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CONTRACT FIELD SAMPLING PLAN RICHARDS GEBAUR AIR FORCE BASE KANSAS CITY MO

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DAMES & MOORE

CONTRACT FIELD SAMPLING PLAN
RICHARDS-GEBAUR AIR FORCE BASE

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PREPARED BY
DAMES & MOORE, INC.

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LIST OF ACRONYMS

1,2-DCA	1,2-Dichloroethane
AFB	Air Force Base
AFBCA	Air Force Base Conversion Agency
BETX	Benzene, Ethylbenzene, Toluene, and Xylenes
BRAC	Base Realignment and Closure (Consists of Base Environmental Coordinator, State Project Manager, and USEPA, Region VII Project Manager)
CDLT	Contractor Data Loading Tool
CME	Central Mining Equipment
FID	Flame Ionization Detector
GC	Gas Chromatograph
HTW	Hazardous and Toxic Waste
I.D.	Inside Diameter
IRPIMS	Installation Restoration Program Information Management System
MDNR	Missouri Department of Natural Resources
NTU	Nephelometric Turbidity Units
OA-1-	Modified ESEPA Method 8015 used to determine total purgeable petroleum hydrocarbon concentrations
OA-2	Modified USEPA Method 8015 used to determine semi-volatile petroleum hydrocarbon concentrations
PID	Photoionization Detector
PNA	Polynuclear Aromatic Compound
POL	Petroleum, Oil and Lubricants
PSA	PSA Environmental, Inc.
QA/QC	Quality Assurance/Quality Control
TPH	Total Petroleum Hydrocarbons
TVH	Total Volatile Hydrocarbons
USAF	United States Air Force
USCS	Unified Soil Classification System
VOC	Volatile Organic Compound

1.0 SITE BACKGROUND

Richards-Gebaur AFB is an Air Force Base Conversion Agency (AFBCA) base located in west-central Missouri, Jackson and Cass counties, and about 3 miles east of the Kansas state line. A brief description of the facility, its location, geological setting, and associated features is presented below.

Richards-Gebaur AFB is located approximately 18 miles south of downtown Kansas City, Missouri. The northern portion of the base is located in Jackson County and the southern portion of the base is located in Cass County. Primary access to the base is by U.S. Highway 71.

In 1941, portions of the land now occupied by Richards-Gebaur AFB were acquired by Kansas City for use as an auxiliary airport (Grandview Airport). In 1952, the USAF Air Defense Command leased the airport from the city for air defense operations, and in 1953 the property (approximately 222,400 acres was formally conveyed to the United States government for establishment of an Air Force base. The C-46 airlift aircraft were the original Air Force aircraft stationed at the base. Conversion to C-119 and C-124 aircraft occurred in 1957 and 1961, respectively. In 1957, the base was named Richards-Gebaur AFB.

Until 1970, the Air Defense Command (ADC) had the primary mission on the base. In 1970, the Air Force Communications Service (AFCS) relocated its headquarters from Scott AFB, Illinois, to Richards-Gebaur AFB and assumed command. In 1971, the C-124 reciprocating engine aircraft were phased out and replaced with C-130 aircraft. It is reported that this conversion cut the industrial waste produced by the base as well as cutting the generation of waste oil in half. AFCS moved back to Scott AFB in 1977 and Richards-Gebaur AFB came under the Military Airlift Command (MAC).

Air Force Reserve (AFRES) assumed operation control of the base in October 1980. In 1981, around 80% of the base property (including runways and taxiways) was excessed (transferred) to the General Services Administration (GSA). The GSA then transferred a majority of the airport-related property to Kansas City Aviation Department as a public benefit transfer with the condition of continued runway access (for a fee) by the Air Force. Other excessed parcels were also transferred by GSA for public and other military uses to

Kansas City, Federal Aviation Administration, City of Belton, the Department of the Navy, and the Department of the Army. Base property presently is comprised of about 428 acres. Associated with this acreage is about 421 acres of easements. Richards-Gebaur AFB closed on 30 September 1994, and all property is now under the operational control of AFBCA.

2.0 SAMPLING OBJECTIVES

The sampling objectives are to collect data of sufficient quality to support the Delivery Order requirements. These requirements are to delineate site contamination by petroleum hydrocarbons and other compounds, to assess if releases from the site, or a substantial threat of release of hazardous substances from the site, present a risk to human health and the environment, and to use these data in the development and evaluation of remedial measures.

The purpose of specific Delivery Order Site Characterizations and Sampling is to gather sufficient information on the nature and extent of the contamination to develop and evaluate viable remedial measures for specific sites and perform a baseline risk assessment, if necessary.

The specific objectives of sampling activities may include some of the following tasks:

- Evaluate the nature and extent (horizontal and vertical) of petroleum hydrocarbon contamination in site soil and groundwater by collecting soil and groundwater samples.
- Measure physical and chemical parameters (such as TOC, TDS, pH,) that may affect potential groundwater monitoring, remediation, and barrier/containment measures.
- Assess existing surface water quality upstream, downstream, and on site through analysis of surface-water grab samples and sediment pore water.
- Establish upgradient and background conditions of soil, sediment, surface water, and groundwater for the site.
- Qualitatively investigate with whatever means necessary, the nature and extent of contamination from spills in soils from previously documented spill areas. Specific procedures will be identified in Delivery Order specific Field Sampling Plans.

- Evaluate by collecting and analyzing soil samples if leakage from on-site storage tanks has occurred.

- Verify and further define the nature and extent of contamination of previously identified on-site areas, surface water, sediments, and groundwater.

- Evaluate the physical characteristics and hydraulic parameters of the hydrogeologic units beneath the site to assess potential contaminant migration, and physical and chemical parameters that may affect potential groundwater monitoring, remediation, barrier or containment technologies.

3.0 SAMPLE LOCATION AND FREQUENCY

This section is reserved for subsequent task-specific delivery orders.

4.0 SAMPLE DESIGNATION

This section is reserved for subsequent task-specific delivery orders.

5.0 SAMPLING EQUIPMENT AND PROCEDURES

5.1 SURFACE SAMPLING EQUIPMENT

The following devices are used to obtain surface soil/sediment samples. Each device is best suited to particular conditions and should be chosen based on field conditions, sample type and projects needs.

1. Sampling Thief
2. Hand Augers
3. Veihmeyer Sampler
4. Scoop/Spade/Shovel
5. Hand Corer
6. Soil/Sediment Punch
7. Other sampling equipment, as required.

The soil/sediments to be sampled must be exposed prior to sample acquisition. If the upper 6 inches of soil/sediment is to be sampled, then the surface vegetation should be removed with a trowel or hand scoop. If the sample is to represent a discrete interval of 6 inches or greater depth, the overlying soil/sediments may be removed with a shovel or hand auger. Samples may then be collected with the most suitable hand method described below.

Extreme care will be exercised when obtaining soil samples for volatile organic compound (VOCs) analysis. It is the intention to employee all necessary precautions to avoid the loss of any VOCs.

5.1.1 Sampling Thief

The sampling thief consists of two slotted, concentric stainless steel tubes with pointed tips; the inner tube may be rotated to close off the sample interior. This equipment should be used to sample dry, granular, or powdery soil/sediments with a particle diameter less than 1/3 the width of the tubes' slots. The appropriate sampling technique is as follows:

1. Close the sampler and insert into the soil/sediment at the desired sampling interval.

2. Rotate the inner tube to open the sampler, and tap to encourage material to advance into the interior.

3. Close the sampler, withdraw it from the soil/sediment, and lay it horizontally with the slots facing upward.

4. Remove the inner tube; transfer the sample to an appropriate container and cap.

5.1.2 Hand Auger

In general, hand-operated augers are useful for sampling all types of soil/sediments except cohesionless materials and hard or cemented soil/sediment. The ship auger, with a helical flight on a solid stem, is best suited for use in cohesive materials. Spiral augers were developed for use in those cases in which helical and screw augers do not work well. The closed-spiral auger is used in dry clay and gravelly soil/sediments. The open-spiral auger is most useful in loosely consolidated deposits. For sampling events requiring consecutive samples from the same hole; the potential for cross-contamination exists when using this device.

The appropriate sampling technique to be used is as follows:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.

2. Begin drilling, periodically removing accumulated soil/sediment. This prevents accidentally brushing loose material back down the borehole when removing the auger for adding drill rods.

3. After reaching the desired depth, slowly and carefully remove auger from boring.

4. Remove auger tip from drill rods, and replace with a precleaned, thin-walled tube sampler. Install proper cutting tip.

5. Carefully lower corer down borehole. Gradually force corer into soil/sediment. Care should be taken to avoid scraping the borehole sides. A fence post driver may be used to push the core. If the wall above the corer collapses, then another hole can be dug for the next deeper sampling interval.

6. Remove corer, and unscrew drill rods.

7. Remove cutting tip, and remove core from device to precleaned bowl or surface.

8. Discard top of core (approximately 1 inch if possible), which represents any material collected by the corer before penetration of the layer in question.

9. Place the sample in the appropriate containers and cap.

5.1.3 Veihmeyer Sampler

The veihmeyer sampler is recommended for core sampling of most types of soil/sediment. The tube comes in various standard lengths from 3 to 16 feet and is graduated every 12 inches. The hammer doubles as a drive weight and handle when pulling the sampler from the ground.

Sampling procedures to be followed when using the Veihmeyer sampler are as follows:

1. Assemble the sampler by screwing in the tip and the drive head on the sampling tube and insert the tapered handle (drive guide) of the drive hammer through the drive head.

2. Place the sampler in a perpendicular position on the soil/sediment to be sampled.

3. Drive the sampler into the ground to the desired sampling depth by pounding the drive head with the hammer. Do not drive the tube further than the tip of the hammers's drive guide.

4. Record the length of the tube that penetrated the ground.

5. Remove the drive hammer and fit the keyhole-like opening on the flat side of the hammer onto the drive head. In this position the hammer serves as a handle for the sampler.

6. Rotate the sampler at least 2 revolutions to shear off the sample at the bottom.

7. Lower the sampler handle (hammer) until it just clears the two ear-like protrusions on the drive head, and rotate approximately 90° degrees.

8. Withdraw the sampler from the ground by pulling the handle (hammer) upwards. When the sampler cannot be withdrawn by hand, as in deep soil/sediment sampling, use the puller jack and grip.

9. Dislodge the hammer from the sampler, turn the sampler tube upside down, tap the head gently against the hammer, and carefully recover the sample from the tube. The sample should slip out easily.

10. Store the sample in a rigid, transparent or translucent (preferably brass , stainless steel, polyethylene or teflon) tube when observation of soil layers is to be made. The use of the tube will keep the sample relatively undisturbed. In other cases, use an appropriate size sample container to store the sample.

11. Place the sample in the appropriate container(s) and cap.

5.1.4 <u>Scoop/Spade/Shovel</u>

This is the simplest, most direct method of collecting soil/sediment samples. This method can be used in most soil/sediment types but is limited somewhat to sampling near (12 to 18 inches) the surface.

1. Carefully remove the top layer of soil/sediment to the desired sample depth with a precleaned spade.

2. Using a precleaned stainless steel scoop or trowel, remove and discard a thin layer of soil/sediment from the area that comes in contact with the shovel.
3. Transfer the sample into an appropriate sample bottle with a stainless steel spatula, spoon, or equivalent and a cap container.

5.1.5 Hand Corer

Hand corers are applicable to many situations and materials. Most corers can be adapted to hold liners generally available in brass, polycarbonate plastic, and teflon.

1. Force the corer in with a smooth, continuous motion.

2. Twist the corer; then withdraw the corer in a single smooth motion.

3. Remove the nosepiece, and withdraw the sample into a stainless steel or teflon tray. If using a core liner extract the sample with liner and cap the end and label. Note, if sampling for VOCs the liner may have to be reduced to eliminate head space.

4. Transfer the sample and core liner into an appropriate sample bottle with a stainless steel lab spoon or equivalent and a cap container.

5.1.6 Soil/Sediment Punch

The soil/sediment punch is applicable to many situations but may not be useful in rocky or very wet soil/sediment. Additionally, it should be noted that this devise does not work well when sampling for VOCs because of potential losses.

1. Drive the tube into the soil/sediment to the desired depth.

2. Extract the tube and the core.

3. Push soil/sediment out of the tube into a stainless steel mixing bowl.

9. Record time vacuum pump is operated before sample collection, and pressure reading (vacuum gauge) of gas in the soil gas probe line, at the time of sampling.

10. The drive pipe(s) and soil probe will be removed at each location after the soil gas has been analyzed. In accordance with the State of Missouri's Well Construction Rules, all boreholes greater than 10 feet in depth will be grouted (See Section 5.4.9). After the removal of the soil probe, the distance between the sampling location and known point will be measured and recorded on the soil gas survey map and a flag left at the sampling location for subsequent surveying.

5.3.2 Sampling for Total Organic Vapor Analysis

In the simplest sampling/analysis technique, an organic vapor monitor such as a PID or FID is used. A piece of tubing of appropriate length is attached to the probe adaptor manifold and the PID/FID. A direct reading of the soil vapor gas total organic concentration may then be made after the PID or FID instrument has pumped sufficiently for the gas sample to reach the detector.

Required Equipment and Apparatus

- Field analytical instrument capable of detecting total organic vapors such as a flame ionization detector (FID) or photoionization detector (PID)
- Accessory tubing between instrument and manifold (maximum length 12 inches)

Collection and Analysis Procedures

1. After purging the system, attach sampling tube from the instrument to the manifold valve port and open the manifold valve.

2. Allow the instrument to pump for a sufficient length of time to displace the ambient air in the sampling tube and instrument before taking a reading.

5.3.3 Sample Collection for Laboratory Analysis

Sampling/analysis of grab samples may also be accomplished by pumping the soil gas from the probe and collecting the gas in a Tedlar bag. Alternatively, the soil gas may be pumped through a charcoal or Tenax trap. The VOCs in the soil gas are absorbed onto the charcoal or Tenax. These samples must then be analyzed at an on-site laboratory since the holding times for these collection methods are short (1 to 8 hours). Analytical methods typically include the use of gas chromatography (GC) and/or mass spectrometry (MS).

Specific analytical methods and calibration procedures, standard concentrations, detectors, temperature programs, etc. are dependent on the method of analysis and analytes of interest. Specific analytical methods and procedures will be detailed in applicable project work plans.

Required Equipment and Apparatus

- Gas collection bags such as Tedlar, carbon sorption, or Tenax sample tubes with accessory tubing (if required)
- Low-flow air sampling pumps, such as Gillian (if required)
- Adapter for the soil gas probe with appropriate tubing
- Vacuum pump to extract soil gas

Collection and Analysis Procedures

1. Run the vacuum pump to purge the system and displace the ambient air in the soil gas probe, drive pipe(s), and tubing. Attach a Tedlar bag and unclamp the flexible tubing, collecting the gas sample in the bag. The bag will then be disconnected, sealed, and transported to the laboratory for analysis.

2. To collect a sample by adsorption, insert a Tenax trap or other sampler into the sample chamber and attach it to the manifold after the probe and adaptor system have been purged. Divert soil gas flow through the sample chamber. Record flow pressure, elapsed time, and volume of flow, if mass flow controller is used.

5.3.4 Sample Collection for Field Gas Chromatographic Analysis

An alternative grab sampling technique requires soil gas to be pumped through the soil probe, collected with a syringe, and immediately injected into a field gas chromatograph or a gas chromatograph located near the sampling site. This method allows for real-time results, and is particularly useful.

Specific analytical method calibration procedures, standard concentrations, detectors, temperature programs, etc. are dependent on the method of analysis and analytes of interest. Specific analytical methods and procedures will be detailed in applicable project work plans.

Required Equipment and Apparatus

- Mobile or field gas chromatograph (GC) and associated support equipment required to properly operate the GC
- A power source and an enclosed area for the GC
- Appropriate calibration gas standards for the GC and all associated equipment needed to perform the calibration
- Sample container(s) with septum(s)

Collection and Analysis Procedures

1. Collect the soil gas sample with a glass syringe by inserting the syringe into the extraction line near the top of the soil gas pump, on the intake side of the pump.

5.4 ENVIRONMENTAL BORINGS, ROCK CORING, AND SOIL/ROCK SAMPLING

Drilling for all phases of the field exploration program will be performed using a truck-mounted drill rig. The choice of drilling methods is influenced by two main factors: (1) the need to minimize the introduction of foreign materials that may influence the results of analysis and (2) the need to penetrate diverse geologic materials.

In unconsolidated materials, environmental borings will be advanced using 3¼-inch to 6¼-inch inside diameter hollow stem augers. For deep borings advanced to collect soil samples for descriptive or geotechnical purposes only, mud or air rotary drilling may be employed. Soil samples will be collected using a split-spoon sampler, Dames & Moore Type U sampler, or a CME™ (Central Mine Equipment) continuous sampler. In the event that a continuous or semi-continuous rock unit is encountered, dual tube air rotary drilling may be employed to advance a boring for the installation of a monitoring well. [Note: air rotary drilling methods will not be employed to drill environmental soil borings and will not be used in an interval to be screened for a monitoring well]. Rock samples will be collected using an NX size core barrel. No oils or lubricants will be used on the drill rods, augers, sampling devices, or other equipment used in drilling and sampling the borings.

Each boring will be continuously sampled and logged by an experienced Dames & Moore field geologist or engineer using a standard Hazardous and Toxic Waste (HTW) Drilling Log, MRK Form 55 (June 1989), as shown in Figure 1, HTW Drilling Log. Information recorded on this log will include boring location, description of location, East and North coordinates for the borehole in state plane format, drilling and sampling method, sampling interval, and sample descriptions using the ASTM (American Society for Testing and Materials) Soil Classification System (ASCS). A copy of the ASCS is shown in Figure 2. Unusual characteristics observed during drilling activities, such as discoloration of soil, odors, or air monitoring results, will also be noted on the drilling log. Missouri Department of Natural Resources (MDNR) requests that recovery of core samples of less than 90 percent be redrilled.

A description of the borehole drilling, sampling, and logging methods and procedures is presented in the following sections.

5.4.1 Description of Drilling Methods

5.4.1.1 Hollow-Stem Auger Drilling

Hollow-stem auger drilling uses interconnected hollow auger flights equipped with a cutting head. The screw action of the augers as they are rotated and pressed into the ground pulls the soil cuttings to the surface. The bottom of the auger flight is fitted with a pilot bit and center plug attached to drill rods which prevent material from entering the augers during drilling. Soil samples are collected by removing the drill rods and center plug and advancing a sampler ahead of the augers.

