area.
2. Stage all the decontamination equipment and supplies (i.e. Pressure Washer, Hoses, PPE, etc.)
3. Connect all hoses and fill the pressure washer with fuel.
4. Dress out in the appropriate PPE (refer to the site-specific HASP).

At a minimum, Tyvek®, safety glasses/goggles, steel toe boots, and nitrile gloves must be worn. If handling any equipment (i.e. drill rods, etc.) work gloves must also be worn to prevent possible injury. For site specific requirements refer to the site-specific HASP.

##### 7.3.2 Decontamination Cleaning Procedures:

1. Physically remove as much of the visible material as possible from the heavy equipment after use and prior to steam cleaning. If contaminated material is suspected as determined by visual observations, instrument readings, or other means, collect material in an appropriate waste container.

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 11 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

2. Place the heavy equipment on the decontamination pad in the decontamination area. Verify the decontamination pad has no leaks and the sump pump is functioning properly before beginning the decontamination process.
3. Power on the pressure washer and begin cleaning from the top to the bottom. Thoroughly clean parts of the heavy machinery that come into contact with visible material (such as tires, bucket, augers, drill rods, tracks and the back and underneath of the drill rig). Scrub areas with excessive dirt/debris with large bristle brushes. A flat head shovel can be used to aide in the removal of the dirt/debris. Continue cleaning until all visible contamination has been removed. If required, apply solvents and/or acid solutions, rinse with deionized/distilled water and then let air dry.

The use of solvents and/or acid solutions will depend on site specific conditions. Check with the site-specific HASP for further guidance.

#### 7.3.3 Post Decontamination Procedures

1. Fill out the appropriate labels for the all the various wastes and affix the labels to the drums and/or containers
2. Transfer potable water rinse waste into an appropriate Department of Transportation (DOT) certified drum or container. Transfer water from the decontamination pad to the liquid waste drums using a sump pump.
3. Collect and transfer solid waste (i.e. nitrile gloves, plastic sheeting, etc.) to a DOT-certified drum or container.
4. Transfer the solvent and acid solution rinse water waste into the appropriately labeled DOT-certified drums or containers.
5. Make arrangements for the pickup of all liquid and solid waste.

For further information on waste disposal, refer to SERAS SOP 2049, *Investigation Derived Waste Management*.

#### 8.0 CALCULATIONS

This section is not applicable to this SOP.

#### 9.0 QUALITY ASSURANCE/QUALITY CONTROL

Documentation of the decontamination process including date, time and personnel that conducted the decontamination activities must be recorded in a field logbook. Record manufacturer and lot numbers of the reagents used for the decontamination procedures.

A rinsate blank is a specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field. Rinsate blanks are samples obtained by pouring analyte free deionized water over previously

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 12 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

decontaminated sampling equipment, testing for residual contamination. The blank water is then collected in sample containers, processed, shipped and analyzed. The rinsate blank is used to assess possible cross-contamination caused by improper decontamination procedures. The most common frequency of collection is one rinsate blank per day per type of sampling device, to meet definitive data objectives. For further information for each analysis, refer to SERAS SOP #2005, *Quality Assurance/Quality Control Samples*.

For information on sample container types and preservation, refer to SERAS SOP #2003, *Sample Storage, Preservation and Handling*.

If sampling equipment requires the use of Teflon® or polyethylene tubing it is required to be disposed of into the on-site waste container and replaced with clean tubing before additional sampling occurs.

#### 10.0 DATA VALIDATION

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. These data are essential to providing an accurate and complete final deliverable. Results of quality control samples will be evaluated for possible cross-contamination of improperly or inadequately decontaminated sampling equipment. This data will be utilized to quantify the sample results in accordance with the project's data quality objectives. The SERAS Task Leader (TL) is responsible for completing the UFP-QAPP verification checklist for each project.

#### 11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow Occupational Safety and Health (OSHA), U.S. EPA, corporate, and other applicable health and safety procedures.

The decontamination process can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before their use. Decontamination materials may degrade protective clothing or equipment and some solvents can permeate protective clothing. If decontamination materials pose a health hazard, measures are to be taken to protect personnel. Alternatively, substitutions can be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process. Material generated from decontamination activities requires proper handling, storage, and disposal. PPE may be required for these activities.

Safety data sheets (SDS) are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e. acetone, alcohol, etc.).

#### 12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, August 2005.

Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 13 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

The Field Branches Quality System and Technical Procedures – Field Equipment Cleaning and Decontamination, USEPA Region IV Science and Ecosystem Support Division, November 2007.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October 1985.

UNCONTROLLED COPY



## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 14 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

APPENDIX A  
Tables  
SOP #2006  
December 2015

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 15 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

TABLE 1. Soluble Contaminants and Recommended Solvent Rinse		
SOLVENT <sup>(1)</sup>	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Potable water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazine's) and inorganic compounds.
Dilute Bases	Sodium bicarbonate	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents <sup>(2)</sup>	Acetone Alcohols Ketones Aromatics Alkanes (e.g., hexane) Common petroleum products (i.e. fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent <sup>(2)</sup>	Hexane	PCBs

<sup>(1)</sup> - Safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

<sup>(2)</sup> - WARNING: Some organic solvents can permeate and/or degrade protective clothing

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## STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 16 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

### SAMPLING EQUIPMENT DECONTAMINATION

---

APPENDIX B  
Figures  
SOP #2006  
December 2015

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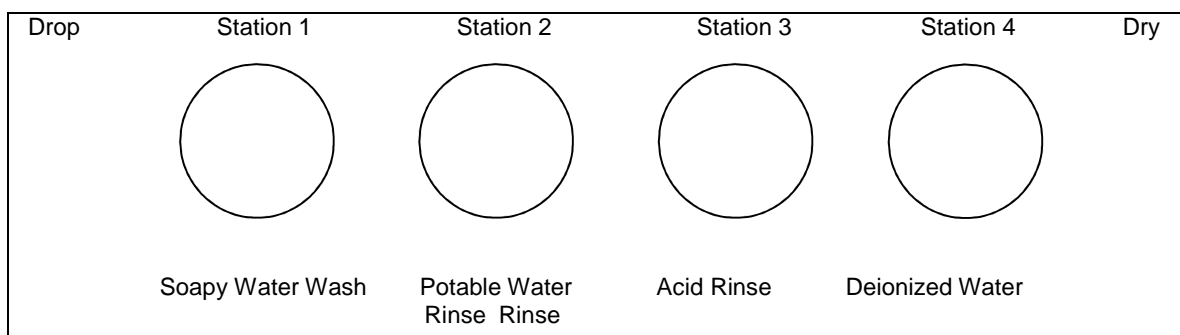
# STANDARD OPERATING PROCEDURES

SOP: 2006  
PAGE: 17 of 17  
REV: 1.0  
EFFECTIVE DATE: 12/28/15

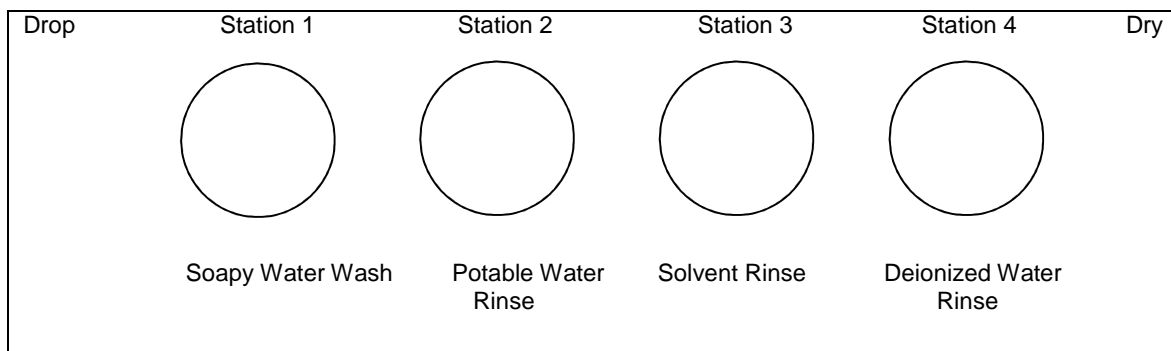
## SAMPLING EQUIPMENT DECONTAMINATION

FIGURE 1. Sampling Equipment Decontamination Area

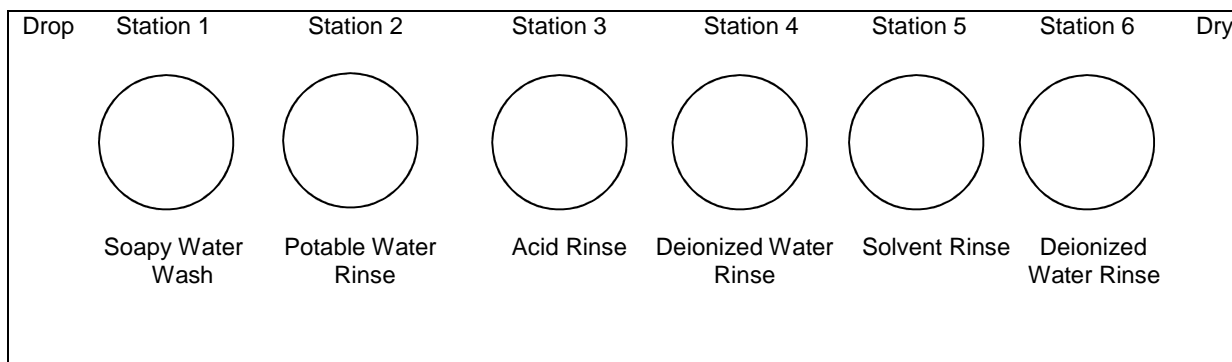
### Configuration for the Removal of Metals



### Configuration for the Removal of Organics



### Configuration for the Removal of Metals and Organics



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SOP 09  
PRE-DRILLING PROCEDURES

SITE UTILITY CLEARANCE

All proposed well and boring locations will be cleared for subsurface and overhead utilities prior to the start of drilling operations. Underground Service Alert will be notified at least two days prior to the start of field work to allow member companies to identify and delineate utility lines. Additionally, a private utility locating contractor will clear all drilling sites. The uppermost five feet at each drilling location will be hand-augured as a precaution against unexpectedly encountering unidentified or abandoned utility lines and other subsurface obstructions.

