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***Final* - Standard Operating Procedures**

Soil Sampling, Hydropunch Sampling, Soil Core Preservation, Monitor Well Installation and Bulk Groundwater Sampling for the

Laboratory Treatability Study for Source Area Remediation

Phoenix-Goodyear Airport-North Superfund Site

Goodyear, Arizona

March 18, 2016

Introduction

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures to be followed for the field collection of groundwater and soil samples for laboratory analysis and soil core preservation for use in the Laboratory Treatability Study (Treatability Study) as part of the Phase I Treatment Activities at the Phoenix-Goodyear Airport-North (PGA-North) Superfund Site, Goodyear, Arizona. All soil and groundwater sampling will be conducted in accordance with the Final Remedial Design/Remedial Action (RD/RA) Work Plan and specifically the Sampling and Analysis Plan, dated April 16, 2015 and approved by the Environmental Protection Agency (EPA) on May 11, 2015.

Sonic drilling will be utilized to advance one soil boring within the proposed Phase I Treatment Area to the base of Subunit A. An 8 5/8-inch diameter drive casing and a 6-inch core barrel will be utilized to advance the boring and to collect soil core that will be used as part of the Treatability Study. Within the saturated zone at 5-foot intervals, depth specific soil samples will be collected from the extracted core and depth specific groundwater samples will be collected using a Hydropunch™.

Once all drilling and sampling is complete, the boring will be completed as a 4-inch diameter monitor well screened through the entire saturated thickness of Subunit A and then the monitor well will be developed. Groundwater from this well will be collected for use in the Treatability Study. During well installation, down hole geophysical sensors will be installed at 10-foot intervals within the filter pack to provide real time tracking of future zero-valent iron (ZVI) injections.

Since February 2015, groundwater samples have been collected from well IRZ-IW-01. Trichloroethene (TCE) analytical results have ranged from 1,200 micrograms per liter (µg/L) to 2,100 µg/L suggesting that significant TCE mass is present near the former Main Drywells Source Area (MDWSA). As such, the PGA-North Team recommends the boring for the Treatability Study be drilled approximately 50 feet southwest of the former MDWSA (Figure 1), consist with the proposed Phase I Treatment Area in the RD/RA Work Plan. The proposed boring location is anticipated to be outside the 30 foot radius of the previous nZVI injections completed in 2010. If impacts of previous nZVI injections are observed, then the boring will be abandoned and moved.

The Treatability Study, which consists of 9 microcosm sets and 12 sediment column sets, will be conducted using a composite of soil core from the entire saturated zone of Subunit A. Based on volume calculations that include a 10% factor of safety for extra material, the total volume of soil needed for the microcosm sets is about 0.6 gallons and the total volume of soil needed for the sediment column sets is about 10.1 gallons. As such, a minimum of 10.7 gallons of soil will be needed to conduct the Treatability Study. Soil core from the saturated zone will be containerized at approximate 5-foot intervals and sealed in 1-quart glass jars. The soil will be stored on ice prior to and during transport to Arizona State University

Bio-Design Institute (ASU) for longer term storage and testing. Approximately 3/4gallon of soil will be collected from each interval. Details regarding soil core preservation and the use of site groundwater for the Treatability Study as well as the general field procedures for soil and groundwater sampling, well installation, geophysical sensor array installation, and well development are provided below.

Field Procedures

1) Soil Logging

- Receive soil core from drillers in plastic sleeve and document the amount/percent of core recovery. Note weather, depth, date, and time of extraction.
- Place extracted soil core on visqueen plastic. Place depth markers at top and bottom intervals and every 2 feet.
- Open plastic sleeve and break open core to expose interior and obtain photographs.
- Use a properly calibrated Photoionization Detector or Flame Ionization Detector to measure any volatile organic compound (VOC) vapors from exposed core. Place select samples in zip lock bags for additional headspace analysis and label bags with the depth intervals.
- Log soil characteristics in accordance with American Society of Testing and Materials D2488.