5.4.1.2 Mud Rotary Drilling

Mud rotary drilling utilizes a rotating rock bit attached to drill rods. One hundred percent sodium bentonite is used as a drilling fluid to lift soil and rock cuttings from the borehole as the bit is advanced. The mud is circulated through the center of the drill pipe where it exits from openings in the drill bit. The fluid circulates back to the surface through the annular space between the drill rods and the wall of the borehole. At the surface, the mud discharges into a holding/settling tank. Drill cuttings are allowed to settle out and a pump circulates the fluid back through the drill rods. Mud rotary drilling penetrates all types of materials and minimal casing is required. Drilling fluids, however, may plug some formations and are difficult to use in extreme cold.

If a drilling mud additive, a substitute to sodium bentonite is proposed, chemical analyses will be delivered for written approval prior to drilling system mobilization.

5.4.1.3 Air Rotary Drilling

Air rotary drilling is similar to mud rotary drilling in that it utilizes a rotating rock bit attached to drill rods. However, filtered air is used as the drilling fluid instead of mud to lift rock cuttings from the borehole as the bit is advanced. Equipment needed for air rotary includes a large air compressor, a swivel hose assembly connected to the top of the drill pipe or kelly, and a rock bit (i.e., tricone, roller type). Air is forced down through the center of the drill pipe and exits through small openings at the bottom of the drill bit. The cuttings are lifted along the annular space of the borehole, forced out the top of the borehole, and deposited on the surface.

The air is filtered to remove organic vapors. The effectiveness of the filter is checked at a frequency of at least every four hours. Air passing through the downstream end of the air line is monitored with a PID or OVA.

Air rotary allows cuttings to be removed rapidly, increases penetration rates, and extreme cold does not impede drilling operations. This method of drilling can only be performed in consolidated or semi-consolidated materials.

Air rotary drilling methods will not be employed to drill environmental soil borings and will not be used in an interval to be screened for a monitoring well.

5.4.1.4 Dual Tube Reverse Circulation Air Rotary

The dual tube reverse circulation air rotary method utilizes an inner drill pipe and drill bit with an outer casing. The drilling fluid (air) is forced down between the inner drill pipe and outer casing. Cuttings and fluid travel through the center of the drill bit, up through the inner drill pipe, and out to a surface collection area. During drilling, the inner drill pipe rotates the drill bit while the outer casing provides transport of drilling fluid to the drill bit and separates the cuttings and fluid from the actual formation being drilled through. Penetration rates are fast in unconsolidated deposits and fractured formations, borehole stabilization is increased, and cross contamination is minimized. Undisturbed samples cannot be collected using the dual tube method.

5.4.2 Installation of Surface Casing

In the event that a surfacing casing is to be installed prior to completing a boring to the planned depth, the borehole will be overdrilled and an 8-, 10- or 12-inch PVC surface casing (80 schedule) installed. Hollow stem auger or air rotary drilling will be used to overdrill the borehole for surface casing installation.

The surface casing will be installed by filling the bottom one foot of the boring with bentonite pellets. The bentonite pellet seal will be hydrated with distilled water or potable water from an approved source and allowed to set up for 12 hours before inserting the casing. A cement-bentonite grout consisting of approximately 94 pounds Portland cement and 3 pounds bentonite (94:3 cement-bentonite grout or approximately 10.0 lbs. Portland cement to 0.319 lbs. bentonite on average per well) will be placed in the annulus around the surface casing from the top of the bentonite seal to the surface using a side discharge tremie pipe. No more than 8.0 gallons of water per sack of cement will be used. The grout will be allowed to set for at least 48 hours and accumulated water removed using a sand pump prior to advancing the boring to the required depth. The boring will be advanced using 3¼-, 4¼-, or 6¼-inch I.D. hollow stem augers.

If an open hole construction is proposed, the surface casing must be set at least five feet into unweathered bedrock, in order to isolate the water in the consolidated zone from water in the unconsolidated sediments in accordance with "Missouri Well Construction Rules", 10CSR23-4.060

5.4.3 Description of Sampling Methods

5.4.3.1 Soil Sampling

Many different types of soil samplers are available, and several different samplers may be used in a single boring. The type of sampler used will depend on the subsurface conditions and the sophistication of analyses required for the proposed laboratory testing program. A description of the types of sampling tools and procedures is provided in the following sections.

<u>Standard Split-Spoon Sampler</u> -- A split-spoon sampler is so named because the main section of the sampler consists of a section of pipe that splits into two pieces along the axis of the pipe. A driving shoe and waste barrel screwed to the ends hold the split sections together during driving. A diagram of the split-spoon sampler is shown in Figure 3, Split-Spoon Sampler.

To collect a soil sample, a split-spoon sampler (typical outside diameter 2.0 inches; inside diameter 1.375 inches) is attached to 1⅝-inch "A" rod or larger drill rods. A soil sample is then obtained by driving the sampler into the soil. The sampler is driven by a 140-pound hammer free-falling a distance of 30 inches onto a collar on the drill rods. The sampler is driven a total of 24 inches into the undisturbed soil. The sampler is then removed from the borehole. The end connections are removed and the split portion is pried open to reveal the sample. The sample then is identified and placed in airtight storage containers or clean, laboratory provided sample bottles. Aids for sample retention, including catchers, springs or gravity traps (in the lower end), and check valves (in the top end) may be incorporated in a split-spoon sampler.

When collecting samples with a split spoon, a standard penetration test in accordance with ASTM D-1586 is performed each time a sample is taken.

Dames & Moore Type U Sampler -- The Dames & Moore Type U sampler is a drive-type split-spoon sampler with several improvements. The sampler, including bit, has an inside diameter of 2.42 inches and an outside diameter of 3.25 inches and consists of a waste barrel for disturbed soil, a split barrel with core retainer rings, and a cutting bit. A diagram of the Type U Sampler is shown in Figure 4, Dames & Moore Type U Sampler.

Sampling with the Dames & Moore Type U sampler is similar to other drive-type samplers. The sampler is attached directly to the drill rods and lowered to the bottom of the hole for sampling. Most commonly, the Type U sampler is driven with a 300- or 340-pound hammer falling 24 inches. Field personnel will record the hammer weight and fall distance used during the sampling procedure. In loose deposits, the Type U sampler may be pushed (using drill rods) in one smooth stroke to help reduce disturbance.

After driving the sampler, the drill rods are withdrawn from the hole and the sampler is detached. The split barrel is separated from the waste barrel bit to reveal the brass rings that contain the sample. The bit is checked after each sampling operation and replaced if it becomes burred or chipped. Filing burrs to smooth the bit will prolong its usefulness.

The decision to use the Dames & Moore Type U sampler depends to a large extent on the type of soil being sampled. The soils which are anticipated in the various task areas at Richards-Gebaur are suitable for sampling with the Dames & Moore Type U sampler.

CME™ Continuous Sampler -- The CME™ continuous sampler is a 2½-inch I.D. five foot long split barrel. The sampler is attached to non-rotating drill rods mounted inside the hollow stem augers and is advanced along with the augers. The split barrel extends below the hollow stem augers and collects a relatively undisturbed soil core as the augers are advanced. A pilot bit and center plug are not used with the continuous sampler.

After advancing through the interval to be sampled, the split barrel is removed from the borehole without removing the hollow stem augers. The split barrel may be reused after emptying the soil core, or a different split barrel may be utilized so that drilling and sampling operations may continue. If soil sample recovery falls below 70%, the field engineer/geologist will switch to standard split spoon or Dames & Moore Type U sampling.

Sampling Guidelines -- Since the sampling techniques used in the field can influence the laboratory test results, the engineering analyses, and the validity of the resulting recommendations, care must be used to maintain sampling consistency from borehole to borehole. The following guidelines will be observed during sampling:

1. If the boring is too small, material from the side wall may be scraped into the sampler; therefore, the drill bit will be of sufficient size to allow free passage of the sampler as it is lowered to the bottom of the borehole.

2. The hole must be drilled to the last depth sampled before the next sample is taken. When the hole is open, the bit of the sampler (without predriving) will be at the last depth drilled. If a cave-in has occurred and/or cuttings have settled to the bottom of the borehole, this extraneous material will be removed by capturing it in the sampler and then a clean sampler is used to take the sample.

3. The hole will not be drilled to the sample depth and left overnight before the next sample is taken. This procedure will be followed: (1) take a sample at the end of the day; and (2) at the beginning of the next day, drill to the next sample interval and take a sample. This procedure helps eliminate pressure release expansion of samples.

4. If the Dames & Moore Type U sampler is being used to collect soil samples below the water table, it will be lowered slowly through the air-water interface. Rapid lowering could dislodge the "doughnut" and permit the sample retainer leaves to spread prematurely. The "doughnut" is a cylindrical metal retaining ring used to affix the individual sample retainer leaves within the sampler. Pre-spread leaves often do not fold back into the retaining ring properly, causing additional soil disturbance.

5. The geologist or field engineer will note the length of rods and bit or sampler in the hole. The boring depth is then calculated by subtracting the amount of "stick-up" from the ground surface from this total length. By constantly knowing the depth of the borehole, the depth of lithologic change indicated by changes in drill speed, the color of the drilling fluid, or other indications of strata change may be noted and properly logged.

6. When taking any form of thin-wall samples, the geologist or field engineer will allow 1 or 2 minutes to pass after advancing the sample tube before pullout. This time will allow the sample to rebound slightly and more firmly adhere to the inside of the sampling tube. The sampler also may be rotated through several complete rotations which will generally shear the soil at the bottom of the tube. These procedures can decrease the possibility of incomplete or zero recovery.

5.4.3.2 Rock Coring

If bedrock is encountered in a soil boring before the planned depth of the boring is reached, the bedrock will be cored to the planned depth of the boring. If bedrock is encountered in a monitoring well boring, the rock will be cored to a depth of five feet below the static water level and the monitor well installed.

To obtain a rock core, a carbide- or diamond-tipped bit is attached to the lower end of a core barrel. As the bit cuts deeper, the formation sample moves up the inside of the core tube. The rock coring will be performed using an NX size double tube core barrel. The double tube core barrel consists of an inner tube core recovery barrel and an outer barrel with a diamond bit. Air or potable water from the approved site source will be used as the drilling fluid. The drilling fluid is circulated between the two walls of the core barrel.

5.4.4 Sample Labeling

Improper sample labeling can result in misleading laboratory data. Therefore, each soil sample jar lid will be initially labeled with the sample identification, collection date and time, and sample depth using indelible ink.

Complete information for each sample selected for analysis will be written by the field geologist/engineer on a label affixed to the sample jars. The label information will include: (1) job number, (2) owner, (3) location, (4) boring (5) sample number, (6) depth, (7) date and time, (8) collector, and (9) comments. A full description of the sample labeling system is provided below.

Job Number -- Dames & Moore assigned job number for the project. Used for internal Dames & Moore tracking.
Owner --
Location --
Boring Number -- See QAPP, Section 5.1.
Sample Number -- See QAPP, Section 5.1.
Depth -- Depth interval in feet from which the sample was taken (e.g. 6'-8').
Date and Time -- Date and time sample was collected.
Collector -- Initials of the field geologist or engineer who collected the sample.
Sample Preservation Method -- Method employed to preserve sample.
Comments -- A description of the soil and/or analysis.

Bottles for water samples will be labeled immediately after sample collection and after they have been wiped dry.

5.4.5 Sample Logging

The borehole logs will contain a detailed description of the soil strata encountered in accordance with the ASTM soil classifications and pertinent information regarding drilling operations and estimated soil properties. Field sample data will be recorded in a bound log and on IRPIMS data base.

5.4.5.1 Consolidated Materials (Rocks Cores)

Lithographic descriptions of consolidated materials (igneous metamorphic, and sedimentary rocks) will follow standard professional nomenclature (c.f. Tennissen, A.C., 1983, Nature of Earth Materials, 2nd Edition, p.204-348). Special attention will be given to describing fractures, vugs, solution cavities and their fillings or coatings and any other characteristics affecting permeability. Colors will be designated by the Musell Color System.

Sedimentary, igneous, and metamorphic rocks and deposits will be represented graphically by the patterns shown in Figure 2-1.

The following information will be recorded in the bound, field log book:

- The depth interval of each core;
- percentage of core recovered;
- number of fractures per foot;
- angle of fractures relative to the core axis; and,
- identified breaks due to coring and core handling as opposed to naturally occurring fractures.

5.4.5.2 Unconsolidated Materials (Soil borings)

Lithographic descriptions of unconsolidated materials (soils or deposits) will be made as follows:

- Names of unconsolidated materials will follow the name of the predominant particle size (e.g., silt, fine sand).
- Dimensions of the predominant and secondary sizes will be recorded using the metric system.
- The grain size and name of the deposit will be accompanied by the predominant mineral content, accessory minerals, color particle angularity, and other characteristics.
- Clastic deposit descriptions will include, as a supplement symbols of the Unified Soil Classification System.
- Colors will be designated by the Munsell Color System.

The following information will be recorded in the bound, field log book:

- Boring or well identification;
- purpose of the boring (e.g., soil sampling, monitoring well);
- location in relation to an easily identifiable landmark;
- names of drilling contractor and logger;
- start and finish dates and times;
- drilling method;
- types of drilling fluids and depths at which they were used;
- diameters of surface casing, casing type, and methods of installation;
- depths at which saturated conditions were first encountered;
- lithographic descriptions and depths of lithographic boundaries;
- sampling interval depths;
- zones of caving or heaving;
- depth at which drilling fluid was lost and the amount lost;
- changes in drilling fluid properties;
- drilling rate; and,
- drilling rig reactions, such as chatter, rod drops, and bouncing.

5.4.6 Sample Head Space Analysis

Head space analysis will be performed (when required) on each soil sample interval to provide information on volatile organic constituents in the soils. Soil samples will be collected continuously at 2-foot intervals to the depth of each borehole or to top of bedrock. Before each soil sample is logged, the sample will be split using a stainless steel sampling knife. A portion of the sample will immediately be placed into laboratory-provided glass jars. Temporary labels will be placed on the jar lids and then the jars placed into an iced cooler.

A portion of the remaining sample then will be placed loosely into a clean jar until it is approximately half full, the jar opening covered with aluminum foil, and the jar capped. The jar will be marked with the same identification number as the filled jars containing the portion of the sample for possible laboratory analysis, gently shaken, and then placed in a warm location.

If a split spoon sampler is being used, it will be fitted with a brass or stainless steel ring system, which will allow the headspace to be analyzed from the rings.

After a period of at least 15 minutes, the cap will be removed and the probe of a photoionization detector (PID) or flame ionization detector (FID) will be pushed through the aluminum foil. The initial highest meter response will be recorded as the head space concentration. The jars used for the head space analysis will be decontaminated and reused. PID/FID instrument calibration will be checked at least every 10 analyses or daily, whichever is more stringent.

5.4.7 Soil Sampling for Chemical Analyses

The following procedures will be followed during soil sampling:

1. Set up the decontamination area, sample preparation area, and support area near the borehole location.

2. Decontaminate all equipment, samplers, and tools that will come in contact with the soil sample.

3. Inform the driller of the sample interval(s) for the borehole, and oversee the sampling process.

4. Prepare and label the sample containers. Label the containers with the location, depth, date, time of sampling and sample preservation method.

5. Have the driller prepare the sampler for opening, but do not allow the driller to completely open the sampler.

6. Open the sampler slowly while it is lying on a clean sheet of plastic. As the sampler is being opened, the surface of the core should be "sniffed" with the PID/FID, with the probe of the instrument about one inch from the sample. Record the instrument readings in the log book.

7. Obtain grab soil samples for total petroleum hydrocarbons (TPH) analyses first and place into two 2-ounce or 4-ounce septa sample jars.

8. If sampling for VOC's in soil, a split spoon with a ring system should be used to analysis for headspace.

9. Collect a sample for headspace analysis in a 16-ounce jar and seal with aluminum foil.

10. Log the core, recording percent recovery; color; texture; clay, sand, USCS designation, blows per sample, depth, and gravel content; and other notable characteristics on the boring log.

11. Perform head space analyses on the soils. Record this reading in the appropriate place on the borehole log and in the field log book.

12. Deposit soil cuttings, wastewater, and waste generated during the decontamination process into 55-gallon 17 E/H steel drums for disposal after the results of chemical analyses of the soil and ground water at that location are known.

5.4.8 Soil Sampling for Geotechnical Analyses

Geotechnical samples may be collected from the soil borings. The purpose of the geotechnical samples is to provide information on the physical properties of the soils for use in preparing the remedial action plans. Geotechnical samples may be collected using the Dames & Moore Type U sampler or the continuous sampler. Samples will be collected from each major lithologic zone encountered to provide a representation of actual subsurface conditions. Field personnel will avoid collecting geotechnical samples in highly contaminated intervals, if possible, and at their discretion may not collect a geotechnical sample from a boring.

Geotechnical samples will be handled using the procedures described above, including head space analysis and collection of soil samples for chemical analysis. The samplers will be decontaminated as described in Section 6.2.1.

5.4.9 Borehole Abandonment

All state and local regulations will be followed for any well being abandoned.

The borings will be backfilled to the ground surface upon their completion. The purpose of the backfilling procedure is to prevent foreign materials from entering the boring and possibly contaminating the ground water, and to prevent cross contamination between two separate water bearing zones.

The boreholes will be backfilled with a 94:3 cement-bentonite grout to within three feet of the ground surface. If necessary, grout will be tremied into the borehole. The top three feet of the borehole will then be backfilled with compacted silts or clays. All abandoned boreholes will be checked 24 to 48 hours after grout employment to determine whether curing is occurring properly.

The backfilled boreholes will be capped with concrete in those areas where the boreholes penetrate existing concrete. The concrete caps will have a minimum thickness equivalent to the surrounding concrete.

The soil cuttings and decon water generated during the advancing of soil borings and the installation of monitoring wells will be containerized in properly labeled 55-gallon drums. All drums shall be clearly labeled and dated with a water resistant weather resistant medium such as paint. Labels shall include, but not be limited to: date filled; ID number; type of material contained; site number and location; and boring(s) number. All drums will be approved Department of Transportation design with removable sealing lids, type 17 E/H.