## SOP 10

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## SOP 11 LITHOLOGIC LOGGING

### GENERAL STATEMENT

During drilling of boreholes for soil and/or groundwater investigation activities, geologic and hydrogeologic conditions encountered during drilling will be recorded and maintained on a lithologic log form; unique or other unexpected conditions will also be noted in the field notebook. The lithologic log will include descriptions of the lithology of sediments and rocks encountered during drilling based on examination of drill cuttings samples and/or soil and rock cores obtained during drilling. In addition to lithology, information regarding the hydrogeologic conditions, such as moisture content, depth to water, etc., will also be recorded along with notations on drilling conditions encountered during borehole construction.

### OBJECTIVE

The objective of compiling lithologic logs and noting hydrogeologic conditions during drilling activities is to collect pertinent information for use in the interpretation of subsurface geologic and hydrogeologic conditions. The lithologic logs and other field notations may be used in construction of interpretative maps or diagrams such as geologic maps, geologic cross sections, fence diagrams, structural contour maps, and isopach maps. Information recorded as part of the lithologic log is also important in the interpretation of hydrogeologic characteristics, such as the ability of these materials to transmit water and adsorb and transmit chemical constituents. Use of standard procedures during borehole drilling also allows ready comparison of data to other similarly collected information in the site vicinity.

## EQUIPMENT

Equipment used as part of lithologic logging may include any or all of the following: hand lens, dropper bottle containing dilute hydrochloric acid, Munsell color chart, sand size chart, sample collection bags, sample collection sieve, binocular microscope, and pocket knife. Onsite use of standard reference materials including American Society for Testing Materials (ASTM) Standard D 2487-06 "Classifications of Soils for Engineering Purposes" (Unified Soil Classification System [USCS]) (ASTM, 2006), ASTM Standard D 2488-00 (Practice for Description and Identification of Soils [Visual-Manual Procedure]) (ASTM, 2000), Manual of Field Geology, or Earth Manual may be included (Compton, 1962; U.S. Department of Interior, 1974).

## PREPARATION

Obtain and review available lithologic logs for wells drilled in the site area. Also review available geologic reports and maps which include information for the site area. If available, review any previous in-house or externally produced reports containing site subsurface geologic and hydrogeologic characterization information.

## PROCEDURES

A lithologic log will be maintained during drilling of boreholes. The following procedures will be used during lithologic logging activities:

- Describe the core sample or drill cuttings using the USCS (ASTM, 2000) and record on the lithologic field form and in the field notebook. Take into account and note any sample alterations caused by the sampling or drilling process.
- Note and record unusual drilling conditions or rig behavior; note the depth(s) of the conditions encountered and an explanation of conditions to the extent possible.
- Complete a chronology of borehole drilling, well construction and completion, and monitor well development activities in the field notebook.

The following procedures will be used for lithologic description of unconsolidated materials:

- Textural classification of soil and sediment:
  - Record the estimated proportion, in percent, of the following grain size fractions present in the sample: gravel, sand, silt, and clay. The size limits for each fraction will be in accordance with the USCS. Estimate and record the predominant grain size(s) present within the gravel and sand fractions in the sample.
  - Provide textural classification name for the soil/sediment. The root of the name is determined by the grain size (gravel, sand, silt, or clay fractions) present in the highest percentage. The root name may be further described using modifying terms based on the relative percentage of the other major size fractions in the sample as described in ASTM 2487-06.
- Unified Soil Classification:
  - Classify the soil/sediment using the USCS (ASTM, 2000 and 2006).
- Color:
  - Compare samples to a Munsell color chart and record hue and chroma values for each sample. Indicate on the lithologic log form and in the field notebook whether the color was determined for a wet, moist or dry sample. Provide a subjective description of the soil color. For example, the description light brown, red-brown, or dark brown could be used in describing a sediment/soil which has an overall brown appearance.
- Moisture Content:
  - For soil/sediment samples collected above the water table using drilling and sampling methods which do not involve the introduction of fluids, estimate

and record the relative moisture content using the terms dry, moist, and wet.

- Sorting:
  - Estimate and record the degree of sorting, or overall grain size distribution of soil/sediment samples, or portions of samples, which consist predominantly of sand-sized or larger particles. Designate the degree of sorting using one of the following descriptors: very poorly sorted, poorly sorted, moderately sorted, well sorted, and very well sorted. The descriptor “very poorly sorted” applies to soils/sediments in which there is a good representation of the continuum of particle sizes. The descriptor “very well sorted” applies to soils/sediments in which most particles have nearly the same grain size.
- Roundness:
  - Estimate and record the predominant roundness categories for the sand and gravel size fractions of soil/sediment samples. The roundness categories are: very angular, angular, sub-angular, sub-rounded, rounded, and well rounded. The on-site hydrogeologist will record in the field notes any actions of the drilling process potentially responsible for increasing the angularity of the sand or gravel size fractions in the sample.
- Consistency, relative density and induration:
  - Estimate the consistency, relative density and induration, of the sample based on examination of the soil/sediment samples. For soil samples obtained by drilling, note and record the drilling characteristics of the soil sampling interval. Consistency descriptors for fine-grained soils/sediments are: very soft, soft, firm, hard, and very hard. Relative density descriptors for coarse-grained soils/sediments are: very loose, loose, medium dense, dense, and very dense. Descriptors of the degree of induration for a soil/sediment as a whole are: poorly indurated, moderately indurated, and



highly indurated.

- Plasticity:
  - Estimate and record the degree of plasticity for the lithologic sample. Plasticity is the property which describes the propensity for a soil to be rapidly deformed or molded without rebounding elastically, changing volume, cracking, or crumbling (U.S. Department of Interior, 1974). Plasticity descriptors are: non-plastic, low plasticity, medium plasticity, and high plasticity.
- Miscellaneous properties:
  - Additional properties should be reported if noted as present in the soil/sediment sample. These properties include, but are not limited to, the following: presence of dense non-aqueous phase liquid, degree of iron or manganese staining of coarse fractions; reactance with dilute hydrochloric acid; odor, presence of man-made, animal, or plant debris.

## DOCUMENTATION

The on-site hydrogeologist will document lithologic descriptions and all observations made during drilling activities on a standard lithologic log form and/or in a field notebook. The lithologic information will be recorded on the appropriate lithologic log form (Table A-1). A field notebook will be used to record a daily log of activities, drilling notes, construction or abandonment details and any other notes pertinent to the field activities; a waterproof ink pen will be used for field notes. Errors will be corrected by drawing a line through the item in error, recording the corrected note immediately below, and initialing the correction. The field notebook will be maintained daily throughout the borehole drilling, well construction and well development processes. All lithologic logging will be performed by an experienced hydrogeologist familiar

with the drill rig selected, the borehole drilling process and monitor well construction. The field notebook entries will also be summarized on the following form:

- Well drilling and completion report forms (Table A-2).

A schematic monitor well construction diagram will be prepared for each monitor well.

### QUALITY ASSURANCE

QA during lithologic logging activities will be accomplished by following the procedures contained in this SOP. In addition, the Project Manager will review all lithologic logs and drilling documentation throughout drilling operations to ensure conformity with this SOP.

## TABLES



## TABLE A-1

### LITHOLOGIC LOG FORM

[illegible]



**TABLE A-1**  
**LITHOLOGIC LOG FORM**

[illegible]

ft/bls = Feet below land surface; ft/bmp = Feet below measuring point;  
DIA = Diameter; USCS = Unified Soil Classification System



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

Drilling Company: \_\_\_\_\_

Driller: \_\_\_\_\_

Drill Rig: \_\_\_\_\_

Date drilling started: \_\_\_\_\_

Date drilling completed: \_\_\_\_\_

Description of drilling \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**A. GENERAL**

Location: \_\_\_\_\_

Location coordinates: x \_\_\_\_\_ y \_\_\_\_\_

Total depth of borehole: \_\_\_\_\_ feet bls

Borehole diameter: \_\_\_\_\_ inches, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

\_\_\_\_\_ inches, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Lost circulation zones: \_\_\_\_\_

Lithology logged by: \_\_\_\_\_

**B. CONSTRUCTION**

**Conductor Casing**

Type: \_\_\_\_\_, O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Centralizers/Shoe: \_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

**Well Casing**

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

**Well Screen**

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Centralizers/Shoe: \_\_\_\_\_

**C. GROUT AND CEMENTING RECORD**

Annular space: \_\_\_\_\_

Type of cement/grout: \_\_\_\_\_

Method of emplacement: \_\_\_\_\_

Approximate number of yards/bag: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Annular space: \_\_\_\_\_

Type of cement/grout: \_\_\_\_\_

Method of emplacement: \_\_\_\_\_

Approximate number of yards/bag: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

**D. GRAVEL PACK**

Type: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_ , Method emplaced: \_\_\_\_\_

Type: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_ , Method emplaced: \_\_\_\_\_

**Grout Filter**

Type: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_ , Method emplaced: \_\_\_\_\_

**Bentonite Seal**

Type: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_ , Method emplaced: \_\_\_\_\_

**E. DEVELOPMENT RECORD**

Date: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes

Pumping duration: \_\_\_\_\_ minutes

Average pump discharge rate: \_\_\_\_\_ gpm

Drawdown at end of pumping: \_\_\_\_\_ feet bls

Field parameters (initial): pH \_\_\_\_\_ , Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_

Field parameters (final): pH \_\_\_\_\_ , Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_





