FINAL
FIELD SAMPLING PLAN
RADIOLOGICAL BACKGROUND STUDY
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

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LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	American Society of Testing and Materials
bgs	below ground surface
Boeing	The Boeing Company
DOE	Department of Energy
DPT	direct push technology
DTL	distance test location
DTSC	Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
HGL	HydroGeoLogic, Inc.
IDW	investigation-derived waste
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MS	matrix spike
MSD	matrix spike duplicate
NASA	National Aeronautics and Space Administration
No.	number
%	percent
PPE	personal protective equipment
PRG	preliminary remediation goal
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RBRA	radiological background reference area
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SSFL	Santa Susana Field Laboratory
USCS	Unified Soil Classification Systems

FINAL
FIELD SAMPLING PLAN
RADIOLOGICAL BACKGROUND STUDY
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

1.0 RADIOLOGICAL BACKGROUND STUDY PROGRAM

This field sampling plan (FSP) describes the sampling process design, and field methods and procedures that will be employed to accomplish the radiological background study objectives by HydroGeoLogic Inc. (HGL) under the direction of the U.S. Environmental Protection Agency (EPA). The subsections below describe the background study soil sampling, the gamma scanning effort, and the rationale for the effort. The primary objective of the Santa Susana Field Laboratory (SSFL) radiological background study is to determine background radionuclide concentrations within surface and subsurface soils overlying the two geologic formations that are present at the SSFL (Chatsworth and Santa Susana Formations). The potential uses of the data generated from this study are as follows:

- Determine the extent of soil contamination at the SSFL;
- Assist the California Department of Toxic Substances Control (DTSC) in establishing appropriate cleanup levels;
- Provide background data to be used in human health and ecological risk assessments; and
- Establish a reference data set for characterization surveys and site closure surveys (final status surveys) in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance.

To accomplish this primary objective, surface and subsurface soil samples will be collected at three radiological background reference areas (RBRA) located outside the SSFL property boundary. Two of these areas overlie the Chatsworth Formation and one area overlies the Santa Susana Formation. The RBRAs that overlie the Chatsworth Formation are known as the Lang Ranch Location and the Rocky Peak Location, and the one that overlies the Santa Susana Formation is known as the Bridle Path Location [Sampling Analysis Plan (SAP) Figure 1.2].

A secondary objective is to determine whether surface soils at the RBRAs have been impacted by atmospheric releases from the SSFL. This objective must be accomplished to determine whether soils at the RBRAs are representative of regional background conditions. To accomplish this secondary objective, surface soil samples will be collected in areas that are located greater than 10 miles from the SSFL. These locations are referred to as distance test locations (DTL). Surface soil samples will be collected and analyzed at 20 of the DTLs identified on SAP Figure 1.6 (for example: 5 in each quadrant). These samples will be analyzed for a targeted group of radionuclides, which would likely be found in SSFL atmospheric releases. Surface soil samples will also be collected at the three RBRAs and analyzed for the same targeted list of radionuclides. A statistical analysis will be conducted to determine whether the radionuclide concentrations in surface soil at the individual RBRAs are higher than the radionuclide concentrations at the DTLs.

1.1 SUMMARY OF ACTIVITIES

The following activities are associated with the study:

- Conduct a screening-level gamma scanning survey of surface soils at the DTLs to identify potential anomalies.
- Collect surface soil samples for laboratory analysis at both the DTLs and RBRAs.
- Collect subsurface soil samples for laboratory analysis at the RBRAs.
- Conduct a gross gamma scanning survey of surface soils at the RBRAs.
- Analyze surface and subsurface soil samples collected at the RBRAs for a large suite of radionuclides. The laboratory analyses will be conducted at a fixed laboratory.
- Analyze surface soil samples collected at the DTLs for a select list of radionuclides. The laboratory analyses will be conducted by Pace Analytical Services located in Greensburg, Pennsylvania.
- Validate the data to determine the usability of the data.
- Conduct a statistical evaluation of radionuclide concentrations in surface soil samples collected from the DTLs and the RBRAs to determine whether the RBRAs have been impacted by SSFL releases.
- Conduct a statistical analysis for surface and subsurface soil data collected at the RBRAs to determine a background concentration for each radionuclide.

1.2 RADIONUCLIDE SELECTION CRITERIA

The selection of radionuclides for laboratory analyses was a key technical issue that was addressed during the project planning phase. The primary goal of this effort was to identify radionuclides that could be present in SSFL soils. The process of selecting radionuclides involved an extensive technical evaluation and several meetings with the Background Study Technical Group. Through these discussions, the following criteria were adopted for the selection of radionuclides that will be included in the RBRA soil analyses:

- Radionuclide was used or produced at SSFL.
- The physical state of the radionuclide was not a gas. An exception to this criterion was that if the radionuclide was a gas and had a parent not removed from the list, it would not be proposed for removal.
- Radionuclide has a half-life greater than 1 year. An exception to this criterion is if the radionuclide has a half-life of less than 1 year and its parent was not removed from the list. In this case, the radionuclide was not proposed for removal.
- Radionuclide has a preliminary remediation goal (PRG) value.

Appendix A of this report summarizes the criteria used to identify radionuclides for laboratory analyses. Table 2 in Appendix A presents the complete list of radionuclides that will be analyzed in RBRA soils. It should be noted that the desired radionuclide detection limits that are listed in Appendix A correspond to agricultural PRGs. These were selected as the desired detection limits, because California law, Article 5.5 in Chapter 6.8 of Division 20 of the Health and Safety Code (SB990), dictates that radiological contamination at the SSFL should ultimately be remediated to agricultural PRGs.

Six radionuclides were selected by the Background Study Technical Group for the laboratory analysis of surface soils collected at the DTLs. These radionuclides were selected by the Radiological Background Study Technical Workgroup based upon the rationale that they would likely be found in soils impacted by atmosphere releases from the SSFL. Table 3 in Appendix A lists these six radionuclides.

1.3 AREA AND LOCATION SELECTION CRITERIA

An extensive evaluation was conducted to identify suitable RBRAs and DTLs. This process focused on finding sampling locations that were within undeveloped, public parklands and opens spaces. Initially, the evaluation focused on identifying sites within the Santa Susana or Chatsworth Formations that could be used for RBRAs. The Background Study Technical Group, consisting of community members, EPA, Department of Energy (DOE), The Boeing Company (Boeing), National Aeronautics and Space Administration (NASA), DTSC and contractors, participated in this evaluation process and the selection of RBRAs. Subsequent efforts focused on the identification of DTLs, located at least 10 miles from the SSFL. The Santa Susana and Chatsworth Formations do not extend more than 6 miles from the SSFL. Consequently, the DTLs could not be located in areas that are not underlain by these geologic formations.

The identification of both RBRAs and DTLs involved the following activities:

- Development of site selection criteria;
- Evaluation of historical studies, maps, and aerial photos;
- Selection of areas for more extensive evaluation;
- Extensive site reconnaissance; and
- Selection of optimal sites based on the selection criteria.

Members of the Background Study Technical Group participated in several field reconnaissance trips. Most members of the Background Study Technical Group participated in the site reconnaissance activities associated with the RBRAs. A smaller group consisting of HGL and several community members conducted the site reconnaissance for the DTLs, and ultimately identified the DTLs that are discussed below.

The following sections describe the selection criteria for the RBRAs and DTLs.

1.3.1 Radiological Background Reference Areas

The RBRAs selected for sampling were evaluated based on the following criteria, which were developed by the Background Study Technical Group:

- Distance and direction from the SSFL;
- Site elevation;
- The size of the area;
- The geologic formation underlying the site (Chatsworth or Santa Susana formations);
- Property access to the location can be obtained;
- The area can be easily cleared for grid spacing, surveying, and sampling;
- The necessary equipment can be mobilized to the site (for example: the site is physically accessible);
- The area is minimally shielded by the surrounding mountains;
- The area is minimally shielded by heavy vegetation;
- There is no indication of human activity in the area;
- There is a sufficient depth of soil to allow for subsurface soil sampling;
- There is minimal evidence of animal disturbance;
- There is minimal evidence of erosion in the area; and
- There is a minimal presence of protected animals and/or plants in the area.

After an extensive site identification and evaluation process, three RBRAs were selected for data collection. Two of these areas overlie the Chatsworth Formation and one area overlies the Santa Susana Formation. The locations of these RBRAs are illustrated on SAP Figure 1.2.

1.3.2 Distance Test Locations

As with the RBRAs, undeveloped, public parklands and opens spaces were evaluated for the purpose of identifying DTLs. Community members provided considerable input into the parklands and open spaces that were ultimately considered for further evaluation. The following criteria were used to identify and select the DTLs:

- Each location is greater than 10 miles from the SSFL;
- The locations are evenly distributed in all directions surrounding the SSFL, with 10 locations in each compass quadrant – northeast, southeast, southwest and northwest;
- There are no obvious industrial facilities with radioactive materials near any of the locations;
- The long-term average precipitation for each location is similar to that of the SSFL;

- Property access for each location can be obtained;
- Each location is physically accessible;
- There is no indication of human activity;
- There is minimal evidence of animal disturbance;
- There is minimal evidence of erosion; and
- There is minimal shielding by heavy vegetation.

Using these evaluation criteria, EPA, community members, and other stakeholders selected at least 10 DTLs in each compass quadrant. The locations of the DTLs are illustrated on SAP Figure 1.6.

1.4 INVESTIGATIVE APPROACH

The steps listed below summarize the investigative approach. The number of samples scheduled to be collected during the study are summarized in Table 1.1 of the FSP. Sample locations are illustrated on Figures 1.2 through 1.6 of the SAP. One or more split samples will be collected for each sample that is collected for laboratory analyses. For each soil sample that is collected, one split sample will be archived at the EPA Region 9 Laboratory. The archived samples will be held under custody and may be analyzed at a future date.

Step 1: Select Distance Test Locations
Forty DTLs were identified as potential sampling locations with 10 DTLs per compass quadrant surrounding SSFL (10 locations in the northeast quadrant, 10 locations in the northwest quadrant, 10 locations in the southeast quadrant, and 10 locations in the southwest quadrant). A random number generator will be used to identify six of the DTLs in each quadrant for surface soil sampling. EPA staff will oversee the process that is used to randomly identify the sampling locations. In the event that one of the locations is not suitable, an alternative location within the quadrant will be selected using the random number generator.

Step 2: Conduct Screening-Level Surface Gamma Scanning Survey
Surface gamma scanning survey will be performed at the six DTLs in each quadrant and each RBRA in accordance with HGL's standard operating procedure (SOP) number (No.) 35. The survey will be conducted over an approximately 50 foot by 50 foot area surrounding each DTL sample location to determine whether there are any anomalies. If an anomaly is detected, the sampling location will be rejected and another location will be selected randomly. At each RBRA, 100 percent (%) of the 1-acre area will be surveyed.