5.5 GROUND WATER MONITORING AND SAMPLING

5.5.1 Monitoring Well Installation and Ground Water Sampling

Monitoring wells will be installed in accordance with "Missouri Well Construction Rules", 10CSR23-4,060. No hydrological testing is currently planned for any well installation. If hydrological testing is determined appropriate and approved in the scope of work, Dames & Moore will use the geotech sample for physical testing during the drilling phase or a slug test or pump test during the completion phase of well installation.

5.5.1.1 Monitoring Well Drilling

The monitoring well borings will be advanced to a depth of approximately 8 feet below the surface of the water table in the first water-bearing zone using 6¼-inch inside diameter hollow-stem augers. Note, this depth may vary depending on the type of contamination, for example DNAPL will require a borehole to a confining unit or bedrock. A description of the hollow-stem auger drilling method is provided in Section 5.4.1.1. Each boring will be sampled and logged as described in Sections 5.4.3 and 5.4.5

If heaving sands are encountered or available information indicates the potential for heaving sands at a site, the monitoring well boring may be pre-drilled and sampled using smaller diameter augers. The boring will then be overdrilled to the planned depth of the monitoring well using 6¼-inch I.D. augers fitted with a PVC plug. The PVC plug will be knocked out prior to installation of the well. If necessary, nonchlorinated potable water will be introduced into the boring via the augers to increase hydraulic head and minimize the inflow and bridging of sand within the bottom of the augers. The potable water will be obtained from an approved source with available chemical data.

If bedrock is encountered prior to the planned depth for completion of the monitoring well boring, rock coring will be performed. Construction of monitoring wells is discussed in the following section.

5.5.1.2 Monitoring Well Construction and Completion

Overburden Wells

The installation of monitoring wells will follow the guidelines set forth by the Missouri Department of Natural Resources (MDNR), Missouri Well Construction Rules, Miscellaneous Publication No. 50. Chapter 4 of this document is devoted to monitoring well construction standards for the purpose of monitoring water quality or for hydrologic studies.

Overburden monitoring well borings (4-inch) will be advanced to at least eight feet below the top of the upper water bearing zone. Deeper borings will be considered based on the contaminate of concern. The monitoring wells will be constructed of new, decontaminated 2-inch diameter Schedule 80 PVC riser pipe (in conformance with ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14) and factory slotted screen (0.010 inch slot) with threaded joints (glued joints will not be used). The riser and a 15-foot section of screen will be installed through the augers with the screen set to straddle the water table. The screen will be at least 5 feet above the water table or a sufficient length to compensate for seasonal water fluctuation and draw down effect. The augers will then be extracted as a filter pack is tremied from the bottom of the borehole to approximately 2 feet above the screened section. The filter pack will consisting of 20/40-grade silica sand or the finest formation material the well is capable of holding as determined by a sieve analysis curve. If the well screen and riser are installed in an open borehole, and the well exceeds a depth of 20 feet, two centralizers will be placed on the well riser pipe (not on well screen) to keep the screen and riser centered in the borehole during completion of the well. A bentonite seal with a minimum thickness of 2 feet will be placed above the sand pack. The bentonite seal will consist of a high solids bentonite slurry and will be placed using a side discharge tremie pipe. The slurry will be allowed to set up per manufactures specifications prior to placing the cement-bentonite grout. A 94:3 cement-bentonite grout will be tremie in the annulus around the well casing from the top of the bentonite seal to the surface. No more than 8.0 gallons of water per sack of cement will be used. During installation, the depths of the well, sand pack and bentonite seal will be verified using a weighted tape. The tape utilized will not be of a kind that the adhesive could produce a false positive in a laboratory result (electrical). The monitoring wells will be capped and locked during any delays of field activities.

A protective steel collar with weep holes and a locking cap will be cemented in place over the PVC casing to prevent damage to the well The protective collar will be seated in a concrete surface pad with approximate dimensions of 4 feet by 4 feet by 4 inches thick. A concrete-grout mixture will be coned inside the protective casing (around the well casing) above the height of the concrete pad, in a manner to prevent the accumulation of condensation water. The protective casing will have two ⅛-inch wide horizontal saw cuts placed at a depth corresponding to the base of the coned grout to allow drainage of condensation water. An air-entrained concrete will be used to prevent spoiling, cracking, and freeze damage. Three 2-inch diameter steel pipes, rising to a height approximately equal to the well, will be installed in concrete to further protect the well. The protective casing and the steel pipes will be primed and painted brown. Reflection tape will be placed on the painted pipes. Alternately, a flush mount protective cover may be installed.

A typical well installation is illustrated in Figure 5, Typical Monitoring Well Installation Details. Information regarding the construction of each monitoring well will be recorded on a Dames & Moore Monitoring Well Information Sheet as shown in Figure 6 and on IRPIMS data base.

Bedrock Wells

If a monitoring well boring reaches bedrock prior to encountering ground water, the boring will be cored and overdrilled to two feet below the bedrock surface and an 8-, 10- or 12-inch PVC surface casing (80 schedule) installed. Hollow stem auger or air rotary drilling will be used to overdrill the borehole for surface casing installation. The surface casing will be installed as described in Section 5.4.2.

Bedrock monitoring well boring will then be advanced at least five feet below the depth where ground water is first encountered in the bedrock. Air rotary drilling methods will not be used in an interval to be screened for a monitoring well. The monitoring wells will be constructed of new, decontaminated 2-inch diameter Schedule 80 PVC riser pipe in conformance with ASTM Standard F-480-88A or the National Sanitation Foundation

Standard 14) and factory-slotted 10-foot screen (0.010 inch slot) with threaded joints (glued joints will not be used). A filter pack consisting 20/40-grade silica sand or the finest formation material the well is capable of holding as determined by a sieve analysis curve will be tremied from the bottom of the borehole to approximately 2 feet above the screened section. A bentonite seal with a minimum thickness of 2 feet will be placed above the sand pack. The bentonite seal will consist of bentonite pellets if the seal is within the saturated zone. A high solids bentonite slurry shall be used in place of the pellets if the seal is placed above the saturated zone. A typical bedrock monitoring well installation is illustrated in Figure 7, Typical Bedrock Monitoring Well Installation Details.

Dependent upon site requirements and subsurface conditions, certain wells may be installed uncased (without a well screen) within the bedrock. The boring will be cored and overdrilled to two feet below the bedrock surface and a 4-inch PVC casing installed. The boring will then be cored a minimum of 10 feet into bedrock and completed as an uncased well.

5.5.1.3 Monitoring Well Development

Monitoring wells will be developed in accordance with Missouri Well Construction Rules, (10CSR23-4,070) using teflon bailers or a pump no sooner than 24-hours after grouting is completed. During development, each well will be mechanically surged for 15 minutes followed by the purging of a minimum of three well casing volumes. Surging and purging will continue until the pH, temperature, conductivity, and turbidity are stabilized; and for a minimum of 4 hours. To perform the stabilization test, the pH, temperature, specific conductance, and turbidity of the development water will be monitored. The wells will be considered developed when readings remain stable within plus or minus 10 percent between three consecutive measurements and the suspended sediment content is less than 0.75 mL/L, as measured in an Imhoff cone according to method E160.5, the turbidity remains within a 10 nephelometric turbidity unit range for at least 30 minutes, and the stabilization criteria of plus or minus 1 degree Celsius for temperature, 0.1 units for pH and 5 percent for electrical conductivity are meet. An example of the form to be filled out during well development is shown in Figure 8.

A minimum of three well volumes will be purged from each well during development. In addition, three times the volume of any water introduced into the well borehole during drilling and monitoring well installation (i.e. water loss during coring) will also be removed during development.

All development equipment will be decontaminated according to the specifications in 6.2.2. Additionally, no detergents, soaps, acids, bleaches, or other additives shall be used to develop a well.

5.5.1.4 Monitoring Well Sampling

A minimum of one week will be allowed for a well to recover after development prior to collecting a ground water sample. Prior to sampling, measure water level using an oil/water interface probe or electronic water level indicator. The well will be sampled when a minimum of three well casing volumes have been purged from the well, ground water parameters meet the stabilization criteria between three consecutive readings, and the suspended sediment content is less than 0.75 mL/L. The stabilization criteria is defined as follows: temperature + or - 1 degree C, pH + or - 0.1 units, and electrical conductivity + or - 5%. An example of the form to be filled out during the stabilization test is shown in Figure 9.

Each time a well is purged and sampled, the following information will be presented in the Informal Technical Information Report and encoded in IRPIMS files when required:

- Depth to water before and after purging;
- well bore volume calculation;
- sounded total depth of the monitoring well;
- the condition of each well, including visual survey;
- the thickness of any nonaqueous layer; and,
- field parameters, such as pH, temperature, specific conductance, and turbidity.

Ground water samples will be collected using dedicated disposable teflon bailers, or by using either a submersible or bladder pump. Ground water samples for VOC analysis will be collected using a teflon bailer and not a mechanical pump. The ground water samples will be transferred directly to laboratory-supplied sample containers. Containers for VOC samples will be filled such that no head space remains. If metals are a concern, both filtered and non-filtered samples will be taken or the slow purge method employed. Turbulence will be minimized during the transfer to prevent the loss of volatile organics. The sample containers will be labeled appropriately, stored in a cooler containing ice, and kept at approximately 4°C during storage and shipment to the laboratory. A full description of sampling procedures follows:

Sample Collection Using a Teflon Bailer

Take the following steps when collecting a groundwater sample using a teflon bailer:

1. On arrival at the well head, remove the locking and protective cap. Check the air in the breathing zone with a PID and the air in the well bore with an explosimeter. Determine depth-to-water with an electric measurement tape (e-tape), and record the determined value, estimated to the nearest 0.01 foot, in the field logbook, as required, by sampling program protocol. A visual check for immiscible hydrocarbons (gasoline, diesel, etc.) floating on the surface in the borehole will be made at the time the water level measurements are made. The sampler shall observe the end of the tape for any greasy, film-like coating or for any detectable odor and make a note in the field logbook if any exists. In situ detectors are currently under evaluation for this purpose. As they become available for general use, these devices will be used to supplement or replace the visual checks noted above.

2. If a metal bailer is attached, unclasp the metal bailer from the winch line, and replace it with the teflon bailer.

3. <u>Slowly</u> lower the bailer into the water. Never drop the bailer into the well as this may cause degassing of volatile organics.

4. Allow about 30 seconds for the sample tube to fill.

5. Slowly raise the teflon bailer to the surface.

6. Purge to remove the water standing (minimum of three well volumes) before collecting a sample.

7. Unscrew the cap of the sample container, being careful not to touch the lip of the bottle or the inside of the teflon liner. Avoid touching the mouth of the teflon bailer.

8. Unclasp the teflon bailer.

9. Pour the water from the bailer into the sample container slowly to prevent trapping any air bubbles (VOC Samples). Avoid splashing or agitating the water while the sample container is being filled.

10. Obtain sample temperature, pH, conductivity and turbidity, and record on the Ground Water Sample Report.

Sample Collection Using a Submersible Pump

Take the following steps to collect a sample from a well that contains a submersible pump.

1. On arrival at the well head, remove the locking and protective cap. Check the air in the breathing zone with a PID and the air in the well bore with an explosimeter. Determine depth-to-water with an oil/water interface probe or electric water level indicator, and record the determined value, estimated to the nearest 0.01 foot, in the field logbook, as required, by sampling program protocol. A visual check for immiscible hydrocarbons (gasoline, diesel, etc.) floating on the surface in the borehole will be made at the time the water level measurements are made. The sampler shall observe the end of the tape for any greasy, film-like coating or for any detectable odor and make a note in the field logbook if any exists. In situ detectors are currently under evaluation for this purpose. These devices will be used to supplement or replace the visual checks noted above as they become available for general use.

2. Check to see that the hose bib for the submersible pump is open.

3. Plug the power cord into one of the 230-v outlets on the generator on the truck and into the outlet at the well head.

4. Start the electric generator.

5. Turn the power switch on to begin the pumping process. Do not handle energized power cords. If the pump does not work properly, as indicated by a lack of air flow out the discharge hose or by generator "lug" down, turn the switch off immediately. Wait a few seconds, then turn the switch on and off several times rapidly, finally pausing in the ON position to determine if the pump has started to function properly. Repeat this several times. If the sample pump still doesn't work, it needs repair. If the breakers or fuses on the generator disengage, an electrical short in the system is indicated, and repair is needed. Record problems in the field logbook.

6. Pump for a minimum of 15 minutes, and check for stabilization of the pH, temperature, conductivity, and turbidity.

NOTE: If the well pumps dry while purging, it does not generally mean that a sample cannot be collected. A sample can still be obtained by following these steps:

a. When the well pumps dry, turn off the pump.

b. Wait for the well to recharge sufficiently to draw a sample (check every 15 minutes).

c. Measure the depth-to-water using an oil/water interface probe or electronic water level indicator. Make sure that the water level is above the pump intake.

d. Turn the pump back on.

e. Measure pH, temperature, conductivity, and turbidity once and record on the Ground Water Sample Report.

f. Collect the samples that are designated for collection with the pump.

g. The well may pump dry during the collection of samples. If this occurs, repeat steps (a.) through (d.) before collecting the remaining samples.

h. If sufficient water to sample has not recharged into well after a total of 45 minutes, report the problem in the field logbook and discontinue sampling at that well. Return to the well to continue sampling after a 24 hour recharge period.

7. Measure the pH, temperature, conductivity, and turbidity of the discharged water at least three times (beginning, middle, and end of the designated purge time) during purging. The pH will be considered stable when two consecutive measurements remain stable within plus or minus 10 percent between three consecutive measurements. Temperature will be considered stable when two consecutive measurements agree within 0.2° C. Conductivity will be considered stable when two consecutive measurements agree within 10 percent of each other.

8. Place sample numbers or description of the samples on the Ground Water Sample Report or field logbook as required and Chain of Custody forms.

9. Fill the appropriate sample containers.

   NOTE - This sampling method should not be employed when the analytes of concern are VOCs or semi-VOCs.

Sample Collection using a Bladder Pump

If the well has a dedicated bladder pump, use the procedure described below:

1. On arrival at the well head, remove the locking and protective cap. Check the air in the breathing zone with a PID and the air in the well bore with an explosimeter. Determine depth-to-water with an oil/water interface probe or

electronic water level indicator, and record the determined value, estimated to the nearest 0.01 foot, in the field logbook, as required, by sampling program protocol. A visual check for immiscible hydrocarbons (gasoline, diesel, etc.) floating on the surface in the borehole will be made at the time the water level measurements are made. The sampler shall observe the end of the tape for any greasy, film-like coating or for any detectable odor and make a note in the field logbook if any exists. In situ detectors are currently under evaluation for this purpose. These devices will be used to supplement or replace the visual checks noted above as they become available for general use.

2. Turn on the air compressor.

3. Hook up the adapter.

4. Five to 15 pumping cycles are required to purge the air from the bladder pump and tubing. Full water flow from the sample supply tube should then begin. After water flows from the outlet tube, run the bladder pump for at least 5 minutes before taking samples.

   NOTE: If the well pumps dry while purging, it does not generally mean that a sample cannot be collected. A sample can still be obtained by following these steps:

   a. When the pumps dry, turn off the pump.

   b. Wait for the well to recharge sufficiently to draw a sample (check every 15 minutes).

   c. Measure the dept-to-water using an oil/water interface probe or electronic water level indicator. Make sure that the water level is above the pump intake.

   d. Turn the pump back on.

e. Measure pH, temperature, conductivity, and turbidity once and record in the field logbook.

f. Collect the samples that are designated for collection with the pump.

g. The well may pump dry during the collection of samples. If this occurs, repeat steps (a.) through (d.) before collecting the remaining samples.

h. If sufficient water to sample has not recharged into well after a total of 45 minutes, report the problem in the field logbook and discontinue sampling at that well. Return to the well to continue sampling after a 24 hour recharge period.

5. To optimize pumping efficiency for a specific well depth, refer to the pump manufacturer's operating instructions.

5.5.2 Piezometer Installation

The piezometer borings will be advanced to a depth of 5 feet below the top of the first water bearing zone using 3¼- or 4¼-inch I.D. hollow stem augers. The piezometer will be constructed of one-inch diameter PVC screen and riser. A 10-foot screen will be placed in the boring and a sand pack installed from the bottom of the boring to two feet above the screened interval. The remaining annular space will be filled with a high solids bentonite slurry to the surface. A protective surface casing will be installed to protect the piezometer and prevent the infiltration of surface water. A typical piezometer installation is illustrated in Figure 10, Typical Temporary Piezometer Installation Details.

5.5.3 Ground Water Level Measurement

Following development of the monitoring wells and installation of piezometers, the water level in each well/piezometer will be allowed to stabilize for a minimum of 48-hours prior to collecting a water level measurement. The depth to ground water and/or free product in each well/piezometer will be measured to the nearest 0.01 foot from the top of the PVC casing using an ORS oil/water interface probe or other electronic water level meter.

If free product is encountered in a monitoring well, the depth to the air/free product interface will be recorded to the nearest 0.01 foot from the top of the PVC casing. The probe will be advanced through the free product until the free product/water interface is encountered. This depth will be recorded to the nearest 0.01 foot from the top of the PVC casing. The thickness of free product will then be determined by subtracting the depth to the air/free product interface from the depth to the free product/water interface. The presence of free product will be confirmed by withdrawing a sample with a clear, bottom-fill teflon bailer.

Water level/free product level measurements from the existing and newly installed monitoring wells/piezometers on a site will be obtained on the same day. If free product is detected in a monitoring well/piezometer, this information will be provided to the BRAC team so that MDNR can be notified in accordance with MDNR and Federal regulations.

All measuring equipment will be decontaminated according to the specifications in Section 6.2.2.

6.0 DECONTAMINATION

6.1 PERSONNEL

Persons working on the site shall undergo decontamination before leaving the site. In most instances, removal of protective clothing will suffice for decontamination. Facilities for storage of reusable protective clothing and for the disposal of clothing contaminated beyond reuse will be constructed or placed on site. Also, facilities for decontaminating hands, boots, and gloves, consisting of a detergent wash and water rinse, will be provided. Decontamination of personnel and miscellaneous small tools will be in accordance with the Site Safety and Health Plan.

6.2 EQUIPMENT

Precautions will be taken to prevent the potential transfer of contamination from one boring location to another during the field activities. Equipment used to advance and sample soil borings will be decontaminated prior to use at each boring location. This equipment includes but is not limited to the drill rig, augers, drill rods, soil and ground water samplers, and pumps. The following sections describe the decontamination procedures that will be used at the site.