**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

**F. PUMP INSTALLATION DATA**

Pump installer: \_\_\_\_\_

Installation date: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Surface completion (hole vault type, etc.): \_\_\_\_\_

**G. REFERENCE ELEVATIONS**

Land surface elevation: \_\_\_\_\_ feet msl

Measuring point elevation: \_\_\_\_\_ feet msl

Description of measuring point: \_\_\_\_\_

Date surveyed: \_\_\_\_\_, by: \_\_\_\_\_

**H. COMMENTS AND NOTES RE DRILLING WELL CONSTRUCTION OPERATIONS**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**MONITOR WELL PLACEMENT FORM**

Proposed Well ID: \_\_\_\_\_ Actual Well ID: \_\_\_\_\_

Date: \_\_\_\_\_ By: \_\_\_\_\_

Street Address or APN: \_\_\_\_\_

City/Town: \_\_\_\_\_

Nearest Cross Street: \_\_\_\_\_

Thomas Brothers Reference: \_\_\_\_\_

Owner/Jurisdiction: \_\_\_\_\_

County Permit No. : \_\_\_\_\_

USA Alert Ticket: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**Sketch Map**

**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**DEVELOPMENT REPORT FOR WELL \_\_\_\_\_**

**A. DEVELOPMENT REPORT**

Well Type: \_\_\_\_\_

Development Company: \_\_\_\_\_

Developer/Helper: \_\_\_\_\_

Development Rig: \_\_\_\_\_

Date of Development: \_\_\_\_\_

H+A Field Notebook: \_\_\_\_\_

H+A Personnel: \_\_\_\_\_

Description of Development: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**B. WELL DEVELOPMENT**

Total Well (Driller): \_\_\_\_\_ feet bls

Depth to bottom of well before development: \_\_\_\_\_ feet bls

Bottom: soft, medium, hard

Depth to water before development: \_\_\_\_\_ feet bls

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**DEVELOPMENT REPORT FOR WELL \_\_\_\_\_**

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Pumping duration: \_\_\_\_\_ minutes

Field parameters (initial): pH \_\_\_\_\_, Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_

Average pump discharge rate: \_\_\_\_\_ gpm Gallons purged: \_\_\_\_\_

Depth to water at end of pumping: \_\_\_\_\_ feet bls, Drawdown \_\_\_\_\_ feet

Specify Capacity: \_\_\_\_\_ gpm/ft

Field parameters (final): pH \_\_\_\_\_, Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_

Depth to bottom of well after development: \_\_\_\_\_ feet bls

Bottom: soft, medium, hard

Depth to water after development and recovery: \_\_\_\_\_ feet bls

Measured: \_\_\_\_\_ hours after final pumping

**C. PUMP INSTALLATION DATA**

Pump installer: \_\_\_\_\_

Installation date: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**DEVELOPMENT REPORT FOR WELL \_\_\_\_\_**

**D. SURVEY DATA**

Surveyor: \_\_\_\_\_

Date surveyed: \_\_\_\_\_

Land surface elevation: \_\_\_\_\_ feet msl

Measuring point elevation: \_\_\_\_\_ feet msl

Location coordinate: x \_\_\_\_\_ y \_\_\_\_\_

Description of measuring point: \_\_\_\_\_

**E. COMMENTS**

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**FOOTNOTES**

°C = degrees Celsius  
bls = Below land surface  
ft = Feet  
gpm = Gallons per minute  
msl = Mean sea level  
O.D. = Outer Diameter  
specs = Specifications  
umhos = Micromhos

## SOP 12 MONITOR WELL CONSTRUCTION

### GENERAL STATEMENT

All monitor well construction and development will be overseen by an experienced hydrogeologist under the direction of an Arizona Registered Geologist. The on-site hydrogeologist is responsible for the collection of subsurface soil samples, description of lithologies encountered, general observations of conditions encountered and selection of screened intervals, and determination of final well depth.

### OBJECTIVE

The objective of the monitor well construction activities is to allow collection of representative and comparable lithologic and groundwater data from the hydrogeologic units of interest. Once wells are installed, measurements and samples obtained from the monitor wells include depth to water, measurement of field parameters and groundwater sample collection for laboratory analysis. Data obtained from monitor wells will be used to evaluate hydrogeologic and geochemical conditions at the site, including water level elevations, direction of groundwater flow and chemical quality of the groundwater.

### EQUIPMENT AND/OR SUPPLIES

Equipment and supplies used to construct the monitor wells may include appropriate drilling equipment specified in the applicable Workplan, steel conductor casing, neat cement grout, blank and perforated polyvinyl chloride (PVC) well casing with end caps, gravel/sand pack materials, bentonite pellets or chips and bentonite grout.

Monitor wells will be developed using a combination of surging, bailing, swabbing, and/or pumping, or by an alternative method approved by the project hydrogeologist.

Once the monitor wells are developed, permanent pumps, well seals, and PVC sounding tubes may be installed. A generator will be used to drive dedicated pumps during future groundwater sampling events. An electrical connector will be installed at each wellhead either beneath the steel cover or beneath an equivalent security cover for wells completed above grade, if a pump is installed.

## PREPARATION

A qualified driller will be selected to drill and construct the monitor wells. A qualified driller is one who has appropriate equipment and capabilities, a current license in the State of Arizona, experience on similar projects, documented health and safety training and a good safety record. This experience requirement shall apply both to the individual driller in the field and to the drilling company as a whole.

The Arizona Department of Water Resources (ADWR) will be contacted prior to entering the field to ensure that the well design and construction methods outlined in the applicable Workplan, and this SOP, comply with regulatory requirements. In addition, the ADWR regulations will be reviewed to make sure the project complies with ADWR requirements regarding access, underground utility clearance, permitting of monitor wells and groundwater extraction for monitoring purposes. Utility clearance will be obtained prior to any site work, in accordance with Section 2.1 of this FSSOP.

## GENERAL PROCEDURES

Monitor wells will be drilled using roto sonic drilling methods, unless conditions require use of another method such as hollow-stem auger or rotary. The initial diameter of the typical monitor well boreholes will be approximately 8 to 10 inches. The boreholes will be enlarged to approximately 12 inches in diameter prior to installation of monitor wells.

### Monitor Wells

The boreholes for ECP monitor wells will be drilled to the total design depth of each well, using drilling methods specified in the applicable Workplan. Screened intervals will be determined based on the results of nearby wells or borehole drilling, the depth at which groundwater is encountered and the estimated saturated thickness of the water bearing interval. The screen will be placed in accordance with the applicable Workplan. Well casing and screen will typically consist of 4-inch internal diameter (ID) PVC. Monitor wells will be completed with a gravel/sand filter pack, a bentonite seal and neat cement grout to the surface. The volume of gravel pack required will be computed and will be installed in the well annular space at a controlled rate to a depth of approximately two to three feet above the top of the screen.

Upon installing the well casing and filter pack, the monitor well may be initially developed to settle the filter pack. Initial development will be performed for a period of at least one to two hours using surging, bailing, or pumping techniques. Filter pack will be added if settlement occurs during development so that the top of the pack is at least three-feet above the top of the screened interval. Two feet of fine-grained number 60 silica sand will be placed above the filter pack. A minimum of three feet of bentonite chips/pellets will be placed in the annular space above the filter pack to prevent the bentonite grout seal from penetrating the gravel pack. Placement will be confirmed and sufficient time will be allowed for hydration prior to sealing the annular space. The annular seal will consist of a neat bentonite grout slurry from the top of the bentonite seal to the surface. All materials will be placed using a tremie pipe.

### Monitor Well Development, Surface Completion, and Surveying

Following a minimum of 72-hour period after the placement of the surface seal, monitor wells will be developed. The method of well development will be determined based on the character of the unit in which it is screened. Well development will consist of a combination of surging, bailing, swabbing and/or pumping. Each monitor well will be developed until the water is clear and sand-free, to the extent feasible. Monitor wells will typically be completed with locking steel casings set in subsurface traffic-rated vaults or monument vaults. After the locking casing is installed, an accurate location and elevation of each monitor well will be established by a



qualified land surveyor licensed by the State of Arizona. The accuracy requirement for the survey will be 0.1 foot for the location and the elevation will be surveyed to an accuracy of 0.01 foot.

#### EQUIPMENT DECONTAMINATION AND WASTE DISPOSAL PROCEDURES

All down-hole drilling equipment will be decontaminated between borings to avoid the potential for cross contamination. All down-hole sampling equipment associated with borehole drilling and sampling will be decontaminated between uses. Drill cuttings and investigation derived fluids will be contained on-site in a manner consistent with Section 11.0 of this FSSOP.

#### DOCUMENTATION

A log of conditions encountered during drilling will be maintained in the field notebook and on the lithologic logging form; see Section 3.0 for further details on logging procedures. The log will include lithologic and hydrogeologic descriptions as well as notations on drill rig behavior and any unusual conditions encountered. All logging will be performed by an experienced hydrogeologist. A completion report will be compiled for each monitor well and will include the following:

- Well drilling and completion forms (Table A-2).
- Lithologic log containing lithologic descriptions of drill cutting samples using the USCS (Section 3.0) (Table A-1).
- Schematic well construction diagram illustrating as built well construction details.
- Field notes compiled by the on-site hydrogeologist during drilling operations.
- Photographs.

## QUALITY ASSURANCE

QA during monitor well construction will be accomplished by following standard procedures contained in the sections of this FSSOP applicable to borehole drilling and monitor well construction. In addition, detailed and complete documentation during drilling and completion of the monitor wells will assure that sufficient data are obtained to allow interpretation of subsurface conditions encountered at each boring location and extrapolation of those conditions to other areas of the Site.

