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Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP)

Fort Stewart Military Reservation and Hunter Army Airfield, Georgia

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ARCADIS

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Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP)

Fort Stewart Military Reservation and Hunter Army Airfield, Georgia

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Acronyms and Abbreviations

amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
ASTM	American Society for Testing and Materials
bgs	below ground surface
COC	chain of custody
DPW	Department of Public Works
FID	flame ionization detector
ft	feet
GAEPD	Georgia Environmental Protection Division
gpm	gallons per minute
GPS	global positioning system
HASP	Health and Safety Plan
HSRA	Hazardous Site Response Act
IDW	investigative derived waste
MIP	membrane interface probe
mL/min	milliliters per minute
MS/MSDs	matrix spike/matrix spike duplicates
NAPL	non-aqueous phase liquid
NTUs	nephelometric turbidity units
O.D.	outside diameter
ORP	oxidation reduction potential
OCGA	Official Code of Georgia Annotated
PBC	Performance Based Contract

PCB	polychlorinated biphenyl
PID	photoionization detector
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and Analysis Plan
TCLP	Toxicity Characteristic Leaching Procedure
UPC	Utility Protection Center
USEPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
VOC	volatile organic compound

1. Introduction

This Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) was prepared by ARCADIS U.S., Inc. (ARCADIS) to provide field personnel with detailed instructions and procedures regarding field activities to be performed in support of Resource Conservation and Recovery Act (RCRA) and Hazardous Site Response Act (HSRA) remedial activities and to document the performance of all environmental field activities at the Fort Stewart Military Reservation and Hunter Army Airfield in Georgia.

This site-wide SAP provides a detailed description of the field investigation methodologies that will be used to complete the RCRA and HSRA remedial process at the Sites included in ARCADIS' Performance Based Contract (PBC) contract. The QAPP, included as Appendix A, presents the policies, organization, objectives, functional activities, and specific quality assurance/ quality control (QA/QC) procedures. The QA/QC procedures will be employed by ARCADIS to ensure that all technical data generated are accurate and representative, and the data will be of known and usable quality for the intended purpose. Site-specific work plans that further define the scope of activities to be performed at each individual Site will reference this plan for the general procedures to be used in completing the prescribed field activities.

ARCADIS field personnel will use the procedures described in this SAP to produce accurate, comparable, and reproducible data for reduction and evaluation. This SAP is divided into four sections. A brief description of each section is provided below:

- **Section 1, Introduction** – Summarizes the purpose and organization of the plan.

- **Section 2, Site Preparation and Mobilization Procedures** – Describes the tasks to be performed prior to mobilization to the field, including notification and coordination requirements.

- **Section 3, Field Investigation Procedures** – Presents a detailed discussion of the procedures to be used in completing the field tasks, including information on drilling, well construction, sampling, decontamination, investigation derived waste, and the site survey.

- **Section 4, Field Documentation Procedures** – Outlines the methods to be used for sample designation, chain-of-custody (COC) procedures, and field documentation.

Throughout this SAP, reference is made to standard forms and logs used by ARCADIS field personnel to record field observations and measurements. Examples of each of these forms are provided in Appendix B of this SAP.

2. Site Preparation and Mobilization Procedures

Initial project coordination, subcontractor coordination, and utility clearance activities will be conducted prior to initiating the field sampling activities. These pre-mobilization activities are discussed in the following subsections.

2.1 Initial Coordination

The Fort Stewart and Hunter Army Airfield environmental staff will be notified at least 2 weeks before the start of any field work.

2.2 Mobilization and Subcontractor Coordination

The subcontractors, including drillers, laboratories, and surveyors, will be selected and contracts will be executed in advance of beginning the field activities.

2.3 Utility Clearance

Prior to mobilization, all underground utility lines, and other underground structures will be clearly marked. ARCADIS personnel will be responsible for making certain the underground utilities and structures are located and marked. ARCADIS is responsible for submitting a utility locate request through the Georgia Utility Protection Center (UPC). UPC will accept these locate request either by phone or internet. The phone number is (800) 282-7411. The UPC web address is www.gaupc.com and click on IRTH login to make the request. In order to submit a request using the website, pre-registration will be required. The contractor must mark the boundaries of the proposed work site using either white paint, flags or stakes. Department of Public Works (DPW) will accept responsibility for accuracy of the locates pertaining to gas and fuel lines, water lines, electrical lines to include secondary electricity, airfield lighting, low voltage, fire systems, sewer lines, roof drain lines, storm drain lines, industrial waste lines, chilled water lines, high temperature water lines, irrigation systems, and DPW non-fiber computer lines. These requests will be forwarded to all utility companies with services present within the proposed work site.

Permits will be issued within 48 hours of the next business day following the receipt of the request by UPC. The permits will only be valid for 21 days and renewal requests should be submitted a minimum of 3 days prior to expiration. Requesting contractors are responsible for maintaining marks during the 21-day period. If, after acquiring a permit, a utility is damaged during field activities, the appropriate utility company must be notified. DPW's utilities are listed above and the points of contact are:

Fort Stewart	Carletha Joyce	(912) 767-6669
HAAF	Tony West	(912) 315-5523

The contractor should be prepared to submit proof of a valid permit at that time.

ARCADIS personnel will be responsible for notifying the Fort Stewart and Hunter Army Airfield environmental office of planned intrusive activities at least 2 weeks prior to the initiation of field activities. Upon arrival at the installation, the field operations leader will check the proposed drilling, sampling, and trenching locations for marked underground utilities, other underground structures, and above-ground pipe racks or power lines. A Utilities and Structures Checklist (Appendix B) will be completed by the Field Operations Leader for each area to be sampled prior to commencement of field activities. A copy of the completed checklist will be retained in the ARCADIS project file.

2.4 Site Reconnaissance

Prior to startup of drilling or sampling activities in a particular area, field personnel will conduct a brief site reconnaissance to determine if any problems with the drilling or sampling locations will be encountered. The sampling locations will be sketched on the Location Sketch Form (Appendix B). In addition, at the start of field activities at each Site, the field personnel will notify the Fort Stewart and Hunter Army Airfield environmental staff of the work schedule, and sampling and drilling locations.

2.5 Field Operations Contingency Plans

If during the field program, any unforeseen problems or conditions are encountered that require re-evaluation or corrective action, such as, but not limited to, extreme precipitation events, site emergencies that require evacuation of field personnel, changes in site conditions, security problems, loss of power or communications, or community relations problems, the following contingencies will be put into place:

- For any problem or condition encountered by the field team, the team personnel will immediately notify the Fort Stewart and Hunter Army Airfield environmental staff and/or the ARCADIS Project Manager for direction or approval of corrective action.

- If the problem or condition requires downtime at the site and re-evaluation of any site conditions, assumptions made about the site conditions, or plans prepared for the site, the field team will contact the ARCADIS Project Manager and the Fort Stewart and Hunter Army Airfield environmental staff for consultation.

- If after consultation, the problem or condition continues, the field program will remain on hold until direction is received from the Fort Stewart and Hunter Army Airfield representative and/or ARCADIS Project Manager. The field program will not continue until the problem is resolved.

- Any time these contingency procedures are implemented, the following will be documented in the daily log of activities:

  - Problem or condition encountered;
  - Personnel involved;
  - Management personnel contacted;
  - Corrective actions taken, if any; and
  - Dates and times involved.

2.6 On-Site ARCADIS Representative

A qualified ARCADIS representative will be on-site during all probing, drilling and sample collection activities. The ARCADIS representative will have in their possession a copy of the Site-Specific Work Plan and the associated Site-Wide Work Plans, including the SAP, QAPP, and Health and Safety Plan (HASP). The Site-Wide Work Plans encompass work at all Fort Stewart and Hunter Army Airfield PBC sites. The ARCADIS representative will also have on-site any equipment, tools, references, and documentation necessary to collect, describe, and document the information generated from the field activities.

2.7 Contractor Compliance and Permitting

The contractors selected for this project shall comply with any and all installation, local, state, and federal health and safety regulations and requirements. The contractors are responsible, per ARCADIS' contractual agreements, for securing and/or complying with permits required by state or local authorities. The selected contractors will have the necessary license(s) or certifications required to perform such work in Georgia.

2.8 Adherence to Technical Specifications

All work performed by ARCADIS or a contractor, whether it be drilling, sampling, equipment decontamination or other related activities will be in accordance with the procedures described in this SAP, and properly and completely documented by the on-site ARCADIS representative on forms provided herein (Appendix B).

3. Field Investigation Procedures

A detailed discussion of the field procedures that will be employed to complete the field tasks is provided in the following sections. All field procedures are in accordance with the United States Environmental Protection Agency (USEPA) Field Branches Quality System Technical Procedures (USEPA, 2008).

All soil, groundwater, and surface water samples collected will be analyzed by a certified Georgia Laboratory as listed in the Site-Wide QAPP (Appendix A). Samples will be preserved according to the selected analytical method. Specific method preservation requirements, size and type of sample containers to be used, and holding times for each parameter are listed in the Site-Wide QAPP (Appendix A).

3.1 Lithologic Logging

The lithology of the soil and bedrock samples collected will be described through visual observations of the soil/bedrock cores using the Unified Soil Classification System (USCS) and/or the American Society for Testing and Materials (ASTM) International Standard D 2488 for Description and Identification of Soils. The Boring/Well Construction Log (Appendix B) will be used to record lithologic logging observations. The following logging sequence will be used for the description of unconsolidated materials:

- Describe major soil type and percentage;
- Describe composition of the soil;
- Describe the moisture, texture, and color of the soil;
- Document other geologic observations such as bedding characteristics, structure and orientation, and primary and secondary permeability/porosity (if possible); and
- Document observations on drilling progress including sample interval loss and recovery.

3.2 Direct Push Borings and Sample Collection

Direct-push soil sampling consists of hydraulically pushing or driving a small diameter, hollow steel rod to a target depth and collecting a soil or groundwater sample. The equipment necessary for the collection of samples using the direct push technique is mounted on a regular van or truck for ease of mobility. The steel probe rods, 3 feet (ft) to 4 ft in length, are threaded for easy connection and have tight seals to provide a continuous length of rod. The rods are hydraulically driven or hammered to target depths. The steel rods can be driven to depths of up 150 ft through unconsolidated sediments.

3.2.1 Soil Sample Collection

The following procedures will be used during the collection of soil samples from direct push borings:

1. Record borehole location and intended sample depth intervals on the Boring/Well Construction Log (Appendix B).
2. Line the 3-ft or 4-ft steel soil sampler core barrel with an acetate, polyethylene or Teflon liner and attach sampler to end of steel rods.
3. Hydraulically push or drive the 3-ft or 4-ft soil sampler and rods to intended depth. Soil samples will be collected from intervals specified in the Site-Specific Work Plan.
4. Open the core barrel and disassemble revealing the soil core sample within the liner. Label the depths on each end of liner and mark the top and bottom to maintain proper core orientation
5. Remove a portion of the liner over the entire length of the core using an appropriate cutting tool.
6. Screen soils immediately in the field using a photoionization detector (PID) or flame ionization detector (FID) to document the levels of organic vapors present. To collect volatile organic headspace readings, place the soil sample in a sealed plastic bag approximately two-thirds full allowing for approximately 30 percent headspace. Place the bag in a dry area, which is as close to room temperature (70° F) as practical. After 10 minutes, use a PID or FID to measure the vapors that accumulate in the bag due to off-gassing from the sample. Base PID/FID usage on the target analytes. If a PID is used, select

the appropriate lamp based on the target analyte. Record the measurement on the Sample/Core Log.