6.2.1 Drilling and Soil Sampling Equipment

The drill rig and other surface drilling equipment will be decontaminated prior to use at each site. Downhole equipment including reusable casing augers, rods, bits and related equipment will be decontaminated between the sampling locations. The procedure for decontaminating equipment will consist of manually scraping visible soil and mud from the equipment and applying a high-pressure low-volume hot water/steam wash and Alconox®, or equivalent laboratory-grade detergent, then rinsed with potable water.

Soil samplers used to obtain soil samples for chemical or geotechnical analyses, along with head space analysis jars, knives, stainless steel trowels, spoons, and mixing bowls, will be decontaminated after each use according to the following procedure:

1. Scrub off a majority of the soil using potable water. Sampling equipment may also be washed by performing a high-pressure low-volume hot water/steam wash of the disassembled parts.
2. Wash with a mixture of potable water and Alconox® (or equivalent laboratory-grade) detergent.
3. Rinse at least three times with an ASTM Type II Reagent Water.*
4. Rinse with pesticide-grade methanol and allow to air dry.
5. Rinse with pesticide-grade hexane and allow to air dry.
6. Decontaminate and air dry equipment on a clean surface or rack elevated at least two feet above ground. If the sampling device is not to be used immediately, wrap in aluminum foil.

* Analytical data or a manufacturer's certification that verifies the quality of the Type II Reagent-Grade Water meets the specifications of ASTM D1193-77 or shows to be free of analytes and contaminants that may interface with the required laboratory analysis will be provided.

To facilitate the decontamination process, decontamination zones will be constructed. The decontamination zone for the soil samplers, water sampling tools, and miscellaneous small tools will be established near each borehole. The decontamination area will consist of a low-lying area covered with a 6-mil polyethylene sheet. At the completion of decontamination procedures at each boring, the debris will be enclosed in the polyethylene sheet and deposited into 55-gallon type 17 E/H drums for later disposal. The decontamination zone for the rear end of the drill rig, augers, rods, and other large items of equipment used during drilling and sampling will be established in the general vicinity of each sampling area. A low-lying area will be covered with a 6-mil polyethylene sheet and bermed to collect the water and solid wastes generated during steam cleaning of the equipment; the debris will be deposited into 55-gallon-type 17 E/H drums for later disposal.

6.2.2 Monitoring Well Development, Sampling, and Monitoring Equipment

Equipment used to surge and purge the monitoring wells during development and the probe used for water level measurements will be decontaminated in the same manner as the sampling equipment described in the previous section.

The instruments used to monitor development water during stabilization tests (i.e. pH, temperature, conductance, and turbidity meter) will be triple rinsed with distilled water only to minimize variance from calibration standards. If obvious signs of contamination remain, the instruments will be decontaminated, as described above, and then recalibrated.

Specific procedures for decontaminating the downhole pump and tubing follows:

1. Immerse the pump and tubing into a container of Alconox® detergent solution and pump a minimum of three pump and tubing volumes of the solution through the pump and tubing.

2. Immerse the pump and tubing into a container with distilled water. Pump a minimum of three pump and tubing volumes of distilled water through the pump and tubing.

3. Remove the decontaminated pump and tubing and place into a clean plastic bag/container for transport.

The outside of the pump will be decontamination by washing with an Alconox® and water solution and triple rinsing with distilled water.

Water samples from the developed wells will be obtained using disposable one-time use dedicated teflon disposable bailers and nylon rope. A teflon bottom discharge device will be used to transfer the water sample from the bailer to the appropriate laboratory container(s).

7.0 FIELD EQUIPMENT

The Dames & Moore field personnel assigned to the project will assemble as much of the field equipment as feasible prior to mobilization to the site. At this time the equipment will be checked to ensure that it is in proper working order, and required maintenance will be performed. Tools and equipment that may be needed for field maintenance will be assembled at this time, and pertinent sections of the manuals will be photocopied for reference in the field.

The personnel will become familiar with the calibration of the instruments, as outlined in the respective manuals, and will make the calibrations that can be made at that time. Pertinent sections of the respective manuals will be photocopied for reference in the field, and the supplies that will be necessary for field calibration of the instruments, such as buffer solutions and calibration gases, will be assembled for mobilization to the site.

Descriptions of the field equipment to be utilized in the field investigation are presented in the following sections.

7.1 PHOTOIONIZATION DETECTOR/FLAME IONIZATION DETECTOR

The PID provides a semi-qualitative concentration readings at the volitile organic compounds in a sample that have ionization potential equal to or less than 10.6 eV. The instrument to be utilized during the field investigation is an HNu PI101 photoionization detector or equivalent. The HNu is battery operated and lightweight, making it very useful in field monitoring projects. The instrument is calibrated by introducing pressurized gas from a cylinder with a known organic vapor concentration into the detector. Once the reading has stabilized, the display of the instrument is adjusted to match the known concentration. A calibration of this type is performed each day prior to using the instrument.

If the output differs greatly from the known concentration of the calibration gas, the initial procedure to remedy the problem is a thorough cleaning of the instrument. The cleaning process normally removes foreign materials (i.e., dust, moisture) that affect the calibration of the instrument. If this procedure does not rectify the problem, further troubleshooting is performed until the problem is resolved. If the problem cannot be resolved by the field personnel, the instrument will be returned to the manufacturer for repair and a replacement unit shipped to the site immediately. The manufacturer's manual will accompany the instrument.

The HNu PI101 detector must be kept clean for accurate operation. Foreign materials can be rinsed or wiped off, or blown out of the detector. The cord between the analyzer and the recorder should not be wound tightly, and will be inspected visually for integrity before going into the field. A new cord will be ordered from the manufacturer if problems are found. A battery check indicator is included on the equipment and will be checked prior to going into the field and prior to use. The batteries will be fully charged each night. The analyzer, probe, and meter should be packed securely and handled so as to minimize the risk of damage.

7.2 CONDUCTANCE, TEMPERATURE, AND pH TESTER

Conductance testing will be preformed in accordance with EPA Method 9050: Specific Conductance. pH testing will be performed in accordance with EPA Method 9040: pH Electrometric Measurements. Temperature measurement does not have a specific procedural method.

A HyDAC conductance, temperature, and pH tester, or equivalent, will be used at the site. The unit has the following detection ranges: conductance 0 to 20,000 μmhos/cm; temperature 0 to 160^{0}F; and pH 0 to 14. Conductance and temperature are factory calibrated: however, conductance will be checked against a standard solution of known conductance each day and recalibrated, if necessary.

The pH will be calibrated prior to each use by immersing the pH electrode in a pH 7.0 buffered solution. The electrode is then placed in a pH 4.0 or 10.0 buffered solution and the "SLOPE" potentiometer on the tester adjusted to display the value of the buffer solution chosen.

The tester and probes will be packed in a protective case for transport. The probes must be kept clean, and will be rinsed with distilled water after each use. The buffer solutions used in calibration will be packed with the meter.

7.3 OIL/WATER INTERFACE PROBE

The oil water interface probe to be used will be an ORS interface probe or equivalent. This unit gives a single tone when its probe interfaces with hydrocarbons and an intermittent tone when it reaches water. Depth is read directly off the tape. Field calibrating will entail measurement between wire marks with an accurate tape measure to help ensure length validity.

7.4 NEPHELOMETRIC TURBIDITY METER

An HF Scientific DRT nephelometric turbidity meter or equivalent will be used during monitoring well development and sampling. The unit is battery operated and will be fully charged prior to all pertinent field operations. Calibration and other pertinent maintenance and operations information is provided in the operator's manual which will accompany the unit to the field.

7.5 DECONTAMINATION SUPPLIES

The decontamination wash solutions will consist of Alconox® detergent and potable water, distilled water, and propanol in accordance with procedures suggested by the USACE. Other supplies will include buckets, tubs, and brushes. The decontamination supplies will be transported in sealed unbreakable containers. The containers will be inspected visually for leaks or contamination prior to each use.

7.6 RESPIRATORS, CARTRIDGES, AND FILTERS

Air purifying filter/cartridge respirators will be donned by sampling personnel if field situations warrant. The respirators will be fitted with GMA cartridges with Type F filters for removal of organic vapors, dusts, and mists. These cartridges are NIOSH (National Institute for Occupational Safety and Health)-tested, and NIOSH- and MSHA (Mine Safety and Health Administration)-approved. The GMA cartridge is approved for use in atmospheres containing at least 19.5 percent oxygen and less than 0.1 percent organic vapors by volume.

7.7 LOCKS

Padlocks will be placed on each monitor well to discourage tampering and vandalism. The locks will be purchased from a locksmith supplier or hardware store and will be performance tested at the time of purchase and when placed on a well. The locks will be keyed alike to avoid the possibility of confusion among keys.

7.8 ELECTRICAL GENERATOR

A portable gasoline powered electrical generator with a minimum 3,500 watt capacity will be used to provide on-site power for the submersible or bladder pump. Care will be taken during the fueling of the generator to prevent the spillage of gasoline at the site.

7.9 SUBMERSIBLE PUMP

A Redi-Flo2 2-inch submersible pump may be used for well development and sample collection when the analytes of concern are not VOCs or semi-VOCs. Both high flow rates needed for purging, and low flow recommended for sampling can be achieved using this pump. Flow rates ranging from 9 gallons per minute to as little as 100 ml per minute can be achieved. This pump can be used on wells with depths up to 250 feet.

7.10 ELECTRONIC WATER LEVEL INDICATOR

The type of water level indicator used will be a Soil Test (or equivalent), 100 foot electronic water level indicator. Each indicator is calibrated against National Bureau of Standards traceable instrumentation. Field calibration will entail measurement between wire marks with an accurate tape measure to help ensure length validity.

8.0 ENVIRONMENTAL SAMPLE HANDLING AND PACKING

8.1 SAMPLE CONTAINERS

Sample containers will be provided by the analytical laboratory. The containers will be either high density polyethylene or glass with teflon-lined lids and will be pretreated with preservatives as applicable.

8.2 SAMPLE HANDLING AND DECONTAMINATION

After sample collection in the field, the exterior of the sample containers will be decontaminated if gross contamination is present. The sample containers will be handled with gloves until decontaminated with a detergent wash and water rinse. Care will be taken to avoid damaging the temporary labeling during decontamination. After decontamination, permanent labels will be placed on clean sample container exteriors.

The sample containers will be well-cushioned with packing materials when they are placed in the insulated cooling chests for transportation to the laboratory. Care will be taken to seal bottle caps tightly. The samples will be shipped via overnight carrier to the laboratory to arrive no later than 48 hours after the time sampled.

8.3 PROCEDURES FOR PACKING AND SHIPPING LOW CONCENTRATION SAMPLES

Samples will be packaged as follows:

- Use water-proof metal (or equivalent strength plastic) ice chests or coolers only.
- After determination of specific samples to be submitted and filling out the pertinent information on the sample label and tag, put the label on the bottle or vial prior to packing. For bottles other than VOC vials, secure the lid with strapping tape (tape on VOC vials may cause contamination).

- Mark volume level on bottle with grease pencil. VOC vials will be completely filled to eliminate head space, and will not be marked with a grease pencil.

- Place about 3 inches of inert cushioning material such as vermiculite in the bottom of the cooler.

- Enclose the bottles in clear plastic bags through which sample tags and labels are visible, and seal the bag. Place bottles upright in the cooler in such a way that they do not touch and will not touch during shipment.

- Place bubble wrap and/or packing material around and among the sample bottles to partially cover them (no more than halfway).

- Add sufficient ice (double bagged) between and on top of the samples to cool them and keep them at approximately 4°C until received by the analytical laboratory.

- Fill cooler with cushioning material.

- Put paperwork (Chain-of-Custody Record) in a waterproof plastic bag and tape it with duct tape to the inside lid of the cooler.

- Tape the drain of the cooler shut with duct tape.

- Secure lid by wrapping the cooler completely with strapping, duct or clear shipping tape at a minimum of two locations. Do not cover any labels.

- Attach completed shipping label to top of the cooler.

- Label "This Side Up" on the top of the cooler, "Up" with arrow denoting direction on all four sides, and "Fragile" on at least two sides.

- Affix numbered and signed custody seals on front right, and back left of cooler. Cover seals with wide, clear tape.

8.4 PROCEDURES FOR PACKING AND SHIPPING MEDIUM CONCENTRATION SAMPLES

An effort will be made to identify samples suspected of having elevated contaminant concentrations based on field observations and screening test. These samples will be segregated and packed in a separate container to the extent allowed by prevailing field conditions. Lids for these samples, except for volatile samples, will be sealed to the containers with tape in addition to the normal processing used on all samples collected. Medium concentration samples will be packed in the same manner as described in Section 7.3 for low concentration samples.

8.5 CHAIN-OF-CUSTODY RECORDS

As part of the sampling plan, chain-of-custody protocols will be established to provide documentation that samples were handled by authorized individuals as a means to maintain sample integrity. The chain-of-custody form will contain the following information:

- Sample identification number;
- Date, time, and depth of sample collection;
- Sample type (e.g. soil);
- Type and number of container;
- Requested analyses;
- Field notes and laboratory notes;
- Project name and location;
- Name of collector;
- Laboratory name and contact person; and
- Signature of persons relinquishing or receiving samples.

Chain-of-custody records will be maintained for each laboratory sample. At the end of each day on which samples are obtained, and prior to the transfer of the samples off-site, chain-of-custody documentation will be completed for each sample. Information on the chain-of-custody form will be verified to ensure that the information is consistent with the information on the container labels and in the field log book.

Upon receipt of the sample cooler at the laboratory, the laboratory custodian will break the shipping container seal, inspect the condition of the samples, and sign the chain-of-custody form to document receipt of the sample containers. Information on the chain-of-custody form will be verified to ensure that the information is consistent with the information on the container labels. If the sample containers appear to have been opened or tampered with, this should be noted by the person receiving the samples under the section entitled "Remarks." The completed chain-of-custody records will be included with the analytical report prepared by the laboratory.

A sample Chain-of-Custody form to be used during this investigation is illustrated in Figure 11, Dames & Moore Chain-of-Custody Form.

9.0 SITE DOCUMENTATION

9.1 FIELD LOG BOOKS

Each Dames & Moore Field Team member will maintain a personal permanently bound field log book while on the site. Information recorded in the log book will be written in an objective, factual manner so that persons reading the entries will be able to determine the sequence of events as they occurred in the field. Information will be recorded with indelible ink. If notes are made in the log book by someone other than the owner of the book, this will be indicated by the writer's signature and date. Information that may be recorded in the field log book includes:

- Date and time of entry;
- Sample number;
- Sample description such as sample depth, amount and physical characteristics;
- Identification of conditions which might affect the representativeness of a sample;
- Method of sampling;
- Identification of sampling device(s);
- Location of sampling;
- Sketch of sample location;
- Numerical value and units of field measurements such as pH, conductivity, temperature, and water level;
- Identity of and calibration results for each field instrument;
- Names and phone numbers of field contacts, drillers, and persons on-site;
- Materials used in well construction;
- Driller's standby and drilling time; and
- Weather and field conditions during drilling and/or sampling.
- Pertinent conversations with project/Richards-Gebaur personnel.

These records will be archived and made available to the Air Force upon request.

In addition to the above information, the following forms will be used to record detailed data:

- HTW Drilling Log (Figure 1) - used in the field to record detailed sample descriptions and drilling methods;

- Stabilization Test Form (Figure 9) - used to stabilize the wells prior to sampling.

- Monitoring Well Installation Details (Figures 5, 7, and 10) - used to record details of well installation.

- Field Memorandum (Figure 12) - used to outline daily activities for information of project manager and file records; and

- Well Development Log (Figure 8) - used to record details of well development.

9.2 CORRECTIONS TO DOCUMENTATION

Errors or mistakes in the original field data will be crossed out with a single line, and the person making the correction will initial it. No data will be erased.

In some circumstances, original documents may be transcribed, making appropriate changes and eliminating errors. In these cases, the successive documents will be dated, numbered as sequential drafts and the originals maintained in the project file.

9.3 SAMPLE TRAFFIC REPORTS

Knowledge of sample status will be maintained through review and evaluation of the Dames & Moore field geologist's/engineer's reports, discussions with field personnel, and through contact with the analytical laboratory on a periodic basis. In this way, a working knowledge of sample traffic will be available throughout the project.

9.4 IRPIMS

All data will be entered and quality checked on IRPIMS data base CDLT program.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

The objective of the Quality Assurance/Quality Control (QA/QC) program is to demonstrate that the data produced are scientifically valid, defensible, and of known precision and accuracy.

QC will be maintained in the field by adhering to the field procedures outlined in the Work Plan; by properly and fully documenting sample information on chain-of-custody forms; by maintaining field logs documenting field activities; and by the collection of QC samples. The QC samples will be analyzed to assess laboratory performance and to assess the possibility of cross-contamination.

10.1 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

As part of the Quality Control program, QC samples will be prepared and collected to provide data for the subsequent review, interpretation, and validation of the analytical data.

10.1.1 Quality Control Samples

Five types of field QC samples will be collected during the entire investigative effort:

1) One VOC trip blank will accompany every shipment or cooler, whichever is packed, of soil and water samples sent to the laboratory for VOC analysis.

2) Ambient condition blanks shall be taken during each VOC sampling round at sites where samples are collected down-wind of possible VOC sources.

3) One equipment blank will be taken by each sampling team on each day of sampling. Sampling equipment blanks will be collected immediately after the equipment has been decontaminated. This blank will be analyzed for all laboratory analyses requested for environmental samples collected at the site.

* all blank samples will consist of Type II Reagent Grade Water.

4) Ten percent of all water samples will be field duplicates. Both duplicates will be analyzed for the same parameters in the laboratory.

5) Ten percent of all soil samples will be field replicates (i.e. splits). Both replicates will be analyzed for the same parameters in the laboratory.

10.1.2 QA Samples

QA samples will be collected to allow for an independent evaluation of the analytical data quality in accordance with the QAPP.

11.0 FIELD MEASUREMENTS

Field measurement procedures are described in previous sampling procedures sections. All field measurements will be entered into IRPIMS Files and Fields Data Set.