## TABLES



## TABLE A-1

### LITHOLOGIC LOG FORM

[illegible]



**TABLE A-1**  
**LITHOLOGIC LOG FORM**

[illegible]

ft/bls = Feet below land surface; ft/bmp = Feet below measuring point;  
DIA = Diameter; USCS = Unified Soil Classification System



**TABLE A-2**  
**WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

Drilling Company: \_\_\_\_\_

Driller: \_\_\_\_\_

Drill Rig: \_\_\_\_\_

Date drilling started: \_\_\_\_\_

Date drilling completed: \_\_\_\_\_

Description of drilling \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**A. GENERAL**

Location: \_\_\_\_\_

Location coordinates: x \_\_\_\_\_ y \_\_\_\_\_

Total depth of borehole: \_\_\_\_\_ feet bls

Borehole diameter: \_\_\_\_\_ inches, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

\_\_\_\_\_ inches, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Lost circulation zones: \_\_\_\_\_

Lithology logged by: \_\_\_\_\_

**B. CONSTRUCTION**

**Conductor Casing**

Type: \_\_\_\_\_, O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Centralizers/Shoe: \_\_\_\_\_

**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

**Well Casing**

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

**Well Screen**

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Centralizers/Shoe: \_\_\_\_\_

**C. GROUT AND CEMENTING RECORD**

Annular space: \_\_\_\_\_

Type of cement/grout: \_\_\_\_\_

Method of emplacement: \_\_\_\_\_

Approximate number of yards/bag: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Annular space: \_\_\_\_\_

Type of cement/grout: \_\_\_\_\_

Method of emplacement: \_\_\_\_\_

Approximate number of yards/bag: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_

**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

**D. GRAVEL PACK**

Type: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_ , Method emplaced: \_\_\_\_\_

Type: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_ , Method emplaced: \_\_\_\_\_

**Grout Filter**

Type: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_ , Method emplaced: \_\_\_\_\_

**Bentonite Seal**

Type: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_ , Method emplaced: \_\_\_\_\_

**E. DEVELOPMENT RECORD**

Date: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes

Pumping duration: \_\_\_\_\_ minutes

Average pump discharge rate: \_\_\_\_\_ gpm

Drawdown at end of pumping: \_\_\_\_\_ feet bls

Field parameters (initial): pH \_\_\_\_\_ , Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_

Field parameters (final): pH \_\_\_\_\_ , Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

**F. PUMP INSTALLATION DATA**

Pump installer: \_\_\_\_\_

Installation date: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Surface completion (hole vault type, etc.): \_\_\_\_\_

**G. REFERENCE ELEVATIONS**

Land surface elevation: \_\_\_\_\_ feet msl

Measuring point elevation: \_\_\_\_\_ feet msl

Description of measuring point: \_\_\_\_\_

Date surveyed: \_\_\_\_\_, by: \_\_\_\_\_

**H. COMMENTS AND NOTES RE DRILLING WELL CONSTRUCTION OPERATIONS**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**MONITOR WELL PLACEMENT FORM**

Proposed Well ID: \_\_\_\_\_ Actual Well ID: \_\_\_\_\_

Date: \_\_\_\_\_ By: \_\_\_\_\_

Street Address or APN: \_\_\_\_\_

City/Town: \_\_\_\_\_

Nearest Cross Street: \_\_\_\_\_

Thomas Brothers Reference: \_\_\_\_\_

Owner/Jurisdiction: \_\_\_\_\_

County Permit No. : \_\_\_\_\_

USA Alert Ticket: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**Sketch Map**

**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**DEVELOPMENT REPORT FOR WELL \_\_\_\_\_**

**A. DEVELOPMENT REPORT**

Well Type: \_\_\_\_\_

Development Company: \_\_\_\_\_

Developer/Helper: \_\_\_\_\_

Development Rig: \_\_\_\_\_

Date of Development: \_\_\_\_\_

H+A Field Notebook: \_\_\_\_\_

H+A Personnel: \_\_\_\_\_

Description of Development: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**B. WELL DEVELOPMENT**

Total Well (Driller): \_\_\_\_\_ feet bls

Depth to bottom of well before development: \_\_\_\_\_ feet bls

Bottom: soft, medium, hard

Depth to water before development: \_\_\_\_\_ feet bls

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**DEVELOPMENT REPORT FOR WELL \_\_\_\_\_**

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Pumping duration: \_\_\_\_\_ minutes

Field parameters (initial): pH \_\_\_\_\_, Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_

Average pump discharge rate: \_\_\_\_\_ gpm Gallons purged: \_\_\_\_\_

Depth to water at end of pumping: \_\_\_\_\_ feet bls, Drawdown \_\_\_\_\_ feet

Specify Capacity: \_\_\_\_\_ gpm/ft

Field parameters (final): pH \_\_\_\_\_, Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_

Depth to bottom of well after development: \_\_\_\_\_ feet bls

Bottom: soft, medium, hard

Depth to water after development and recovery: \_\_\_\_\_ feet bls

Measured: \_\_\_\_\_ hours after final pumping

**C. PUMP INSTALLATION DATA**

Pump installer: \_\_\_\_\_

Installation date: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**DEVELOPMENT REPORT FOR WELL \_\_\_\_\_**

**D. SURVEY DATA**

Surveyor: \_\_\_\_\_

Date surveyed: \_\_\_\_\_

Land surface elevation: \_\_\_\_\_ feet msl

Measuring point elevation: \_\_\_\_\_ feet msl

Location coordinate: x \_\_\_\_\_ y \_\_\_\_\_

Description of measuring point: \_\_\_\_\_

**E. COMMENTS**

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**FOOTNOTES**

°C = degrees Celsius  
bls = Below land surface  
ft = Feet  
gpm = Gallons per minute  
msl = Mean sea level  
O.D. = Outer Diameter  
specs = Specifications  
umhos = Micromhos



# STANDARD OPERATING PROCEDURES

SOP No.: ERT-PROC-2044-19

PAGE: 1 of 9

REV: 1.0

EFFECTIVE DATE: 01/31/20

## MONITORING WELL DEVELOPMENT

---

### CONTENTS

#### DISCLAIMERS

- 1.0 SCOPE AND APPLICATION
- 2.0 METHOD SUMMARY
- 3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE
- 4.0 INTERFERENCES AND POTENTIAL PROBLEMS
- 5.0 EQUIPMENT/APPARATUS
- 6.0 REAGENTS
- 7.0 PROCEDURES
  - 7.1 Preparation
  - 7.2 Operation
  - 7.3 Post-Operation
- 8.0 CALCULATIONS
- 9.0 QUALITY ASSURANCE/QUALITY CONTROL
- 10.0 DATA VALIDATION
- 11.0 HEALTH AND SAFETY
- 12.0 REFERENCES
- 13.0 APPENDICES



# STANDARD OPERATING PROCEDURES

SOP No.: ERT-PROC-2044-19

PAGE: 2 of 9

REV: 1.0

EFFECTIVE DATE: 01/31/20

## MONITORING WELL DEVELOPMENT

---

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# STANDARD OPERATING PROCEDURES

SOP No.: ERT-PROC-2044-19

PAGE: 3 of 9

REV: 1.0

EFFECTIVE DATE: 01/31/20

## MONITORING WELL DEVELOPMENT

---

### 1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide an overview of monitoring well development practices. The development of a monitoring well (herein development) removes fine-grained material and/or drilling fluids from the well screen and filter pack. This activity is necessary to restore the formation properties disturbed during the drilling process, to improve the hydraulic characteristics of the filter pack, and to recondition hydraulic communication between the well and the hydrologic unit adjacent to the well screen because fine-grained materials or fluids may interfere with water quality analyses [American Society for Testing and Materials (ASTM) D5092M-16 (Reapproved 2016)].

Development allows groundwater to flow freely from the geological formation (herein formation) into the monitoring well and also reduces the turbidity of the groundwater during sampling. There are several factors to be considered when choosing a development method. These factors include but are not limited to: well construction; aquifer characteristics and hydraulic conductivity of the formation surrounding the well screen; groundwater quality of the water-bearing zone being monitored; consequences of introducing foreign fluids into the well and aquifer; drilling method used during borehole installation; depth to static water level and water column height in the well; type and portability of available equipment; time available for development; and cost effectiveness of the method (ASTM D5521M-13). The most common well development methods are surging, hydraulic jetting, over-pumping, bailing and air lifting.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the UFP-QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the UFP-QAPP. These changes must also be documented in the final deliverable.

### 2.0 METHOD SUMMARY

The chosen development method should not interfere with the setting of the monitoring well seal. After construction, a well should not be disturbed for up to 48 hours to allow grout/concrete to cure. This is especially important, if a vigorous development method (i.e. hydraulic surging) is being used. If a less vigorous method is used (i.e. bailing), it may be initiated shortly after installation.

Several activities must take place prior to development. First, open the monitoring well, take initial measurements (i.e., headspace air monitoring readings, groundwater level, total depth of the well, etc.), and record results in a site logbook and/or field data sheet. Develop the well by the appropriate method to accommodate site conditions and project objectives. The most common development methods are surging, hydraulic jetting, over-pumping, bailing and air lifting. These methods are described below:

- **Surging** involves raising and lowering a surge block or surge plunger inside the monitoring well. The resulting surging motion forces water into the formation and loosens sediment, pulled from the formation into the well. Occasionally, sediments must be removed from the well with a sand bailer to prevent sand locking of the surge block. This method may cause the sandpack around the screen to be displaced to a degree that damages its value as a filtering medium. Channels or voids may form near the screen if the filter pack sloughs away during surging (Keel and Boating, 1987).