2) Soil Sampling

Collect one representative soil sample every 5 feet in the saturated zone using 2 8-ounce (oz) glass jars for perchlorate analysis and one 40-milliliter (ml) glass volatile organic analysis (VOA) vial for VOC analysis per Table 8 in the Final RD/RA Work Plan (also included in this SOP as Attachment 1). To collect each sample:

- Using a new or decontaminated Teflon scoop or stainless steel trowel, break open the soil core column then loosen the desired volume of soil.
- Transfer the discrete grab sample into 2 8-oz glass jars and secure with cap.
- Label and tag sample containers, and record appropriate data on soil sample data sheets (depth, location, color, and other observations).
- Have ready a 40-ml glass VOA vial containing the appropriate volume of methanol preservative. With the plunger seated in the handle, push the Terra Core™ into freshly exposed soil core until the sample chamber is filled. A filled chamber will deliver approximately 5 grams of soil.
- Wipe all soil or debris from the outside of the Terra Core™ sampler. The soil plug should be flush with the mouth of the sampler. Remove any excess soil that extends beyond the mouth of the sampler.
- Rotate the plunger that was seated in the handle top 90 degrees until it is aligned with the slots in the body. Place the mouth of the sampler into the 40-ml VOA vial containing the appropriate volume of methanol preservative, and extrude the sample by pushing the plunger down. Quickly place the lid back on the 40-ml VOA vial.
- Label and tag the VOA vials and record appropriate data on soil sample data sheets (depth, location, color, and other observations).

- Place each VOA vial in a plastic bubble wrap bag and along with the 8-oz glass jars put on ice in a cooler for shipping. Upon arrival at the laboratory, samples should have an internal cooler temperature of 4°C.
- Complete chain of custody form(s).

3) Soil Core Preservation and Storage for Treatability Study

- Once soil sampling is completed, collect representative soil core samples from the saturated zone at approximate 5 foot intervals. Approximately ¾ of a gallon of material will be collected from each interval and placed in 1-quart glass Mason jars. Fill jars to the capacity to minimize headspace. Label each jar with Borehole/Well ID, depth, date and time and place in iced cooler prior to and during transport to ASU. Note that there will be some inherent homogenization of each section of core as it is placed within the 1-quart containers. Approximately 10.7 gallons of soil will be collected for the Treatability Study. The soil will be transported to ASU for long term storage and testing on a daily basis.

4) Hydropunch™ Sample Collection

Groundwater samples will be collected every 5 feet in the saturated zone (approximately 90 feet to 160 feet below ground surface [bgs]) using a Hydropunch™ sampling device. Laboratory analyses will be conducted per Table 8 in the Final RD/RA Work Plan (also included in this SOP as Attachment 1).

- Connect Hydropunch™ to a 2-inch diameter drive pipe and lower to the bottom of the borehole.
- Drive the tool with a 140-pound hammer or the Sonic Drive head to a depth of 18 to 24 inches below the bottom of the current borehole depth. As the tool is advanced it remains in the closed position, which prevents soil or groundwater from entering the Hydropunch™.
- Once the desired sampling depth is obtained, open tool to expose to the aquifer by pulling up the drive pipe approximately 12 to 18 inches. In the open position, groundwater can flow freely into the sample chamber of the tool.
- When the sample chamber is full, a clean/new disposable bailer (1.5-inch diameter) and disposable twine are lowered to collect a groundwater sample.
- Raise the bailer to the surface and transfer groundwater to sample collection containers.
- Quality Assurance/Quality Control (QA/QC) sample sets (Field Duplicate and Equipment Blank) will be collected for VOC and perchlorate analysis per the QA/QC requirements specified in the Final RD/RA Work Plan.
- Label and tag the sample containers and record appropriate data on soil sample data sheets (depth, location, color, and other observations).
- Place each sample container on ice in a shipping cooler. Samples should be cooled to 4°C as soon as possible.
- The tool is decontaminated using a steam cleaner after each discrete sampling interval and the temporary well screen is disposed.

- Complete chain of custody forms and ship to laboratory for a 24-hour turnaround time for VOC and perchlorate analysis.
- Use a new 0.010-inch polyvinyl chloride screen for each depth specific interval.

5) Monitor Well Installation

- Once the total depth of the boring is reached, the boring will be completed as a monitor well. The exact screen interval will be determined in the field based on the hydrostratigraphy to ensure that the monitor wells are only completed within Subunit A. The bottom portion of the well will be backfilled with bentonite pellets to seal off Subunit B. The design will consist of 4-inch diameter Sch 40 PVC (riser and screen) screened throughout the saturated thickness of Subunit A. The annular space will be filled via a tremie pipe or equivalent with engineered filter pack (10 x 20 silica sand) commensurate with the aquifer formation and the slot size of the well screen (0.020-inch) will be commensurate with the size of the filter pack.