HTW DRILLING LOG

HTW DRILLING LOG							HOLE NO.
1. COMPANY NAME			2. DRILLING SUBCONTRACTOR				SHEET OF SHEETS
3. PROJECT				4. LOCATION			
5. NAME OF DRILLER				6. MANUFACTURER'S DESIGNATION OF DRILL			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT				8. HOLE LOCATION			
				9. SURFACE ELEVATION			
				10. DATE STARTED		11. DATE COMPLETED	
12. OVERBURDEN THICKNESS				15. DEPTH GROUNDWATER ENCOUNTERED			
13. DEPTH DRILLED INTO ROCK				16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED			
14. TOTAL DEPTH OF HOLE				17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED		19. TOTAL NUMBER OF CORE BOXES			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %	
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR			

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h

MRK FORM JUN 89 55 | PROJECT | HOLE NO.

Figure 1
HTW DRILLING LOG

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Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

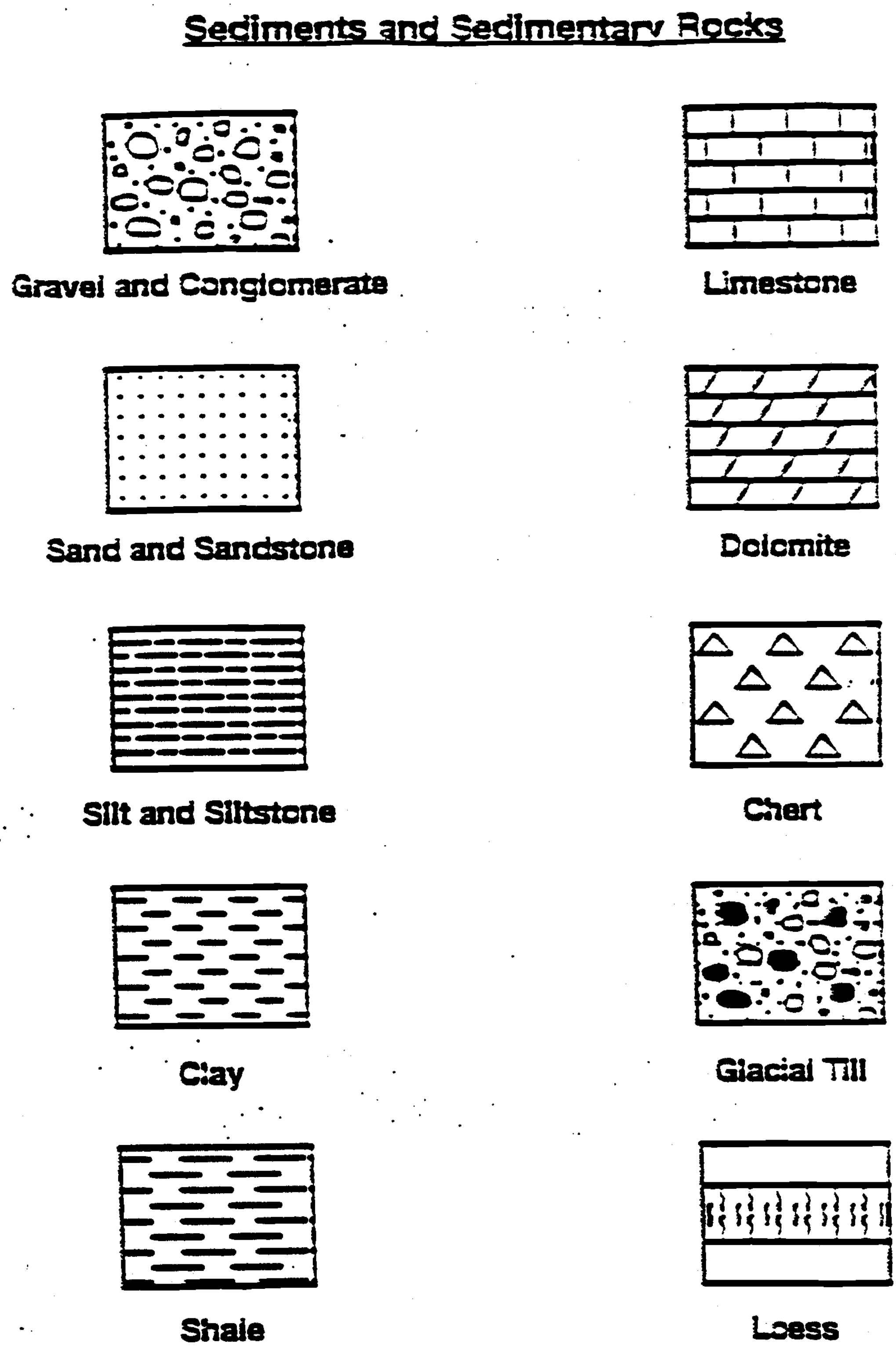

Figure 2.1
Lithologic patterns for illustrations

Dames & Moore

Richards-Gebaur AFB
Air Force Center of Environmental Excellance

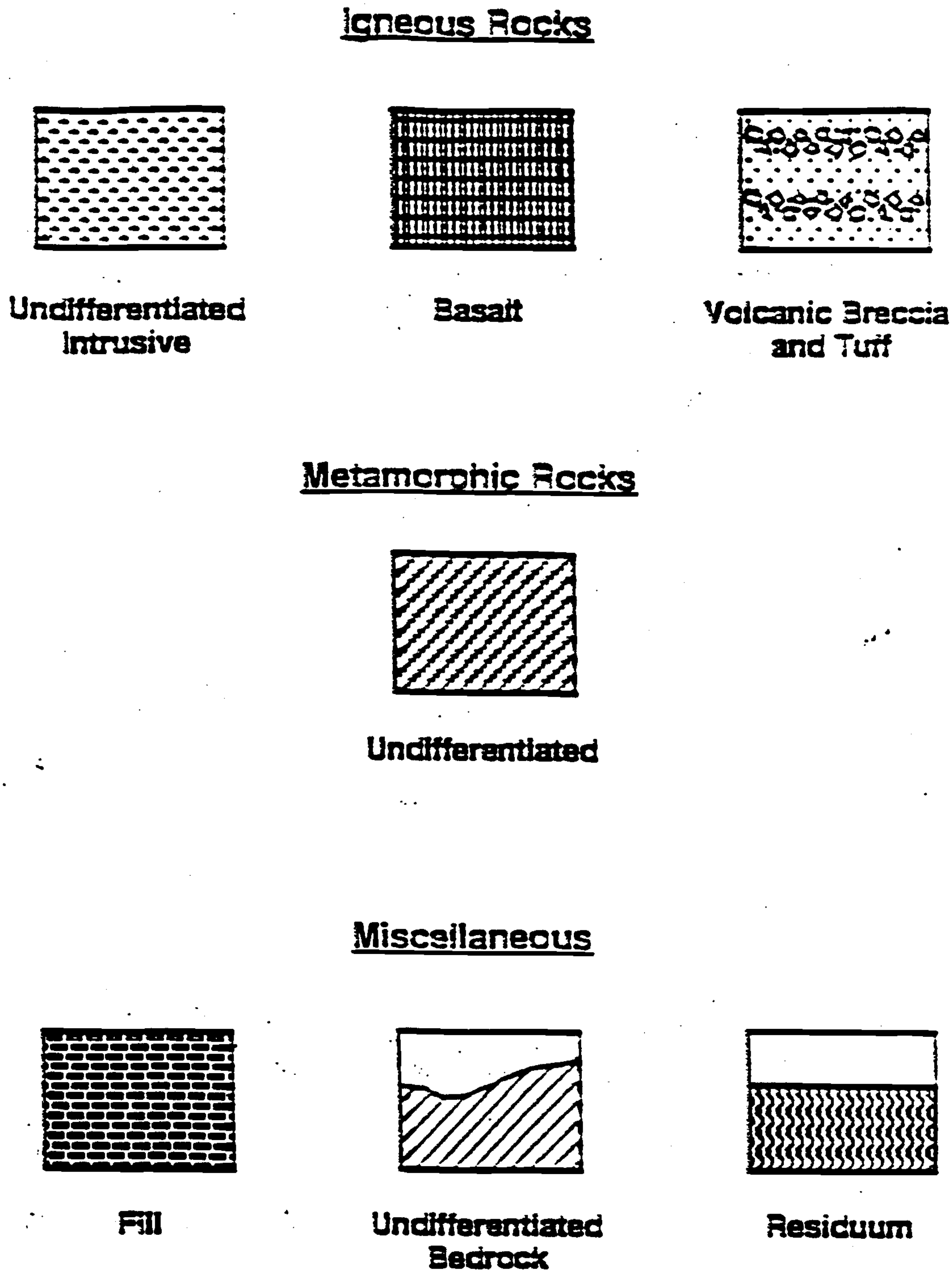

Figure 2.1
Lithologic patterns for illustrations
(Continued)

Dames & Moore

Richards-Gebaur AFB
Air Force Center of Environmental Excellance

Test 1	Test 2a	Test 2b		Test 2c / Test 4		Symbol
COARSE-GRAINED SOILS More than half of the material (by weight) is individual grains visible to the naked eye.	GRAVELLY SOILS–More than half of coarse fraction is larger than 1/4".	Test 2b	CLEAN GRAVELS Will not leave a stain on a wet palm	Test 2c	Substantial amounts of all grain particle sizes	GW
					Predominantly one size or a range of sizes with intermediate sizes missing	GP
			DIRTY GRAVELS Will leave a stain on a wet palm	Test 4	Nonplastic fines	GM
					Plastic fines	GC
	SANDY SOILS–More than half of coarse fraction is smaller than 1/4".	Test 2b	CLEAN SANDS Will not leave a stain on a wet palm	Test 2c	Wide range in grain size and substantial amounts of all grain particle sizes	SW
					Predominantly one size or a range of sizes with intermediate sizes missing	SP
			DIRTY SANDS Will leave a stain on a wet palm	Test 4	Nonplastic fines	SM
					Plastic fines	SC

Test 3	Test 5–RIBBON	Test 6–LIQUID LIMIT	Test 7–DRY CRUSHING STRENGTH	Test 8–DILATANCY REACTION	Test 9 TOUGHNESS	Test 10 STICKINESS	Symbol
FINE-GRAINED SOILS More than half of the material (by weight) is individual grains not visible to the naked eye.	None	<50	None to Slight	Rapid	Low	None	ML
	Weak	<50	Medium to High	None to Very Slow	Medium to High	Medium	CL
	Strong	>50	Slight to Medium	Slow to None	Medium	Low	MH
	Very Strong	>50	High to Very High	None	High	Very High	CH

Test 11–HIGHLY ORGANIC SOILS — Readily identified by color, odor, spongy feel, and frequently by fibrous texture. — OL, OH, Pt

Figure 2.2

ASTM Soil Classification Chart

Dames & Moore

Richards-Gebaur AFB
for
Air Force Center for Environmental Excellence

Test 1 COARSE-GRAINED SOILS More than half of the material (by weight) is individual grains visible to the naked eye.	Test 2a GRAVELLY SOILS–More than half of coarse fraction is larger than 1/4".	Test 2b	CLEAN GRAVELS Will not leave a stain on a wet palm	Test 2c	Substantial amounts of all grain particle sizes	GW
					Predominantly one size or a range of sizes with intermediate sizes missing	GP
			DIRTY GRAVELS Will leave a stain on a wet palm	Test 4	Nonplastic fines	GM
					Plastic fines	GC
	Test 2a SANDY SOILS–More than half of coarse fraction is smaller than 1/4".	Test 2b	CLEAN SANDS Will not leave a stain on a wet palm	Test 2c	Wide range in grain size and substantial amounts of all grain particle sizes	SW
					Predominantly one size or a range of sizes with intermediate sizes missing	SP
			DIRTY SANDS Will leave a stain on a wet palm	Test 4	Nonplastic fines	SM
					Plastic fines	SC

Test 3 FINE-GRAINED SOILS More than half of the material (by weight) is individual grains not visible to the naked eye.	Test 5–RIBBON	Test 6–LIQUID LIMIT	Test 7–DRY CRUSHING STRENGTH	Test 8–DILATANCY REACTION	Test 9 TOUGHNESS	Test 10 STICKINESS	
	None	<50	None to Slight	Rapid	Low	None	ML
	Weak	<50	Medium to High	None to Very Slow	Medium to High	Medium	CL
	Strong	>50	Slight to Medium	Slow to None	Medium	Low	MH
	Very Strong	>50	High to Very High	None	High	Very High	CH

Test 11–HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel, and frequently by fibrous texture.	OL
		OH
		Pt

Figure 2.2

ASTM Soil Classification Chart

Dames & Moore

Richards-Gebaur AFB
for
Air Force Center for Environmental Excellence

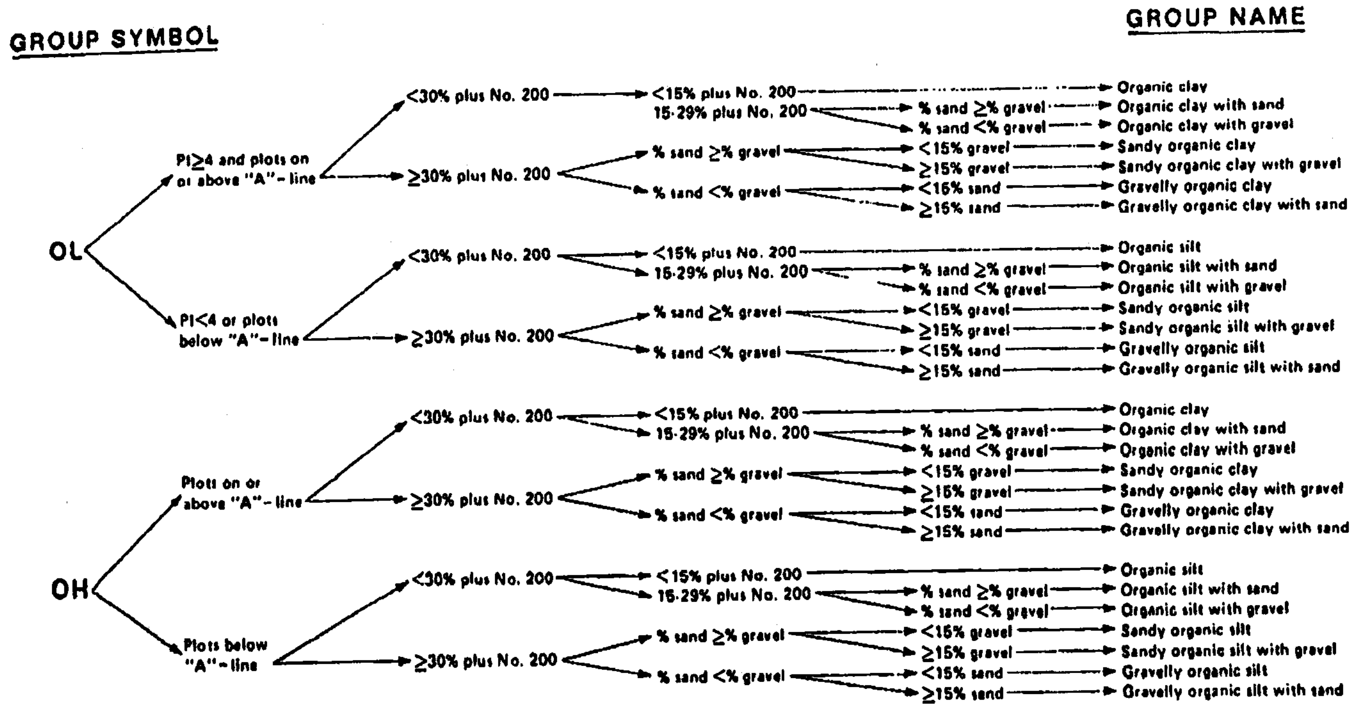

Figure 2.2.2

Flow Chart for Classifying
Organic Fine-Grained Soil

DAMES & MOORE

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For
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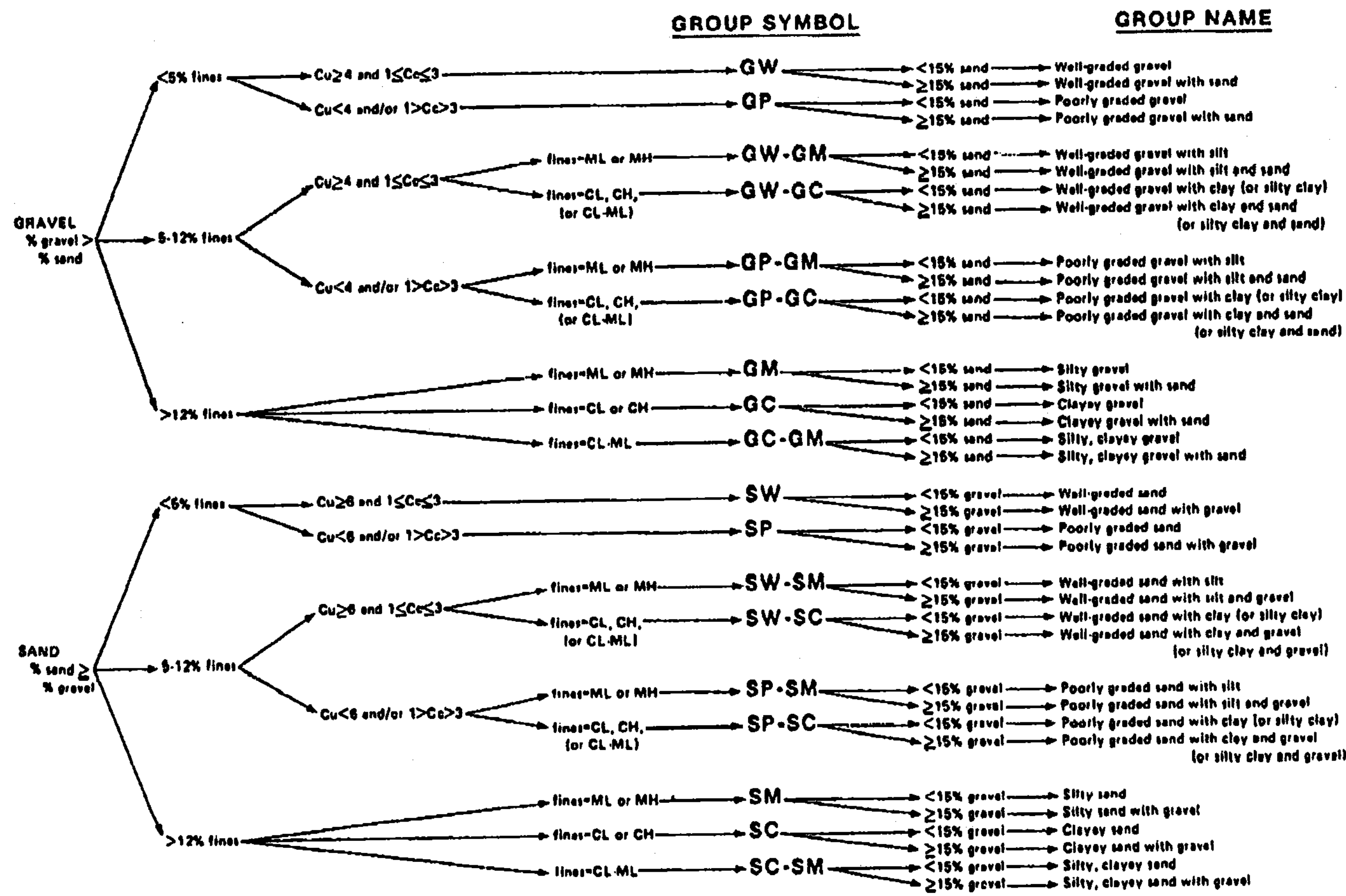