# STANDARD OPERATING PROCEDURES

SOP No.: ERT-PROC-2044-19

PAGE: 4 of 9

REV: 1.0

EFFECTIVE DATE: 01/31/20

## MONITORING WELL DEVELOPMENT

---

- **Hydraulic jetting** involves lowering a small diameter pipe into the monitoring well and injecting a high velocity horizontal stream of water or air through the pipe into the screen openings. This method is especially effective at breaking down filter cakes developed during mud-rotary drilling. Simultaneous air lift pumping is usually used to remove fine particles.
- **Over-pumping** involves pumping at a high rate to increase drawdown as low as possible and then allowing the well to recharge to near the original level before repeating the process until the purge water is sediment-free.
- **Bailing** includes the use of a simple manually operated check-valve bailer to remove groundwater from the monitoring well. The bailing method, like many other methods, should be repeated until the purge water is sediment-free. Bailing may be the method of choice in a shallow monitoring well or on a monitoring well that recharges slowly.
- **Air lifting** is done by injecting a sudden charge of compressed air into the well with an air-line in a way that water is forced through the monitoring well screen, or extracted from the well using air as the lifting medium (air-lift pumping). The air injection is cycled allowing the water column to rapidly rise and fall repeatedly in the well pipe. Periodically, the airline is pulled up into a pipe string known as the eductor pipe. The air injection cycling is repeated until the purge water is sediment-free. Method variations include leaving the air line in the pipe string at all times or using the monitoring well casing as the eductor pipe.

Once a monitoring well is developed (i.e., purge water is sediment free), record readings (e.g., pH, temperature, and specific conductivity) in a site logbook and/or field data sheet. Containerize all purge water from the monitoring well with known or suspected contamination. Label containers with the location where purge waters will be stored. Decontaminate monitoring well development equipment prior to use in the next well.

### 3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

### 4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The following problems are often encountered during development activities:

- Over-pumping is not as vigorous as surging and hydraulic jetting, even though it is the most desirable development method.
- Surging and jetting development methods have the potential of distorting the monitoring well filter pack.
- Introduction of other source (s) water or air by jetting may alter the hydrochemistry of the aquifer.
- Air lifting may produce “air locking” in some formations, preventing water from flowing into the well.
- The use of surge blocks in clay-rich formations may plug/smear the well screen.



# STANDARD OPERATING PROCEDURES

SOP No.: ERT-PROC-2044-19

PAGE: 5 of 9

REV: 1.0

EFFECTIVE DATE: 01/31/20

## MONITORING WELL DEVELOPMENT

- Small (two-inch nominal diameter) submersible pumps that fit in two-inch diameter well casings are especially susceptible to clogging if used in well development applications.
- Improper decontamination of drilling equipment may cause cross-contamination in monitoring well.

### 5.0 EQUIPMENT/APPARATUS

The type of equipment used for development is dependent on the well diameter and the development method. For example, the diameter of most submersible pumps is too large to fit into a two-inch inner diameter (ID) monitoring well; thus other development methods should be used. Obtaining the highest possible yield is not usually an objective in developing monitoring wells and vigorous development is not always necessary. Many monitoring wells are constructed in fine-grained formations that would not normally be considered aquifers. Specifications for the drilling contract should include the necessary monitoring well development equipment (e.g., air compressors, pumps, air lines, surge blocks, generators, etc.).

### 6.0 REAGENTS

Chemicals [e.g., polyphosphates (a dispersing agent), acids, or disinfectants] are often used in development, but should be avoided for monitoring wells in which groundwater quality is most important. Polyphosphates should not be used in thinly bedded sequences of sands and clays. The use of decontamination solutions may also be necessary. If decontamination of equipment is required at a monitoring well, refer to the Environmental Response Team (ERT) SOP, *Sampling Equipment Decontamination* and the site-specific UFP-QAPP.

### 7.0 PROCEDURES

#### 7.1 Preparation

1. Coordinate site access and obtain keys to access monitoring well.
2. Obtain information on each well to be developed [i.e., drilling method, well diameter, well depth, screened interval, presence of contaminants; (if any)].
3. Obtain a water level meter, a depth sounder, air monitoring instruments, materials for decontamination, and water quality instrumentation. The water quality instrumentation needs to be capable of measuring, at a minimum, pH, specific conductivity, temperature, turbidity, dissolved oxygen (DO) and oxidation-reduction potential. Choose a development method and proceed (Refer to Section 2.0 *Method Summary*).
4. Assemble and label containers for temporary storage of water produced during development. Containers must be structurally sound, compatible with suspected contaminants, and easy to manage in the field. The use of truck-mounted or roll-off tanks may be necessary in some cases; alternately, a portable water treatment unit (i.e.: granulated activated carbon) may be used to treat purge water.



# STANDARD OPERATING PROCEDURES

SOP No.: ERT-PROC-2044-19

PAGE: 6 of 9

REV: 1.0

EFFECTIVE DATE: 01/31/20

## MONITORING WELL DEVELOPMENT

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### 7.2 Operation

Development should be performed as soon as it is practical after the monitoring well is installed, but at least 48 hours after monitoring well installation to allow grout/cement to cure.

1. Assemble necessary equipment on a plastic sheet surrounding the monitoring well.
2. Record pertinent information in a site logbook and/or field data sheet (personnel, time, location ID, etc.).
3. Open monitoring well, wait at least three to five seconds and take air monitor readings at the top of casing and in the breathing zone (BZ), as appropriate.
4. Measure depth to groundwater and the total depth of the monitoring well. Calculate the water column volume of the monitoring well (Equation 1, Section 8.0).
5. Begin development and measure/record the initial pH, temperature, turbidity, specific conductivity, DO and oxidation-reduction potential of the groundwater. Note the initial color, clarity, and odor of the groundwater.
6. Continue to develop the well and periodically measure the water quality parameters indicated in step 5. Depending on project objectives and available time, development should proceed until the water color and clarity are transparent or near transparent and all silt to sand purged from the well. The development water should reach a turbidity of less than 50 nephelometric turbidity units (NTUs). Most important is to confirm that sand from the surrounding sandpack is not entering the wells.

Note: In practice, well development should continue until water quality parameters stabilize; however, this is not always possible. The addition of drilling fluids (e.g., mud, foam, or lost-circulation additives (LCA)) may require the sandpack to be flushed for an extended period under ambient flow conditions. Wells installed in bedrock commonly intersect isolated water bearing fractures and may require some time to re-establish equilibrium.

7. All water produced by development of contaminated or suspected contaminated wells must be containerized or treated. Each container must be clearly labeled with the location ID, date collected, and sampling contractor. Determination of the appropriate disposal method will be based on the analytical results from each well.
8. No water will be added to the well to assist development without prior approval by the ERT Work Assignment Manager (WAM). In some cases, small amounts of potable water may be added to help develop a poor yielding well. It is essential that at least five times the amount of water injected must be recovered from the well in order to assure that all injected water is removed from the formation.



# STANDARD OPERATING PROCEDURES

SOP No.: ERT-PROC-2044-19

PAGE: 7 of 9

REV: 1.0

EFFECTIVE DATE: 01/31/20

## MONITORING WELL DEVELOPMENT

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9. Note the final water quality parameters along with the following data:

- Well designation (location ID)
- Date(s) of monitoring well installation
- Date(s) and time of development
- Static water level before and after development
- Quantity of groundwater removed; and initial and completion time
- Type and capacity of pump or bailer used
- Description of development techniques

### 7.3 Post-Operation

1. Decontaminate all equipment used. Refer to the site-specific UFP-QAPP and ERT SOP, *Sampling Equipment Decontamination*.
2. Secure holding tanks or containers of purge water.
3. Review analytical results and determine the appropriate water disposal method. Actual disposal of the purge water is generally carried out by the US EPA On-Scene Coordinator (OSC); however, at times ERT contractor personnel may be requested to contract someone to dispose of this material.

## 8.0 CALCULATIONS

To calculate the volume of water in the monitoring well, the following equation is used:

$$\text{Well volume } (V) = \pi r^2 h (cf) \quad \text{Equation 1}$$

Where:

- $\pi$  = Pi (3.14)  
 $r$  = Radius of monitoring well in feet (ft)  
 $h$  = Height of the water column in ft. (This may be determined by subtracting the depth to groundwater from the total depth of the well as measured from the same reference point)  
 $cf$  = Conversion factor in gallons per cubic foot (in Equation 1, 7.48 gal/ft<sup>3</sup> is the conversion factor)

Monitoring well diameters are typically two, three, four, or six inches. A number of standard conversion factors can be used to simplify the above equation using the diameter of the monitoring well. The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

$$V (\text{gal} / \text{ft}) = \pi r^2 h (cf) \quad \text{Equation 2}$$

Where:

- $\pi$  = Pi (3.14)  
 $r$  = Radius of monitoring well (feet)  
 $cf$  = Conversion factor (7.48 gal/ft<sup>3</sup>)



# STANDARD OPERATING PROCEDURES

SOP No.: ERT-PROC-2044-19

PAGE: 8 of 9

REV: 1.0

EFFECTIVE DATE: 01/31/20

## MONITORING WELL DEVELOPMENT

For example, a two-inch diameter monitoring well, the volume per linear foot can be calculated as follows:

$$V (\text{gal} / \text{ft}) = \pi r^2 h (\text{cf})$$
$$V = 3.14 (1/12 \text{ ft})^2 7.48 \text{ gal/ft}^3$$
$$V = 0.1631 \text{ gal/ft}$$

NOTE: The diameter must be converted to the radius in feet as follows:

$$\text{Well Diameter (in inches)} \times 0.5 = \text{Well Radius (feet)}$$

The volume in gallons/feet for the common size monitoring wells is as follows:

Well diameter (inches):	2	3	4	6
Volume (gal/ft):	0.1631	0.3670	0.6524	1.4680

If the volumes for the common size wells above-mentioned are used, **Equation 1** is modified as follows:

$$\text{Well volume} = (h)(f)$$

Where:

- $h$  = height of water column (feet)  
 $f$  = the volume in gal/ft calculated from **Equation 2**

### 9.0 QUALITY ASSURANCE/QUALITY CONTROL

Specific Quality Assurance/Quality Control (QA/QC) activities that apply to the implementation of these procedures will be listed in the QAPP prepared for the applicable sampling event. The following general QA procedures will also apply:

1. All well development data, including the items listed in Section 7.2, step 9, must be documented in site logbooks or on field data sheets.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer or instrument-specific SOPs, unless otherwise specified in the UFP-QAPP. Equipment checkout and calibration is necessary prior to purging and sampling and must be done according to the instruction manuals supplied by the manufacturer.