- The well will be initially surged to settle the filter pack around the well screen during emplacement. Additional filter pack will be added if settlement occurs during surging to bring the filter pack up to the appropriate level. The tremie pipe or equivalent will be flushed periodically with water to mitigate bridging. A 5-foot bentonite seal will be emplaced above the filter pack and hydrated with water, bentonite grout will then be emplaced from the top of the bentonite seal to 20 ft below ground surface. The top 20 ft will be filled with neat cement..

6) Geophysical Sensor Array Installation

- The geophysical sensor arrays for Phase I electrical resistivity characterization and monitoring are comprised of a nested set of electrodes spaced every 10 feet along the length of the outside of the well casing within the annular space. The electrodes are constructed of a 304 stainless steel rod with a length of 12 inches and diameter of a ½ inch. Each electrode will use an individual wire to ensure a direct connection to the resistivity system. The electrodes and wires will be attached to the outside of the well screen using plastic cable-ties. Upon installation, the connectivity and electrical conductance of each sensor will be tested.

- The nested set of electrodes for each monitor well will be fabricated by the Hydrogeophysics, Inc. (HGI) office in Tucson, Arizona using non-VOC electrical tape. The electrodes will form a multi-wire cable bundle and each bundle will be labeled for the appropriate borehole and depth of placement. Upon installation, the bottom of the cable will be attached to the bottom of the first section of the PVC well casing. As the well casing is lowered down the hole, the electrode cable is fed with it and attached using cable-ties at five-foot intervals to ensure that cable slack does not grab onto the borehole walls. At the top of the well, a pigtail of labeled wires will have at least 5 feet of slack to allow for sufficient above ground connection to the resistivity system

7) Well Development

- Once the monitor well is installed, it will be developed first by bailing and swabbing using a 20-foot double flanged perforated swabbing tool and then by pumping using a temporary submersible pump provided by the drilling subcontractor. Since the initial development water is expected to have high solids content, development water will be pumped to a temporary storage

tank. The development water in the storage tank will be emptied periodically and hauled to the MTS development pad.

- Swabbing and bailing will be conducted in 10-foot sections within the screen interval of the well. Development within each 10-foot section will continue until the sand content is less than 5 milliliters (ml) using an Imhoff cone and the turbidity is less than 100 Nephelometric Turbidity Unit (NTU) as measured using an YSI or equivalent portable meter. Once swabbing and bailing is complete, a 2-inch or 4-inch submersible pump will be installed for continued development to remove residual fine sediment from the filter pack. Water parameters (pH, temperature, Oxidation reduction potential (ORP), Dissolved Oxygen (DO), and conductivity) will be collected during development activities to monitor the progress of development. During development, the pump will be moved from the bottom up, in approximate 10-foot increments, to work the entire length of the screen. Pumping at each specific interval will continue until the water is clear, sand content is less than 5 ml/L as measured using an Imhoff cone, and/or turbidity values are less than 100 NTU. Since it is anticipated that the pumped development water will have high solids content, a portable water wagon will be used to containerize the pumped water for transport to the MTS.

- At the conclusion of well development activities, a discharge sample will be collected for analysis of TCE and perchlorate in accordance with EPA Methods 8260 and 314.1.

8) Bulk Groundwater Sample Collection for Treatability Study

Approximately one week after the monitor well is installed and developed, collect 40 Liters (L) or 10.5 gallons of groundwater using low flow purge methods for shipment to ASU for use in the microcosm study. A description of the low flow purge method is presented in the EPA Approved PGA-North Groundwater Monitoring Work Plan Addendum dated July 15, 2015. Use unpreserved 10-L or 20-L Carboy's, if available, or 1-L bottles to containerize the groundwater. As a precautionary measure, an additional 10 L of groundwater will be collected. Place containers in cooler containing ice and transport to the ASU laboratory the same day.

The pump intake for the overall bulk groundwater sample will be set in the area that exhibited the highest TCE mass identified by the Hydropunch™ samples.

Once the sediment column study begins, additional groundwater will be collected using similar methods.

9) QA/QC Samples

In accordance with the Final EPA Approved RD/RA Work Plan, field duplicates will be collected every 10 samples for both soil and groundwater. Rinsate blank and equipment blank samples will be collected at the end of each work day. Trip blanks will also be submitted in each shipment to the laboratory for VOC analysis.