7. Collect soil sample(s) for laboratory analysis. Don a clean pair of disposable gloves immediately prior to sample collection. VOC samples will be collected directly from the target depth interval of the soil core to minimize disturbance using an EnCore™ sampler or equivalent (Terra Core). Transfer the remaining soil from the target depth interval to a stainless steel bowl. Mix the soil using a stainless steel spoon until the sample is visually uniform. Remove any debris or larger rocks observed during mixing using the spoon. Collect non-VOC analysis samples from the bowl and place in appropriate sample container, label the container, and place on ice. Note on the field sample log the depth interval from which the sample aliquot was collected. The container and preservative requirements for soil samples are outlined in the Site-Wide QAPP (Appendix A). Double-bag the ice used for sample shipment in self-sealing bags prior to placement in the cooler.

8. Extract from the liners the portion of the soil core not submitted to the laboratory for analysis and use for logging purposes.

9. Describe the soil samples in the field. The lithology of the soil will be described by a qualified and experienced ARCADIS representative through visual observations of the soil core using the USCS or ASTM designation.

10. Place all soil cuttings in drums or roll-off box.

11. Properly decontaminate all down-hole sampling equipment prior to subsequent use in consecutive sample collection. Decontamination procedures are described in Section 3.12.

3.2.2 Groundwater Sample Collection

The following procedures will be used during the collection of shallow groundwater samples from direct push borings. When sampling for metals from direct push borings, both total and dissolved metals will be analyzed to assess the effect of turbidity on the sample results. Polychlorinated biphenyl (PCB) samples will not be collected from direct push borings.

1. Record sampling location and intended sample depth intervals on the Geoprobe® Groundwater Sampling Form (Appendix B).

2. Drive a stainless steel retractable screen attached to the bottom of the hollow steel rods to the target depth beneath the groundwater table. Target depths will be specified in the Site-Specific Work Plan for each Site.
3. Raise rods to approximately 2 to 4 ft to allow the screen to be exposed at the target depth, thus allowing collection of groundwater samples at the target depth.
4. Insert polyethylene or Tygon tubing (1/4-inch diameter) into the hollow rods to allow for collection of grab groundwater samples with a peristaltic pump or dedicated tubing with a check valve assemblage. The tubing with check valve method will be used as the sole means of collecting samples for volatiles organic analysis.
5. Don a clean pair of disposable gloves immediately prior to sample collection. Collect groundwater samples directly into laboratory-prepared, preserved sample bottles and place directly on ice. Fill the sample bottles in the following order: volatile organic compounds (VOCs) first, then remaining analytes.
6. Prepare sample containers according to the container and preservative requirements outlined in the QAPP (Appendix A). Include on the sample label the following: sample identifier, laboratory methodology requested, the sample matrix, date, time, project name, and name of sampler.

3.2.3 Membrane Interface Probe Borings

The Membrane Interface Probe (MIP) is a type of direct push tool, advanced by a standard direct push rig that logs both total VOC concentrations and soil conductivity with depth. The following procedures will be used during the completion of direct push borings using the MIP.

1. Record borehole location on the Boring/Well Construction Log (Appendix B).
2. Hydraulically push the MIP and rods to intended target depth, typically not greater than 60 ft below ground surface (bgs). Because the MIP probe cannot be hydraulically hammered, the MIP probe cannot be driven as deep as conventional Geoprobe® borings.

3.2.4 Temporary Piezometer Installation

Temporary piezometers may be installed in selected Geoprobe® groundwater boring locations in accordance with the Official Code of Georgia Annotated (OCGA) Well

Standards 12-5-134 (State of Georgia, 2008). The temporary piezometer installation procedures are discussed below.

1. After the collection of groundwater samples from the selected Geoprobe® groundwater borings, a temporary piezometer will be installed in the borehole and will be constructed with 10 ft sections of 1-inch to 1¼-inch diameter polyvinyl chloride (PVC) screen and riser.
2. The natural formation will be allowed to collapse around the piezometers.
3. The annular space around the upper 10 ft of the piezometer will be filled with granular bentonite and then hydrated to prevent possible interference from surface water leakage.
4. Because the piezometer is considered temporary, a concrete surface pad will not be installed. Unless otherwise approved by the Georgia Environmental Protection Division (GAEPD), temporary piezometers will be converted to permanent monitoring points or abandoned within 5 days.
5. Each piezometer will be closed with a PVC cap.

3.2.5 Temporary Piezometer Fluid Gauging

Static fluid levels in each temporary piezometer will be gauged using an electronic water-level indicator. Fluid-level measurements will be documented on the Water Level Measurement Form (Appendix B) and will later be converted to mean sea level for reporting purposes.

The following procedures will be implemented when collecting fluid-level measurements:

1. Remove the piezometer cap and document the general condition of the piezometer. In areas where non-aqueous phase liquids (NAPLs) are known to exist or have been present in the past, a PID or FID will be used to check the well for build-up of potentially hazardous gases.
2. Measure static fluid-level elevation using an electronic water-level indicator from fixed reference point (generally the north side of the top of the PVC casing).
3. Repeat the measurements every 5 minutes until two consecutive measurements are obtained that are within 0.01 ft.

Fluid-level measurements will be referenced to a surveyed elevation point located on the top of the piezometer casing. All fluid-level measurements will be taken at least two times to check the reproducibility of the measurement data. If it is found that the measurement cannot be reproduced, a second set of data will be collected. Fluid levels will be collected until the data can be reproduced. This measurement validation process ensures the accuracy of the fluid-level data.

Equipment used to measure the fluid level will be properly decontaminated before first use and between use at each well using the procedures described in Section 3.12.

3.2.6 Direct Push Boring Abandonment

Direct push soil borings installed at the site will be abandoned by allowing the saturated portion of the formation (i.e., unconsolidated sands and gravel) to collapse back into the 2-inch diameter borehole as the Geoprobe® rods are retracted. The upper 10 ft of the borehole will be plugged with granular bentonite and hydrated with potable water to make an impermeable seal.

3.2.7 Temporary Piezometer Abandonment

After the well casing and screen materials from the temporary piezometers have been pulled out of the ground, the borehole will either be filled with granular bentonite or a high solids bentonite-cement slurry mix to within at least three feet of ground surface. If bentonite is used, it will be hydrated with potable water, and the remainder of the borehole will be filled with native soil or clay.

3.3 Drilling Techniques

All soil borings and monitoring wells will be drilled and installed by a Georgia licensed water well driller.

3.3.1 Hollow-Stem Auger Techniques in Soil

Dependent on subsurface soil conditions at the Sites, shallow soil borings may be drilled using hollow-stem auger techniques (ASTM 1452). Soil samples can be collected continuously (if so scoped in a site-specific work plan) using a continuous sampler, or split-spoon sampler (ASTM 1586 and 1587) depending upon percent recovery realized using the continuous core sampler. The following steps outline the procedures that will be used to drill a shallow borehole for geotechnical or analytical purposes and for the installation of a monitoring well.

1. Record borehole location on the Location Sketch form and intended sample depth intervals on a Boring/Well Construction Log (Appendix B).

2. Clean and assemble the continuous sampler. The continuous core sampler (5 ft in length by 6 inches outside diameter (O.D.) is advanced in the borehole ahead of the augers (8-inch O.D.) and retrieved through the hollow-stem portion of the augers after each 5 ft drilled.

3. Disassemble the core barrel, revealing the soil core sample. Screen the soil samples with a PID/FID and describe in the field using the logging method described in Section 3.1.

4. Collect discrete samples from the core sample based on field screening data (prior to logging) and place in laboratory-prepared glass jars for analytical purposes. The preservation and handling of the samples is discussed in Section 3.4.3.

5. If continuous core sampling is not possible due to the character of the subsurface material encountered, collect samples every 5 ft using a standard split-spoon sampler (2 ft by 2 inch O.D.). Attach the split spoon to the drill rods, insert within the hollow-stem auger, and drive into the unconsolidated deposits using a standard 140-pound drop hammer and rig-driven cathead. Record blow counts for each 6-inch penetration of the split spoon. Drive each split spoon a total of 24 inches.

6. Collect all soil cuttings generated during the drilling of the boreholes and store temporarily on plastic or in a drum or roll-off box while awaiting characterization.

3.3.2 Mud Rotary Drilling

The mud-rotary system consists of a drilling fluid mixture of potable water and bentonite that is pumped down the inside of the drill pipe, and then returned to the surface through the annulus between the drill pipe and the borehole wall. This fluid cools the drill bit, carries the cuttings to the surface, prevents excessive fluid loss into the formation, and prevents the formation from collapsing. The drilling fluid flows into a mud pit where the cuttings settle out and then is pumped back down the drill rods.

The following steps outline the procedures that will be used for mud rotary drilling.

1. Record borehole location and intended sample depth intervals (if appropriate) on the Boring/Well Construction Log (Appendix B).

2. Drill the deep boreholes from the surface to 1 to 2 ft into the bedrock using a mud rotary drilling rig equipped with a six-inch bit and stabilizer. No formation sampling will be conducted in the deep boreholes.

3. Record any significant or sudden fluid loss or production and soil cutting observations from drilling mud on the Boring/Well Construction Log (Appendix B).

4. Terminate the borehole within the upper 1 to 2 ft of the bedrock surface, which will be determined by the detection of the bedrock fragments in the return mud.

5. Collect all drill cuttings generated during the deep borehole drilling and temporarily stage in either 55-gallon steel drums or a roll-off box while awaiting chemical characterization as discussed in Section 3.13.

3.3.3 Rotasonic Drilling Methodology

Monitoring wells and the soil borings (other than those drilled using direct push methods) will have the option to also be drilled using rotasonic drilling methods. The rotasonic drilling method uses a combination of rotary power, hydraulic pull down pressure, and mechanically generated oscillations to advance a dual line of drill pipe. The top mounted hydraulically powered drill head transmits the rotary power, hydraulic down pressure, and vibratory power directly to the dual line of pipe. The inner drill pipe, measuring from 3-inch to 9-inch I.D., contains a core bit and represents the core barrel sampler. The outer pipe, measuring 4 inches to 12 inches, is used to prevent the collapse of the borehole and is therefore used in the construction of monitoring wells from 1 inch to 8 inches in diameter. This combination of forces advances the inner core barrel sampler through typically difficult unconsolidated deposits and some consolidated formations without the use of mud or air.

Water is not necessary during drilling but may be used in small quantities to help lubricate the drill pipe as it is advanced. Drilling rates are equal to or greater than other conventional rotary methods when they include some method of continuous sampling. The inner drill pipe is always advanced in front of the outer drill pipe. Continuous core samples of 1 foot to 20 ft can be completed depending on job specifications and site conditions.

During typical borehole advancement, the first step is to advance the inner drill pipe and core bit about 6 ft or 10 ft into the ground. Once the inner drill pipe is set, the outer drill pipe is advanced down over the inner drill pipe to hold the boring open. The inner drill pipe is mechanically lifted by the drill head to the surface for core sample recovery. The core sample is vibrated out of the inner drill pipe into a plastic sheath or a stainless steel sample tray. The core sample also can be collected in a split stainless steel or a lexan core barrel liner. The inner drill pipe is then advanced to the top of the next sample interval. These steps are repeated until the desired total depth is reached. Installation of a well would be performed inside the outer drill pipe, which would be removed as the well materials are installed. This will keep the borehole walls from collapsing and ensure that a good sand pack is installed. Monitoring well construction details are discussed in Section 3.5.