Step 3: Collect Surface Soil Samples at Distance Test Locations
One surface soil sample will be collected at each of the six locations in each quadrant of the DTLs after the gamma survey is completed and measurements indicate no anomalies. After all six samples are collected, a random number generator again will be used to select five of the six soil samples from each quadrant for laboratory analysis; all six will be delivered to the

laboratory(ies). The sixth sample will be archived as a backup sample. Therefore, a total of 20 surface soil samples collected from the DTLs will be submitted to the laboratory for analysis and 4 samples will be archived for possible future analysis. The potential causes for invalidation of results include, but are not limited to, quality control issues, values determined to be outliers, and so forth. Each sample will be analyzed for the radionuclides of potential concern listed in Appendix A (Table 3).

For quality assurance (QA)/quality control (QC) purposes, two field duplicates and one matrix spike (MS)/matrix spike duplicate (MSD) sample will be collected and analyzed during the soil sampling activities.

Step 4: Determine RBRA Sample Locations

The specific sample locations will be positioned in a grid pattern that is superimposed onto each RBRA in accordance with a Class 1 MARSSIM survey unit. The start location of the grid will be randomly selected, and the grid nodes will be based on a sample density of 50 samples over a 1-acre area. This number of samples is within the typical range of MARSSIM guidance and within the range of most MARSSIM final status surveys. The grid will be triangular in shape to maximize statistical coverage with a grid length of 31.7 feet as determined in accordance with MARSSIM.

Step 5: Collect Surface Soil Samples at Radiological Background Reference Areas

A total of 100 surface soil samples will be collected at the RBRA areas from ground surface to a depth of 6 inches. Fifty samples will be collected from the single area overlying the Santa Susana Formation and a total of 50 will be collected from the two areas overlying the Chatsworth Formation (for example, 25 surface soil samples at each RBRA).

Five field duplicate samples and three MS/MSD samples will be collected and analyzed from the Santa Susana Formation RBRA and three field duplicates samples and 2 MS/MSD samples will be collected and analyzed from each of the Chatsworth Formation RBRAs for QA/QC purposes (for a total of 11 field duplicates and 7 MS/MSDs).

In addition, 2 additional split soil samples will be collected from both the Santa Susana Formation and the Chatsworth Formation for the EPA laboratory in Las Vegas, Nevada. These samples will be collected in the field, milled and sieved to the laboratory mesh size, and sent to the EPA laboratory in Las Vegas.

Step 6: Collect Subsurface Soil Samples and Conduct Borehole Gamma Survey

Within each geologic formation, 20 subsurface soil samples will be collected and analyzed for the radionuclides of interest. At each sampling location, a subsurface soil sample will be collected from a depth interval of 3 to 10 feet below ground surface (bgs). If bedrock is encountered at a depth that is shallower than 10 feet, then the soil sample will be collected from a depth interval of 3 feet bgs to refusal. The selected depth interval is thought to be representative of background conditions for SSFL subsurface soils, because it is not likely to be impacted by radioactive fallout. The radionuclide concentrations at this depth interval should reflect naturally occurring radionuclide concentrations. The soil collected from the entire depth interval will be composited into one homogenous soil sample.

Two field duplicates and one MS/MSD sample will be collected and analyzed from each formation for QA/QC purposes.

As part of the sampling process, a gross gamma count rate survey will be conducted for each borehole in accordance with HGL SOP No. 36. This will be conducted to identify subsurface anomalies and to characterize the natural subsurface gamma profile.

Step 7: Conduct Laboratory Sample Analysis

All samples will be analyzed for the selected radionuclides using appropriate laboratory analytical methods. The list of radionuclides in RBRA and DTL soils that will be analyzed are presented in Appendix A, Tables 2 and 3, respectively.

Step 8: Conduct RBRA Surface Gamma Scanning Survey

The gamma survey will be performed using a gamma scanning system that is being constructed for the Area IV radiological characterization study currently being planned. The purpose of the RBRA gamma survey will be to characterize the general distribution of background gamma radiation. This information will be used to help interpret gamma survey data that will be subsequently collected on the SSFL. This system will be capable of detecting low levels of gamma radiation. A comprehensive surface gamma scanning survey will be performed for the three RBRAs.

Step 9: Data Validation

The sample analytical results will be reviewed to ensure the reported values meet predetermined criteria. The data validation process is discussed in detail in Section 4.0 of the Quality Assurance Project Plan (QAPP).

Step 10: Conduct Statistical Analysis of Data

Once the data are determined as useable, statistical analyses will be used to compare radionuclide concentrations in soil samples collected at the DTLs to radionuclide concentrations in soil samples collected at the RBRAs. In addition, statistical tests will be used to determine whether the background data sets that are collected at the three RBRAs can be combined into one or more larger data sets. Finally, background concentrations will be calculated for each radionuclide in surface and subsurface soils. The statistical tests that will be used to conduct this comparison are described in the QAPP.

In addition to the statistical analyses, surface soil sampling results from each of the four DTL quadrants will be qualitatively evaluated to determine whether there are any quadrants that contain elevated radionuclide concentrations, compared to the other quadrants.

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2.0 FIELD ACTIVITY METHODS AND PROCEDURES

This section describes the field methodology to be implemented to execute the sampling activities detailed in Section 1.0. All site work will be conducted in strict accordance with the protocols detailed in the HGL SOPs provided in Appendix B. Referenced field forms are included in Appendix C. The following field activities will be performed by HGL personnel:

- Site access;
- Mobilization;
- Procurement of equipment, supplies, and containers;
- Field logbook documentation;
- Site reconnaissance;
- Surface gamma scanning survey;
- Surface soil sampling;
- Borehole gamma logging survey;
- Subsurface soil sampling;
- Borehole abandonment; and
- Equipment decontamination.

2.1 SITE ACCESS

In accordance with EPA protocol, written consent from the site owners of each sampling area will be obtained before mobilization for sampling. All appropriate local, state and federal officials, site owners and other affected parties will be notified of the sampling schedule.

2.2 MOBILIZATION

Once signed access agreements have been obtained, HGL will identify and provide all necessary personnel, equipment, and materials for mobilization and demobilization to and from the site for the background study activities. All mobilization activities will be conducted in accordance with HGL SOP No. 1, *General Field Operations*.

HGL has identified the equipment and supplies necessary to support the background study. HGL will subcontract a suitable analytical laboratory(ies) and will coordinate with the laboratory(ies) prior to mobilizing to the field.

2.3 PROCUREMENT OF EQUIPMENT, SUPPLIES, AND CONTAINERS

Equipment and supplies needed for this project include sampling and monitoring equipment, health and safety supplies, decontamination materials, field operations supplies (for example: shipping containers, sample containers), and handheld construction equipment. Most equipment to be used for this project will be rented. Supplies required to implement sampling activities will be purchased and are expected to be expended over the course of the investigation. The anticipated field equipment and supplies are summarized in Table 2.1 of the FSP.

2.4 FIELD LOG BOOK DOCUMENTATION

Field logbook documentation is discussed in Section 2.3.3 of the QAPP.

2.5 SURFACE GAMMA SCANNING

A surface gamma scanning survey will be conducted at each of the DTLs and RBRAs to determine the homogeneity of the surface soil. In addition, the gamma scanning survey data collected from each RBRA will form a surface soil gamma background data set for each geological formation. Two methodologies will be utilized to conduct the gamma scanning that will be conducted during the background study as detailed below.

Screening-Level Gamma Scanning Screening-level gamma scanning will be performed at the DTLs and RBRAs in accordance with HGL SOP No. 35. The gamma scanning will be conducted during the soil sampling field mobilization, using a Ludlum Model 44-20 sodium iodide scintillator detector with a Ludlum Model 2221 rate meter.

Before the survey is conducted, the survey area will be marked. The detector will be fixed at a height of 6 inches above the ground surface by attaching a strap for hand-held use. The detector will be moved in a serpentine (S-shape) motion to form a 3 foot wide transect. The detector scan rate will be approximately 1 to 2 feet per second. The survey will be conducted by walking a straight line from one side of the survey area to the opposite side. Measurements (in units of counts per minutes) will be observed while conducting the scanning walkover survey. If measurements increase by a factor of two, the location will be flagged as possible anomaly. Upon completion of each transect, we will move 3 feet from the transect centerline to an adjacent transect. Scanning will continue on transects until 100% of the area has been scanned.

If flags were placed at potential anomalies, we will return to each location and carefully resurvey the locations to determine if the anomaly is a concern or was due to natural background fluctuations. Results of each anomaly survey will be recorded in the field logbook. The approximate minimum, maximum, and average measurements observed during the survey will also be recorded in a field logbook.

At the DTLs, a 50-foot by 50-foot area around each sample location will be surveyed. Measurements will be reviewed in the field to determine the presence of any anomalies. At the RBRAs, 100% of the soil sampling grid will be surveyed.

RBRA Surface Gamma Survey The RBRA gamma surveys will be accomplished utilizing a large-area gamma detector system that will be custom-built to provide increased sensitivity for the project. As of the date of this SAP, this system is in development. Further information will be provided for this section upon completion and testing of this system. This system will not be used at the DTLs since the purpose of the survey is to determine natural background gamma at each geological formation as a comparison to on-site gamma data.

2.6 SOIL CLASSIFICATION

The soil at each sampling location will classified according the procedures provided in HGL SOP No. 24, *Geologic Borehole Logging* and will be lithologically characterized using the Unified Soil Classification Systems (USCS). The lithology of the unconsolidated material in all boreholes will be continuously logged. The boring log form in Appendix C will be used for recording the lithologic logging information. Information on the boring log form includes: borehole and drilling locations; sampling information such as sample intervals, recovery, and blow counts; and sample description. Lithologic descriptions of unconsolidated materials encountered in the boreholes will generally be in accordance with the following American Society for Testing and Materials (ASTM) Standard Practices:

- Classification of Soils for Engineering Purposes (USCS, ASTM D-2487); and
- Description and Identification of Soils (Visual-Manual Procedure, ASTM D-2488).

Descriptive information to be recorded in the field logbook will include:

- Identification of the predominant particles size and range of particle sizes;
- Maximum particle size or dimension;
- Percent of gravel, sand, fines, or all three;
- Description of grading and sorting of coarse particles;
- Particle angularity and shape;
- Color using Munsell Color System;
- Odor;
- Moisture content (dry, moist, or wet);
- Consistency of fine grained soils (very soft, soft, firm hard, or very hard);
- Cementation of intact coarse-grained soils (weak, moderate, or strong);
- Plasticity of fine-grained soils;
- Structure of intact soils (stratified, laminated, fissured, slickensided, blocky, lensed, or homogeneous); and
- USCS group symbol (for example: CL – silty clay, SP – Poorly Graded Sands, etc).

Additional information to be recorded includes the depth to the water table (if encountered), caving or sloughing of the borehole, changes in drilling rate, depths of laboratory samples, presence of organic materials, presence of voids, location of geologic boundaries, and other noteworthy observations or conditions.

2.7 SURFACE SOIL SAMPLING

Surface soil sampling will be conducted in accordance with HGL SOP No. 16, *Surface and Shallow Depth Soil Sampling,* unless otherwise noted. Surface soil sampling will be conducted in the DTLs and in the RBRAs.

Surface soil samples will be collected using a stainless steel shovel or spade to retrieve a discrete sample from the 0 to 6 inches bgs depth interval. Approximately 4 liters of soil will be required for proper laboratory analysis. The soil sample will be placed directly into an appropriate sample container, properly labeled, sealed, packaged, and then shipped to the selected laboratory. Each surface soil sample will be lithologically characterized using the USCS as detailed in Section 2.6.