Figure 2.2.3

Flow Chart for Classifying Coarse-Grained Soil

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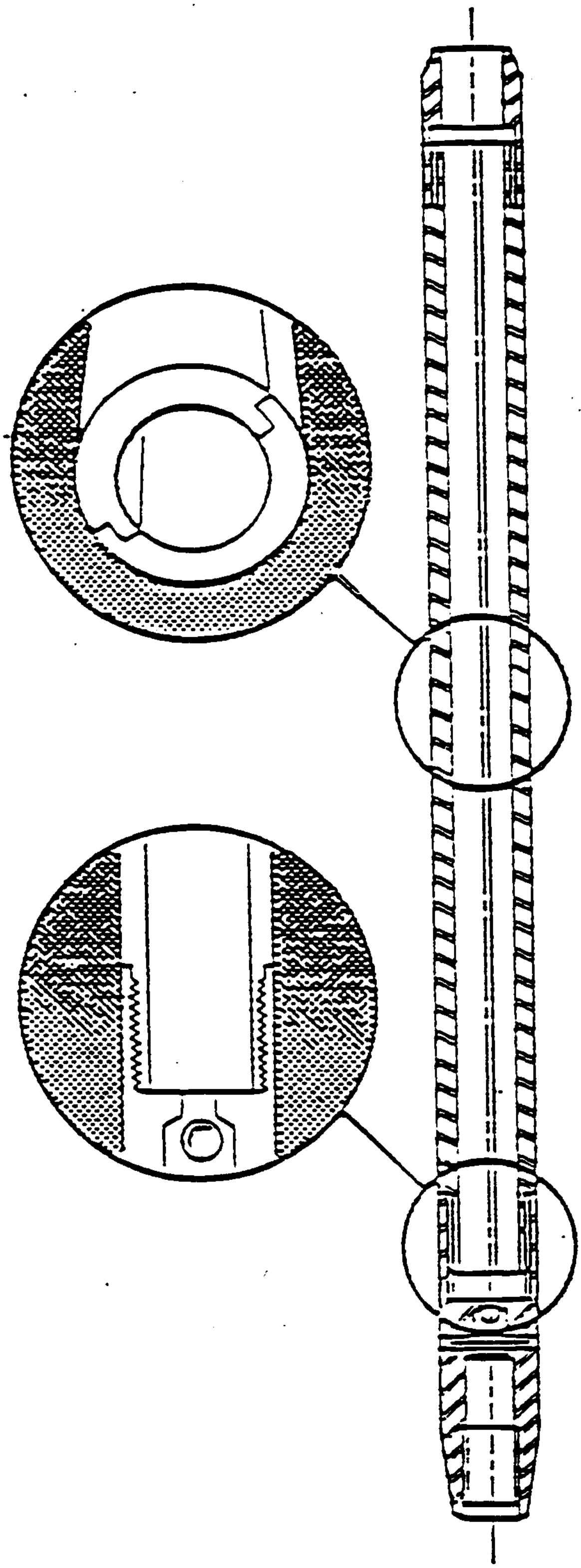

Figure 3
SPLIT-SPOON SAMPLER

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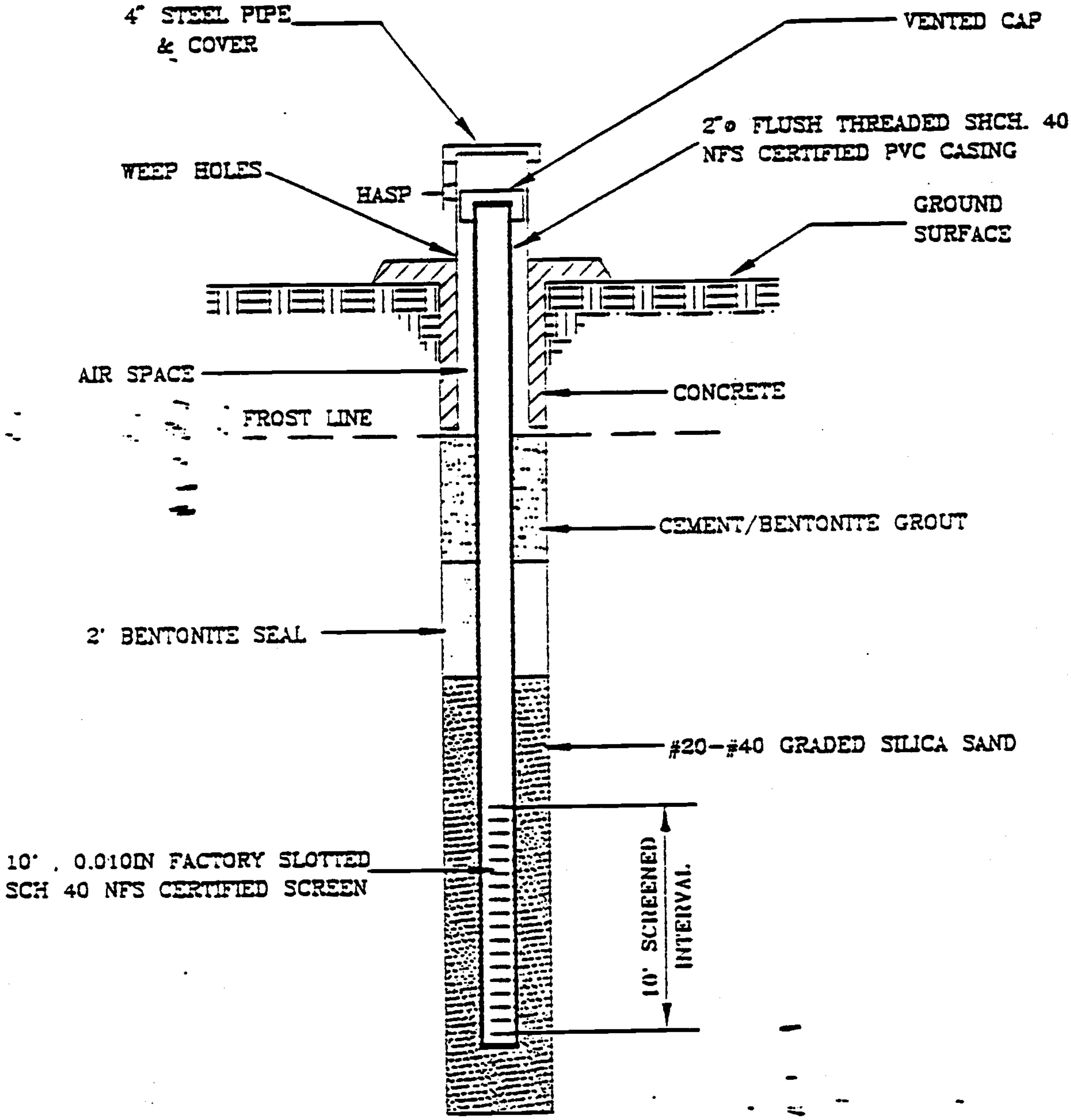
For
Air Force Center of Environmental Excellence



NOTE:
AFTER COMPLETION OF DEVELOPMENT AND SAMPLING ACTIVITIES VERIFY THAT NO WATER IS PRESENT BETWEEN THE GROUND AND THE FROST LINE

NOT TO SCALE

Figure 5
TYPICAL MONITORING WELL INSTALLATION DETAILS

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

GROUND SURFACE ELEVATION ____________

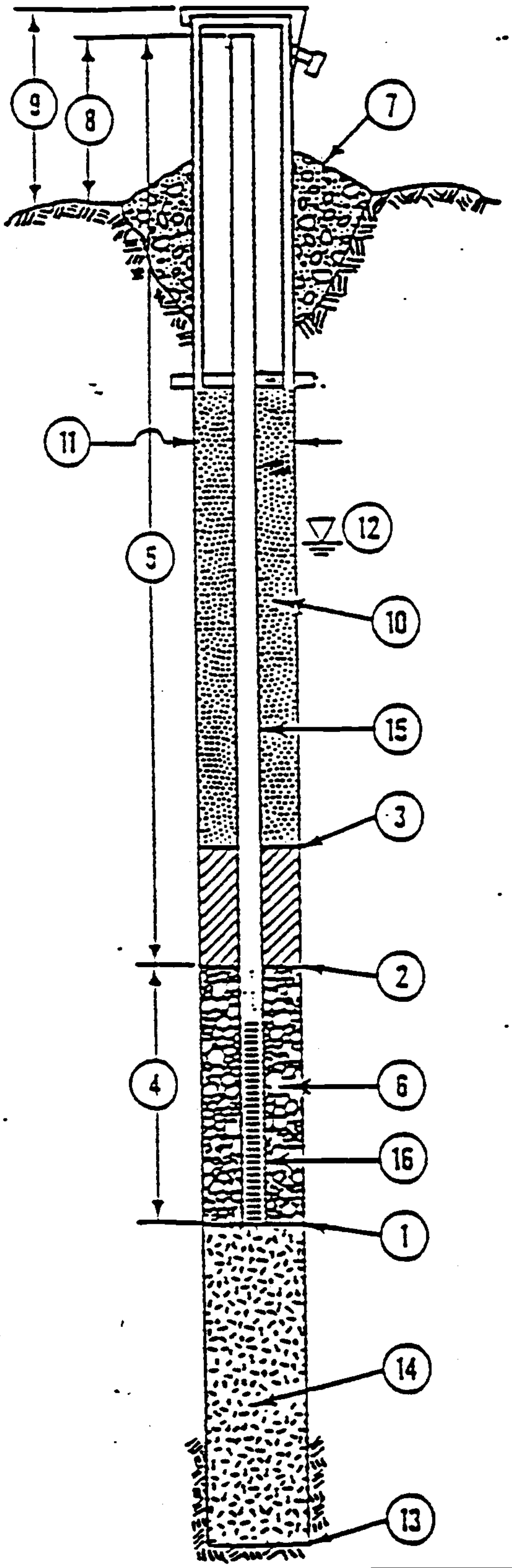
TOP OF WELL CASING ELEVATION ____________

JOB NUMBER ____________

BORING NUMBER ____________

DATE ____________

LOCATION ____________



(1) DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE ____________ FEET.*

(2) DEPTH TO BOTTOM OF SEAL (IF INSTALLED) ____________ FEET.*

(3) DEPTH TO TOP OF SEAL (IF INSTALLED) ____________ FEET.*

(4) LENGTH OF WELL SCREEN ____________ FEET.
SLOT SIZE ____________.

(5) TOTAL LENGTH OF PIPE ____________ FEET AT ________ INCH DIAMETER.

(6) TYPE OF PACK AROUND WELL POINT OR SLOTTED PIPE ____________.

(7) CONCRETE CAP. YES NO (CIRCLE ONE)

(8) HEIGHT OF WELL CASING ABOVE GROUND ____________ FEET.

(9) PROTECTIVE CASING? YES NO (CIRCLE ONE)
HEIGHT ABOVE GROUND ____________ FEET.
LOCKING CAP? YES NO (CIRCLE ONE)

(10) TYPE OF UPPER BACKFILL ____________.

(11) BOREHOLE DIAMETER ____________ INCHES.

(12) DEPTH TO GROUND WATER ____________ FEET.*

(13) TOTAL DEPTH OF BOREHOLE ____________ FEET.*

(14) TYPE OF LOWER BACKFILL ____________.

(15) PIPE MATERIAL ____________.

(16) SCREEN MATERIAL ____________.

*(DEPTH FROM GROUND SURFACE)

Figure 6
MONITOR WELL INFORMATION SHEET

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

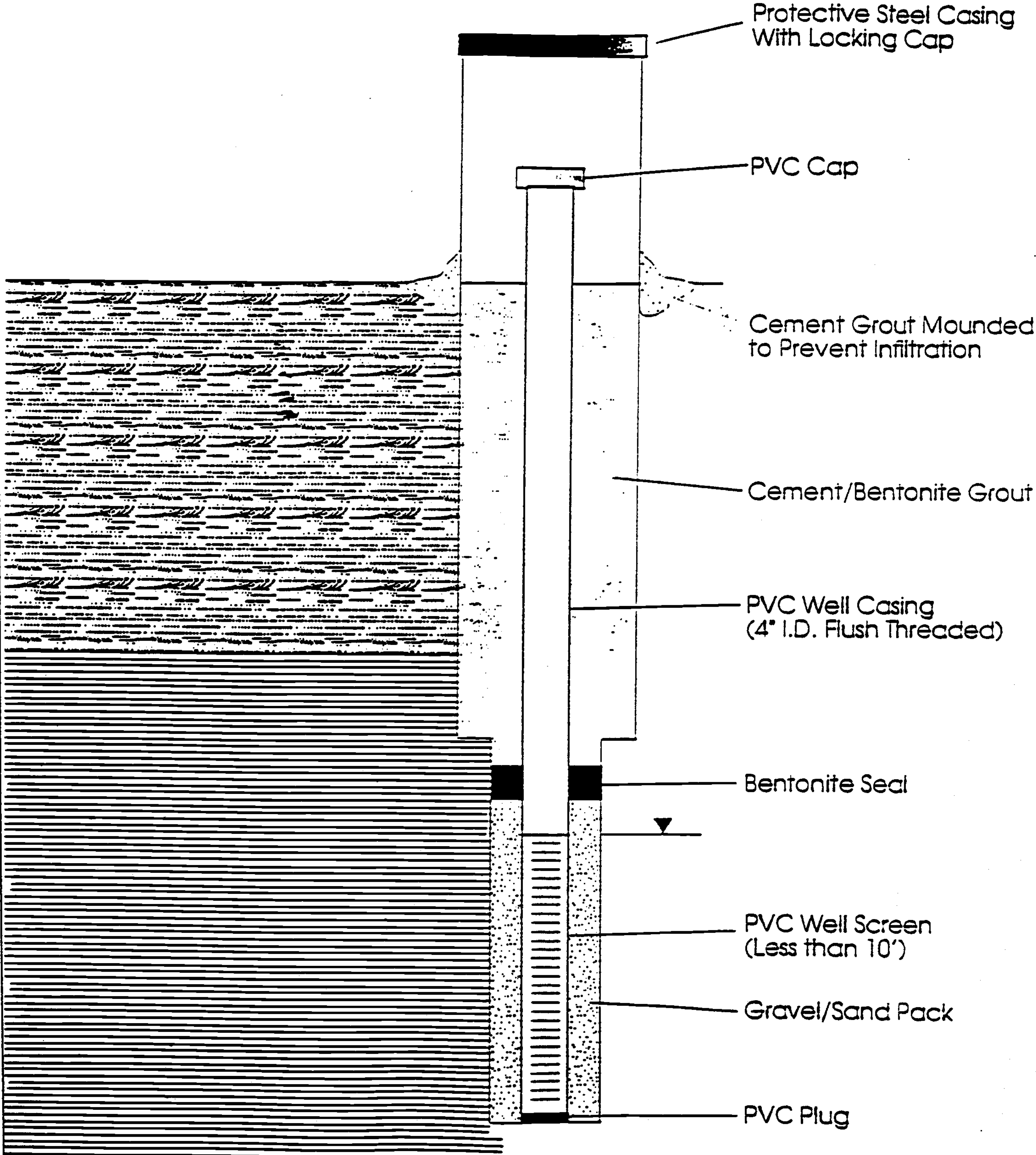


Figure 7
TYPICAL BEDROCK MONITORING WELLINSTALLATION DETAILS

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

1. Date of Development: MM/DD/YY
   Time of Development: Hours/Minutes

2. Elapsed time between grouting and well development: Hours/Minutes

3. Equipment Description: Equipment Used

4. Water level prior to development: WL (ft) from top of casing
   Total well depth prior to development: TD (ft) from top of casing
   Height of Water Column: TD - WL = WC (ft)

5. Development and Stabilization Data Table:

Parameter	Cycle - (includes 15 minutes of surging followed by submersible pumping)										
	1	2	3	4	5	6	7	8	9	10	11
Gallons Pumped (Total = ___)											
Borehole Volumes Pumped (Vol = ___)											
TDS (Total Dissolved Solids) (ppm)											
pH											
Temperature °F											
Turbidity (NTUs) (>200 = offscale)											
Color											
Remarks: (Odor,Cement & Grout)											

For "Borehole Volume" the following formula is used:

Given:
Borehole Size = 11.25" Water = 7.48 gal/ft³ Z = water column height (ft)
PVC Diameter = 2.375" Pack Porosity = 35% X = gallons/borehole volume

$$Volume = \frac{\pi}{(4)(144)} \times (11.25^2 - 2.375^2) \times 0.35 - \frac{\pi}{(4)(144)} \times 2.375^2 \times 7.48 = 2.0 \frac{gallons}{ft.\ water\ column}$$

$$Then,\ 2 \frac{gallons}{ft.\ water\ column} \times (Z)\ ft.\ water\ column = (X) \frac{gallons}{borehole\ volume}$$

6. Development Criteria: The well is considered developed when TDS (tolerance = < 0.75ppm); pH (tolerance = ±0.1 units); temperature (tolerance = ± 1.0 °F) and turbidity (below 100 NTUs for at least 30 minutes) are within tolerance for 3 consecutive cycles. A cycle includes surging followed by the withdrawal of at least one (if possible) borehole volume, as previously defined.