All drilling and sampling equipment will be decontaminated according to the procedures outlined in Section 3.12 of this report between each borehole location.

3.4 Collection of Samples for Geotechnical and Chemical Analyses

The procedures for the collection of soil samples during hollow stem auger drilling for geotechnical and chemical analyses are described below.

3.4.1 Geotechnical Samples in Soil and Unconsolidated Deposits

1. Record the soil sample location, depth, date and time of collection, sample identification, name of sampling personnel, and type of drilling and sampling equipment on the Boring/Well Construction Log (Appendix B).

2. Clean and assemble the continuous or split-spoon sampler. The sampler will be fitted with 6-inch long California (brass) rings or equivalent sampler liners, so that soil samples can be retrieved with minimum disturbance for geotechnical analyses.

3. Lower the sampler through the drill stem to the desired sampling depth. If using a split-spoon sampler, drive the sampler with a standard 140-pound hammer free-falling 30 inches in accordance with ASTM Method D1586. Record the number of blows per foot required to drive the split spoon.

4. After the continuous core barrel or split-spoon sampler is retrieved and opened, mark with indelible ink the depths of the sample at the top and bottom of each brass ring. Don a clean pair of disposable gloves immediately prior to sample collection. Using a stainless steel spatula or knife, cut the soil sample between the brass rings. Using plastic caps, cap each end of each ring. Label each ring with the appropriate sample designation.

5. The geotechnical samples do not have to be placed on ice or chilled.

6. Submit to geotechnical laboratory using COC procedures (Section 4.3).

7. From the remaining soil core, conduct field screening and describe soil sample lithology using procedures outlined in Section 3.1.

8. Alternate methodologies that may be used to obtain geotechnical samples, such as the use of a Shelby tube, will be described in the Site-Specific Work Plan for each Site.

3.4.2 Geotechnical Samples in Sediment

The procedures for the collection of geotechnical samples from shallow and deep sediments are outlined below.

1. If standing water is located over the sampling location and a deep sediment sample is to be collected, then the upper sediment and surface water should be removed prior to sample collection. Drive a minimum 4-inch O.D. schedule 40 PVC blank casing into sediment sampling location. Place a wooden board on top of PVC casing while driving casing into sediment to prevent breaking the casing. Use peristaltic pump to remove surface water from casing.

2. If collecting the geotechnical sample at 1.5 to 2.0 ft bgs, remove overburden with a decontaminated stainless steel bucket auger to a depth just above top of sampling depth (i.e., 1.5 ft bgs).

3. Drive a decontaminated 1 to 2-inch diameter stainless steel soil sampler lined with a plastic or acetate liner to depth required. A disposable acetate or thin walled stainless steel soil probe may also be used.

4. If a gravelly substrate is encountered, a decontaminated bucket auger may be used to collect the sample from 1.5 to 2.0 ft bgs.

5. Cap the liner and retract the sampler. The sample core may not remain in the sampler or tube if the top is not capped.

6. Cap the bottom of the sample. If a liner is used, remove the liner from the sampler, then cap the bottom of the sample.

7. If freestanding water was also captured in the sampling tube or liner, remove the top cap and gently pour off the water without disturbing the sediment sample.

8. Don a clean pair of disposable gloves immediately prior to sample collection. If using a bucket auger to collect the geotechnical sample, remove sample from bucket and pack into laboratory container.

9. Document the sample on a Soil/Sediment Sample Log (Appendix B).

10. The geotechnical samples do not have to be placed on ice or chilled.

11. Submit to geotechnical laboratory using COC procedures (Section 4.3).

3.4.3 Samples for Chemical Analyses

The procedures for collection of samples for chemical analyses are outlined below.

1. Record the soil sample location, depth, date and time of collection, sample identification, name of sampling personnel, and type of drilling and sampling equipment on the Boring/Well Construction Log (Appendix B).

2. Clean and assemble the continuous core barrel or split-spoon sampler.

3. Lower the sampler through the drill stem to the desired sampling depth. If using a split-spoon sampler, drive the sampler with a standard 140-pound

hammer free-falling 30 inches in accordance with ASTM Method D1586. Record the number of blows per foot required to drive the split spoon sampler.

4. After the continuous core barrel or split-spoon sampler is retrieved and opened, collect soil samples for chemical analysis. Don a clean pair of disposable gloves immediately prior to sample collection. Collect VOC samples directly from the core barrel or spit spoon sampler using an EnCore™ sampler or equivalent (Terra Core) to minimize sample disturbance. Place the remaining soil sample volume into a stainless steel bowl. Mix the soil using a stainless steel spoon until the sample is visually uniform. Remove any debris or larger rocks from the soil during the mixing process using the spoon. Place the remaining soil samples into their appropriate containers. If the sample material is of size or consistency that an EnCore sampler cannot be used, place the material in a glass 4-ounce container. Immediately store the containers in a cooler on ice at 4° C. Complete the sample label for soil samples selected for analyses.

5. Document the sample on a Soil/Sediment Sample Log.

3.5 Monitoring Well Construction

3.5.1 Shallow and Intermediate Well Construction

The shallow and intermediate wells will be installed in boreholes drilled using hollow-stem auger techniques. Monitoring well construction details will be documented on the appropriate Well Construction Log (Appendix B). No water will be introduced during monitoring well construction unless the borehole conditions require stabilization. If required, the water will be obtained from the Fort Stewart or Hunter Army Airfield potable water system.

1. The screened interval for all monitoring wells is anticipated to be 5- to 10 foot-sections of factory-milled 10-slot, 2-inch O.D., schedule 40 PVC screen, placed in the bottom of each well. The well screen attached to threaded, flush joint, 2-inch O.D., schedule 40 PVC casing will be inserted in the borehole through the minimum 6.25-inch O.D. hollow-stem auger.

2. The screened interval of the monitoring wells will be specified in the Site-Specific Work Plan for each Site.

3. PVC casing will be threaded to the screen and brought to a height of 3 ft above ground level for completion.

4. The annular space between the well and the borehole wall will be backfilled with a clean, graded, size 20 to 40 silica sand pack that will extend from the bottom of the borehole to a minimum of 2 ft above the top of the screened interval. The sand pack will be placed by tremie pipe from the bottom of the borehole through the hollow-stem augers to ensure complete placement around the well screen. The hollow stem auger will be retrieved as the sand pack is emplaced and can typically serve as the tremie pipe for filter pack placement.

5. Approximately 1 ft of very fine sand grade size 50 or smaller may be emplaced above the filter pack to prevent the migration of the bentonite slurry into the well screen.

6. A minimum thickness of 3 ft of bentonite pellets or chips will be placed on top of the filter pack as a seal. If the seal is within the unsaturated zone at the time of installation, granular bentonite will be placed in one-foot lifts, saturated with potable water, and allowed to hydrate. Hydration time will conform to the manufacturer's recommendations before further work on the well is performed.

7. The annular space from the top of the bentonite seal to within 1 foot beneath the frost line (approximately 30 to 36 inches bgs) will be filled with a cement and bentonite slurry containing high solids mixed to the manufacturer's specifications. Alternatively, cement/bentonite slurry consisting of 8 gallons water and 5 percent bentonite by weight per bag of Portland cement will be used, with a target density of 14 to 15 pounds per gallon. The bentonite slurry will be placed with a tremie pipe from the bottom of the annular area to be grouted to ensure proper placement of the slurry.

8. The remaining annular space near land surface will be filled with concrete. All wells will be completed above grade using a protective steel cover. A concrete apron will be installed around the cover. The apron will be a minimum of 2 ft by 2 ft and 6 inches in thickness, and shall be sloped to promote drainage away from the well. The wells will also be equipped with locking caps.

9. At selected locations, steel guard posts or protective barriers will be installed around the wells in a manner designed to prevent vehicles from accidentally damaging the well.

3.5.2 Pre-pack Screen Monitoring Well Construction

For shallow to intermediate monitoring wells where heaving (flowing) sands are expected to be encountered, an alternative method of monitoring well construction would include the use of pre-packed screens during well construction. Figure 3-1 shows the well schematic for the prepacked screens. The construction of these wells would follow the same steps detailed in Section 3.5.1 with the following exceptions.

1. The screened portion of the monitoring well will consist of 5- to 10-foot sections of pre-packed screen. In the case of 2-inch diameter well, the screen will have a 2.0-inch I.D. and a 3.63-inch O.D. Previous site investigations have shown that the 12-slot screen with a 10 by 20 sand pack will be more than adequate for construction of the monitoring well.

2. Formation material will be allowed to collapse around the screen upon removal of the augers to a point 2 ft above the screened interval.

3.5.3 Monitoring Well Construction Beneath a Confining or Semi-Confining Layer

Installation of monitoring wells beneath a confining or semi-confining layer is outlined in the procedures below. Monitoring well construction details will be documented on the appropriate Well Construction Log.

1. An 8-inch PVC casing will be set 1 foot into the top of the confining unit. The casing will then be grouted around the annulus of the casing to the land surface to seal off the casing from the aquifer. The grout will be allowed to set for a period of time in accordance with the manufacturer's specifications to ensure a proper seal is set.

2. Inside of the casing the bore hole will be completed through the confining layer to the aquifer below to the target depth.

3. Inside of the 8-inch casing, the well will be constructed with 2-inch threaded flush joint, Schedule 40 PVC casing and 2-inch threaded flush joint, Schedule 40 PVC, 0.010-inch continuously mill-slotted screen. Schedule 80 well material

will be used for monitoring wells deeper than 100 ft. Pipe joint compound (glue) will not be used in constructing the monitoring wells. If the depth of the well is to be greater than 50 ft, centralizers above the screened interval may be used to aid in well construction.

4. Casing will be added to the well screen and brought from the top of the screened interval to a height of 3 ft above ground level for completion.

5. The annular space between the well and the borehole wall will be backfilled with a clean, graded, size 20 to 40 silica (or alternative gradation based on site-specific data) sand pack that will extend from the bottom of the borehole to a minimum of 2 ft above the top of the screened interval. The sand pack will be placed by tremie pipe from the bottom of the borehole through the hollow-stem augers to ensure complete placement around the well screen.

6. Approximately 1 ft of very fine sand may be emplaced above the filter pack to prevent the migration of the bentonite slurry into the well screen.

7. A minimum thickness of 3 ft of bentonite pellets or chips will be placed on top of the filter pack as a seal. If the seal is within the unsaturated zone at the time of installation, the bentonite will be saturated with potable water and allowed to hydrate. Hydration time will conform to the manufacturer's recommendations before further work on the well is performed.

8. The annular space from the top of the bentonite seal to within 1 foot beneath the frost line will be filled with a cement and bentonite slurry containing high solids mixed to the manufacturer's specifications. The bentonite slurry will be placed with a tremie pipe from the bottom of the annular area to be grouted to ensure proper placement of the slurry.

9. The remaining annular space near land surface will be filled with concrete. All wells will be completed above grade using a protective steel cover. A concrete apron will be installed around the cover. The apron will be a minimum of 2 ft by 2 ft and 6 inches in thickness, and shall be sloped to promote drainage away from the well. The wells will also be equipped with locking caps.