2.8 SUBSURFACE SOIL SAMPLING

Subsurface soil sampling will be conducted using direct-push technology (DPT) and hand augering to collect soil samples with depth. Subsurface sampling will be conducted by a drilling subcontractor with HGL oversight in accordance with the HGL SOP No. 27 *Soil Sampling* and *Basic GeoProbe® Operations* (Appendix B). Subsurface soils will be continuously sampled using GeoProbe® Macrocore samplers that provide 1.5-inch diameter, 4-foot long soil cores contained in acetate sleeves.

Where DPT sampling is not allowed by the property owner, subsurface soils will be sampled using a decontaminated hand auger.

The general sampling procedure is as follows:

1) Drive the sample apparatus into the sample material.
2) Retract and disassemble the sample apparatus.
3) Remove the acetate liner.
4) Open the acetate liner with a cutting tool.
5) Screen the soil core using a gamma survey meter.
6) Collect the sample using a clean utensil. A minimum of one kilogram will be required.
7) Place the sample in an appropriate container.

The general hand auger sampling procedure is included in HGL SOP No. 16.

The soil sample will be placed directly into an appropriate sample container, properly labeled, sealed, packaged, and then shipped to the selected laboratory. Each surface soil sample will be lithologically characterized using the USCS as detailed in Section 2.6.

2.9 BOREHOLE GAMMA LOGGING SURVEY

After subsurface soil sampling activities are completed, a DPT drive apparatus will be assembled and advanced down the previously sampled borehole to 10 feet bgs. Once the drive apparatus has advanced to 6 feet bgs, polyvinyl chloride (PVC) piping with an inner diameter of at least 1.5 inches and an end cap will be lowered to the bottom of the borehole. Next, downward pressure will be applied to the PVC piping to dislodge the disposable tip of the drive apparatus. The drive apparatus will then be retracted while continually applying downward pressure to the PVC piping ensuring the PVC remains at least 6 feet bgs. After the drive apparatus has been fully retracted, the remaining PVC piping will be measured to document the final completion depth. For areas that need to be hand augered, a 1.5-inch PVC pipe and an end cap will be lowered to the bottom of the borehole. The borehole gamma survey will be executed in accordance with HGL SOP No. 36 *Borehole Gamma Logging*.

2.10 BOREHOLE ABANDONMENT

Each logging/sampling borehole will be sealed with high-solids bentonite grout chips after completion of activities at each location. Grouting will occur as quickly as possible to minimize the possibility of contaminant migration. Each borehole will be patched at the surface with native soil.

2.11 EQUIPMENT DECONTAMINATION

Equipment decontamination is discussed in Section 2.2.4 of the QAPP.

2.12 FIELD BLANK SAMPLING

The field blank samples will consist of equipment blanks and source blanks. One equipment blank sample will be collected per field team per day. These samples will be collected to ensure each field team is properly decontaminating their sampling supplies. The source samples will be collected at a frequency of one per day. The source samples are necessary to document the existing radionuclide concentrations in the water used to collect the equipment blank sample.

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3.0 INVESTIGATION-DERIVED WASTE MANAGEMENT

The investigation-derived waste (IDW) that will be generated during the SSFL background study field activities will consist of disposable personal protective equipment (PPE) and general municipal refuse. Used PPE and general refuse will be collected in garbage bags and disposed of as solid municipal waste.

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4.0 REFERENCES

American Society of Testing and Materials (ASTM), 2006. *D2487 – 06e1 Standard Practice for Classification of Soils for Engineering Purposes (Unified Classification System)*. Developed by subcommittee D18.07.

ASTM, 2005. *D2488 – 06 Standard Practice for Description and Identification of Soils (Visual Manual Procedure)*. Developed by subcommittee D18.07.

U.S. Environmental Protection Agency, et al., 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*. August.

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TABLES

Table 1.1
Summary of Surface and Subsurface Soil Sample Collection
Radiological Background Study

Activity	Location	Number of Samples
Surface Soil Samples		
Soil Sampling*	Radiological Background Reference Areas	50 samples per geologic formation (100 total)
Field Duplicate QA/QC Sampling (10%)	Radiological Background Reference Areas	5 samples from the Santa Susana Formation location and 3 from each of the Chatsworth Formations locations (11 total)
MS and MSD QA/QC Sampling (5%)	Radiological Background Reference Areas	3 samples from the Santa Susana Formation location and 2 from each of the Chatsworth Formations locations (7 total)
Split samples for EPA lab	Radiological Background Reference Areas	2 samples from the Santa Susana Formation and 2 samples from the Chatsworth Formation (4 total)
Soil Sampling	Distance Test Location	5 samples per quadrant (20 total)
Soil Contingency Sampling (20%)	Distance Test Location	1 sample per quadrant (4 total).
Field Duplicate QA/QC Sampling (10%)	Distance Test Location	2 samples total
MS and MSD QA/QC Sampling (5%)	Distance Test Location	1 sample total
Sub-Surface Soil Samples		
Soil Sampling*	Radiological Background Reference Areas	20 samples per geologic formation (40 total)
Field Duplicate QA/QC Sampling (10%)	Radiological Background Reference Areas	2 samples per geologic formation (4 total)
MS and MSD QA/QC Sampling (5%)	Radiological Background Reference Areas	1 sample per geologic formation (2 total)

Notes:
1) Extra sample volume will be collected from designated locations to account for quality assurance/quality control samples.
2) Surface soil samples will be collected from ground surface to a depth of 6 inches.
3) The contingency samples will not be analyzed unless needed.
4) The radionuclides of interest are listed in Table 1.11 of the Quality Assurance Project Plan.
5) The depth of the subsurface soil samples will be determined in the field based on the depth to bedrock.
* An archived sample will be collected and stored.

MS Matrix Spike
MSD Matrix Spike Duplicate
QA/QC Quality Assurance/Quality Control

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Table 2.1
Field Equipment and Supplies

Sampling Supplies	
Sample containers	Deionized water
Sample shipping coolers	Shipping material (packaging tape, bubble wrap)
Baggies	Sampling field forms
Plastic containers	Sample labels
Alconox	Chain-of-Custody forms
Plastic spray bottles	Custody seals
Acetate liners for Geoprobe®	
Sampling Equipment	
Stainless steel shovel and/or spade	Laptop computer
Custom sample preparation processing equipment	GPS +/o surveying equipment
Ludlum Model 2221 Gamma Survey Logger	Custom Gamma Survey Equipment
Ludlum Model 44-1 Gamma Survey Logger	Geoprobe® or equivalent equipment
Health and Safety	
Hard hat	Eye wash station
Safety vest	First aid kits
Safety glasses	Fire extinguishers
Hearing protection	Drinking water
Snake bite kit	Insect repellent
Communication devices (i.e. satellite radio)	Sunblock
General Field Operations	
Logbooks	Indelible ink pens
Digital camera	Paper towels
Kimwipes	Trash bags
Plastic sheeting	5-gallon buckets for decontamination
Measuring tape	Utility knives
Munsell color chart	Clear/duct tape
Brushes	

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APPENDIX A

RADIONUCLIDE LIST AND SELECTION CRITERIA

Final
Table 1
Proposed Radionuclides for Consideration - Reference Information
Santa Susana Field Laboratory Radiological Background Study
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Symbol	Radionuclide	Physical Half-Life	Half-Life Units	Ag PRG (pCi/g)	Estimated Analytical Method	Estimated Best MDC (pCi/g)	Ag PRG Met (estimated)?	Likely Parents	Radioactive Daughters	Comment	Failed Selection Criteria
Ac-227	actinium-227+D	21.772	Years	0.0831	AS	0.042	Yes	Ra-227/**Pa-231**	Th-227+D/Fr-223+D	Ra-227 and parents have a very short half-life. Fr-223 and daughters have a very short half-life. Th-227 and daughters have a very short half-life.	Pass
Ac-228	actinium-228	6.15	Hours	731	GS	0.225	Yes	**Ra-228**	**Th-228+D**	None	Pass-Parent
Ag-108	silver-108	2.37	Minutes	6010000	TBD	TBD	TBD	**Ag-108m**	None	None	Pass-Parent
Ag-108m	silver 108m	418	Years	0.00629	GS	0.0398	No	None	**Ag-108**	None	Pass
Ag-110	silver-110	24.6	Seconds	17600000	TBD	TBD	TBD	**Ag-110m**	None	None	3
Ag-110m	silver-110m	249.76	Days	0.152	GS	0.0391	Yes	None	**Ag-110**	None	3
Ag-111	silver-111	7.45	Days	13.6	TBD	TBD	TBD	Pd-111	None	Pd-111 and parents have a very short half-life.	3
Al-28	aluminum-28	2.2414	Minutes	58400	TBD	TBD	TBD	**Mg-28**	None	None	3
Am-241	americium-241	432.6	Years	0.0132	AS	0.0939	No	**Pu-241/Cm-241**	**Np-237+D**	None	Pass
Am-243	americium-243+D	7,370	Years	0.0111	AS	0.0466	No	Pu-243/Bk-247	**Np-239+D**	Parents of Bk-247 (1380 year half-life) have a very short half-life. Pu-243 and parents have a very short half-life, except for Cm-247 (1.56E+7 year half-life) and Cf-251 (898 year half-life).	Pass
Ar-39	argon-39	269	Years	148	TBD	TBD	TBD	Cl-39	None	Cl-39 and parents have a very short half-life.	2
Ar-41	argon-41	109.61	Minutes	1740	GS	4.14	Yes	Cl-41	None	Cl-41 and parents have a very short half-life.	2,3
As-76	arsenic-76	1.0942	Days	365	TBD	TBD	TBD	None	None	None	3
As-77	arsenic-77	38.83	Hours	8190	TBD	TBD	TBD	Ge-77	None	Ge-77 and parents have a very short half-life.	3
Ba-133	barium-133	10.5	Years	0.161	GS	0.004	Yes	Ba-133m/La-133	None	Ba-133m and La-133 and parents have a very short half-life.	Pass
Ba-135m	barium-135m	28.7	Hours	4020	TBD	TBD	TBD	None	None	None	3
Ba-137m	barium-137m	2.552	Minutes	178000	GS	TBD	TBD	**Cs-137**/La-137	None	Parents of La-137 (6E+4 years half-life) have a very short half-life.	Pass-Parent
Ba-139	barium-139	83.06	Minutes	88900	GS	30.7	Yes	Cs-139	None	Cs-139 and parents have a very short half-life.	3
Ba-140	barium-140	12.7527	Days	83.7	GS	0.187	Yes	Cs-140	**La-140**	Cs-140 and parents have a very short half-life.	3
Be-10	beryllium-10	1.51E+06	Years	11.6	LS	2.253	Yes	None	None	None	Pass
Bi-210	bismuth-210	5.012	Days	1340	TBD	TBD	TBD	**Pb-210**/At-214	**Po-210**	At-214 and parents have a very short half-life.	Pass-Parent
Bi-212	bismuth-212	60.55	Minutes	22400	GS	0.763	Yes	**Pb-212**/At-216	Po-212+D/**Tl-208**	At-216 and parents have a very short half-life. Po-212 has a very short half-life and no radioactive daughters.	Pass-Parent
Bi-214	bismuth-214	19.9	Minutes	8190	GS	0.112	Yes	**Pb-214**/At-218	Po-214+D	At-218 and parents have a very short half-life. Po-214 and daughters have a very short half-life except for **Pb-210.**	Pass-Parent
Bk-249	berkelium-249	330	Days	6610	TBD	TBD	TBD	Cm-249/Es-253	**Cf-249+D**	Cm-249 and Es-253 and parents have a very short half-life.	3
Br-82	bromine-82	35.282	Hours	45.8	TBD	TBD	TBD	Br-82m	None	Br-82m does not have a parent.	3
C-14	carbon-14	5,700	Years	0.0000563	LS	0.028	No	B-14	None	B-14 and parents have a very short half-life.	Pass
Ca-45	calcium-45	162.61	Days	31.4	TBD	TBD	TBD	K-45	None	K-45 and parents have a very short half-life.	3
Ca-47	calcium-47	4.536	Days	32.4	TBD	TBD	TBD	K-47	Sc-47	K-47 and parents have a very short half-life. Sc-47 half-life has a very short half-life.	3
Cd-109	cadmium-109	461.4	Days	0.266	GS	0.819	No	In-109	None	In-109 and parents have a very short half-life.	3
Cd-113	cadmium-113	7.7E+15	Years	0.0028	TBD	TBD	TBD	Ag-113	None	Ag-113 and parents have a very short half-life.	Pass
Cd-113m	cadmium-113m	14.1	Years	0.00526	TBD	TBD	TBD	None	None	None	Pass
Cd-115	cadmium-115	53.46	Hours	27.1	TBD	TBD	TBD	Ag-115	**In-115m**	Ag-115 and parents have a very short half-life.	3
Cd-115m	cadmium-115m	44.56	Days	0.75	TBD	TBD	TBD	None	**In-115**	None	3