### 10.0 DATA VALIDATION

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. This may include but is not limited to location information, water quality parameter measurements, development techniques, water levels, quantity of groundwater removed, date of monitor well installation, and date and time of development. These data are essential to providing an accurate and complete final deliverable. The ERT contractor's Task Leader (TL) is responsible for completing the UFP-QAPP verification checklist for each project.



# STANDARD OPERATING PROCEDURES

SOP No.: ERT-PROC-2044-19

PAGE: 9 of 9

REV: 1.0

EFFECTIVE DATE: 01/31/20

## MONITORING WELL DEVELOPMENT

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### 11.0 HEALTH AND SAFETY

Based on Occupational Safety and Health Administration (OSHA) requirements, a site-specific health and safety plan (HASP) must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, [29 CFR 1910.120](#). Field personnel working for EPA's ERT should consult the Emergency Responder Health and Safety Manual currently located at <https://response.epa.gov/HealthSafetyManual/manual-index.htm> for the development of the HASP, required personal protective equipment (PPE) and respiratory protection.

### 12.0 REFERENCES

ASTM International. 2013. Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers. Designation: D-5521M-13.

ASTM International. 2016. Standard Practice for Design and Installation of Groundwater Monitoring Wells. Designation: D-5092M-16.

Driscoll, F. G. 1986. "Development of Water Wells." In: *Groundwater and Wells*. Second Edition. Chapter 15. Johnson Filtration Division, St. Paul, Minnesota. p. 497-533.

Freeze, Allan R. and John A. Cherry. 1979. *Groundwater*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Keel, J.F. and Kwasi Boating. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 1: Conceptualizations". *Groundwater*, 25(3):300-313.

Keel, J.F. and Kwasi Boating. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 2: Case Histories". *Groundwater*, 25(4):427-439.

Ohio EPA, 2009. Monitoring Well Development, Maintenance, and Redevelopment, Chapter 8, *Technical Guidance Manual for Ground Water Investigations*. Division of Drinking and Ground Waters. State of Ohio Environmental Protection Agency. February 2009 (rev. 2).

### 13.0 APPENDICES

This section is not applicable to this SOP.

## SOP 14 AQUIFER TESTING

### GENERAL STATEMENT

Aquifer tests may be conducted to evaluate the hydraulic parameters of the hydrogeologic unit in which a well is completed. Water level drawdown, recovery, and well discharge rates will be monitored throughout the test. Water quality parameters such as temperature, electrical conductivity (EC), turbidity, dissolved oxygen (DO), and pH of discharged water may also be monitored periodically.

### OBJECTIVE

Aquifer tests may be conducted in selected monitor wells to estimate hydraulic properties in accordance with the applicable Workplan. The decision to conduct an aquifer test at a selected monitor well will be based on the location of the well, the need for additional data on hydraulic characteristics, and water quality data. Aquifer testing will consist of constant discharge and recovery tests. The duration and type of tests will depend on the well design and capacity, aquifer characteristics, and the observed responses in available observation wells. Water level drawdown and recovery data will be obtained in the pumping well and observation wells that are within the radius of influence of the pumping well during aquifer testing.

### EQUIPMENT AND/OR INSTRUMENTATION

Equipment used during aquifer testing includes discharge and water level measuring devices. A calibrated 5- to 55-gallon container and stopwatch or an in-line flow meter will be used to measure discharge rates. Water levels will be measured with calibrated water level indicators, and synchronized watches will be used to note the time of each measurement. Pressure transducers and electronic data loggers may also be used to record water levels.

## PREPARATION

The following procedures will be performed during preparation for the aquifer tests.

- Measure the total depth of the well to be tested.
- Install submersible test pump in well at the depth determined by the on-site hydrogeologist. Install a check valve in the discharge pipe above the pump to prevent return flow after pump shutoff.
- Assemble all necessary forms and graph paper.
- Prior to the start of pumping, measure static water level in the pumping and observation wells and record measurement time on the appropriate aquifer test forms (Tables A-14 and A-15). If the well has been pumped for development or pump performance purposes, water levels must regain prepumping levels prior to beginning the test.
- Perform a limited pumping pretest to determine appropriate valve settings, to test for leaks in the discharge system, and to ensure that discharge is directed into a suitable storage tank.
- Prior to commencement of the test, the on-site hydrogeologist will select time increments for water level measurements and water sample collection and will determine which wells will be used as observation wells.
- Provide a reliable portable power supply if a standard power source will not be available.
- Calibrate instruments for the measurement of pH, EC, turbidity, DO, and temperature, if appropriate.
- Prepare equipment for discharge measurement. A calibrated 5- to 55-gallon container or in an in-line flowmeter will be used to monitor discharge from wells.
- Install a gate valve in the pump discharge line. Discharge will be controlled to maintain a constant flow rate.
- Install pressure transducers and electric data loggers and recorders in selected wells prior to initial testing, as required by the applicable Workplan.
- Familiarize all personnel with the aquifer test procedures.
- Synchronize all personnel's watches and chronometers, then start the pump.



## PROCEDURES

The following procedures will be used to conduct the aquifer test.

- Start pump and maintain a constant discharge. The on-site hydrogeologist will determine when to terminate the test based on the target duration in the Workplan and a field plot of actual aquifer response.
- In the pumping well and observation wells, measure water levels every one-half minute for the first 5 minutes and decrease the frequency of measurements as follows: every 1 minute between 5 and 10 minutes; every 2 minutes between 10 and 30 minutes; every 5 minutes between 30 and 60 minutes; every 10 to 15 minutes between 60 minutes and 120 minutes; and every 20 minutes between 120 and 240 minutes.
- Periodically measure discharge rate, pH, EC, and temperature, if appropriate. Adjust valve to maintain constant discharge. Record measurements on aquifer test data forms with corresponding measurement time.
- After the pump is turned off, begin water level recovery measurements according to the schedule given for aquifer test start-up. Record measurements and measurement times on the aquifer test data forms (Tables A-5 and A-6).
- The on-site hydrogeologist will determine when recovery has reached approximately 100 percent of the static water level.

## EQUIPMENT DECONTAMINATION AND DISPOSAL

Groundwater generated during aquifer testing will be contained in drums, polyurethane tanks, and/or roll off bins. Groundwater will be properly characterized and disposed.

## DOCUMENTATION

Observations made during aquifer test activities will be recorded on aquifer test data forms (Tables A-5 and A-6). The aquifer test data forms and field plots of aquifer test data will be included with the completion report for the monitor well (Table A-2).

#### QUALITY ASSURANCE/QUALITY CONTROL

QA objectives for aquifer test data will be satisfied by following the procedures described in this SOP.

Upon return to the office after the field event, all aquifer test mathematical computations, field data plots, and aquifer parameter computations will be checked for correctness. The applicability of the selected analytical method to the particular data set will be assessed by the Project Manager.

## TABLES



**TABLE A-2**  
**WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

Drilling Company: \_\_\_\_\_

Driller: \_\_\_\_\_

Drill Rig: \_\_\_\_\_

Date drilling started: \_\_\_\_\_

Date drilling completed: \_\_\_\_\_

Description of drilling \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**A. GENERAL**

Location: \_\_\_\_\_

Location coordinates: x \_\_\_\_\_ y \_\_\_\_\_

Total depth of borehole: \_\_\_\_\_ feet bls

Borehole diameter: \_\_\_\_\_ inches, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

\_\_\_\_\_ inches, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Lost circulation zones: \_\_\_\_\_

Lithology logged by: \_\_\_\_\_

**B. CONSTRUCTION**

**Conductor Casing**

Type: \_\_\_\_\_, O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Centralizers/Shoe: \_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

**Well Casing**

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

**Well Screen**

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Type: \_\_\_\_\_ , O.D.: \_\_\_\_\_

Wall thickness: \_\_\_\_\_ , from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Centralizers/Shoe: \_\_\_\_\_

**C. GROUT AND CEMENTING RECORD**

Annular space: \_\_\_\_\_

Type of cement/grout: \_\_\_\_\_

Method of emplacement: \_\_\_\_\_

Approximate number of yards/bag: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Annular space: \_\_\_\_\_

Type of cement/grout: \_\_\_\_\_

Method of emplacement: \_\_\_\_\_

Approximate number of yards/bag: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

**D. GRAVEL PACK**

Type: \_\_\_\_\_, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_, Method emplaced: \_\_\_\_\_

Type: \_\_\_\_\_, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_, Method emplaced: \_\_\_\_\_

**Grout Filter**

Type: \_\_\_\_\_, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_, Method emplaced: \_\_\_\_\_

**Bentonite Seal**

Type: \_\_\_\_\_, from \_\_\_\_\_ to \_\_\_\_\_ feet bls

Volume emplaced: \_\_\_\_\_, Method emplaced: \_\_\_\_\_

**E. DEVELOPMENT RECORD**

Date: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes

Pumping duration: \_\_\_\_\_ minutes

Average pump discharge rate: \_\_\_\_\_ gpm

Drawdown at end of pumping: \_\_\_\_\_ feet bls

Field parameters (initial): pH \_\_\_\_\_, Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_

Field parameters (final): pH \_\_\_\_\_, Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**COMPLETION REPORT FOR WELL \_\_\_\_\_**

**F. PUMP INSTALLATION DATA**

Pump installer: \_\_\_\_\_

Installation date: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Surface completion (hole vault type, etc.): \_\_\_\_\_

**G. REFERENCE ELEVATIONS**

Land surface elevation: \_\_\_\_\_ feet msl

Measuring point elevation: \_\_\_\_\_ feet msl

Description of measuring point: \_\_\_\_\_

Date surveyed: \_\_\_\_\_, by: \_\_\_\_\_

**H. COMMENTS AND NOTES RE DRILLING WELL CONSTRUCTION OPERATIONS**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**MONITOR WELL PLACEMENT FORM**