10. At selected locations, steel guard posts or protective barriers will be installed around the well in a manner designed to prevent vehicles from accidentally damaging the well.

3.5.4 Borehole and Well Abandonment

A Georgia licensed water well driller will abandon all boreholes not used for monitoring well installation, temporary wells, or permanent wells in accordance with the OCGA Georgia Well Standards 12-5-134 (State of Georgia, 2008).

3.5.5 Temporary Well Abandonment

Temporary wells will be abandoned by the following procedures.

1. The monitoring well riser pipe and well screen will be removed from each borehole. The riser pipe and screen will be decontaminated by steam cleaning at the designated decontamination area and will be discarded in a sanitary waste landfill.

2. The entire borehole will be grouted with a cement and bentonite slurry containing high solids mixed to the manufacturer's specifications. The bentonite slurry will be placed with a tremie pipe from the bottom of the annular area to be grouted to ensure proper placement of the slurry.

3. The abandoned borehole will be marked with a flag or stake.

3.5.6 Soil Boring Abandonment

The procedures for abandoning boreholes are as follows:

1. The entire borehole will be grouted with a cement and bentonite slurry containing high solids mixed to the manufacturer's specifications. The bentonite slurry will be placed with a tremie pipe from the bottom of the annular area to be grouted to ensure proper placement of the slurry.

2. The abandoned borehole will be marked with a flag or stake to allow for surveying.

3.6 Groundwater Level Measurements and Sampling

3.6.1 Groundwater Level Measurements

Water level measurements will be referenced to a surveyed elevation point located on the top of the well casing. This measurement point will be surveyed by a Certified Land Surveyor and referenced to ft above mean sea level (amsl). An electronic water level probe will be used to gauge the water level in the new wells, in addition to the existing monitoring wells and piezometers at the facility.

Water levels will be recorded in the new monitoring wells, existing monitoring wells and piezometers within 24 hours prior to each groundwater sampling event. The total well depth may also be measured at this time to determine if sediment has accumulated in the well thereby reducing the effective well depth. Water level measurements at each Site will begin with the upgradient wells (i.e., inferred least contaminated wells) and proceed to the downgradient wells (i.e., inferred most contaminated wells). Water-level measurements will be collected within a single 24-hour period and will be measured twice to check the reproducibility of the measurement data. This measurement validation helps ensure accuracy with regard to the water level data collection. The procedure for obtaining water level measurements is as follows:

1. Describe the area surrounding the well, whether or not the lock was secure (if applicable), if the well could have been impacted by surface water runoff, ambient weather conditions and other factors that could affect the final data analysis. This documentation is recorded on a Water Level Measurement Form) Appendix B).

2. Decontaminate the electronic water probe prior to initiating water level measurements and between all wells and piezometers. Decontamination procedures are described in Section 3.12.

3. Unlock the protective casing and remove the inner cap on the riser.

4. Check the probe to verify that it is operational, then lower down the monitoring well.

5. If the well is not vented, allow the water level to equilibrate for a few minutes prior to collecting the first measurement. Take fluid level measurements from a

fixed reference point (the north side of the top of the PVC riser) using an electric tape graduated in 0.01-foot intervals.

6. Repeat the measurements until two measurements are obtained that are within 0.01 ft.

7. Remove and decontaminate the probe, replace the inner cap, and lock the protective casing.

3.6.2 Low-Flow Groundwater Purging and Sample Collection

The following protocol has been developed to obtain groundwater samples that are representative of formation conditions and is intended for use in sampling monitoring wells during the field activities. New monitoring wells will not be sampled for at least 24 hours following non-stressful means of well development (e.g., purging with submersible pump or bailer) and 48 hours following stressful means of well development (e.g., air lift, surge and purge). Monitoring wells will be purged prior to collecting groundwater samples to ensure that representative formation water is being sampled. The monitoring wells will be purged and sampled in the same order as that for water-level measurements (upgradient to downgradient, or least contaminated to most contaminated where known based upon prior sampling results). Prior to introduction into the well, all non-dedicated equipment and materials will be decontaminated in accordance with the procedures outlined in Section 3.12.

The following procedures will be implemented when performing well purging prior to sample collection:

1. Put on clean latex or vinyl surgical gloves or nitrile gloves.

2. Unlock the metal protective casing, remove the well cap, and document the general condition of the well.

3. Determine static fluid-level elevation using electronic probe. Record on Groundwater Sampling Form (Appendix B).

4. Compute the volume of water in the well (0.162 gallon/foot for a 2-inch diameter well). The volume of water to be purged will be computed based on the total well depth recorded upon the completion of well installation. The total depth will be measured periodically during the monitoring program to determine if

sediment has accumulated in the well thereby reducing the effective well volume. If it is determined that sediment has accumulated in the well, then the new well depth will be used to compute the volume of water to be purged.

5. Insert the pre-cleaned bladder (or peristaltic) pump and tubing into the well to the midpoint of the well screen. Record installation time in field notes. Dedicated Teflon and/or PVC bailers may be used to facilitate sample collection where site conditions warrant, such as low recovery wells.

6. Start pump at the lowest possible flow rate and adjust the pumping rate to approximately 100 milliliters per minute (mL/min). Record pump start time in field notes. Verify the flow rate with the graduated cylinder or equivalent by collecting the water from the discharge line for one minute. Record results in field notes. Based on the recovery rate of the well, the pump may need to be raised or lowered to adequately purge the entire well column. Adjustments will be recorded in the field notes.

7. Monitor water level to verify that little or no drawdown (0 to 0.3 ft) is occurring in the well. If desired, the flow rate may be increased to up to 300 mL/min in more permeable formations as long as little or no drawdown is observed in the well. Record measurements and flow rates in field notes.

8. Obtain field parameter measurements (temperature, specific conductance, pH, dissolved oxygen, oxidation-reduction potential [ORP], and turbidity) every 5 minutes and record on the Groundwater Sample Log. Purge until the criteria listed below have been met (unless low well recovery precludes this):

   - The field parameters stabilize to within +/- 10 percent of three consecutive meter readings taken at least 5 minutes apart.

   - The measured turbidity is less than 10 nephelometric turbidity units (NTUs), unless low recovery precludes this.

9. Collect VOC samples for laboratory analysis (if required) at a low flow rate (100 mL/min) directly into the appropriate sample container. If a peristaltic pump is used, the downhole tubing will be filled using suction and removed from the well to prevent the sample from contacting the pump head. The pump speed is reduced and the direction reversed to push the sample out of the tubing and into the sample containers. Ensure that no air bubbles are present in the vial.

Secure sample container lid and store sample containers in chilled cooler after filling out the sample label.

10. Collect additional samples for non-VOC analysis (collecting in the order of explosives, metals, and indicator parameters). If samples are being collected usig a persitaltic pump following VOC sample collection, repeat steps 1 through 8. Collect non-VOC samples at low flow rate (100 mL/min). Flow rates of up to 500 mL/min can be used if all stabilization criteria are achieved. Unless specified in the site-specific work plan, metals samples will be collected unfiltered. If site conditions require filtration for metals analysis, an in-line 45 micron filter will be used. Secure sample container lids and store sample containers in chilled cooler.

11. Complete sampling documentation on the Groundwater Sampling Form, record the collection date and time on the sample key, and fill out the Well Sampling Summary form (Appendix B).

12. If inadequate water is present in the well to fill the required sample containers, return periodically within 24 hours until adequate sample volume is obtained and field parameters measured. Collect groundwater for individual analyses in the appropriate sample order. If required, collect VOCs and store first, then metals and other indicator parameters.

13. If drawdown in the well cannot be maintained within the 0.3-foot requirement, sample collection will be performed after three well volumes of groundwater have been purged. Begin sample collection with VOC analysis unless otherwise noted in the site-specific work plan. For wells that purge dry before all of the samples are collected, allow the well to recover and then make one more attempt to collect the remaining samples within a 24-hour period.

14. Turn off pump. Remove portable pump from well and decontaminate or dispose. Tubing will be left as dedicated tubing in the well or disposed of after use.

15. Determine the total depth of the well. Compare the measurement of the total depth of the well with previous measurements and well construction log to determine available screen length. Record on water sampling log. If more than 20 percent of a well screen is occluded by sediment, the well must be redeveloped prior to collecting future groundwater quality samples. Samples

collected prior to the total well depth measurement will be representative only if the field data indicate that the well met stabilization criteria prior to sampling.

16. Replace cap on well and protective casing lock well.

3.6.3 Slug Test

This procedure defines the requirements for conducting a slug test in a monitoring well. The purpose of this procedure is to provide a uniform basis for conducting slug tests and to ensure the continuity between field personnel. A water level indicator will be used to measure the change in water levels versus time during the slug test. However, for slug tests completed in wells screened in very permeable formations, a transducer and data logger may be used to measure and record water level changes over time.

1. Open the locking and vented caps and inspect the wellhead. Note in particular the condition of the surveyed reference mark, if any.

2. Measure and record the static water level and the depth to the bottom of the well. Record this data on the Water Level/Pumping Test Record (Appendix B).

3. Lower the slug into the water until it is fully submerged. Allow the well to equilibrate to static water level.

4. Verify the static water level has been reestablished with an electronic water-level indicator.

5. Withdraw the slug quickly, but avoid surging. Record the time of withdrawal to the second. Start the stopwatch, if used, at the instant the slug is withdrawn.

6. Using an electronic water level indicator, measure and record the initial displacement of water as soon as the slug has been withdrawn.

7. Measure and record the rise in water level vs. time. Using the water-level indicator and a stopwatch, record depth-time data at the fastest rate possible for the first 5 minutes of well recovery. Generally the water levels should be recorded every 30 seconds for the first 5 minutes, then every minute for the next 5 minutes. Subsequent recording intervals may be adjusted to suit the rate of well recovery. An electronic data logger and pressure transducer may be used in lieu of manual water level measurements.

8. Continue recording depth-time data until the well has recovered to nearly the static water level or at least 90 percent of the static water level. If 90 percent of the static water level has not been achieved within 2 hours, then field personnel may return periodically within the next 24 hours to record the water level.

9. Record the time of test completion in the field data forms.

10. Decontaminate all equipment according to the procedures outlined in Section 3.12. Close and lock the well before leaving.

3.6.4 Constant Rate Pump Test

1. Upon arriving at the site, collect a round of static water levels from all site monitoring wells. Record this data on the Water Level/Pumping Test Record (Appendix B).

2. Place the pump in the pumping well and connect to the electrical service. The pump discharge will be connected to 1) a control valve, 2) inline filter (optional), and 3) flow meter. Dependent on site conditions, treatment systems (i.e., flow-through vessels, carbon units) may be used prior to water storage or discharge.

3. Initiate a short step test beginning at 2 gallons per minute (gpm). The initial step test pumping rate may be altered depending on site specific conditions. The pumping rate will be increased in two subsequent steps (the amount of increase will be determined in the field based on the drawdown achieved at 2 gpm). Measure water levels in the pumping well and the three closest monitoring wells during the step test.

4. Based on the results of the step test, determine a pumping rate that will 1) achieve significant drawdown in the pumping well, and 2) will not result in dewatering the well during the pumping test.

5. Begin the pumping test after the water levels in the pumping well and observation wells have returned to static conditions.