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Ce-141	cerium-141	32.508	Days	84.6	GS	0.0653	Yes	La-141	None	La-141 and parents have a very short half-life.	3
Ce-143	cerium-143	33.039	Hours	507	TBD	TBD	TBD	La-143	**Pr-143+D**	La-144 and parents have a very short half-life.	3
Ce-144	cerium-144+D	284.91	Days	3.45	GS	0.282	Yes	La-144	**Pr-144+D**	La-144 and parents have a very short half-life.	3
Cf-249	californium-249	351	Years	0.0613	AS	0.042	Yes	**Bk-249**/Fm-253/Es-249	**Cm-245+D**	Fm-253 and Es-249 and parents have a very short half-life.	Pass
Cl-36	chlorine-36	3.01E+05	Years	0.0102	TBD	TBD	TBD	None	None	None	Pass
Cm-241	curium-241	32.8	Days	13.1	GS	0.0523	Yes	Cf-245/Bk-241	**Am-241+D/Pu-237**	Cf-245 and Bk-241 and parents have a very short half-life.	3
Cm-242	curium-242	162.8	Days	18.9	TBD	TBD	TBD	Am-242/Bk-242/Cf-246	**Pu-238+D**	Am-242, Bk-242, and Cf-246 and parents have a very short half-life.	3
Cm-243	curium-243	29.1	Years	0.127	AS	0.042	Yes	Bk-243	**Pu-239+D**	Bk-243 and parents have a very short half-life.	Pass
Cm-244	curium-244	18.1	Years	0.304	AS	0.03	Yes	Am-244/Cf-248/Bk-244	**Pu-240+D**	Am-244 has a very short life but its parent is Bk-248 (greater than 9 year half-life); the parent of Bk-248 is Es-252 (471.7 day half-life); parents of Es-252 have a very short half life. Cf-248 and parents have a half-life of less than 1 year. Bk-244 and parents have a very short half-life.	Pass
Cm-245	curium-245	8,500	Years	0.0922	AS	0.03	Yes	Am-245/**Cf-249**/Bk-245	**Pu-241+D**	Am-245 and Bk-245 and parents have a very short half-life.	Pass
Cm-246	curium-246	4,760	Years	0.129	AS	0.03	Yes	Am-246/Cf-250/Bk-246	**Pu-242+D**	Bk-246 and parents have a very short half-life. Parents of Cf-250 (13.03 year half-life) have a very short half life. Am-246 and parents have a very short half-life except for Cm-250 (8.3E+3 year half-life).	Pass
Cm-248	curium-248	348,000	Years	0.00143	AS	0.0111	No	Am-248/Cf-252/Bk-248m	**Pu-244+D**	Am-248 and Bk-248m have short half-life and have no parents. Parents of Cf-252 (2.645 year half-life) have a very short half-life except Es-252 (471.7 day half-life); parents of Es-252 have a very short half life.	Pass
Co-58	cobalt-58	70.86	Days	0.127	GS	0.0466	Yes	Co-58m	None	Co-58m has a very short and has no parents.	3
Co-60	cobalt-60	5.275	Years	0.000901	GS	0.0012	No	Fe-60	None	Parents of Fe-60 (1.5E+6 years) have a very short half-life.	Pass
Cr-51	chromium-51	27.7025	Days	241	GS	0.404	Yes	Mn-51	None	Mn-51 and parents have a very short half-life.	3
Cs-132	cesium-132	6.480	Days	15.5	TBD	TBD	TBD	None	None	None	3
Cs-134	cesium-134	2.0652	Years	0.00747	GS	0.004	Yes	Cs-134m	None	Cs-134m has a very short half-life and no parents.	Pass
Cs-135	cesium-135	2.3E+06	Years	0.00509	GS	0.0357	No	**Xe-135**	None	None	Pass
Cs-136	cesium-136	13.04	Days	1.56	GS	0.0491	Yes	Cs-136m	None	Cs-136m has a very short half-life and no parents.	3
Cs-137	cesium-137+D	30.08	Years	0.0012	GS	0.0012	Yes	Xe-137	**Ba-137m**	Xe-137 and parents have a very short half-life.	Pass
Cs-138	cesium-138	33.41	Minutes	3030	TBD	TBD	TBD	Xe-138	None	Xe-138 and parents have a very short half-life.	3
Cu-64	copper-64	12.701	Hours	553000	GS	20.2	Yes	None	None	None	3
Cu-67	copper-67	61.83	Hours	767	TBD	TBD	TBD	Ni-67	None	Ni-67 and parents have a very short half-life.	3
Dy-165	dysprosium-165	2.334	Hours	91700	TBD	TBD	TBD	Tb-165	None	Tb-165 and parents have a very short half-life.	3
Er-169	erbium-169	9.392	Days	84100	TBD	TBD	TBD	Ho-169	None	Ho-169 and parents have a very short half-life.	3
Er-171	erbium-171	7.516	Hours	1900	TBD	TBD	TBD	Ho-171	**Tm-171**	Ho-171 and parents have a very short half-life.	3
Eu-152	europium-152	13.537	Years	0.0376	GS	0.011	Yes	Eu-152m2	**Gd-152+D**	Eu-152m2 has a very short half-life and no parents.	Pass
Eu-152m	europium-152m	9.3116	Hours	1640	TBD	TBD	TBD	None	**Gd-152+D**	None	3
Eu-154	europium-154	8.593	Years	0.0472	GS	0.013	Yes	Eu-154m	None	Eu-154m does not have any parents.	Pass

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Eu-155	europium-155	4.753	Years	3.74	GS	0.011	Yes	Sm-155	None	Sm-155 and parents have a very short half-life.	Pass
Eu-156	europium-156	15.19	Days	8.4	TBD	TBD	TBD	Sm-156	None	Sm-156 and parents have a very short half-life.	3
Fe-55	iron-55	2.737	Years	0.821	LS	2	No	Co-55	None	Co-55 and parents have a very short half-life.	Pass
Fe-59	iron-59	44.495	Days	1.2	GS	0.0915	Yes	Mn-59	None	Mn-59 and parents have a very short half-life.	3
Ga-72	gallium-72	14.095	Hours	105	TBD	TBD	TBD	Zn-72	None	Zn-72 and parents have a very short half-life.	3
Gd-152	gadolinium-152	1.08E+14	Years	4.8	ICP-MS	0.001	Yes	**Eu-152**/Tb-152	**Sm-148+D**	Tb-152 and parents have a very short half-life.	Pass-Parent
Gd-153	gadolinium-153	240.4	Days	21.5	GS	TBD	TBD	Tb-153	None	Tb-153 and parents have a very short half-life.	3
Gd-159	gadolinium-159	18.479	Hours	6200	TBD	TBD	TBD	Eu-159	None	Eu-159 and parents have a very short half-life.	3
H-3	tritium (H-3) organic	12.32	Years	0.16	LS	0.148	Yes	None	None	None	Pass
Ho-166	holmium-166	26.824	Hours	6070	TBD	TBD	TBD	Dy-166	None	Dy-166 and parents have a very short half-life.	3
Ho-166m	holmium-166m	1,230	Years	0.011	GS	0.005	Yes	None	None	None	Pass
I-129	iodine-129	1.57E+07	Years	0.0000276	XS	0.412	No	**Te-129**	None	None	Pass
I-130	iodine-130	12.36	Hours	8.77	GS	0.0811	Yes	I-130m	None	I-130m has a very short half-life and no parents.	3
I-131	iodine-131	8.0252	Days	0.0833	GS	0.0478	Yes	Te-131	Xe-131m	Te-131 and parents have a very short half-life. Xe-131m has a very short half-life with no radioactive daughters.	3
I-132	iodine-132	2.295	Hours	271	TBD	TBD	TBD	**Te-132**	None	None	3
I-133	iodine-133	20.8	Hours	2.34	GS	0.0710	Yes	Te-133	**Xe-133**	Te-133 and parents have a very short half-life.	3
I-134	iodine-134	52.5	Minutes	1260	TBD	TBD	TBD	Te-134	None	Te-134 and parents have a very short half-life.	3
I-135	iodine-135	6.58	Hours	33.2	GS	0.345	Yes	Te-135	**Xe-135+D**	Te-135 and parents have a very short half-life.	3
In-115	indium-115	4.41E+14	Years	4.14	ICP-MS	0.001	Yes	**Cd-115m/In-115m**	None	None	Pass
In-115m	indium-115m	4.486	Hours	7210	TBD	TBD	TBD	**Cd-115**	**In-115**	None	3
K-40	potassium-40	1.248E+09	Years	0.0445	GS	0.0445	Yes	None	None	None	Pass
Kr-79	krypton-79	35.04	Hours	538	TBD	TBD	TBD	Kr-79m/Rb-79	None	Kr-79m and Rb-79 and parents have a very short half life.	2,3
Kr-81	krypton-81	229,000	Years	3.84	TBD	TBD	TBD	Kr-81m/Rb-81	None	Kr-81 and Rb-81 and parents have a very short half-life.	2
Kr-85	krypton-85	10.73	Hours	22.3	TBD	TBD	TBD	Br-85	None	Br-85 and parents have a very short half-life.	2,3
La-140	lanthanum-140	1.67855	Days	43.8	GS	0.0804	Yes	**Ba-140**	None	None	3
Mg-28	magnesium-28	20.915	Hours	148	TBD	TBD	TBD	Na-28	**Al-28**	Na-28 and parents have a very short half-life.	3
Mn-54	manganese-54	312.12	Days	0.369	GS	0.0486	Yes	None	None	None	3
Mn-56	manganese-56	2.5789	Hours	782	GS	1	Yes	Cr-56	None	Cr-56 and parents have a very short half-life.	3
Mo-93	molybdenum-93	4000	Years	1.05	TBD	TBD	TBD	Mo-93m/Tc-93	**Nb-93m**	Mo-93m has a very short half-life and no parents. Tc-93 and parents have a very short half-life.	Pass
Mo-99	molybdenum-99	65.94	Hours	437	GS	0.398	Yes	Nb-99	**Tc-99**	Nb-99 and parents have a very short half-life.	3
Na-22	sodium-22	2.6027	Years	0.0852	GS	0.005	Yes	Mg-22	None	Mg-22 and parents have a very short half-life.	Pass
Na-24	sodium-24	14.997	Hours	61.5	GS	0.0776	Yes	Ne-24	None	Ne-24 and parents have a very short half-life.	3
Nb-93m	niobium-93m	16.13	Years	137	LS	25	Yes	**Zr-93/Mo-93**	None	None	Pass
Nb-94	niobium-94	2.03E+04	Years	0.0115	GS	0.004	Yes	Nb-94m	None	Nb-94m has a very short half-life and no parents.	Pass
Nb-95	niobium-95	34.991	Days	6.81	GS	0.0436	Yes	**Zr-95/Nb-95m**	None	None	3
Nb-95m	niobium-95m	3.61	Days	984	GS	0.168	Yes	None	**Nb-95**	None	3
Nb-97	niobium-97	72.1	Minutes	5690	TBD	TBD	TBD	**Zr-97/Nb-97m**	None	None	3
Nb-97m	niobium-97m	58.7	Seconds	365000	TBD	TBD	TBD	None	**Nb-97**	None	3