Proposed Well ID: \_\_\_\_\_ Actual Well ID: \_\_\_\_\_

Date: \_\_\_\_\_ By: \_\_\_\_\_

Street Address or APN: \_\_\_\_\_

City/Town: \_\_\_\_\_

Nearest Cross Street: \_\_\_\_\_

Thomas Brothers Reference: \_\_\_\_\_

Owner/Jurisdiction: \_\_\_\_\_

County Permit No. : \_\_\_\_\_

USA Alert Ticket: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**Sketch Map**





**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**DEVELOPMENT REPORT FOR WELL \_\_\_\_\_**

**A. DEVELOPMENT REPORT**

Well Type: \_\_\_\_\_

Development Company: \_\_\_\_\_

Developer/Helper: \_\_\_\_\_

Development Rig: \_\_\_\_\_

Date of Development: \_\_\_\_\_

H+A Field Notebook: \_\_\_\_\_

H+A Personnel: \_\_\_\_\_

Description of Development: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**B. WELL DEVELOPMENT**

Total Well (Driller): \_\_\_\_\_ feet bls

Depth to bottom of well before development: \_\_\_\_\_ feet bls

Bottom: soft, medium, hard

Depth to water before development: \_\_\_\_\_ feet bls

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**DEVELOPMENT REPORT FOR WELL \_\_\_\_\_**

Procedure: \_\_\_\_\_

Duration: \_\_\_\_\_ minutes, Comment: \_\_\_\_\_

Pumping duration: \_\_\_\_\_ minutes

Field parameters (initial): pH \_\_\_\_\_, Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_

Average pump discharge rate: \_\_\_\_\_ gpm Gallons purged: \_\_\_\_\_

Depth to water at end of pumping: \_\_\_\_\_ feet bls, Drawdown \_\_\_\_\_ feet

Specify Capacity: \_\_\_\_\_ gpm/ft

Field parameters (final): pH \_\_\_\_\_, Conductivity \_\_\_\_\_ (umhos),

Temperature \_\_\_\_\_ (°C), Turbidity \_\_\_\_\_

Depth to bottom of well after development: \_\_\_\_\_ feet bls

Bottom: soft, medium, hard

Depth to water after development and recovery: \_\_\_\_\_ feet bls

Measured: \_\_\_\_\_ hours after final pumping

**C. PUMP INSTALLATION DATA**

Pump installer: \_\_\_\_\_

Installation date: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Pump purpose/type: \_\_\_\_\_

Pump model/specs: \_\_\_\_\_

Pump setting: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_



**TABLE A-2  
WELL COMPLETION AND DEVELOPMENT REPORT**

Project No. \_\_\_\_\_

Project Name \_\_\_\_\_

**DEVELOPMENT REPORT FOR WELL \_\_\_\_\_**

**D. SURVEY DATA**

Surveyor: \_\_\_\_\_

Date surveyed: \_\_\_\_\_

Land surface elevation: \_\_\_\_\_ feet msl

Measuring point elevation: \_\_\_\_\_ feet msl

Location coordinate: x \_\_\_\_\_ y \_\_\_\_\_

Description of measuring point: \_\_\_\_\_

**E. COMMENTS**

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**FOOTNOTES**

°C = degrees Celsius  
bls = Below land surface  
ft = Feet  
gpm = Gallons per minute  
msl = Mean sea level  
O.D. = Outer Diameter  
specs = Specifications  
umhos = Micromhos



## PUMPED WELL

Page \_\_\_\_ of \_\_\_\_

MEASURING POINT: \_\_\_\_\_ ft (above land surface)      ELEV OF MEAS PT: \_\_\_\_\_ ft (above mean sea level)

WELL LOCATION/COORDINATES: \_\_\_\_\_

STATIC WATER LEVEL: \_\_\_\_\_ DATE/TIME: \_\_\_\_\_

[illegible]

ft = feet; ELEV OF MEAS PT = Elevation of measuring point;  
t = elapsed time since start of pumping; t' = elapsed time from end of pumping



## OBSERVATION WELL

Page \_\_\_\_ of \_\_\_\_

RESPONSE TO PUMPING AT WELL: \_\_\_\_\_ DISTANCE TO PUMPING WELL (feet): \_\_\_\_\_

MEASURING POINT: \_\_\_\_\_ ft (above land surface)      ELEV OF MEAS PT: \_\_\_\_\_ ft (above mean sea level)

WELL LOCATION/COORDINATES: \_\_\_\_\_

STATIC WATER LEVEL: \_\_\_\_\_ DATE/TIME: \_\_\_\_\_

ft = feet; ELEV OF MEAS PT = Elevation of measuring point;  
t = elapsed time since start of pumping; t' = elapsed time from end of pumping

SOP 15  
FIELD WATER QUALITY PARAMETER MEASUREMENTS

GENERAL STATEMENT

Field groundwater quality parameters including temperature, pH, EC, turbidity, and DO will be measured during well development, groundwater sampling and aquifer testing at each sampling location using a multi-parameter meter or single parameter meters and a transfer bottle.

OBJECTIVE

The objective of collecting field water quality parameter measurements is to provide data for defining the general groundwater chemistry conditions and to ensure that field parameters are stable prior to collecting water quality samples for chemical analysis. Stabilization of field water quality parameters provides an indication that the groundwater is representative of groundwater obtained from the aquifer of interest.

EQUIPMENT AND/OR INSTRUMENTATION

Field equipment/instrumentation used for field parameter monitoring includes a multi-parameter meter to measure EC, pH, temperature, turbidity, and DO, or a series of single parameter meters for the individual parameters to be measured. Groundwater field parameters will be measured in a flow cell with the multi-parameter instrument, if possible, or with the single parameter meters.

## PREPARATION

Prior to the start of sampling activities, field parameter instruments and equipment will be calibrated following manufacturer's recommendations. Re-calibration during the event will also follow manufacturer's recommendations. The probes on the field parameter meters will be thoroughly rinsed with distilled water, inspected, and cleaned, prior to calibration. Field meter calibration notes will be recorded on the project meter calibration form (Tables A-7).

The multi-parameter instrument is calibrated automatically using a single pH 4 buffer solution obtained for the particular instrument model being used. Record values for pH, EC, DO, turbidity, and temperature in the field notebook. Following calibration of the instrument, pH and EC calibration may be verified by using a pH 7 test solution and a 1,000 microsiemens per centimeter (uS/cm) or a 1,413 uS/cm EC test solution. The DO meter will be adjusted to local elevation and calibrated to ambient air.

For single parameter meters, the pH meter will be calibrated in pH 4 and pH 10 solutions. These two pH values are expected to bracket the range of pH in groundwater samples collected at the Site. The conductivity meter will be calibrated by using a 1,000 uS/cm or a 1,413 uS/cm EC buffer. These two solutions are within the range of conductivity expected at the Site.

All manufacturer's instructions for calibration, use, and storage of the field parameter meters will be followed.

## PROCEDURES

A representative groundwater sample will be placed in a transfer bottle, or measurements will be made directly at the well discharge point. Field pH, EC, DO, turbidity, and temperature parameters at each sampling location will be measured in a flow cell as follows:

- Calibrate the field parameters to standard buffer solutions according to the manufacturer's instructions.

- Install the multi-parameter probe or single parameter probes in the appropriate in-line flow cell.
- Turn on the groundwater supply valve to the flow cell. Fill the cell slowly to avoid trapping air. Shake the flow cell gently to remove trapped air bubbles.
- Record all field measurements on the appropriate field sampling form.
- For all field parameter measurements, compare current measurements to past measurements at the same well or compare to nearby well measurements, if available. If a discrepancy exists greater than should be expected for routine changes in groundwater quality, repeat the process. If the discrepancy still exists, verify calibration of the field parameter meter(s) and retest the field water quality parameters.
- Groundwater used for measurement of field parameters will not be used for sample collection.

#### EQUIPMENT, DECONTAMINATION, AND WASTE DISPOSAL

The transfer bottle and the probes used for measurement of field parameters will be decontaminated before and after each measurement by rinsing with distilled water.

#### DOCUMENTATION

Measurements of EC, pH, DO, turbidity, and temperature will be recorded in the field notebook or groundwater sampling field data form. The following information will be recorded on the appropriate forms:

- well location/identifier;
- date and time measurement was collected; and
- field personnel's initials.



## QUALITY ASSURANCE

QA of field measurements will be accomplished by following the procedures described in this SOP and by following the manufacturer's operating, cleaning and maintenance instructions. Temperature, pH, DO, turbidity, and EC will be measured during each groundwater sampling event. Prior to measuring field parameters, field personnel will verify that the instruments are properly decontaminated and calibrated. Calibration documentation for each instrument will be maintained for reference purposes. Reference solutions for pH and EC will be obtained and used to properly calibrate the instruments. The meters will be calibrated before each event.

Field parameter measurement data will be compared with previous data and examined for variations if previous data are available. If variations of greater than 10 percent exist which cannot be accounted for by changes in field conditions and/or field measurement stabilization, the measurement instrument will be recalibrated and the measurements repeated. If large discrepancies exist from what is expected based on previous measurements, an alternative measuring device, as appropriate and available, will be utilized to verify the data.

## TABLES



## GROUNDWATER SAMPLING FIELD METER CALIBRATION FORM

[illegible]

## SOP 16 WATER LEVEL MEASUREMENT

### GENERAL STATEMENT

Water levels will be measured as part of monitor well construction, discharge measurement activities, aquifer testing, water level measurement rounds, and groundwater sample collection.

### OBJECTIVE

The objective of collecting water level measurements from monitor wells or other Site wells is to provide data that will be used in conjunction with measuring point elevation data to derive water level elevations for individual wells, construct water level contour maps for the hydrogeologic units of interest, determine the direction(s) of groundwater flow, and allow estimation of horizontal gradients within the groundwater systems present beneath the Site. Water level and elevation data will be used in the interpretation of groundwater occurrence and movement for the Site area.