6. Turn on the pump in the test well and operate at a constant rate during the remainder of the test.

7. Collect water levels at a logarithmic interval in the pumping well, monitoring wells within 100 ft of the pumping well, piezometers within 100 ft of the pumping well, and at least one background well. Collect the water levels using a handheld electronic water level indicator or through the use of pressure transducers.

8. After the test has been conducted for a period of 24 hours, evaluate the pump test data to determine if continuation of the pump test is justified. If so, continue the test for a total of 48 hours, or until the data indicate that asymptotic conditions were achieved.

9. When the determination has been made to stop the pumping test, initiate the recovery portion of the test.

10. After the pump has been shut off, measure water levels at a logarithmic interval in the pumping well, monitoring wells within 100 ft of the pumping well, piezometers within 100 ft of the pumping well, and the selected background well. Continue measurements until the water level in the pumping well has recovered at least 90 percent.

3.6.5 LNAPL Bail Down Test

This procedure defines the requirements for conducting an LNAPL Bail Down Test in a monitoring well. The purpose of this procedure is to measure the thickness and depth to free product in the well as it recovers. The results of these tests are analyzed in accordance with techniques described in "How to Effectively Recover Free Product at Leaking Underground Storage Tank Sites," (EPA 510-R-96-001) to assist choice of potential free product recovery methods. The following steps will be used:

1. Measure the depth to LNAPL and groundwater.

2. Remove as much LNAPL from the well as possible using a weighted disposal bailer.

3. Measure the recovery rate of free product and groundwater using a hydrocarbon probe. Record the LNAPL thickness and recovery time in the well at regular intervals until the recovery rate has stabilized.

4. Determine 80 percent of the maximum LNAPL recovery thickness.

5. Interpolate the recovery time for 80 percent recovery.

6. Compute gallons per foot of LNAPL thickness in the well screen.

7. Compute the average recovery rate in gallons per day to 80 percent recovery.

3.7 Test Pit Excavations

The following procedures may be used to install test trenches, if deemed necessary to characterize waste materials.

1. Complete a trench to approximately 4 ft bgs with a track hoe or equivalent piece of excavation equipment.

2. Describe the profile of waste based on visual observations of the material removed from the trench and record on a Boring/Well Construction Log (Appendix B).

3. Backfill the trench with waste material after the trench has been completed.

4. Cover the trench with compacted soil.

5. Mark the trench area with a stake for surveying purposes.

3.8 Sediment Sampling

The following procedures will be used to collect sediment samples during the field activities at the Fort Stewart and Hunter Army Airfield.

3.8.1 Shallow Ditch Sediment Sampling

1. Sediment samples will be collected with a decontaminated stainless steel trowel or hand auger. Decontamination procedures are outlined in Section 3.12. A stainless steel hand auger or trowel will be used to collect sedimentsoils from the 0 to 0.5-foot (6-inch) interval.

2. The sediment sample will be placed directly into a stainless steel bowl. The sediment will be mixed using a stainless steel spoon until the sample is

visually uniform. During the mixing process any debris or larger rocks will be removed using the spoon.

3. The sample will be transferred from the bowl into a laboratory-prepared sampling containers supplied by the laboratory.

4. The sample will be documented on a Soil/Sediment Sample Log and the Soil Sample Summary Form.

Surficial soil samples will be collected from ditch areas that may be dry or have no freestanding water at the time of sampling. The following dry ditch sediment sampling procedures should be used only if the ditch is dry or has no freestanding water:

1. Prior to sample collection, any rocks, vegetation or debris will be removed with a stainless steel trowel.

2. Surficial soil samples will be collected with a decontaminated stainless steel trowel or hand auger. Decontamination procedures are outlined in Section 3.13. A stainless steel hand auger or trowel will be used to collect soils from the 0 to 0.5-foot (6-inch) interval.

3. The soil sample will be placed directly into a stainless steel bowl. The soil will be mixed using a stainless steel spoon until the sample is visually uniform. During the mixing process any debris or larger rocks will be removed using the spoon.

4. The sample will then be transferred from the container into the laboratory-prepared sampling containers supplied by the laboratory. The sampling activities will be documented on a Soil/Sediment Sample Log and the Soil Sample Summary Form.

5. Following sampling, the sample location will be filled in and any removed rocks or vegetation replaced.

3.8.2 Deep Ditch Sediment Sampling

1. Remove overburden with a decontaminated stainless steel bucket auger to just above the top of the prescribed sampling depth.

2. Drive a decontaminated 1 to 2-inch diameter stainless steel soil sampler lined with a plastic or acetate liner an additional 6 inches in depth. A disposable acetate or thin walled stainless steel soil probe may also be used.

3. Use a decontaminated bucket auger to collect the sample from 1.5 to 2.0 ft bgs if a gravelly substrate is encountered.

4. Cap the liner and retract the sampler. The sample core may not remain in the sampler or tube if the top is not capped.

5. Cap the bottom of the sample. If a liner is used, remove the liner from the sampler, then cap the bottom of the sample.

6. If freestanding water was also captured in the sampling tube or liner, remove the top cap and gently pour off the water without disturbing the sediment sample. Place the sediment sample directly into a stainless steel bowl. Mix the sediment using a stainless steel spoon until the sample is visually uniform. Remove any debris or larger rocks from the sediment during the mixing process using the spoon.

7. The sample will then be transferred from the container into the laboratory-prepared sampling containers supplied by the laboratory.

8. Document the sample on a Soil/Sediment Sample Log and the Soil Sample Summary Form.

Subsurface soil samples may be collected from ditch areas that may be dry or have no freestanding water at the time of sampling. The following dry ditch sediment sampling procedures described below should be used only if the ditch is dry or has no freestanding water:

1. Prior to sample collection, any rocks, vegetation or debris will be removed with a stainless steel trowel.

2. A decontaminated stainless steel hand auger will be used to collect soils from the prescribed depth interval. The collected soil sample will be placed directly into a stainless steel bowl. The soil will be mixed using a stainless steel spoon until the sample is visually uniform. During the mixing process any debris or larger rocks will be removed from the soil using the spoon.

3. The sample will then be transferred from the container into the laboratory-prepared sampling containers supplied by the laboratory. The sampling activities will be documented on a Soil/Sediment Sample Log and the Soil Sampling Summary Form.

4. Following sampling, the sample location will be filled in with surrounding sediment.

3.8.3 Shallow Stream Sediment Sampling

Stream sediment samples may be collected along predetermined transects upstream, adjacent to, and downstream of the area of interest in conjunction with surface water sampling for the characterization of the aquatic environment. Please note that the sediment samples may have to be collected by personnel outfitted with waders.

The sediment sampling procedures are described below and assume that all samples can be collected by personnel outfitted with waders that can access all sampling locations on a transect.

1. Position identification markers for the sediment and surface sampling locations along the stream bank prior to sampling. At each transect, mark and stake opposite banks of the stream to support a rope premarked at least at 10-foot intervals or measuring tape pulled taut across the stream slightly above water level. Each tape mark will become a station for a depth sounding of the river and a point for flow velocity measurements. For streams that are 10 ft in width or less, only one sampling station is required at the stream mid-point.

2. Measure the water velocity and flow using a current meter. Measure flow velocity at each station and at each 5-foot depth interval to the base of the stream. In every case, collect a flow measurement at the base and upper surface of the stream.

3. Briefly describe the substrate beneath each station as marked on the rope, such as silt, sand, gravel, and bedrock. In this manner, select the site for sediment sampling. Preferred sediment sample collection locations are areas of deposition, where fine-grained materials, such as clay, silt, or fine sand, collect. In addition, collect samples in pools, rather than riffles. The dredge sampler may not function properly if the substrate being sampled contains a large amount or large pieces of gravel.

4. Approach the sampling location from downstream to avoid disturbing the sediment prior to sampling.

5. Collect the sediment samples using an Ekman or Ponar dredge or equivalent. Gently advance the dredge approximately 6 inches into the sediment. The dredge closes with a messenger weight and the spring-loaded jaws shut to collect the sediment sample. A minimum of three aliquots will be collected at each sampling location.

6. Place the sediment samples directly into a clean stainless steel bowl. If VOC samples are to be collected, they should be taken directly from the sampling device using an EnCore™ sampler or equivalent (Terra Core). If the VOC samples cannot be collected from the sample device, they can be collected immediately after placement of the sediment in the stainless steel bowl. Following VOC sample collection, the remaining sediment will be mixed using a stainless steel spoon until the sample is visually uniform. During the mixing process any debris or larger rocks will be removed using the spoon.

7. Fill the appropriate laboratory jars for the non-VOC parameters specified in the Site-Specific Work Plan. Attach the lids and label appropriately. Complete the Soil Sample Summary Log (Appendix B).

8. With the remaining sediment sample, record the sediment characteristics, such as texture, odor, color, and other distinguishing factors on a Soil/Sediment Sample Log (Appendix B).

9. Remove the rope marking the transect, if not collecting deep sediment samples. Do not remove the stakes marking the transect. Survey the elevation of the stakes to a known elevation datum to provide a depth profile of the river.

3.9 Surface Water Sampling

Surface water samples may be collected along predetermined transects upstream, adjacent to, and downstream of the area of interest in conjunction with stream sediment sampling for the characterization of the aquatic environment. Please note that the surface water samples will have to be collected using a small boat or by personnel outfitted with waders. The optimum time to collect the surface water samples will be at a low stream flow so that personnel outfitted with waders can collect the samples.

Using a boat to collect the samples introduces special health and safety concerns and typically doubles the amount of time required to complete the task.

The surface water sampling procedures are described below and assume that all samples can be collected by personnel outfitted with waders that can access all sampling locations on a transect.

1. Follow steps 1 and 2 outlined in the stream sediment sampling procedure outlined in Sections 3.8.3.

2. At each transect, collect a surface water sample near the top of the water column with a clean Pyrex sampling cup or equivalent for field measurement of temperature, pH, specific conductance, and dissolved oxygen. An equivalent flow-through meter may also be used for each field parameter.

3. At locations that are deeper than 5 ft, collect the field measurements at each 5-foot depth interval using a Van Dorn or Kemmerer Type sampler.

4. Record the field measurements in a Surface Water Sample Log (Appendix B).

5. If the stream does not exhibit thermal or chemical stratification as determined by the field measurements (temperature and pH), collect a surface water sample with a clean Pyrex sampling cup or equivalent near the top of the water column. Immerse the Pyrex cup at an angle such that water gently flows in with minimal disturbance. Use the sample to fill laboratory-prepared sample bottles for analysis.

6. If the stream exhibits thermal or chemical stratification as determined by the field measurements (temperature and pH), then collect surface water samples every 5 ft using a Van Dorn or Kemmerer style water sampler.

7. Record the sampling location, date and time of collection, sample collection method, sample identification, sample preservative, methods of analysis, and initials of the sampling personnel on the Surface Water Sample Log (Appendix B).

8. Decontaminate the sampling equipment as described in Section 3.12.

3.10 Field Analytical Measurements

Several instruments may be used to collect field analytical data. These instruments include a pH meter, specific conductance meter, a thermometer, dissolved oxygen meter, and turbidity meter (nephelometer). The following equipment (including model number and manufacturer) will be used:

- pH meter (model SA-230) manufactured by Orion Research, Inc. or equivalent;
- Specific conductivity meter (model 0148-40) manufactured by Cole-Palmer Instrument Company or equivalent;
- Digital thermometer that meets the National Bureau of Standards requirements;
- Dissolved oxygen meter (model 810) manufactured by Orion Research, Inc. or equivalent; and
- Turbidity meter (model 800) manufactured by Engineered Systems or equivalent.