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Nd-144	neodymium-144	2.29E+15	Years	Not Available	TBD	TBD	TBD	**Sm-148/Pr-144/**Pm-144	None	Pm-144 and parents have a very short half-life.	5
Nd-147	neodymium-147	10.98	Days	156	GS	0.138	Yes	**Pr-147**	**Pm-147+D**	None	3
Ni-59	nickel-59	76,000	Years	2.15	XS	1.766	Yes	Cu-59	None	Cu-59 and parents have a very short half-life.	Pass
Ni-63	nickel-63	100.1	Years	1.01	LS	0.501	Yes	Co-63	None	Co-63 and parents have a very short half-life.	Pass
Ni-65	nickel-65	2.5172	Hours	2840	TBD	TBD	TBD	Co-65	None	Co-65 and parents have a very short half-life.	3
Ni-66	nickel-66	54.6	Hours	126	TBD	TBD	TBD	Co-66	Cu-66	Co-66 and parents have a very short half-life. Cu-66 and daughters are very short half-life.	3
Np-236	neptunium-236	1.53E+05	Years	0.00281	TBD	TBD	TBD	Am-240	**Pu-236+D/U-236**	Am-240 and parents have a very short half-life.	Pass
Np-237	neptunium-237+D	2.144E+06	Years	0.000448	AS	0.0111	No	U-237/**Am-241/Pu-237**	Pa-233+D	U-237 and parents have a very short half-life. See **U-233** for long life daughters of Pa-233.	Pass
Np-239	neptunium-239	2.356	Days	22.6	GS	0.132	Yes	U-239/**Am-243**	**Pu-239+D**	U-239 and parents have a very short half-life.	Pass-Parent
P-32	phosphorus-32	14.262	Days	51.5	TBD	TBD	TBD	Si-32	None	Parents of Si-32 (152 year half-life) are very short half-life.	3
Pa-231	protactinium-231	32,760	Years	0.21	AS	0.042	Yes	**Th-231**/U-231	**Ac-227+D**	U-231 and parents have a very short half-life.	Pass
Pb-205	lead-205	1.73E+07	Years	0.153	TBD	TBD	TBD	Pb-205m/Bi-205/Po-209	None	Pb-205m and Bi-205 and parents have a very short half-life. Parents of Po-209 (102 year half-life) have a very short half-life.	Pass
Pb-210	lead-210+D	22.20	Years	0.0000642	GS	0.019	No	Tl-210/Po-214	**Bi-210+D**	Tl-210 and parents have a very short half-life. Long life parents of Po-214 are found in Cf-250 decay series.	Pass
Pb-212	lead-212	10.64	Days	80	GS	0.0906	Yes	Po-216	**Bi-212+D**	Long life parents of Po-216 are found in **Cm-244**, **Cm-248**, and **Np-236** decay series.	Pass-Parent
Pb-214	lead-214	26.8	Minutes	34900	GS	0.114	Yes	Po-218	**Bi-214+D**	Long life parents of Po-218 are found in Cf-250 decay series.	Pass-Parent
Pd-107	palladium-107	6.50E+06	Years	24	TBD	TBD	TBD	Rh-107	None	Rh-107 and parents have a very short half-life.	Pass
Pd-109	palladium-109	13.7012	Hours	24600	TBD	TBD	TBD	Rh-109	None	Rh-109 and parents have a very short half-life.	3
Pm-147	promethium-147	2.6234	Years	669	LS	TBD	TBD	**Nd-147**	**Sm-147**	None	Pass
Pm-148	promethium-148	5.368	Days	56	TBD	TBD	TBD	**Pm-148m**	**Sm-148+D**	None	3
Pm-148m	promethium-148m	41.29	Days	2.28	TBD	TBD	TBD	None	**Pm-148+D**	None	3
Pm-149	promethium-149	53.08	Hours	7490	TBD	TBD	TBD	Nd-149	None	Nd-149 and parents have a very short half-life.	3
Pm-151	promethium-151	28.40	Hours	562	TBD	TBD	TBD	Nd-151	**Sm-151**	Nd-151 and parents have a very short half-life.	3
Po-210	polonium-210	138.376	Days	19.4	TBD	TBD	TBD	**Bi-210**/At-210/Rn-214	None	At-210 and Rn-214 and parents have a very short half-life.	Pass-Parent
Pr-142	praseodymium-142	19.12	Hours	3310	TBD	TBD	TBD	Pr-142m	None	Pr-142m has a very short half-life and no parents.	3
Pr-143	praseodymium-143	13.57	Days	7530	TBD	TBD	TBD	**Ce-143**	None	None	3
Pr-144	praseodymium-144	17.28	Minutes	363000	TBD	TBD	TBD	**Ce-144**	**Nd-144**	None	3
Pr-147	praseodymium-147	13.4	Minutes	23700	TBD	TBD	TBD	Ce-147	**Nd-147+D**	Ce-147 and parents have a very short half-life.	3
Pu-236	plutonium-236	2.585	Years	0.104	AS	0.021	Yes	**Np-236**/Cm-240	**U-232+D**	Cm-240 and parents have a very short half-life.	Pass
Pu-237	plutonium-237	45.2	Days	105	TBD	TBD	TBD	Pu-237m/Am-237/**Cm-241**	**Np-237+D/U-233**	Pu-237m has a very short half-life and no parents. Am-237 and parents have a very short half-life.	3
Pu-238	plutonium-238	87.7	Years	0.00731	AS	0.00731	Yes	Np-238/**Cm-242**	**U-234+D**	Np-238 has a very short half-life and no parents.	Pass
Pu-239	plutonium-239	24,110	Years	0.00609	AS	0.00609	Yes	**Np-239/Cm-243**/Am-239	**U-235+D**	Am-239 and parents have a very short half-life.	Pass
Pu-240	plutonium-240	6,561	Years	0.0061	AS	0.00609	Yes	Np-240/Am-240/**Cm-244**	**U-236+D**	Am-240 and parents have a very short half-life. Long life parents of Np-240, which has a very short half-life, are found in **Cm-248** decay series.	Pass

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Symbol	Radionuclide	Physical Half-Life	Half-Life Units	Ag PRG (pCi/g)	Estimated Analytical Method	Estimated Best MDC (pCi/g)	Ag PRG Met (estimated)?	Likely Parents	Radioactive Daughters	Comment	Failed Selection Criteria
Pu-241	plutonium-241	14.290	Years	1.05	LBC	0.835	Yes	Np-241/**Cm-245**	**Am-241+D**	Np-241 has a very short half-life and no parents.	Pass
Pu-242	plutonium-242	375,000	Years	0.00642	AS	0.00642	Yes	Np-242/Am-242/**Cm-246**	**U-238+D**	Np-242 and parents have a very short half-life. Long life parents of Am-242, which has a very short half-life, are found in **Cm-242** decay series.	Pass
Pu-244	plutonium-244+D	8.00E+07	Years	0.00506	TBD	TBD	TBD	**Cm-248**/Np-244	**U-240+D**	Np-244 has a very short half-life and no parent.	Pass
Ra-226	radium-226+D	1,600	Years	0.000632	D	0.003	No	**Th-230**/Fr-236/Ac-226	**Rn-222+D**	Fr-216 and parents have a very short half-life. Ac-226 has a very short half-life and no parents.	Pass
Ra-228	radium-228+D	5.75	Years	0.00116	GS	0.01	No	**Th-232**/Fr-228	**Ac-228+D**	Fr-228 and parents have a very short half-life.	Pass
Rb-86	rubidium-86	18.642	Days	71.7	GS	0.751	Yes	Rb-86m	None	Rb-86m has a very short half-life and no parents.	3
Rh-103m	rhodium-103m	56.114	Minutes	84400000	TBD	TBD	TBD	**Ru-103**	None	None	3
Rh-106	rhodium-106	30.07	Seconds	2530000	GS	0.470	Yes	**Ru-106**	None	None	3
Rn-220	radon-220	55.6	Seconds	774000000	GS	34.6	Yes	Ra-224/At-220/Fr-220	Po-216+D	At-220 and Fr-220 and parents have a very short half-life. Long life parents of Ra-224, which has a very short half-life, are found in **Cm-244** and **Cm-248** decay series. Po-216 and daughters have a very short half-life.	Pass-Parent
Rn-222	radon-222+D	3.8235	Days	127000	TBD	TBD	TBD	**Ra-226**/At-222	Po-218+D	At-222 and parents have a very short half-life. Po-218 and daughters have a very short half-life.	Pass-Parent
Rn-224	radon-224	107	Minutes	Not Available	TBD	TBD	TBD	None	Fr-224+D	Fr-224 and daughters have a very short half-life.	2,3,5
Rn-225	radon-225	4.66	Minutes	Not Available	TBD	TBD	TBD	None	Fr-225+D	Fr-225 and daughters have a very short half-life.	5
Ru-103	ruthenium-103	39.26	Days	6.81	GS	0.0394	Yes	Tc-103	**Rh-103m**	Tc-103 and parents have a very short half-life.	3
Ru-106	ruthenium-106+D	371.8	Days	0.172	GS	1	No	Tc-106	**Rh-106**	Tc-106 and parents have a very short half-life.	3
Sb-122	antimony-122	2.7238	Days	158	GS	0.0657	Yes	Sb-122m	None	Sb-122m has a very short half-life and no parents.	3
Sb-124	antimony-124	60.20	Days	1.58	GS	0.0479	Yes	Sb-124m	None	Sb-124m has a very short half-life and no parents.	3
Sb-125	antimony-125+D	2.7586	Years	0.46	GS	0.009	Yes	**Sn-125**	**Te-125m**	None	Pass
Sc-46	scandium-46	83.79	Days	1.05	GS	1	Yes	Sc-46m	None	Sc-46m has a very short half-life and no parents.	3
Sc-48	scandium-48	43.67	Hours	28.7	TBD	TBD	TBD	Ca-48	None	Parents of Ca-48 (1.9E19 year half-life) have a very short half-life.	3
Se-79	selenium-79	2.95E+05	Years	0.132	TBD	TBD	TBD	As-79	None	As-79 and parents have a very short half-life.	Pass
Si-31	silicon-31	2.62	Hours	685000	TBD	TBD	TBD	Al-31	None	Al-31 and parents have a very short half-life.	3
Sm-146	samarium-146	1.03E+08	Years	3.57	TBD	TBD	TBD	Pm-146/Eu-146	None	Pm-146 (5.53 year half-life) has no parents. Eu-146 and parents have a very short half-life.	Pass
Sm-147	samarium-147	1.06E+11	Years	3.93	ICP-MS	0.001	Yes	**Pm-147**/Eu-147	None	Eu-147 and parents have a very short half-life.	Pass
Sm-148	samarium-148	7E+15	Years	Not Available	TBD	TBD	TBD	**Gd-152/Pm-148**/Eu-148	**Nd-144**	Eu-148 and parents have a very short half-life.	5
Sm-151	samarium-151	90	Years	242	GPC	200	Yes	**Pm-151**	None	None	Pass
Sm-153	samarium-153	46.284	Hours	3970	TBD	TBD	TBD	Pm-153	None	Pm-153 and parents have a very short half-life.	3
Sn-117m	tin-117m	13.76	Days	132	TBD	TBD	TBD	In-117	None	In-117 and parents have a very short half-life.	3
Sn-119m	tin-119m	293.1	Days	1030	TBD	TBD	TBD	In-119	None	In-119 and parents have a very short half-life.	3
Sn-121	tin-121	27.03	Hours	613000	GS	10	Yes	In-121/**Sn-121m**	None	In-121 and parents have a very short half-life.	Pass-Parent
Sn-121m	tin-121m	43.9	Years	41.4	TBD	TBD	TBD	None	**Sn-121**	None	Pass
Sn-125	tin-125	9.64	Days	56.9	TBD	TBD	TBD	In-125	**Sb-125+D**	In-125 and parents have a very short half-life.	3
Sn-126	tin-126	2.30E+05	Years	0.711	GS	0.1	Yes	In-126	Sb-126m+D	In-126 and parents have a very short half-life. Sb-126m and daughters have a very short half-life.	Pass