### EQUIPMENT AND/OR INSTRUMENTATION

Water levels will be measured with calibrated Solinst water level meters and, if needed, a steel tape. The water level sounder used to measure water levels will have graduated markers on the cable at 0.01-foot intervals, or attached to the sounder cable at longer intervals. A standard weighted electrode, which will signal contact with the water in the well, will be attached to the end of the sounder cable. A steel tape graduated in hundredths of feet will be used to measure above or below the interval marker on the sounder cable, if needed, to determine the depth to water.

## PREPARATION

Solinst water level meters are used at the Site. These meters are calibrated to a hundredth of a foot and use durable PVDF non-stretch tape. The water level meters will be calibrated after any damage or repairs. Water level sounder calibration notes will be kept on the Water Level Indicator Calibration Form (Table A-3). Sounders will be periodically checked for kinks.

The following procedures will be used during preparation for measuring water levels in wells:

- Identify the wells to be measured.
- Identify established measuring point and associated elevation for each well. The same measuring point must be used for all measurements at the well.
- Review the previous water level measurement for each well, if available.

## PROCEDURES

The following procedures will be used for measuring water levels in monitor wells:

- Sound each well twice for depth to water. Unless the well is being pumped or recovering from being previously pumped, variations between the two measurements must be less than 0.05 foot.
- All measurements should be obtained where the water level indicator registers maximum deflection, or sound, against the measuring point and marks. Repeat measurements should utilize the same deflection and/or sound criteria as the first measurement.
- When the water level has been encountered, measure the distance above or below the appropriate marker on the sounder cable, subtract or add difference value as appropriate, and record the calculated depth to water.
- Record depth to water, date, and time of measurement on the water level measurement form.

- Examine the previous measured water level for the monitor well, if available. If the difference between the current water level measurement and the previous measurement is greater than  $\pm 1$  foot, recheck the current measurement. If possible, use an alternative instrument to verify the accuracy of the data. The field hydrogeologist will indicate the method(s) of water level measurement and any rechecked water levels on the water level measurement form.
- If possible, the depth of the well should be measured the first time the water level is measured. This will only apply to wells that provide access to the well casing without interfering with downhole equipment. Record the measured depth of the well on the water level measurement form. Record a description of the measuring point at the wellhead. The same measuring point must be used for subsequent measurements. Record the elevation difference between the measuring point and the reference point and note in writing, a description of the measuring point and the reference point at that well. Reference point elevations will be surveyed following construction of new monitor wells.

## DOCUMENTATION

All water level measurements will be recorded on the standard water level measurement form (Table A-4). The reported data will include depth to water in feet below the measuring point, the date and time of the measurement, the method of measurement, and the field personnel's initials. Water level measurements will be reported to the nearest 0.01 foot on the appropriate field form.

## QUALITY ASSURANCE

QA of water level measurement data will be accomplished by following procedures described in this SOP. In addition, detailed and complete documentation during measurement activities will assure that sufficient data are obtained to allow interpretation of subsurface conditions encountered at each location and extrapolation of those conditions to other areas of the Site.

## TABLES



**TABLE A-3**

**WATER LEVEL INDICATOR  
CALIBRATION DOCUMENTATION FORM**

PROJECT NUMBER: \_\_\_\_\_

DATE	TIME	WATER LEVEL INDICATOR TYPE	WATER LEVEL INDICATOR NUMBER	CALIBRATION METHOD	CALIBRATED BY (INITIALS)	REMARKS



**TABLE A-4**  
**STATIC WATER LEVEL DATA FORM**



**HARGIS+ASSOCIATES, INC.**  
HYDROGEOLOGY • ENGINEERING



WATER LEVEL DATA FORM PROJECT: \_\_\_\_\_

*Sampler's Initials:*

Date:

*Sounder Type:*

*Sounder No.*

[illegible]

*Footnotes:*

*DTW = Depth to Water*

*ft BMP = Feet below measuring point*

*WL = Water Level*

*ft BLS = Feet below land surface*

UTM = Unable to measure

*NM = Not measured*

- - = Information not available

Well Status: I = Injecting, P = Pumping, A = Abandoned

## SOP 17 HANDLING, STORAGE, CHARACTERIZATION, AND DISPOSAL OF INVESTIGATION-DERIVED WASTE

SOPs have been developed for the handling, storage, characterization, and disposal of wastes generated during field work activities. Wastes generated during future investigations at the Site may include well purge water, decontamination water, soil cuttings, and personal protective equipment (PPE).

### HANDLING AND STORAGE

Wastes generated during Site investigations will be appropriately handled, containerized and temporarily stored on site, as needed. The following sections describe the primary steps associated with handling and eventually disposing of each of the types of investigation derived wastes.

#### Equipment Decontamination

All drilling equipment and sampling devices will be properly decontaminated prior to each use. The drilling equipment for each rig will be decontaminated using a high-pressure water wash or steam cleaner prior to use. Sampling equipment will be decontaminated using a non-phosphate soap wash, double tap water rinse, and final DI water rinse. At the end of each workday, the accumulated decontamination water will be pumped into U.S. Department of Transportation (DOT) approved steel drums pending waste characterization and final disposal.

#### Water

Well purge water and decontamination water may be generated during aquifer testing, groundwater sampling, or future investigation activities. DOT 55-gallon drums, lined roll-off bins or baker tanks will be used to contain water generated during Site investigations. A central staging area for decontamination of drilling and sampling equipment may be established at the

Site, if warranted. Water generated during decontamination procedures will be temporarily containerized and transferred to wastewater storage drums, bins or tanks.

### Soil

Soil cuttings will be stored in 55-gallon drums, roll off bins, or portable tanks. Each container will be clearly labeled with the soil boring identifier, date, and depth interval from which the waste was derived.

### Waste Management

Soil cuttings may be generated during investigation programs. The soil cuttings will be placed in 55-gallon drums and/or roll-off bins. The bins will be lined with plastic sheeting and sealed in accordance with state and federal guidelines. Per federal guidelines in 40 CFR §265.173(a) Management of containers, all containers holding hazardous waste be closed during storage, except when it is necessary to add or remove waste. All containers will be labeled in accordance with state and federal guidelines. At a minimum, the label will indicate the generator, Site address, generation date, contact name, and contact phone number. When full, the roll-off bins will be relocated to a secure and accessible location approved by ADEQ for temporary storage. The soil cuttings in each bin will be characterized based on the results of investigation samples collected during drilling or sampling activities or waste characterization samples collected from the soil cuttings. Once characterized in accordance with state and federal guidelines, the soil cuttings will be transported off-Site for recycling or disposal within 90 days of the generation date.

Well purge water and decontamination water will be placed in 55-gallon steel drums or temporary tanks. The sealed drums will be labeled in accordance with regulatory guidelines, and temporarily stored on Site. Per federal guidelines in 40 CFR §265.173(a) Management of Containers, all containers holding hazardous waste be closed during storage, except when it is necessary to add or remove waste. A composite water sample will be collected from the

temporary containers, for analysis of some or all chemicals of concern, in accordance with the applicable Workplan.

The decontamination wastewater will be characterized in accordance with state and federal guidelines based on the waste characterization samples. Following characterization, the wastewater will be transported for disposal within 90 days of the generation date. Depending on the characterization of the wastewaters, disposal may be accomplished by treatment/disposal at an off-Site regulated facility.

### CHARACTERIZATION

Waste characterization may include sample collection and laboratory analysis of soil or water generated during field activities. Characterization of waste may be required to determine appropriate waste disposal. The analytical results for soil samples collected from borings will be used to characterize soil generated during drilling activities. The analytical results of groundwater sampling will be used to characterize decontamination water.

### DISPOSAL

Disposal of wastes generated during field activities will be based upon analytical results for waste characterization samples. Water generated from decontamination will be stored in DOT 55-gallon drums or tanks. Soil cuttings generated during soil sampling and drilling activities will be stored in storage containers pending evaluation of other disposal options.

### PERSONAL PROTECTIVE EQUIPMENT

All used PPE will be decontaminated at the Site using either dry (brush) or wet (water rinse) methods as needed. The PPE will then be sealed in a plastic bag and disposed as a non-hazardous waste.

## REFERENCES

- Amec Foster Wheeler, 2017. Field Sampling Protocols to Avoid Cross-Contamination of Per and Polyfluorinated Alkyl Substances (PFAS), SOP AFW-01 (PFAS). Rev. 3. February 7, 2017.
- American Society for Testing and Materials (ASTM), 2000. Practice for Description and Identification of Soils (Visual-Manual Procedure). ASTM Standard D 2488-00. 2000.
- \_\_\_\_\_, 2006. Classifications of Soils for Engineering Purposes (Unified Soil Classification System). ASTM Standard D 2487-06. 2006.
- California State Water Quality Control Board (CSWQCB), 2019. Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guidelines. March 20, 2019.
- Compton, 1962. Manual of Field Geology. New York. John Wiley & Sons, Inc. 1962.
- Hargis + Associates, Inc., (H+A), 2013. Site-Wide Health and Safety Plan for East Central Phoenix, Water Quality Assurance Revolving Fund Site. June 21, 2013.
- Michigan Department of Environmental Quality, 2018. General PFAS Sampling Guidance. October 16, 2018
- U.S. Department of the Interior, 1974. Earth Manual. Second Edition; U.S. Department of the Interior, Bureau of Reclamation, 1974. Reprinted 1980.
- U.S. Environmental Protection Agency, 1987. Compendium of Superfund Field Operations Methods. September 1987.
- \_\_\_\_\_, 1996. Ground Water Issue – Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. OSWER, EPA540/S-95/504. April 1996.
- \_\_\_\_\_, 2001. Guidance for Preparing Standard Operating Procedures, EPA QA/G-6. March 2001.
- \_\_\_\_\_, 2017. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells EQASOP GW4. Date: July 30, 1996 Revised: September 19, 2017.