Field instruments will be calibrated at least once a day, and more often if conditions warrant. Calibration procedures will follow manufacturer's specifications and will be documented by field personnel on the Field Instrument Calibration Log (Appendix B).

3.11 Quality Control Samples

To monitor sampling and laboratory performance it may be necessary to collect several types of field QA/QC samples. The field QA/QC samples include trip blanks, equipment rinsate blanks, and field duplicates. The specific number and type of QA/QC samples that will be collected at each Site are outlined in the Site-Specific Work Plans and may be more or less than the criteria stated below based upon data quality objectives and professional judgment.

A trip blank is a container filled with distilled and organic-free water prepared in, and provided by, the analytical laboratory. A trip blank is sent from the analytical laboratory to the field-sampling site, and is returned to the laboratory for analysis. The trip blank results are used to evaluate whether contamination by VOCs occurred during shipment of samples and/or during container transport. One trip blank is required in each sample cooler transporting samples for VOC analysis.

An equipment rinsate blank is a sample of organic free water (for VOC analyses) poured into, or over, or pumped through the sampling device, collected in the sample bottle, and transported to the laboratory for analysis. Equipment rinsate blanks are used to assess the effectiveness of equipment decontamination procedures.

Equipment rinsate blanks are collected immediately after the equipment has been decontaminated. Equipment rinsate blanks are collected by gently pouring distilled or deionized water over selected clean non-dedicated equipment and collected for laboratory analysis. For example, the equipment rinsate blank for soil and sediment sampling programs will be collected by gently pouring distilled or deionized water over clean core barrels or soil core samplers. The equipment rinsate blank for surface water and groundwater sampling programs will be collected by gently pouring distilled or deionized water over clean non-dedicated bailers or sampling cups. Equipment rinsate blanks will be collected at a frequency of 5 percent of the field samples at critical points in the sampling program, such as the sampling of a background well or the end of the sampling program.

The frequency requirements for collecting equipment rinsate blanks are a minimum of five percent of the environmental samples. The blank shall be analyzed for all laboratory analyses requested for the environmental samples collected at the Site. When an analyte is detected in the equipment rinsate blank the appropriate validation flag, as described in the data validation section, shall be applied to all sample results from samples collected. It should be noted that the laboratory will supply the organic free water. A sample aliquot of the organic free water will be submitted for the analysis of all parameters of interest.

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection. A field duplicate will be collected at a rate of one per twenty samples or one per sampling event, if less than twenty samples.

Field duplicate sample results are used to assess precision, including variability associated with both the laboratory analysis and the sample collection process. Field duplicates will be collected at a frequency of 5 percent of samples collected. Analytical results for field duplicate will be assessed during the data validation process. Specific locations will be designated for collection of field duplicate samples prior to the beginning of sample collection. Control limits for evaluation of precision for field duplicates will be 40 percent for aqueous samples and 70 percent for soil/sediment samples.

Laboratory quality assurance protocols including the performance of laboratory control samples and matrix spikes relating to method acceptance criteria are included in Section 2.7 of the Site-Wide QAPP (Appendix A). The QAPP also defines the data qualification guidelines for evaluating potential matrix interferences identified during matrix spike analyses. The parent and field duplicate sample will be included in all reporting.

3.12 Field Equipment Decontamination

The cleaning procedures outlined in this section will be used by all personnel to clean sampling and other field equipment to prevent cross-contamination during separate phases of the investigation. Documentation regarding decontamination will be recorded on the Daily Log (Appendix B). Specific cleaning procedures are presented in the following section.

A decontamination area will be established where steam cleaning of the drilling and well construction equipment and materials can occur and containment and proper disposal of wash water is possible. An impervious decontamination area will be utilized and the water used to clean the equipment will be containerized for offsite disposal.

3.12.1 Cleaning Materials

The laboratory detergent used to wash the equipment will be a standard brand of phosphate-free laboratory-grade detergent such as Micro or Liquinox. The use of any other detergent must be justified and documented in the field logbooks and inspection or investigative reports.

Potable water is defined as tap water fit for human consumption from a known source. Deionized water is defined as tap water that has been treated by passing through a standard deionizing resin column. The deionized water should contain no metals or other inorganic compounds (i.e., at or above analytical detection limits). The brushes used to clean equipment as outlined in the following sections, will be stiff plastic bristled and will not be wire-wrapped.

3.12.2 Marking and Segregation of Used Field Equipment

Field or sampling equipment that needs to be repaired shall be identified with a tag indicating date repair requested, problem if known, personnel requesting repair, and if the equipment has been decontaminated. Field equipment needing cleaning or repairs will not be stored with clean equipment or sample containers. Field equipment and/or disposable sample containers that are not used during the course of an investigation may not be placed in storage without being recleaned unless it is the opinion of the field investigator that the materials have not become contaminated during the course of the field investigation. However, equipment and sample containers must be labeled as such.

3.12.3 Safety Procedures to be Utilized During Cleaning Operations

The materials used to implement the cleaning procedures outlined in this section can be dangerous if improperly handled. Caution must be exercised by all personnel, and all applicable safety procedures shall be followed. At a minimum, the following precautions will be taken in the field during these cleaning operations:

- Safety glasses with side shields or goggles, and latex or vinyl surgical gloves or nitrile rubber gloves will be worn during all cleaning operations;
- All rinsing operations will be conducted in the open (never in a closed room); and
- No eating, smoking, drinking, chewing, or any hand-to-mouth contact shall be permitted during cleaning operations.

3.12.4 Storage of Field Equipment and Sample Containers

Decontaminated field and sampling equipment will be stored in covered containers or wrapped in aluminum foil to minimize contamination. All decontaminated equipment, when not in use, will be kept in a designated storage area. Sampling equipment and sample containers will not be stored or transported with any gasoline, diesel, or other fuel containers or gasoline or diesel fuel powered equipment. Decontaminated equipment shall be clearly identified by labeling the wrapping material. Field equipment and reusable sampling containers requiring cleaning or repairs shall not be stored with clean equipment. Instead, equipment requiring repairs will be clearly identified and the repairs documented on the daily field log. Field equipment that requires cleaning will be segregated from clean equipment and will be stored on plastic sheeting pending cleaning.

3.12.5 Cleaning Procedures

3.12.5.1 Drilling and Direct Push Equipment

All drilling and direct push equipment used during completion of soil borings or installation of the monitoring wells will be steam-cleaned prior to initiating drilling or direct push activities. This will include, but is not limited to, the drill stem, augers, drill bits, direct push rods, core barrels, and tools utilized by the contractor.

The drill rig or direct push rig utilized for the installation of the borings and wells will be decontaminated at the decontamination area prior to the initiation of the drilling or direct push activities. The drill rig or direct push rig itself will not be decontaminated between soil boring or monitoring well locations. Augers and other drilling, direct push, or sampling equipment will be returned to the decontamination area to be cleaned after each use. Cleaning of equipment will be performed using a high-pressure steam cleaner to prevent cross-contamination of the soil borings and monitoring wells. Potable water for steam cleaning will be obtained from the installation water supply system.

Tools and equipment used to measure the depth of well completion materials and water levels (i.e., measuring tapes, electric/electronic probes, tampers, tremie pipes) also will be decontaminated by steam cleaning between well locations to avoid cross-contamination. All equipment and tools will be isolated from contact with the ground by placing them onto sheets of polyethylene plastic.

3.12.5.2 Teflon™, Stainless Steel, or Glass Field Sampling Equipment

When Teflon™, stainless steel, or glass sampling equipment is used to collect samples that contain hard to remove materials, it may be necessary to steam clean the field equipment before proceeding with Step 1. If the field equipment cannot be cleaned utilizing these procedures, it should be discarded.

1. Wash equipment thoroughly with laboratory detergent and tap water using a plastic brush to remove any particulate matter or surface film.

2. Teflon™, stainless steel, or glass sampling equipment will be rinsed thoroughly with potable water from an approved onsite source.

3. Rinse thoroughly with analyte free water.

4. Rinse thoroughly with solvent. Do not solvent rinse PVC or plastic items.

5. Rinse thoroughly with organic/analyte free water. If organic/analyte free water is not available, equipment should be allowed to completely dry. Do not apply a final rinse with analyte water.

6. Wrap equipment completely with aluminum foil or store in Ziploc™ plastic bags to prevent contamination during storage and/or transport to the field.

3.12.5.3 Other Sampling Equipment

Miscellaneous sampling equipment will be washed with laboratory detergent, rinsed with potable water, followed by a thorough deionized water rinse, and dried before being stored. This procedure is not used for any equipment utilized for the collection of samples for trace organic compounds analyses.

3.12.5.4 Trace Organic Sampling Equipment

The following procedures are to be used for all sampling equipment used to collect routine samples undergoing trace organic or inorganic constituent analyses:

- Clean with tap water and soap using a brush if necessary to remove particulate matter and surface films. Equipment may be steam cleaned (soap and high pressure hot water) as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two ft above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned;

- Rinse thoroughly with tap water;

- Rinse thoroughly with analyte free water;

- Rinse thoroughly with solvent. Do not solvent rinse PVC or plastic items;

- Rinse thoroughly with organic/analyte free water. If organic/analyte free water is not available, equipment should be allowed to completely dry; and

- Remove the equipment from the decontamination area and cover with plastic. Equipment stored overnight should be wrapped in aluminum foil and covered with clean, unused plastic.

3.12.5.5 Field Analytical Equipment and Other Field Instruments

The exterior of sealed, watertight equipment should be washed with a mild detergent (for example, liquid dishwashing detergent) and rinsed with tap water before storage. The interior of such equipment may be wiped with a damp cloth if necessary. Other field instrumentation should be wiped with a clean, damp cloth. Conductivity probes, pH meter probes, etc., should be rinsed with deionized water before storage.

3.12.5.6 Ice Chests and Shipping Containers

If the ice chests (labeled accordingly for sampling use) and reusable containers that will be used to store or ship samples and sample containers are believed to be contaminated, the containers should be washed with laboratory detergent (interior and exterior) and rinsed with potable water and air dried before storage. In the event that an ice chest or other reusable container becomes severely contaminated with concentrated waste or suspected hazardous material, it shall be cleaned as thoroughly as possible, rendered unusable, and disposed of properly.

3.12.6 Disposable Materials

Disposable materials generated from the decontamination and sampling activities will be contained in plastic garbage bags. These materials include, but are not limited to gloves, Tyvek suits, latex booties, paper and plastic. A waste determination will be made on a site by site basis for the disposable materials generated during the sampling programs. The waste determination will be based on both process knowledge of the contents of the site and on existing analytical data from the site, if available. The wastes will be disposed off-site in accordance with all applicable federal and state regulations.

3.13 Characterization and Disposal of Investigative Derived Wastes

Investigative derived wastes (IDW) including soil and waste cuttings and decontamination, development, and purge water will be collected and characterized with the procedures described below.

3.13.1 Soils/Sediment/Waste

Soil, sediment, and waste cuttings (not including material excavated from test trenches during waste characterization) will be collected at the borehole and stockpiled on plastic sheeting or placed in appropriate containers, such as a roll-off box or 55-gallon drum for temporary storage. The temporarily stored solid material will be covered to prevent runoff.