7. Water level following development: WL (ft) from top of casing
   Total well depth following development: TD (ft) from top of casing

   Average pumping rate: GPM (gallons per minute)
   Duration of development: Hours/Minutes

8. Comments: Overall Observations

Figure 8
WELL DEVELOPMENT LOG

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

WELL NO. ______ STABILIZATION TEST

DATE: __________ TIME: __________

PARAMETER	WELL VOLUME EXTRACTED									
	1	2	3	4	5	6	7	8	9	10
SPECIFIC CONDUCTANCE (TEMPERATURE CORRECTED) ± 10μMHOS/cm										
pH: ±0.1 UNIT										
TEMPERATURE: ±0.5 C										
TURBIDITY: ±10 NTUs										
COLOR										
ODOR OF DISCHARGE										

PROCEDURE:

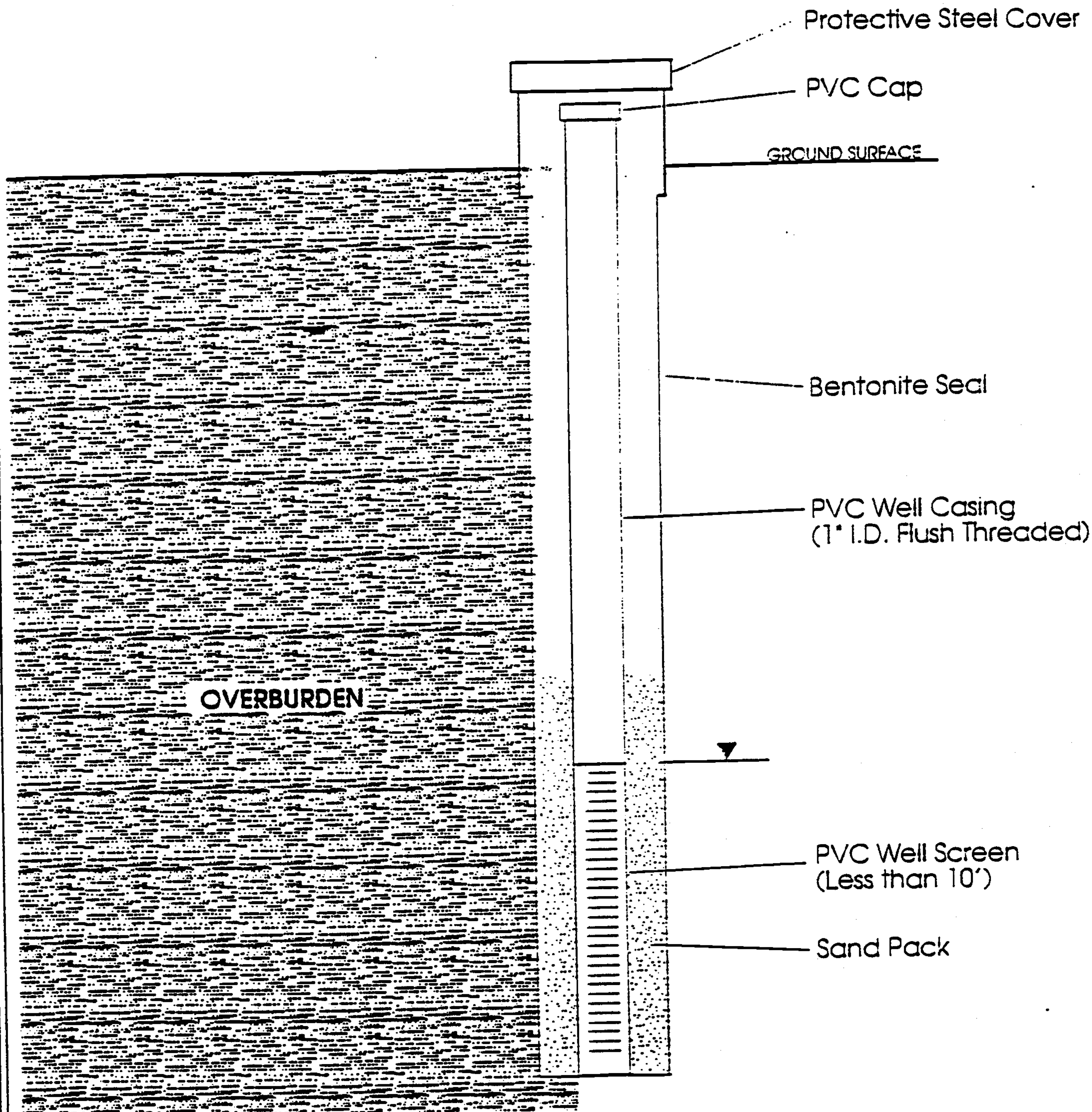
1) Remove one well volume of water - test for pH, temperature, and conductivity. Record the readings.

2) Repeat the procedure at least two more times.

3) Continue the above procedure until three consecutive readings of pH, temperature, and conductivity are equivalent within the ranges shown above.

Figure 9
STABILIZATION TEST FORM

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence



NOT TO SCALE

Figure 10 **TYPICAL TEMPORARY PIEZOMETER INSTALLATION DETAILS**	DAMES & MOORE Richards-Gebaur A.F.B. For Air Force Center of Environmental Excellence

DAMES & MOORE CHAIN-OF-CUSTODY RECORD

Sample Source & Client:						Field Personnel (Signature)
Project Title:			Job No.			
Date	Time	Sample I.D. No.	Sample Type	No. of Containers	Sampling Site	Remarks/Analysis

Relinquished by:	Date	Time	Relinquished by:	Date	Time	Relinquished by:	Date	Time	Relinquished by:	Date	Time
Relinquished by:	Date	Time	Relinquished by:	Date	Time	Relinquished by:	Date	Time	Relinquished by:	Date	Time
Relinquished by:	Date	Time	Relinquished by:	Date	Time	Relinquished by:	Date	Time	Relinquished by:	Date	Time

Figure 11
DAMES & MOORE CHAIN-OF-CUSTODY RECORD

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

FIELD MEMORANDUM

ACTION	INFO	
To:		File:
		X-Ref:
		Date:

From:

Reply Required By:

Subject:

Reference(s):

ROUTING

114.8 (REV. 5-88)

DAMES & MOORE

Figure 12
FIELD MEMORANDUM

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

Water Level Record

Job No:

Client: Date:

Location: Measured by:

Well No.	Time	Elevation of top of casing*	Depth to Water**	Water Elevation*	Screened Interval**	Depth to Bottom**	Comments

* Feet above National Geodetic Vertical Datum of 1929

** Feet below top of casing

DAMES & MOORE

Figure 13
WATER LEVEL RECORD

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

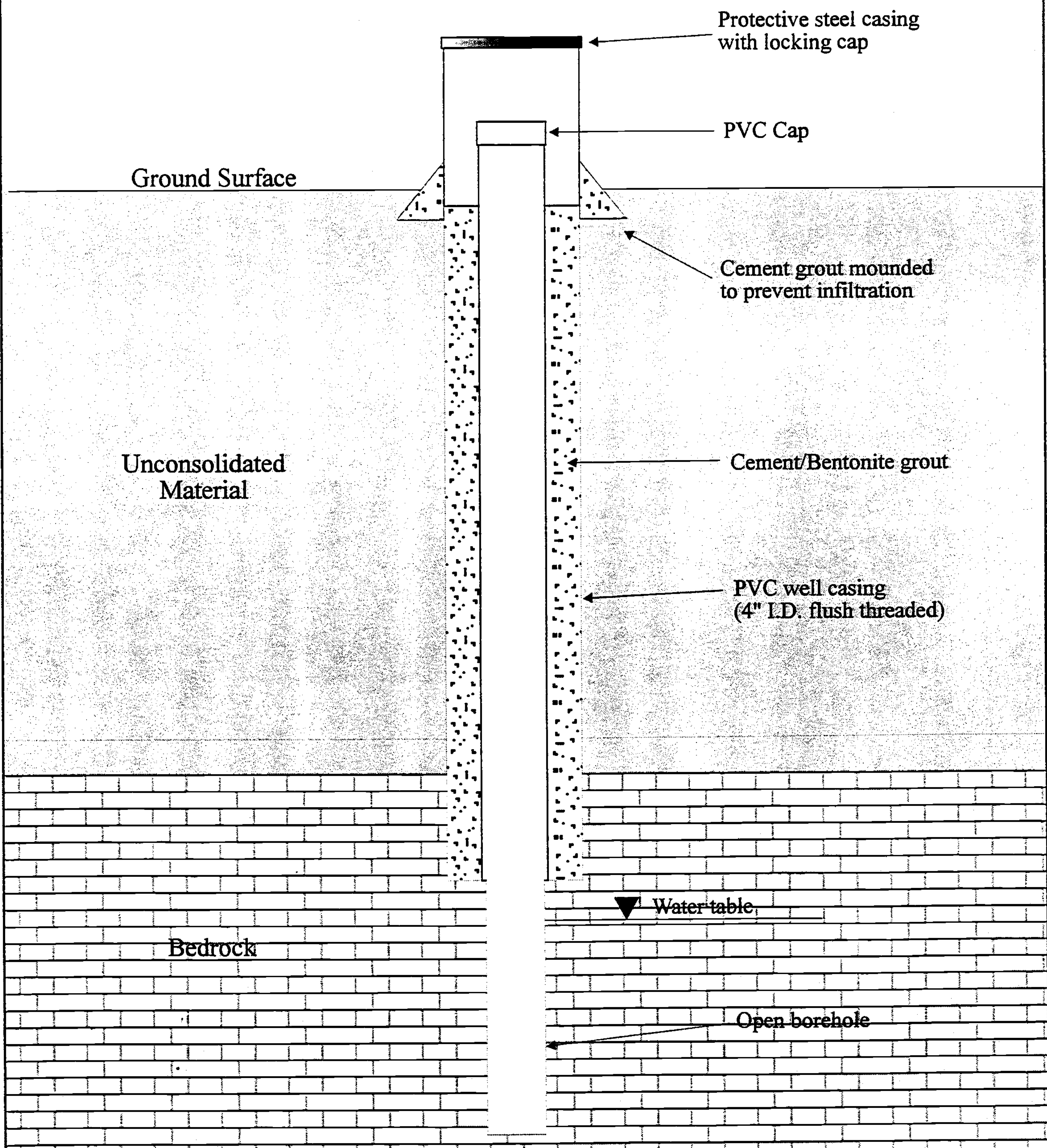


Figure 14
Typical installation details of uncased bedrock monitoring well.

Dames & Moore

Richards-Gebaur AFB
Air Force Center of Environmental Excellance

APPENDIX A

IRPIMS FILES and FIELD DATA SET WORKSHEETS

Location Definition Information (LDI) Worksheet
IRPIMS Files and Fields Data Set

FIELD NAME	CORRECT ENTRY
SiteID	
Location Identifier	
Location Classification Code (IRPIMS DLHB Ver 2.2-p. A-48)	
Location Proximity Code (IRPIMS DLHB Ver 2.2-p. A-47)	
Coordinates (FT) - North	
Coordinates (FT) - East	
Elevation (FT - MSL)	
Date Established	
Establishing Company (Code) (WORKBOOK p. E-1)	
Drilling Company (Code) (WORKBOOK p. E-1)	
Excavating Company (Code) (IRPIMS DLHB Ver 2.2-p. A-38)	
Construction Method (Code) (IRPIMS DLHB Ver 2.2-p. A-32)	
Depth of Borehole or Test Pit (FT)	
Borehole Diameter (IN)	
Location Description	

Well Completion Information Worksheet
IRPIMS Files and Fields Data Set

FIELD NAME	CORRECT ENTRY
Location Identifier	
Installation Date	
Well Owner Code (IRPIMS DLHB Ver 2.2-p. A-99)	
Well Type Classification Code (IRPIMS DLHB Ver 2.2-p. A-100)	
Well Completion Method Code (IRPIMS DLHB Ver 2.2-p. A-98)	
Geologic Completion Zone (IRPIMS DLHB Ver 2.2-p. A-40)	
Sole Source Aquifer Code (IRPIMS DLHB Ver 2.2-p. A-93)	
Measuring Point Elevation(FT)	
Total Casing Depth(FT)	
Seal End Depth(FT)	
Screen Beginning Depth(FT)	
Filter Pack Length(FT)	
Screen Length(FT)	
Screen Slot Size(IN)	
Casing Inside Diameter(IN)	
Screen Diameter(IN)	
Casing Material Code (IRPIMS DLHB Ver 2.2-p. A-32)	
Screen Percent Open Area(%)	
Remarks	

Lithologic Data Worksheet
IRPIMS Files and Fields Data Set

FIELD NAME	CORRECT ENTRY
Location ID	
Logdate	
Logging Company (Code) (WORKBOOK p. E-1)	
Beginning Depth	
Ending Depth	
Lithology Code (IRPIMS DLHB Ver 2.2-p.A-43)	
ASTM Code (IRPIMS DLHB Ver 2.2-p.A-30)	
Stratigraphic Order	
Remarks	
Beginning Depth	
Ending Depth	
Lithology Code (IRPIMS DLHB Ver 2.2-p.A-43)	
ASTM Code (IRPIMS DLHB Ver 2.2-p.A-30)	
Stratigraphic Order	
Remarks	
Beginning Depth	
Ending Depth	
Lithology Code (IRPIMS DLHB Ver 2.2-p.A-43)	
ASTM Code (IRPIMS DLHB Ver 2.2-p.A-30)	
Stratigraphic Order	
Remarks	

Groundwater Level Data Worksheet
IRPIMS Files and Fields Data Set

FIELD NAME	CORRECT ENTRY
Location Identifier	
Date Measurements were taken	
Contract ID	
Delivery Order Number	
Static Measurements	
Log Time (HHMM)	
Logging Company (Code) (WORKBOOK p. E-1)	
Static Depth (FT)	
Sounding (FT)	
Dynamic Measurements	
Logtime (HHMM)	
Initial Depth (FT)	
Production Rate	
Pump Depth (FT)	
Recover Depth (FT)	
Recovery Time (HHMM)	
Sounding	
Remarks	

Calculated Hydrologic Parameters Worksheet
IRPIMS Files and Fields Data Set

FIELD NAME	CORRECT ENTRY
Delivery Order Number	
Location Identifier	
Date of Test	
Calcd. Param Code (IRPIMS DLHB Ver 2.2-p. A-31)	
Parameter Value	
Units of Measure	

Calculated Hydrologic Parameters Worksheet
IRPIMS Files and Fields Data Set

FIELD NAME	CORRECT ENTRY
Contract ID	
Delivery Order Number	
Location Identifier	
Date of Test	
Calcd. Param Code (IRPIMS DLHB Ver 2.2-p. A-31)	
Parameter Value	
Units of Measure	

Environmental Sampling Information Worksheet
IRPIMS Files and Fields Data Set

FIELD NAME	CORRECT ENTRY
Delivery Order Number	
Location Identifier	
Log Date	
Log Time	
Log Code (WORKBOOK p. E-1)	
Sample QC Type (Code) (IRPIMS DLHB Ver 2.2-p. A-91)	
Matrix (Code) (IRPIMS DLHB Ver 2.2-p. A-49)	
Sample Method (Code) (IRPIMS DLHB Ver 2.2-p. A-94)	
Begin Depth	
End Depth	
Lot Control Number	

Environmental Sampling Information Worksheet
IRPIMS Files and Fields Data Set

FIELD NAME	CORRECT ENTRY
Delivery Order Number	
Location Identifier	
Log Date	
Log Time	
Log Code (WORKBOOK p. E-1)	
Sample QC Type (Code) (IRPIMS DLHB Ver 2.2-p. A-91)	
Matrix (Code) (IRPIMS DLHB Ver 2.2-p. A-49)	
Sample Method (Code) (IRPIMS DLHB Ver 2.2-p. A-94)	
Begin Depth	
End Depth	
Lot Control Number	

FIELD NAME	CORRECT ENTRY
Sample Description	
Location	
Log Date	
Matrix (Code) (IRPIMS DLHB Ver 2.2-p. A-49)	
QC Type (Code) (IRPIMS DLHB Ver 2.2-p. A-91)	
Begin Depth	
End Depth	
Contract ID	
DO #	
Test Description	
Analytical Method (Code) (IRPIMS DLHB Ver 2.2-p. A-10)	
Extraction Method (Code) (IRPIMS DLHB Ver 2.2-p. A-39)	
Parameter Value Classification Code (IRPIMS DLHB Ver 2.2-p. A-90)	
Units (Code) (IRPIMS DLHB Ver 2.2-p. A-95)	
Laboratory (Code) (WORKBOOK p. E-1)	
Laboratory Sample ID	
Extraction Date	
Time	
Analysis Date	
Time	
Laboratory QC lot Number	
Basis (Code) (IRPIMS DLHB Ver 2.2-p. 2-18)	

BCHRES Worksheet
IRPIMS Files and Fields Data Set

Results

Analyte	VQ	Par Val	Prec	Expected	Det Limit

FIELD NAME	CORRECT ENTRY
Sample Description	
Location	
Log Date	
Matrix (Code) (IRPIMS DLHB Ver 2.2-p. A-49)	
QC Type (Code) (IRPIMS DLHB Ver 2.2-p. A-91)	
Begin Depth	
End Depth	
Contract ID	
DO #	
Test Description	
Analytical Method (Code) (IRPIMS DLHB Ver 2.2-p. A-10)	
Extraction Method (Code) (IRPIMS DLHB Ver 2.2-p. A-39)	
Parameter Value Classification Code (IRPIMS DLHB Ver 2.2-p. A-90)	
Units (Code) (IRPIMS DLHB Ver 2.2-p. A-95)	
Laboratory (Code) (WORKBOOK p. E-1)	
Laboratory Sample ID	
Extraction Date	
Time	
Analysis Date	
Time	
Laboratory QC lot Number	
Basis (Code) (IRPIMS DLHB Ver 2.2-p. 2-18)	

This worksheet continues on the next page.

Results

Analyte	VQ	Par Val	Prec	Expected	Det Limit

FORMER UNDERGROUND STORAGE TANK SITE ST007

PRELIMINARY FINDINGS
AND
RECOMMENDATIONS

RICHARDS-GEBAUR AIR FORCE BASE
F41624-94-D-8102-0004
DELIVERY ORDER 0003
UEBL 95-6004

This document presents the preliminary results of an assessment of the performance of a passive bio-venting remedial action ongoing at the site and recommendations for closure.