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Sr-87m	strontium-87m	2.815	Hours	4890	TBD	TBD	TBD	Y-87	None	Y-87 and parents have a very short half-life.	3
Sr-89	strontium-89	50.53	Days	0.929	TBD	TBD	TBD	Rb-89	None	Rb-89 and parents have a very short half-life.	3
Sr-90	strontium-90+D	28.90	Years	0.00139	LBC	0.001	Yes	Rb-90	**Y-90**	Rb-90 and parents have a very short half-life.	Pass
Sr-91	strontium-91	9.63	Hours	272	TBD	TBD	TBD	Rb-91	**Y-91**	Rb-91 and parents have a very short half-life.	3
Sr-92	strontium-92	2.66	Hours	758	TBD	TBD	TBD	Rb-92	**Y-92**	Rb-92 and parents have a very short half-life.	3
Tb-160	terbium-160	72.3	Days	2.24	GS	1	Yes	None	None	None	3
Tb-161	terbium-161	6.906	Days	3230	TBD	TBD	TBD	Gd-161	None	Gd-161 and parents have a very short half-life.	3
Tc-99	technetium-99	211,100	Years	0.00557	Eichrom	0.1	No	**Mo-99/Tc-99m**	None	None	Pass
Tc-99m	technetium-99m	6.0058	Hours	4110	GS	0.121	Yes	None	**Tc-99**	None	3
Te-125m	tellurium-125m	57.40	Days	32	TBD	TBD	TBD	**Sb-125/Te-129m**	None	None	Pass-Parent
Te-129	tellurium-129	69.6	Minutes	65300	TBD	TBD	TBD	Sb-129	**I-129**	Sb-129 and parents have a very short half-life.	3
Te-129m	tellurium-129m	33.6	Days	11.2	TBD	TBD	TBD	None	**Te-129+D**	None	3
Te-132	tellurium-132	3.204	Days	83.4	GS	0.0445	Yes	Sb-132	**I-132**	Sb-132 and parents have a very short half-life.	3
Th-228	thorium-228+D	1.9116	Years	0.0338	GS	2.44	No	**Ac-228/U-232**	Ra-224+D	Ra-224 and daughters have a very short half-life.	Pass-Parent
Th-229	thorium-229+D	7,880	Years	0.00171	AS	0.015	No	Ac-229/**U-233**	Ra-225+D	Ra-225 and daughters have a very short half-life. Ac-229 and parents have a very short half-life.	Pass
Th-230	thorium-230	75,400	Years	0.0105	AS	0.015	No	Ac-230/Pa-230/**U-234**	**Ra-226+D**	Ac-230 and parents have a very short half-life. Pa-230 has a very short half-life and no parent.	Pass
Th-231	thorium-231	25.52	Hours	3310	GS	0.456	Yes	**U-235**/Ac-231	**Pa-231+D**	Ac-231 and parents have a very short half-life.	Pass-Parent
Th-232	thorium-232	1.405E+10	Years	0.00942	AS	0.015	No	Ac-232/**U-236**	**Ra-228+D**	Ac-232 and parents have a very short half-life.	Pass
Th-234	thorium-234	24.1	Days	15.3	GS	0.514	Yes	Ac-224/**U-238**	Pa-234m+D	Ac-244 and parents have a very short half-life. See **U-234** for long half-life daughters of Pa-234m.	Pass-Parent
Tl-208	thallium-208	3.053	Minutes	22600	GS	0.0532	Yes	Hg-208/**Bi-212**	None	Hg-208 has a very short half-life and no parent.	Pass-Parent
Tm-170	thulium-170	128.6	Days	483	TBD	TBD	TBD	None	None	None	3
Tm-171	thulium-171	1.92	Years	1250	TBD	TBD	TBD	**Er-171**	None	None	Pass
U-232	uranium-232	68.9	Years	0.00059	TBD	TBD	TBD	**Pu-236**/Np-232/Pa-232	**Th-228+D**	Np-232 and parents have a very short half-life. **Pu-236** and Pa-232 have long life parents found in the **Cm-244** and **Cm-248** decay series.	Pass
U-233	uranium-233	1.592E+05	Years	0.00184	TBD	TBD	TBD	Pa-233/**Pu-237**/Np-233	**Th-229+D**	Long life parents of Pa-233, which has a very short half-life, are found in Bk-249 decay series. Np-233 and parents have a very short half-life.	Pass
U-234	uranium-234	245,500	Years	0.00187	LAS	0.001	Yes	Pa-234/Np-234/**Pu-238**	**Th-230+D**	Long life parents of Pa-234, which has a very short half-life, are found in **Th-234** decay series. Np-234 and parents have a very short half-life.	Pass
U-235	uranium-235+D	7.040E+08	Years	0.00181	LAS	0.001	Yes	Pa-235/Np-235/**Pu-239**	**Th-231+D**	Pa-235 and Np-235 and parents have a very short half-life.	Pass
U-236	uranium-236	2.3420E+07	Years	0.00198	LAS	0.001	Yes	Pa-236/**Np-236**/**Pu-240**	**Th-232+D**	Pa-236 and parents have a very short half-life.	Pass
U-238	uranium-238+D	4.468E+09	Years	0.00147	LAS	0.001	Yes	Pa-238/Np-238/**Pu-242**	**Th-234+D**	Pa-238 and parents have a very short half-life. Np-238 has a very short half-life and no parents.	Pass
U-240	uranium-240	14.1	Hours	298	TBD	TBD	TBD	**Pu-244**	Np-240m+D	Np-240m and daughters are found in the **Cm-248** decay series.	Pass-Parent
Xe-127	xenon-127	36.4	Days	24.4	TBD	TBD	TBD	Xe-127m	None	Xe-127m has a very short half-life and no parent.	2,3
Xe-129m	xenon-129m	8.88	Days	2490	TBD	TBD	TBD	None	None	None	2,3
Xe-131	xenon-131	11.84	Days	NA	TBD	TBD	TBD	Xe-131m	None	Xe-131m and parents have a very short half-life.	2,3
Xe-133	xenon-133	5.243	Days	2440	TBD	TBD	TBD	**I-133/ Xe-133m**	None	None	2,3
Xe-133m	xenon-133m	2.19	Days	4180	TBD	TBD	TBD	None	**Xe-133**	None	2,3
Xe-135	xenon-135	9.14	Hours	2300	GS	0.0900	Yes	**I-135**	**Cs-135**	None	2,3

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Y-90	yttrium-90	64.053	Hours	9630	TBD	TBD	TBD	**Sr-90**	None	None	Pass-Parent
Y-91	yttrium-91	58.51	Days	387	TBD	TBD	TBD	**Sr-91/Y-91m**	None	None	3
Y-91m	yttrium-91m	49.71	Minutes	10500	TBD	TBD	TBD	None	**Y-91**	None	3
Y-92	yttrium-92	3.54	Hours	4550	TBD	TBD	TBD	**Sr-92**	None	None	3
Y-93	yttrium-93	10.18	Hours	4320	TBD	TBD	TBD	Sr-93	**Zr-93+D**	Sr-93 and parents have a very short half-life.	3
Zn-65	zinc-65	243.66	Days	0.00301	GS	0.103	No	Ga-65	None	Ga-65 and parents have a very short half-life.	3
Zn-69m	zinc-69m	13.76	Hours	7.15	TBD	TBD	TBD	None	Zn-69	Zn-69 has a very short half-life.	3
Zr-93	zirconium-93	1.53E+06	Years	200	ICP-MS	20	Yes	**Y-93**	**Nb-93m**	None	Pass
Zr-95	zirconium-95	64.032	Days	3.89	GS	0.0808	Yes	Y-95	**Nb-95**	Y-95 and parents have a very short half-life.	3
Zr-97	zirconium-97	16.744	Hours	1380	TBD	TBD	TBD	Y-97	**Nb-97**	Y-97 and parents have a very short half-life.	3

Key:

Ag = Agricultural
AS = alpha spectroscopy
D = De-emanation
+D = additional daughters
Eichrom = Ion exchange
GS = gamma spectroscopy (Radionuclides determined by gamma spectroscopy will be reported with an applicable MDC. However, additional radionuclides will be reported if detected and identified with or without an applicable MDC.)
GPC = gas proportional counting
ICP-MS = Inductively Coupled Plasma-Mass Spectroscopy
LAS = Leach and Alpha Spectroscopy
LBC = Leach and Beta Counting
LS = Liquid Scintillation
MDC = minimum detectable concentration
pCi/g = picocurie per gram
PRG = Preliminary Remediation Goal
TBD = To Be Determined
XS = X-Ray Spectroscopy
Bold = Radionuclide is included on table.
Shading = Radionuclide failed one or more criteria.