Specific disposal options will be made on a site by site basis, taking into account the types of compounds known to be present, and will conform to applicable installation, local, state, and federal requirements.

3.13.2 Water

Investigative derived water, which will consist of decontamination wash, well development, and purge water, will be temporarily containerized in a portable poly tank. Based on previous and/or current analyses, liquids that would not fail Toxicity Characteristic Leaching Procedure (TCLP) analysis will be properly disposed of in accordance with Georgia State laws. Disposal options will be evaluated on a site by site basis.

3.14 Site Survey

A site survey will be conducted by a registered land surveyor to measure elevations (X, Y, and Z coordinates) of any new monitoring wells. The north side of the top of the casing and the land surface adjacent to each well will be surveyed relative to mean sea level to the nearest 0.01 ft. The horizontal location of each monitoring point and well will also be determined relative to the Georgia state plane system and the Fort Stewart and Hunter Army Airfield installation grid to the nearest 1.0 foot. All surveying will be performed by a certified land surveyor, and will be tied into the existing on-site benchmark.

The location of each soil and waste boring, test pit location, sediment, surface water, and stream gauging location may also be surveyed by hand-held global positioning system (GPS) equipment, as conventional land surveying will be difficult to complete at these areas.

4. Field Documentation Procedures

Information on the sample designation, field documentation, COC, and sample shipment activities are discussed in the following three sections.

4.1 Sample Designation

A numbering system was developed for each type of environmental sample collected during the field investigation for the unique identification of each individual sample. This number system will provide a tracking procedure to allow ease of data retrieval, reduction, and evaluation, and to ensure that sample identifiers are not duplicated. The most important aspect of any sample numbering system that is developed is ensuring the uniqueness of an individual sample number. A listing of the sample identification numbers will be maintained by the project manager and the field task supervisor will ensure that it is universally applied to samples collected during the project.

The numbering system for this project consists of the following components described below:

- The Site number in the format "HA##" for Hunter Army Airfield and "FS##" for Fort Stewart;
- The location type;
- The sample number;
- Water and sediment sample IDs will end with the date (in "mmddyy" format); or
- Soil samples will end with the depth range (in ft).

Blind duplicate samples will be labeled sequentially starting at 1 in the form D1(mmddyy).

Examples of the numbering system are provided below:

- Surface water sample 1 taken from HAA-01 on November 8, 2009 would be: HA01SW001(110809);

- Surface soil sample 4 taken from FST-13 at a depth of 0 to 6 inches would be: FS13SS004(0-0.5).

The location type codes are listed below:

MW – monitoring well;
TW – temporary well;
SB – soil boring (by drilling);
SS – surface soil by trowel or other hand collection method;
SW – surface water by any collection method; and
SE – sediment by any collection method.

In addition to the above nomenclature, the COC will be completed to include both the Sample Type and Sample Matrix using the codes defined below:

Acceptable sample type codes are listed below:

N = normal or primary sample;
FD = field duplicate;
EB = equipment blank;
MS = matrix spike;
SD = matrix spike duplicate; and
TB = trip blank.

The sample matrix will be identified using the following codes:

SO = soil sample;
SE = sediment sample;
WG = groundwater;
WS = surface water;
WB = water collected from borehole or during Geoprobe® investigation; and
WL = leachate.

Field duplicate samples will be given a unique number that is completely different from the original sample following the normal sample pattern. Duplicate samples will be labeled sequentially starting at 1 in the form D1(mmddyy). This number will be recorded in the field logbook, so that the duplicates can be identified at a later date. Samples collected with an additional volume for matrix spike/matrix spike duplicates (MS/MSDs) will be designated on the COC in the remarks column.

Equipment and trip blanks will be identified using the sample type code (i.e., EB or TB) followed by the date as MMDDYY. For trip blanks, if more than one trip blank is submitted to the laboratory on a given day, the sample code will be followed by the a number starting with 1. For example the second trip blank submitted on December 1, 2003 would be identified as follows: TB2(120103).

4.2 Field Activity Documentation

Documentation of field operations and sample custody is achieved through use of ARCADIS pre-printed forms and a bound field logbook. The field log consists of notes and drawings describing the location, field conditions, and method of sample collection and identification. Examples of the pre-printed forms that will be used for this project are provided in Appendix B.

All aspects of sample collection and handling as well as visual observations shall be documented on the forms or in the field logbooks. All sample collection equipment (where appropriate), field analytical equipment, and equipment utilized to make physical measurements shall be identified in the field logbooks. All calculations, results, and calibration data for field sampling, field analytical, and field physical measurement equipment shall be recorded on the forms or in the field logbooks.

In addition, the Field Operations Leader will fill out a daily site activity log that details the activities and/or issues that occurred that day.

All entries in field logbooks or the preprinted sampling logs shall be dated, legible, and contain accurate and inclusive documentation of an individual's project activities. At the end of each day's activity, or of a particular event as appropriate, all documents in the field will be secured by the Field Operations Leader for each task. Once completed, these field logbooks and/or preprinted forms will be maintained as a part of the project files.

All data forms will be completed in indelible black ink. Make an entry in each blank. Where there is no data entry, enter "UNK" for Unknown, "NA" for Not Applicable, or "ND" for Not Done. To change an entry, the person making the change will draw a single line through the mistake, add the correct information above or adjacent to it, and initial the change.

4.2.1 Utilities and Structures Checklist

The Field Operations Leader will check the proposed drilling, sampling, and trenching locations for marked underground utilities, other underground structures and above-ground pipe racks or power lines. A Utilities and Structures Checklist will be completed by the Field Operations Leader for each area to be sampled prior to commencement of field activities.

4.2.2 Location Sketch

All drilling, sampling, and trenching locations will be drawn on a Location Sketch, if a reasonable site map is not available for the area of interest.

4.2.3 Boring/ Well Construction Logs

All soil borings, boreholes, and monitoring well installations completed by the field team will be documented on Boring/Well Construction Logs. The logs document the drilling location, drilling dates and times, drilling personnel, logging personnel, soil descriptions, sample depths, recovery, boring location and volatile organic vapor content. The log also documents the well identification, drilling method, development technique, well construction materials, material depths, and abandonment, if any.

4.2.4 Water Level Measurement Form

All water level measurements will be recorded on a Water Level Measurement Form. The log identifies the measurement location, and measurement date and time.

4.2.5 Sample Key

All samples to be collected will be recorded on the Sample Key. The form identifies all sample locations, sample date and time, and analytical parameters to be collected.

4.2.6 Sampling Location Survey Summary

The sampling location survey summary is to be completed prior to field activities. It will provide northing, easting, and elevation information for site monitoring wells.

4.2.7 Water Sample Log

All surface water samples collected by the field team will be documented on a Water Sample Log. The log identifies the sample identification, duplicate identification, if any, sampling times, location, equipment used, color, odor, appearance, sample parameters, container description, sample preservative, and sampling personnel.

4.2.8 Groundwater Sampling Form

The results of field measurements while purging monitoring wells, prior to collecting a groundwater sample, will be recorded on the Groundwater Sampling Form. This form records time series measurements of conductivity, temperature, turbidity, redox potential, and dissolved oxygen. The form also provides a record of the volume of water purged prior to sample collection.

4.2.9 Well Sampling Summary

A summary of the results of field measurements while purging monitoring wells, prior to collecting a groundwater sample, will be recorded on the Well Sampling Summary Form. This form records collection date and time and the final measurements of conductivity, temperature, turbidity, redox potential, and dissolved oxygen. The form also provides a record of the volume of water purged prior to sample collection.

4.2.10 Water Level/Pumping Test Record

The data from slug tests and pumping tests completed in monitoring wells will be documented on a Water Level/Pumping Test Record. The log identifies the well the test is conducted in, the static water level, the initial displacement, and changes in the water level versus time.

4.2.11 Soil/Sediment Sample Log

All soil samples collected by the field team will be documented on a Soil/Sediment Sample Log. The log identifies the sample identification number, soil type, duplicate identification, if any, sampling times, depth and location of sample, sampling equipment used, color, odor, appearance, sample parameters, container description, sample preservative, and sampling personnel.

4.2.12 Soil Sampling Summary

All soil samples collected by the field team will be documented on Soil Sampling Summary form. The form identifies the sample identification, sampling times, depth and location of the sample.

4.2.13 Surface Water Sample Log

All surface water samples collected by the field team will be documented on a Surface Water Sample Log. The log identifies the sample identification, duplicate identification, if any, sampling times, sampling location, equipment used, color, odor, appearance, sample parameters, container description, sample preservative, and sampling personnel.

4.2.14 Field Instrument Calibration Form

The field team will record all daily calibration results for field instrumentation on the Field Instrument Calibration Form.

4.2.15 Daily Log

The Daily Log form is used by the Site Manager to record all pertinent sampling events, field observations or other information pertinent to the field effort. The following types of information are generally entered into the Daily Log:

- Date
- Client
- Field Location
- Ambient Weather Conditions
- Field Team
- Instrument Problems
- Site Visitors
- Delays
- Unusual Situations
- Well Damage
- Accidents
- Work Progress
- Quality Control
- Site Schedule

4.2.16 Sample Label

All samples collected by the field team will be properly identified by labeling. Labels will be affixed to the sample bottle prior to the filling of the container(s). Labels are never affixed to lids or caps, although the sample identification information may duplicated on the cap for ease of sample identification. The following labeling information is supplied for every sample bottle.

- Sample Identification Number
- Initials of Sample Collector
- Date and Time of Collection
- Project Number
- Project Location
- Requested Analyses

4.2.17 Chain-of-Custody Form

The COC form is a multi-copy record, which documents the custody of the samples from sample collection through laboratory analysis. It has spaces for signatures of those receiving and relinquishing the samples. The sampler, the individual preparing the samples for shipment, and the receiving individual at the laboratory normally sign the form. An example of this form is provided in Appendix B.

The field personnel collecting the sample will fill out the COC forms. The COC process will be initiated upon sample collection. The field personnel who sign the form will be responsible for the samples until they are transferred to the custody of the laboratory or another custodian. Once the form has been completed, all remaining field sample identification spaces will be crossed through to prevent unauthorized addition of sample information.

The information required on the COC form includes the complete sample identification, date and time of sample collection, number of sample containers, analyses and method required, container type, project number, sample collection personnel, complete name, address, and telephone number of the person analytical reports will be sent to, turnaround time, and signatures of all sample custodians, excluding shippers, such as Federal Express. In addition, the method of shipment, courier name and air bill number must be included. The back copy of the form will be retained. The original form will accompany the sample shipment to the laboratory.

4.2.18 Chain-of-Custody Seal

All coolers submitted to analytical laboratories containing samples collected during the field investigations will be sealed with two signed and dated COC seals. The seals ensure that the samples have not been tampered with during shipment.

4.2.19 Bill of Lading

A bill of lading (air bill) documents receipt of the samples by the carrier. It is not possible for the carrier's representative to sign the COC because it is sealed in the ice chest. Bills of lading are kept on file as part of the sample COC documentation.

4.3 Chain-of-Custody Procedures

The primary objective of the COC process is to create an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. A sample is considered to be in custody when one of the criteria listed below has been satisfied:

- The sample is in one's actual possession.
- The sample is in one's view after being in one's physical possession.
- The sample is in one's physical possession and is then locked up so that no one can tamper with it.
- The sample is kept in a secured area that is restricted to authorized personnel.