10) Laboratory Composite Sampling

Care must be taken in order to preserve any microbial colonies that may be present in the soil and minimize the exposure to an oxygen rich environment. As such, all mixing will be done by hand in a glove box chamber in the ASU laboratory. Prior to mixing, the atmosphere in the glove

box chamber will be evacuated such that no oxygen will be present. This will minimize volatilization and minimize the exposure of air to the microbial populations. Prior to bulk homogenization, each depth specific interval will be homogenized. Since the overall bulk sample for use in the Treatability Study will require 10.5 gallons of soil, it is recommended that approximately three 3.5-gallon batches be prepared. The following procedures will be used to prepare a homogenization of each depth specific interval and each 3.5-gallon batch within the glove box chamber. A PGA-North Team geologist will be present during the mixing to confirm the homogenization process and that a sufficient amount of sand dominant material is used to ensure that percolation will occur.

Depth Specific Interval Homogenization

- Each quart sample container (4 total) from each depth specific interval will be emptied onto a stainless steel mixing tray, total volume is 1.0 gallon. Samples containing appreciable sand size particles should be preferentially used to ensure that percolation and movement within the microcosms and sediment columns occurs in a timely manner.

- A stainless steel trowel or spatula will be used to mix the soil by gently folding layers of soil into one another. This process will be repeated until sample homogeneity is achieved.

- Once homogenization is complete, carefully and gently transfer the soil mix into a 1-gallon poly container. Each container will be properly labeled with the depth interval and date.

Bulk Sample Homogenization and Sediment Column Packing

- 1 quart from each depth specific interval will be emptied onto a stainless steel mixing tray – total volume is 3.5 gallons. Samples containing appreciable sand size particles should be preferentially used to ensure that percolation and movement within the microcosms and sediment columns occurs in a timely manner.

- A stainless steel trowel or spatula will be used to mix the soil by gently folding layers of soil into one another. This process will be repeated until sample homogeneity is achieved.

- Once homogenization is complete, carefully and gently transfer the soil mix into a 5-gallon poly container, saturate with Site groundwater and seal with a lid. This will be done in the glove box in an oxygen free environment.

- Both microcosms and sediment columns will utilize the homogenized soil. Microcosm vials will be filled approximately ½ full using approximately 25 grams of the homogenized soil. Sediment columns will be filled from bottom up by carefully placing the homogenized soil into each column. Material will be placed in 10 centimeter lifts and slightly tamped to ensure that no bridging or void spaces occur.

Table 8. High Resolution Characterization Sampling Matrix
Phoenix-Goodyear Airport - North Superfund Site
Goodyear, Arizona
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Analyte	Groundwater	Soil	Field Test	Laboratory Test	Analytical Method	Number of Groundwater Samples/Boring (excluding duplicates)	Number of Soil Samples/Boring (excluding duplicates)	Total Samples
VOCs	X	X		X	EPA 8260B	7	1	72
Perchlorate	X	X		X	EPA 314.1	7	1	72
DO	X		X		Field Probe	7	1	72
ORP	X		X		Field Probe	7	1	72
Conductivity	X		X		Field Probe	7	1	72
Temperature	X		X		Field Probe	7	1	72
pH	X	X	X		Field Probe	7	1	72
TOC		X		X	SW 846 9060		1	9
TKN		X		X	EPA 351.2		1	9
Ammonia		X		X	SM4500 NH3 D		1	9
Total Phosphorous		X		X	SM4500 P E		1	9
Ortho-Phosphate		X		X	SM4500 P E OR		1	9
Aerobic and Anaerobic Heterotrophic Microorganisms		X		X	SM 9215C		1	9
Total Fe		X		X	EPA 200.7		1	9
Ferrous Fe		X		X	Hach Test Kit		1	9
FOC		X		X	ASTM D2974		1	9

Sampling to be conducted at approximately five-foot intervals in Saturated zone in Subunit A. One sample to be collected in upper portion of Subunit B.
Quality Assurance/Quality Control (QA/QC) Samples
- Field duplicates 10% of total samples
- Equipment Blanks at the end of each work day for laboratory analyses only
- Rinsate blanks at the end of each work day for laboratory analyses only
- Matrix Spike/Matrix Spike Duplicate (MS/MSD) for laboratory analyses only
- Trip Blank for every shipment to laboratory of VOCs

VOCs = Volatile Organic Compounds
DO = Dissolved Oxygen
ORP = Oxidation Reduction Potential
TOC = Total Organic Carbon
TKN = Total Kjedahl Nitrogen
Fe = Iron
FOC = Fractional Organic Carbon