Radionuclide Selection Criteria

1. Radionuclide was used or produced at SSFL.
2. The physical state of the radionuclide was not a gas. An exception to this criterion is if the radionuclide is a gas and its parent was not removed from the list, then it would not be proposed for removal.
3. Radionuclide has a half-life greater than one year. An exception to this criterion is if the radionuclide has a half-life of less than one year and its parent was not removed from the list, then it would not be proposed for removal.
4. The SSFL Technical Workgroup elected to keep a specific radionuclide.

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Table 2

Proposed Radionuclides for Analysis - Organized by Analytical Method

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Symbol	Radionuclide	Method Reference	Half-Life	Units	Ag PRG (pCi/g)	PASI MDC (pCi/g)	Ag PRG Met?
Alpha Spectroscopy							
Am-241	americium-241	HASL 300	432.6	Years	0.0132	0.05	No
Am-243	americium-243	HASL 300	7,370	Years	0.0111 (+D)	0.05	No
Cm-243	curium-243	HASL 300	29.1	Years	0.127	0.127	Yes
Cm-244	curium-244	HASL 300	18.1	Years	0.304	TBD	TBD
Cm-245	curium-245	HASL 300	8,500	Years	0.0922	0.0922	Yes
Cm-246	curium-246	HASL 300	4,760	Years	0.129	0.0922	Yes
Cm-248	curium-248	HASL 300	348,000	Years	0.00143	TBD	TBD
Np-237	neptunium-237	HASL 300	2.14E+06	Years	0.000448 (+D)	0.0111	No
Po-210	polonium-210	HASL 300	138.376	Days	19.4	2	Yes
Pu-236	plutonium-236	HASL 300	2.585	Years	0.104	0.104	Yes
Pu-238	plutonium-238	HASL 300	87.7	Years	0.00731	0.00731	Yes
Pu-239	plutonium-239	HASL 300	24,110	Years	0.00609	0.00609	Yes
Pu-240	plutonium-240	HASL 300	6,563	Years	0.0061	0.00609	Yes
Pu-242	plutonium-242	HASL 300	375,000	Years	0.00642	0.0064	Yes
Pu-244	plutonium-244	HASL 300	8.00E+07	Years	0.00506 (+D)	TBD	TBD
Th-228	thorium-228	HASL 300	1.9116	Years	0.0338 (+D)	0.04	No
Th-229	thorium-229	HASL 300	7,880	Years	0.00171 (+D)	0.05	No
Th-230	thorium-230	HASL 300	75,400	Years	0.0105	0.05	No
Th-232	thorium-232	HASL 300	1.41E+10	Years	0.00942	0.04	No
U-232	uranium-232	HASL 300	68.9	Years	0.00059	0.33	No
U-233	uranium-233	HASL 300	1.59E+05	Years	0.00184	0.33	No
U-234	uranium-234	HASL 300	245,500	Years	0.00187	0.04	No
U-235	uranium-235	HASL 300	7.04E+08	Years	0.00181 (+D)	0.04	No

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U-236	uranium-236	HASL 300	2.34E+07	Years	0.00198	0.05	No
U-238	uranium-238	HASL 300	4.47E+09	Years	0.00147 (+D)	0.04	No
U-240	uranium-240	HASL 300	14.1	Hours	298	TBD	TBD
Gas Flow Proportional Counting							
Bi-210	bismuth-210	Eichrom	5.012	Days	1340	0.2	Yes
Pb-210	lead-210+D	Eichrom	22.2	Years	0.0000642 (+D)	0.2	No
Sr-90	strontium-90	Eichrom	28.8	Years	0.00139 (+D)	0.03	No
Y-90	yttrium-90	Eichrom	64.053	Hours	9630	0.03	Yes
Gamma Spectroscopy [(1)]							
Ac-227	actinium-227	EPA 901.1M	21.772	Years	0.0831 (+D)	0.0831	Yes
Ac-228	actinium-228	EPA 901.1M	6.15	Hours	731	0.5	Yes
Ag-108	silver-108	EPA 901.1M	2.37	Minutes	6010000	TBD	TBD
Ag-108m	silver 108m	EPA 901.1M	418	Years	0.00629	0.01	No
Ba-133	barium-133	EPA 901.1M	10.5	Years	0.161	0.161	Yes
Ba-137m	barium-137m	EPA 901.1M	2.552	Minutes	178000	0.0012	Yes
Bi-212	bismuth-212	EPA 901.1M	60.55	Minutes	22400	0.5	Yes
Bi-214	bismuth-214	EPA 901.1M	19.9	Minutes	8190	0.5	Yes
Cd-113m	cadmium-113m	EPA 901.1M	14.1	Years	0.00526	TBD	TBD
Cf-249	californium-249	EPA 901.1M	351	Years	0.0613	0.0613	Yes
Co-60	cobalt-60	EPA 901.1M	5.275	Years	0.000901	0.000901	Yes
Cm-245	curium-245	EPA 901.1M	8,500	Years	0.0922	0.0922	Yes
Cm-246	curium-246	EPA 901.1M	4,760	Years	0.129	0.0922	Yes
Cs-134	cesium-134	EPA 901.1M	2.0652	Years	0.00747	0.0075	Yes
Cs-137	cesium-137	EPA 901.1M	30.08	Years	0.0012 (+D)	0.0012	Yes

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Symbol	Radionuclide	Method Reference	Half-Life	Units	Ag PRG (pCi/g)	PASI MDC (pCi/g)	Ag PRG Met?
Eu-152	europium-152	EPA 901.1M	13.537	Years	0.0376	0.0376	Yes
Eu-154	europium-154	EPA 901.1M	8.593	Years	0.0472	0.0472	Yes
Eu-155	europium-155	EPA 901.1M	4.753	Years	3.74	1	Yes
Ho-166m	holmium-166m	EPA 901.1M	1,230	Years	0.011	0.011	Yes
I-129	iodine-129	HASL-300 Gamma Low	1.57E+07	Years	0.0000276	1	No
K-40	potassium-40	EPA 901.1M	1.25E+09	Years	0.0445	0.0445	Yes
Na-22	sodium-22	EPA 901.1M	2.6027	Years	0.0852	0.0852	Yes
Nb-94	niobium-94	EPA 901.1M	2.03E+04	Years	0.0115	0.0115	Yes
Np-236	neptunium-236	EPA 901.1M	1.53E+05	Years	0.00281	0.333	No
Np-239	neptunium-239	EPA 901.1M	2.356	Days	22.6	20	Yes
Pa-231	protactinium-231	EPA 901.1M	32,760	Years	0.21	0.21	Yes
Pb-212	lead-212	EPA 901.1M	10.64	Days	80	0.5	Yes
Pb-214	lead-214	EPA 901.1M	26.8	Minutes	34900	0.5	Yes
Ra-226	radium-226	EPA 901.1M	1,600	Years	0.000632 (+D)	0.01	No
Ra-228	radium-228	EPA 901.1M	5.75	Years	0.00116 (+D)	0.01	No
Rn-220	radon-220	EPA 901.1M	55.6	Seconds	774000000	0.5	Yes
Rn-222	radon-222	EPA 901.1M	3.8235	Days	127000 (+D)	0.5	Yes
Sb-125	antimony-125	EPA 901.1M	2.7586	Years	0.46 (+D)	0.46	Yes
Sn-126	tin-126	EPA 901.1M	2.30E+05	Years	0.711	0.711	Yes
Te-125m	tellurium-125m	EPA 901.1M	57.4	Days	32	TBD	TBD
Th-231	thorium-231	EPA 901.1M	25.52	Hours	3310	100	Yes
Th-234	thorium-234	EPA 901.1M	24.1	Days	15.3	1	Yes
Tl-208	thallium-208	EPA 901.1M	3.053	Minutes	22600	0.5	Yes

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Tm-171	thulium-171	EPA 901.1M	1.92	Years	1250	TBD	TBD
Liquid Scintillation							
C-14	carbon-14	EPA-EERF	5,700	Years	0.0000563	10	No
Fe-55	iron-55	HASL-300	2.737	Years	0.821	10	No
H-3	tritium (hydrogen-3), organic	EPA 906.0M (on combustate)	12.32	Years	0.16	0.16	Yes
Ni-59	nickel-59	HASL-300	76,000	Years	2.15	2.15	Yes
Ni-63	nickel-63	HASL-300	100.1	Years	1.01	1.01	Yes
Pu-241	plutonium-241	HASL-300	14.29	Years	1.05	1.05	Yes
Tc-99	technetium-99	Eichrom	211,100	Years	0.00557	0.1	No
Removed from Program							
Be-10	beryllium-10	No method available	1.51E+06	Years	11.6	Removed	
Cd-113	cadmium-113	No method available	7.70E+15	Years	0.0028	Removed	
Cs-135	cesium-135	No method available	2.30E+06	Years	0.00509	Removed	
Gd-152	gadolinium-152	No method available	1.08E+14	Years	4.8	Removed	
In-115	indium-115	No method available	4.41E+14	Years	4.14	Removed	
Mo-93	molybdenum-93	No method available	4000	Years	1.05	Removed	
Nb-93m	niobium-93m	No method available	16.13	Years	137	Removed	
Pb-205	lead-205	No method available	1.73E+07	Years	0.153	Removed	
Pd-107	palladium-107	No method available	6.50E+06	Years	24	Removed	
Sm-146	samarium-146	No method available	1.03E+08	Years	3.57	Removed	
Sm-147	samarium-147	No method available	1.06E+11	Years	3.93	Removed	
Sm-151	samarium-151	No method available	90	Years	242	Removed	
Sn-121	tin-121	No method available	27.03	Hours	613000	Removed	

Final

Table 2

Proposed Radionuclides for Analysis - Organized by Analytical Method

Santa Susana Field Laboratory Radiological Background Study

Symbol	Radionuclide	Method Reference	Half-Life	Units	Ag PRG (pCi/g)	PASI MDC (pCi/g)	Ag PRG Met?
Sn-121m	tin-121m	No method available	43.9	Years	41.4	Removed	
Zr-93	zirconium-93	No method available	1.53E+06	Years	200	Removed	
To Be Determined							
Cl-36	chlorine-36	TBD	3.01E+05	Years	0.0102	TBD	TBD
Pm-147	promethium-147	TBD	2.6234	Years	669	TBD	TBD
Se-79	selenium-79	TBD	2.95E+05	Years	0.132	TBD	TBD

Ag = Agricultural

(+D) = PRG calculated for target isotope plus additional daughters

PASI = Pace Analytical Services, Inc.

MDC = minimum detectable concentration

pCi/g = picocuries per gram

PRG = Preliminary Remediation Goal

TBD = To Be Determined

(1) Radionuclides determined by gamma spectroscopy will be reported with an applicable MDC. However, additional radionuclides will be reported if detected and identified with or without an applicable MDC.