Strict COC procedures will be followed for all collection, handling, and shipping of environmental samples. The field personnel are responsible for the care and custody of the sample collected until the samples are properly and formally transferred to another person or a courier for shipment to the laboratory. To simplify the COC record, as few people as possible will handle the sample during the investigation or inspection and an inventory of the sample containers will be maintained.

A COC form will be completed for all samples collected. A separate COC record will be utilized for each cooler of samples shipped to each laboratory used during this investigation. During the data validation activities, it will be determined whether these procedures were adequately followed.

4.3.1 Transfer of Custody

A COC form will accompany all samples. Prior to shipment or transfer of custody, all samples will be maintained in the custody of the Field Operations Leader. Upon transfer of custody, the Field Operations Leader will verify the information on each sample label and assure that each container is intact and sealed. The Field Operations Leader will then sign and date the COC form. The individuals receiving the samples shall sign, date, and note the time that they reviewed the samples on the COC form. This form documents transfer of custody of samples from the field investigator to another person to the laboratory.

4.3.2 Sample Preparation and Shipment

All samples will be stored at approximately 4°C from immediately after collection until analysis. In the field and during transportation to the laboratory, samples will be kept in coolers on ice, <u>not</u> "blue ice". Ice for coolers will be double-bagged in self-sealing plastic bags. Protective foam or Styrofoam packing will be used to minimize the risk of breakage during transport. When packaging samples for commercial transport, individual bottles will be wrapped separately in padded materials.

The samples are then placed in an ice chest, in direct contact with the ice, lined with a plastic trash bag or other barrier to prevent leakage and Styrofoam, bubble wrap, or similar packaging to prevent breakage. The top two copies of the original COC form will be placed in a plastic bag secured inside the shipping container closed with a chain-of-custody seal.

4.3.3 Laboratory Sample Receiving

After the ice chests are delivered to the laboratory, the samples are logged in, the COC is signed, and the samples are checked for breakage or leakage. The temperature of the ice bath is checked. If the temperature exceeds 4° C or if any other problems are noted, this information is recorded on the COC and the Field Operations Leader or Project Manager will be notified of the problem.

5. References

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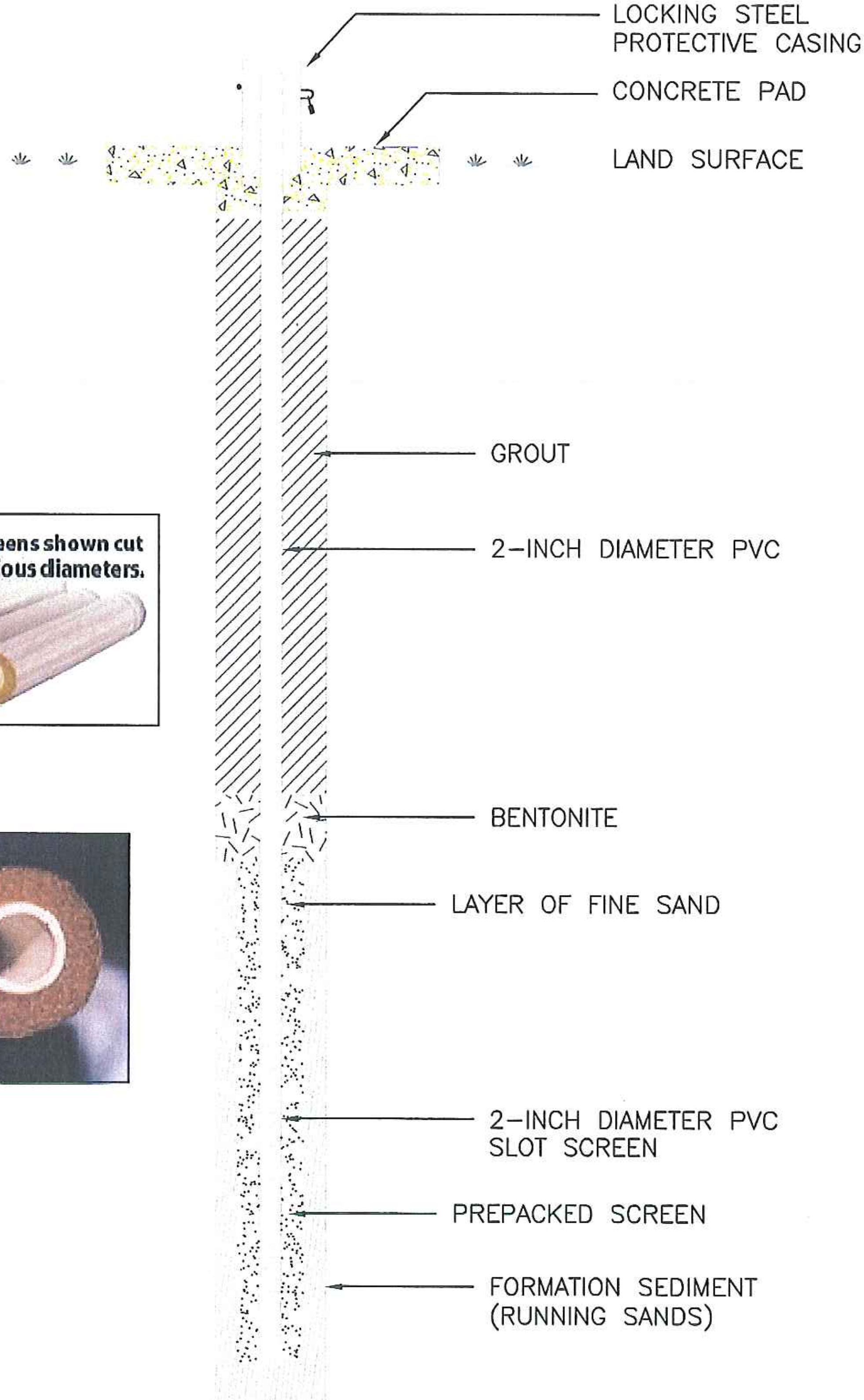
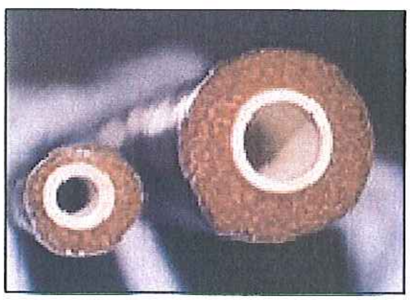
United States Environmental Protection Agency (USEPA), 2008. Field Branches Quality Systems and Technical Procedures, http://www.epa.gov/region4/sesd/fbqstp/. November 2008.

USEPA, 1996. *"How to Effectively Recover Free Product at Leaking Underground Storage Tank Sites,"* (EPA 510-R-96-001), September 1996.

ARCADIS

Figure





NOT TO SCALE

ARCADIS

PRJT MANAGER:	CHECKED BY:	WELL SCHEMATIC FOR WELL WITH PREPACKED SCREEN	FIG-NO 3-1
DRAWING:			
PRJT NO:			
DWG DATE:	DRAFTER:		

ARCADIS

Appendix A

Site Wide QAPP

ARCADIS
Infrastructure, environment, facilities

Imagine the result

Appendix A:

Quality Assurance Project Plan (QAPP)

Fort Stewart Military Reservation and Hunter Army Airfield, Georgia

February 2009

ARCADIS

Jane Kennedy
Project Chemist

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Appendix A: Quality Assurance Project Plan

Fort Stewart Military Reservation
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Our Ref.:
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Date:
February 3, 2009

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Tables

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Acronyms and Abbreviations

Air Toxics	Air Toxics, Ltd.
ARCADIS	ARCADIS U.S., Inc.
AOC	Area of Concern
APM	Associate Project Manager
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	Chain-of-Custody
DoD	Department of Defense
DQO	Data Quality Objectives
DQM	Data Qualification Module (Earthsoft®)
DRMO	Defense Reutilization Market Office
EB	Equipment blank
EDD	Electronic data deliverable
FHSO	Field Health and Safety Officer
GA EPD	Georgia Environmental Protection Division
GIS	Geographic Information System
HAAF	Hunter Army Airfield
HSP	Health and Safety Plan
HSRA	Hazardous Site Response Act
HSWA	Hazardous and Solid Waste Amendments
IRP	Installation Restoration Program
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
LTO	Laboratory Task Order
MDL	Method detection limit
Microseeps	Microseeps Laboratories, Inc.
MNA	Monitored natural attenuation
MS	Matrix spike
MSD	Matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
NFG	National Functional Guidelines
PARCC	Precision, accuracy, representativeness, completeness, and comparability

PBA	Performance Based Acquisition
PM	Project Manager
PMP	Project Management Plan
PT	Performance Testing
QA	Quality Assurance
QAO	Quality Assurance Officer
QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCP	Quality Control Plan
% R	Percent recovery
RCRA	Resource Conservation and Recovery Act
RL	Reporting Limit
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SOPs	Standard Operating Procedures
SOW	Scope of Work
SWMU	Solid Waste Management Unit
TB	Trip blank
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
USTMP	Underground Storage Tank Management Program
VOCs	Volatile organic compounds

Introduction

The Installation Restoration Program (IRP) activities at Fort Stewart and Hunter Army Airfield (HAAF) are performed in accordance with the provisions of the Resource Conservation and Recovery Act (RCRA) as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984. The Georgia Environmental Protection Division (GA EPD) issued Hazardous Waste Management Permit No, HW-045(S) which addresses the corrective action requirements for all Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) at Fort Stewart. Hazardous wastes generated at HAAF are transferred to the Fort Stewart Defense Reutilization Market Office (DRMO) yard. Corrective action activities performed at HAAF are executed under either the Georgia Hazardous Site Response Act (HSRA) or the Georgia Underground Storage Tank Management Program (USTMP). The goal of the Performance Based Acquisition (PBA) contract is to meet the corrective action requirements for all sites, as defined in the contract and summarized in the Project Management Plan (PMP) (ARCADIS 2008). The full scope of services for this contract is defined in the Contract W91ZLK-05-D-0015: Task 0003 as executed between the Army Environmental Command (USAEC) and ARCADIS U.S., Inc. (ARCADIS). All work performed under the contract will be consistent with all applicable regulatory requirements, and relevant Department of Defense (DoD) and Army policy.

This Quality Assurance Project Plan (QAPP) presents the policies, organization, functions, and Quality Assurance (QA) requirements designed to achieve the data quality objectives for additional contaminant delineation, groundwater monitoring, and remedial attainment to be performed in support of the environmental restoration as identified in the PBA contract This QAPP has been prepared for use by field personnel, data quality reviewers, and laboratories who perform environmental activities to ensure that the data are scientifically valid and usable for the intended purpose. Analytical protocols and documentation requirements will ensure that the data are collected, reviewed, and analyzed in a consistent manner. The method performance criteria and the analytical laboratory quality management program, as well as the protocols set forth in this QAPP, will be employed to establish data usability.

The general guidelines followed in the preparation of this QAPP are presented in EPA Requirements for QAPPs for Environmental Data Operations, EPA QA/R-5 (United States Environmental Protection Agency [USEPA], March 2001). The EPA document was used as guidance and this QAPP presents only the applicable components. Other documents that have been referenced in this QAPP are presented in Section 5.