Questions regarding this plan may be directed to the Delivery Order Manager, Wayne Mizer, (913) 677-1490, ext 118.

PREPARED FOR
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS

November 13, 1996

PREPARED BY:
DAMES & MOORE, INC.

1.0 INTRODUCTION

Underground storage tank (UST) site ST007 at the former Richards-Gebaur Air Force Base (AFB), Missouri is being closed in compliance with Missouri Department of Natural Resources (MDNR) and federal regulations. This work is being performed as part of the Base Realignment and Closure Cleanup Plan (BCP) for Richards-Gebaur AFB.

2.0 Background

Richards-Gebaur AFB, under the control of the Air Force Base Conversion Agency (AFBCA), is located in western Missouri, approximately 18 miles south of downtown Kansas City and 3 miles east of the Kansas state line.

Site ST007 was located adjacent to Building 902 and consisted of four steel 25,000-gallon UST used by the Air Force to store jet fuel (JP-4). The tanks were in use from 1954 until 1971 and were abandoned in place in 1977. The tanks, pumps, and associated piping were removed during the first quarter of 1988. Fuel-contaminated soil was observed at the site during removal of the tanks.

In October 1989, General Testing Laboratories, Inc. (GTL) of Kansas City, Missouri advanced 8 soil borings at the site and collected one soil sample per boring for environmental analysis of benzene, ethylbenzene, toluene, xylenes (BETX) and total petroleum hydrocarbons (TPH). The soil samples ranged in depth from 3 to 12.5 feet and confirmed the presence of petroleum contamination at the site. The analytical results for the soil samples reported no concentrations of benzene or toluene above the method detection limits (MDL). Concentrations of ethylbenzene and xylene were detected in two borings at 1.4 and 1.8 mg/Kg. TPH was detected in five borings at concentrations ranging from 62 to 1,618 mg/Kg.

A passive bio-venting system was installed at that time as an initial remediation effort. The GTL soil boring and bio-vent locations are shown on Figure 1.

In November 1991, Geraghty & Miller (G&M) performed an investigation of the site. Due to standing water in the former excavation, three monitoring wells and eight soil borings were installed outside of the perimeter of the tank removal area. The soil borings were drilled to the top of bedrock, approximately 12 to 17 feet below surface. Analytical results of the eight soil samples reported no BETX constituents and TPH ranging from non-detect to 18 mg/Kg. The analytical results of the water samples reported no TPH above the MDL, but xylene was detected in MW-1 at 21 micrograms per liter (µg/L). The G&M soil boring and monitoring well locations are shown on Figure 1.

3.0 ST007 CLEANUP GOALS AND OBJECTIVES

The cleanup goal is the reduction of contaminants in soils to action levels acceptable to MDNR and Air Force. Since ST007 is a former UST site, the MDNR Leaking UST Soil Cleanup Guidelines for Undisturbed Soil (matrix) was used to determine cleanup objectives. A score of 80 was calculated for the site from this matrix which establishes cleanup objectives for benzene, toluene, ethylbenzene, and xylene at 1, 5, 10, and 10 milligrams per kilogram (mg/Kg), respectively, and TPH at 200 mg/Kg. The MDNR Leaking UST Soil Cleanup Guidelines for Undisturbed Soil matrix is presented as Table 1.

If groundwater has been impacted by petroleum contamination, the following criteria established by MDNR must be achieved prior to declaring a site clean: 50 µg/L benzene; 320 µg/L ethylbenzene; 150 µg/L toluene; 320 µg/L xylenes; 750 µg/L total BETX; and 10,000 µg/L TPH.

4.0 SITE ST007 CLOSURE PROGRAM

Dames & Moore conducted subsurface soil and ground water sampling to assess the performance of the passive bio-venting remedial action ongoing at the site. If MDNR closure criteria were met, the bio-vents were to be closed/decommissioned in accordance with current MDNR Well Construction Rules.

Table 1
MDNR Leaking Underground Storage Tank
Cleanup Guidelines for Undisturbed Soil

Site Features	Score 15 if True		Score 10 if True		Score 5 if True		Score 0 if True	
Groundwater potable?	No	15	Unknown		Poor		Yes	
Depth to groundwater?	> 100 ft.		51-100 ft.		25-50 ft.		< 25 ft.	0
Natural fractures present?	None		Unknown	10	Present		Predominant	
Man-made vertical conduits?	None		Unknown	10	Present		Predominant	
Man-made horizontal conduits?	None		Unknown		Present	5	Predominant	
Coarse soil or sand present?	None	15	Unknown		Present		Predominant	
Water wells nearby?	> 1,000 ft. away	15	501-1,000 ft. away		100-500 ft. away		< 100 ft. away	
Background levels present?	Above action levels		Unknown	10	Below action level		Non-detectable	
Subtotals		45		30		5		0
						Total Score =	**80**	

Soil Cleanup (mg/Kg)				
Total Score	101-120	71-100	41-70	40 or less
BETX =	2/10/50/50	1/5/10/10	0.5/1/2/2	B+T+E+X < 2
TPH =	500	200	100	50

PRELIMINARY FINDINGS AND RECOMMENDATIONS - FORMER UST SITE ST007

Soil borings were to be advanced and sampled to assess BETX and TPH concentrations in the site soil. Two rounds of seasonal (March-dry season, June-wet season) groundwater sampling of three existing monitoring wells were to be conducted to assess groundwater contamination.

4.1 MONITORING WELL SAMPLING

Dry season sampling of the three monitor wells was conducted on March 22, 1996. The three water samples and one duplicate sample were shipped to Ross Analytical Services, Inc. (RASI) in Strongsville, Ohio for BETX, gasoline range organic (GRO) TPH, and diesel range organic (DRO) TPH analyses. The analytical results for the ground water samples reported no concentrations of BETX or GRO above the estimated quantitation limit (EQL). Concentrations of DRO ranging from 0.14 mg/L in MW-2 and MW-3 to 2.1 mg/L in MW-1 were detected in the ground water samples.

Wet seasoning sampling of the three monitor wells was conducted on June 3, 1996. The three water samples and one duplicate sample were shipped to RASI for analysis of BETX and TPH (GRO, DRO). The analytical results for the ground water samples reported no concentrations of benzene, toluene, and xylene or GRO above the estimated quantitation limit (EQL). Ethylbenzene and DRO were detected in MW-1 at a concentrations of 13 μg/L and 2.3 mg/L, respectively.

4.2 INITIAL SOIL SAMPLING

Dames & Moore conducted soil sampling activities at the former UST site on April 11 and 12, 1996. PSA Environmental (PSA) of Lee's Summit, Missouri utilized a truck-mounted GeoProbe rig to collect the soil samples. A total of nine borings were advanced by PSA at the southwest, southeast, and northeast corners of the site, adjacent the existing bio-vents. Eighteen soil samples (two from each boring) and two field duplicates were submitted to RASI for laboratory analysis of BETX and TPH (GRO, DRO).

The analytical results for the soil samples reported no concentrations of benzene, toluene, or xylene above MDNR Cleanup Guidelines for USTs. Ethylbenzene was detected above MDNR Cleanup Guidelines in RG3-USTSB-7-2' and RG3-USTSB-8-6' in concentrations of 13.4 and 12.54 mg/Kg, respectively. Concentrations of TPH (GRO, DRO) above MDNR Cleanup Guidelines were detected in 12 of the 18 samples ranging from 216 mg/Kg in RG3-USTSB9-6.3' to 2,150 mg/Kg in RG3-USTSB4-3'.

4.3 ADDITIONAL SOIL SAMPLING

Dames & Moore installed five additional borings to further delineate the extent of contaminated soil. The analytical results reported no concentrations of benzene, toluene, xylene, or GRO above the EQL. The analytical results for the soil samples reported no concentrations of BETX or DRO above MDNR Cleanup Guidelines.

One grab water sample was collected from inside a bio-vent located at the northeast corner of the vent grid. The water sample was collected with a disposable Teflon bailer and submitted to RASI for BETX and TPH (GRO, DRO) analysis. The analytical results reported no BETX or GRO concentrations above the EQL. DRO were detected at 1,500 μg/L.

The Dames & Moore boring locations are shown on Figure 3. A summary of the soil analytical results is presented in Table 2.

5.0 CONCLUSIONS

The results of the site investigation indicate the passive bio-venting systems is not remediating the petroleum contaminated soils at site ST007. This is likely due to the saturation of the soils by groundwater, which would inhibit aerobic biodegradation of contaminants in the soil. The ground water level within the former tankhold was observed approximately 18 to 24 inches below the top of the bio-vent casings during the last sampling event on August 30, 1996.

Table 2
Summary of Soil Analytical Results
Richards-Gebaur Air Force Base
Delivery Order 0003
Former UST Site ST007

			Total TPH (mg/Kg)	Benzene (ug/Kg)	Toulene (ug/Kg)	Ethyl Benzene (ug/Kg)	Xylenes (ug/Kg)
	Cleanup Guideline		200	1,000	5,000	10,000	10,000
Sample Identification	Date Sampled	Matrix Soil/Water					
RG3-USTSB3-2.5	4/15/96	Soil	510	<EQL^{250}	210 (J)	<EQL^{250}	<EQL^{500}
RG3-USTSB4-3	4/15/96	Soil	2,140	<EQL^{250}	<EQL^{250}	<EQL^{250}	130 (J)
RG3-USTSB4-6.8	4/15/96	Soil	1,140	<EQL^{250}	<EQL^{250}	5,148	<EQL^{500}
RG3-USTSB5-5.5	4/15/96	Soil	1,004	<EQL^{250}	<EQL^{250}	<EQL^{250}	<EQL^{500}
RG3-USTSB5-2	4/15/96	Soil	2,130	<EQL^{250}	<EQL^{250}	<EQL^{250}	<EQL^{500}
RG3-USTSB5-2FD	4/15/96	Soil	2,150	<EQL^{250}	<EQL^{250}	<EQL^{250}	<EQL^{500}
RG3-USTSB6-2.1	4/15/96	Soil	261	<EQL^{250}	<EQL^{250}	<EQL^{250}	<EQL^{500}
RG3-USTSB6-4	4/15/96	Soil	430	<EQL^{250}	<EQL^{250}	4,548	<EQL^{500}
RG3-USTSB7-5.1	4/15/96	Soil	252	*<EQL$^{2.0}$	*<EQL$^{2.0}$	*57	<EQL$^{4.0}$
RG3-USTSB8-2	4/15/96	Soil	1,120	*<EQL^{500}	*<EQL^{500}	*9,770	*<EQL^{1000}
RG3-USTSB8-6	4/15/96	Soil	172	*<EQL^{500}	*<EQL^{500}	*11,430	*<EQL^{1000}
RG3-USTSB9-6.3	4/15/96	Soil	416	*<EQL^{640}	*<EQL^{640}	*16,870	*<EQL^{1300}
RG3-USTSB7-2	7/13/96	Soil	NA	<EQL^{500}	<EQL^{500}	13,400	<EQL^{1000}
RG3-USTSB8-6	7/13/96	Soil	NA	<EQL^{500}	<EQL^{500}	12,540	<EQL^{1000}

[MDNR UST Cleanup Guidlines]
EQL - Estimated Quantitation Limit.
NA - Specified parameter not analyzed.
* - Due to a R.A.S.I. laboratory systems error these 8020 BTEX samples exceeded holding times and should only be used for screening purposes.

PRELIMINARY FINDINGS AND RECOMMENDATIONS - FORMER UST SITE ST007

Based on the data provide by the laboratory analyses, field screening data, and boring logs, the estimated volume of TPH-contaminated soil exceeding MDNR UST soil cleanup guideline is 300 cubic yards (yd^3). The location and areal extent of contaminated soil is presented on Figure 1.

Groundwater contamination exceeding MDNR cleanup criteria is limited to the former UST tank pit area and does not appear to be migrating downgradient at concentrations that would pose a risk to human health and the environment.

6.0 RECOMMENDATIONS

Dames & Moore recommends AFBCA request closure of site ST007 with no further action under the MDNR UST Program. A copy of the October 17, 1995 MDNR letter presenting the MDOH cleanup levels is attached.

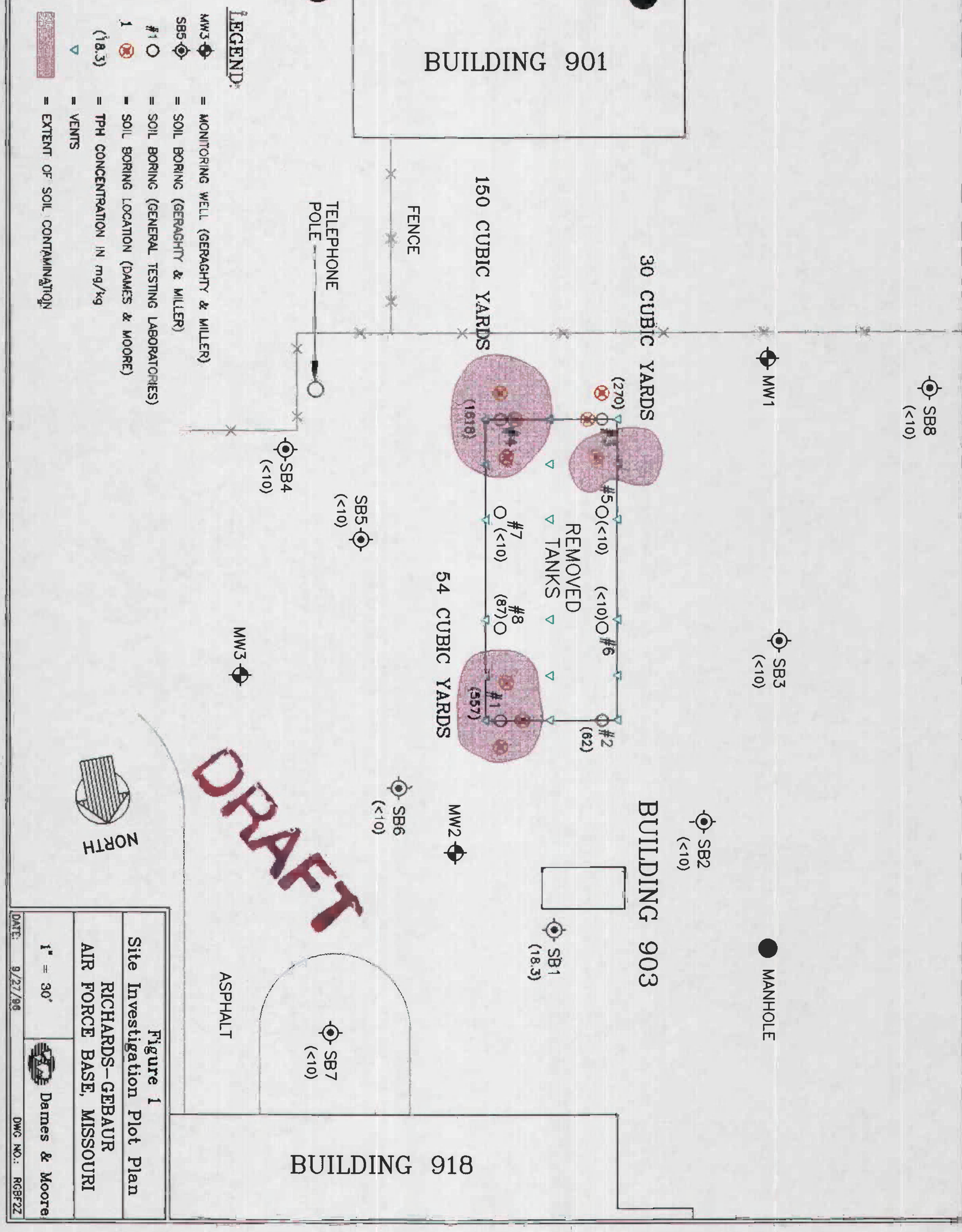
Final closure of the site should include the following:

- Draining of the contaminated water from the former tank pit;
- Removal/closure of the bio-vents; and
- Backfilling/capping of the site.

Table 1
MDNR Leaking Underground Storage Tank
Cleanup Guidelines for Undisturbed Soil

Site Features	Score 15 if True		Score 10 if True		Score 5 if True		Score 0 if True	
Groundwater potable?	No	15	Unknown		Poor		Yes	
Depth to groundwater?	> 100 ft.		51-100 ft.		25-50 ft.		< 25 ft.	0
Natural fractures present?	None		Unknown	10	Present		Predominant	
Man-made vertical conduits?	None		Unknown	10	Present		Predominant	
Man-made horizontal conduits?	None		Unknown		Present	5	Predominant	
Coarse soil or sand present?	None	15	Unknown		Present		Predominant	
Water wells nearby?	> 1,000 ft. away	15	501-1,000 ft. away		100-500 ft. away		< 100 ft. away	
Background levels present?	Above action levels		Unknown	10	Below action level		Non-detectable	
Subtotals		45		30		5		0
						Total Score =	**80**	

Soil Cleanup (mg/Kg)				
Total Score	101-120	71-100	41-70	40 or less
BETX =	2/10/50/50	1/5/10/10	0.5/1/2/2	B+T+E+X < 2
TPH =	500	200	100	50


LEGEND:
MW3 = MONITORING WELL (GERAGHTY & MILLER)
SB5 = SOIL BORING (GERAGHTY & MILLER)
#1 = SOIL BORING (GENERAL TESTING LABORATORIES)
1 = SOIL BORING LOCATION (DAMES & MOORE)
(18.3) = TPH CONCENTRATION IN mg/kg
= VENTS
= EXTENT OF SOIL CONTAMINATION
BUILDING 901
BUILDING 903
BUILDING 918
150 CUBIC YARDS
30 CUBIC YARDS
54 CUBIC YARDS
REMOVED TANKS
FENCE
TELEPHONE POLE
MANHOLE
ASPHALT
NORTH
DRAFT
MW1
MW2
MW3
SB1 (18.3)
SB2 (<10)
SB3 (<10)
SB4 (<10)
SB5 (<10)
SB6 (<10)
SB7 (<10)
SB8 (<10)
(270)
(1818)
#4
#5 (<10)
#6 (<10)
#7 (<10)
#8 (87)
#1 (557)
#2 (62)
Figure 1
Site Investigation Plot Plan
RICHARDS-GEBAUR
AIR FORCE BASE, MISSOURI
1" = 30'
Dames & Moore
DATE: 9/27/96
DWG NO.: RGBF2Z