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Final
Table 3
Proposed Radionuclides for Distance Test Locations
Santa Susana Field Laboratory Radiological Background Study
August 17, 2009

Symbol	Radionuclide	Physical Half-Life	Half-Life Units	Agricultural PRG (pCi/g)	Estimated Best MDC (pCi/g)	Agricultural PRG Met (estimated)?
Gamma Spectroscopy						
Cs-137	cesium-137+D	30.1	Years	0.0012	0.0012	Yes
Co-60	cobalt-60	5.27	Years	0.000901	0.000901	Yes
Leach and Beta Counting						
Sr-90	strontium-90+D	28.8	Years	0.00139	0.00139	Yes
Alpha Spectroscopy						
Pu-238	plutonium-238	87.7	Years	0.00731	0.00731	Yes
Pu-239	plutonium-239	24,110	Years	0.00609	0.00609	Yes
Pu-240	plutonium-240	6,563	Years	0.0061	0.00609	Yes

Key:

Ag = Agricultural

+D = additional daughters

MDC = minimum detectable concentration

pCi/g = picocurie per gram

PRG = Preliminary Remediation Goal

Radionuclides determined by gamma spectroscopy will be reported with an applicable MDC. However, additional radionuclides will be reported if detected and identified with or without an applicable MDC.

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APPENDIX B

HGL STANDARD OPERATING PROCEDURES

SOP No. 1	General Field Operations
SOP No. 16	Surface and Shallow Depth Soil Sampling
SOP No. 24	Geologic Borehole Logging
SOP No. 27	Basic Geoprobe® Operations
SOP No. 35	Gamma Radiation Screening Walkover Survey for Surface Soil
SOP No. 36	Borehole Gamma Logging

SOP No. 1

General Field Operations

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STANDARD OPERATING PROCEDURES

1. GENERAL FIELD OPERATION

1.0 PURPOSE

This procedure outlines the general field organization as well as the field structure of sample collection, sample identification, record keeping, field measurements, and data collection. These guidelines are followed to ensure that the activities used to document sampling and field operations provide standardized background information and identifications. Site-specific deviations from the methods presented herein must be approved by the Field Team Leader (FTL) and HydroGeoLogic, Inc (HGL) Quality Assurance Manager (QAM).

2.0 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

Project Plans: Includes all documents or plans related to an individual site or Technical Direction Document. Project Plans include the Health and Safety Plan, Sampling Plan, and others.

2.2 Abbreviations

ASC	Analytical Services Coordinator (HGL employee)
EM	Equipment Manager (HGL employee)
OSC	On-Scene Coordinator (EPA employee)
FTL	Field Team Leader (HGL employee)
PPs	Project Plans
QA	Quality Assurance
QAC	Quality Assurance Coordinator (HGL employee)
QAM	Quality Assurance Manager (HGL employee)
QAO	Quality Assurance Officer (HGL employee)
QC	Quality Control
SHSC	Site Health and Safety Coordinator (HGL employee)
SAM	Site Assessment Manager (EPA employee)
TDMT	Technical Data Management Team
SOP	Standard Operating Procedures

3.0 RESPONSIBILITIES

The FTL is the primary point of contact with the EPA On-Scene Coordinator (OSC) or Site Assessment Manager (SAM). The OSC or SAM, when on site, has the ultimate responsibility for decisions concerning the project/site. If the OSC or SAM is not on site, the FTL has ultimate responsibility for project/site decisions. The FTL is responsible for development and completion of the Sampling Quality Assurance/Quality Control (QA/QC) Plan or Field Sampling Plan (FSP), project team organization, ensuring that appropriate sampling, testing and analysis procedures are followed; coordinating subcontracting and procurement activities; site access; and reporting to the OSC or SAM on project progress. The OSC or SAM is responsible for all public relations efforts concerned with EPA policy issues.

The FTL interacts with the Equipment Manager (EM) to obtain appropriate field equipment, oversee the implementation of the Project Plans (PPs) in the field, and interacts with the OSC on problems relating to instrumentation, sampling objectives, and field methodologies. The FTL oversees all equipment calibration and maintenance in the field, and ensures that decontamination procedures are correctly instituted in the field. The FTL reviews and approves all field forms for completeness.

The QAC works with the QAM and FTL to ensure the implementation of all QA program requirements for the project. The QAC informs the FTL when new or improved technical and QA procedures are needed; provides QA indoctrination and training to project staff; and interacts with the QAM and FTL on technical problems related to methods and instrumentation. The QAM ensures that data collection activities are consistent with the information requirements and that data are correctly and completely reported.

The Analytical Services Coordinator (ASC) ensures that the proper sample containers are sent to the field. The ASC maintains close contact with the FTL regarding the number of samples and types of analyses to be preformed. The information that the ASC needs pertaining to planned and altered sample shipments is contained in HGL Standard Operating Procedure (SOP) 3, Chain of Custody.

The designated Site Health and Safety Coordinator (SHSC) or the FTL is responsible for writing the Site Health and Safety Plan prior to mobilization, conducting daily on-site safety meetings (for example tailgate safety meetings), and ensuring project personnel are in compliance with health and safety protocols. Dedicated HGL subcontractors will abide by guidelines set forth in the Site Health and Safety Plan. Subcontractors must perform work in accordance with their own HASP, which must be approved by the SHSC. The SHSC will ensure that project personnel are equipped with proper safety equipment. The SHSC interacts with the FTL on environmental monitoring programs and decontamination processes.

Field personnel are responsible for performing site duties as instructed by the FTL. The FTL is also responsible for collecting and organizing the field data entry forms (Exhibits) and reviewing SOPs prior to performing site activities.

4.0 PROCEDURE

4.1 Mobilization/Demobilization

The FTL will write applicable PPs, if required, and have them approved by the OSC or SAM. The FTL will then assign personnel to review the plans and field equipment checklist (provided in Exhibit 1-1). Specific items required for field activities will be identified and acquired.

All equipment to be used will be checked by the EM to verify that it is operational before leaving the program support office. In accordance with manufactures' recommendations, performance checks and/or calibration will also be performed, as needed and directed by the FTL. In general, this will occur when the equipment reaches the site. The FTL will obtain copies of the appropriate SOPs and PPs that will be taken into the field. SOPs brought to the field will contain current versions of procedures and respective exhibits used for the applicable field method. These SOPs will be revised and updated by appropriate staff members as needed.

Upon return from the site, all equipment will be returned clean and orderly to the EM. If any problems occurred on site with any equipment, the problems should be noted in detail in the field log book and any applicable field form (if used). This information will be written down in a note or memo format and attached to the equipment in question.

4.2 Shipping

If sensitive field equipment is to be shipped to the site, proper care must be taken to ensure that damage will not be incurred en route, including the packaging of individual items in separate containers filled with protective packaging material (e.g., foam pellets or bubble wrap). If possible, equipment with carrying cases will be packed in the respective case and placed inside a second padded container.

Non-sensitive field equipment can be combined in appropriate shipping containers.

All containers used to ship equipment shall be labeled with the following items:

- Receiving company name, address and telephone;
- Attention (person receiving items in field);
- Return company name, address and telephone; and
- Return attention.

4.3 Serialization

All non-disposable equipment purchased will be permanently labeled with serial numbers. Any equipment purchased by an outside agency for use on a project will be tagged with the agency serial number.

A permanent inventory of equipment will be maintained, and will include at a minimum: serial numbers, types of equipment, initial costs, service records, and warranty information. Refer to the HGL Manual for Control of Government Property and Equipment Plan for specific guidance on equipment management.

All field forms and field log books will be permanently identified by document control numbers and kept in the project files when returned from the field. Log books will be assigned to project personnel, the assignment recorded in a master log book, and this assignment will be for the duration of the project activities.

4.4 Field Organization

4.4.1 Chain-of-Command

Chain-of-Command protocols will be defined by the HGL Quality Management Plan and implemented by the FTL. These protocols will be strictly followed while performing field tasks. All decisions concerning sampling, equipment problems and changes in strategy will be made by the OSC and/or the FTL or an approved appointee. Public relations problems will be addressed by the OSC or SAM only. The FTL or an approved designee shall conduct a daily "tailgate meeting" prior to field activities, during which individual roles will be delineated and safety issues discussed.

4.4.2 Field Documentation

All project activities will be recorded each day in the field log book. These methods are outlined in HGL SOP 6, Use and Maintenance of Field Log Books. On occasion, non-routine field activities will be recorded on special field forms if the HGL Quality Assurance Officer (QAO) and FTL approve.

4.4.3 Sampling Organization

The FTL shall ensure that the sampling design, outlined in the applicable PPs and SOPs, is followed during all phases of sampling activities at the site. For each sampling activity, field personnel shall record the information required by the applicable SOPs on the Exhibits provided.

Survey personnel shall identify and locate the monitoring and sampling stations described in the applicable PPs. Benchmarks located on the site and nearby shall be located and used as permanent reference markers. All sample locations shall be clearly marked, labeled and photographed according to the methods outlined in HGL SOP 5, Sample Location Documentation.

4.5 Review

The FTL or an approved designee shall check field log books, daily logs, and all other documents (Exhibits) that result from field operations for completeness and accuracy. Any discrepancies on these documents will be noted and returned to the originator for correction. The reviewer will acknowledge that review comments have been incorporated by signing and dating the applicable reviewed documents.

5.0 REFERENCES

HydroGeoLogic, Inc. 2007. Standard Operating Procedure 3, "Chain of Custody." Standard Operating Procedures.

HydroGeoLogic, Inc. 2007. Standard Operating Procedure 5, "Sample Location Documentation." Standard Operating Procedures.

HydroGeoLogic, Inc. 2007. Standard Operating Procedure 6, "Use and Maintenance of Field Log Books." Standard Operating Procedures.

6.0 EXHIBITS

1-1 Field Equipment Checklist

EXHIBIT 1-1
Field Equipment Checklist

General

X 1. Health and Safety Plan
X 2. Site base map
__ 3. Hand calculator
__ 4. Brunton compass
X 5. Cellular Telephone
X 6. Project-specific SAP (FSP, QAPP, and DMP)
X 7. Personal clothing and health and safety equipment
X 8. Personal Protective Equipment (see HASP for specifics)
X 9. Contact Information (PRP contractor; HGL Project Manager; HGL Corporate Health and Safety Manager; EPA Work Assignment Manager)

Environmental Monitoring Equipment – All Monitoring Equipment to be Provided/Operated by PRP

X 1. Shovels
__ 2. Keys to well caps
__ 3. pH meter (with calibrating solutions)
__ 4. pH paper
__ 5. Thermometer
__ 6. Conductivity meter (with calibrating solution)
__ 7. Organic vapor analyzer or photo-ionization detector with calibration gas
__ 8. H_2S, O_2, combustible gas indicator

Sampling Equipment – Supplies for Submittal of Analytical Samples via Overnight Courier

X 1. Tool box with assorted tools (knife, pipe wrenches, screwdrivers, socket set and driver, open and box end wrenches, hacksaw, hammer, vice grips)
X 2. Geologic hammer
X 3. Trowel
__ 4. Stainless steel and/or Teflon® spatula
X 5. Hand auger
__ 6. Engineer's tape
__ 7. Steel tape
__ 8. Electric water level sounder
__ 9. Petroleum Interface Probe
X 10. Batteries
__ 11. Bailers (Teflon®, stainless steel, acrylic, PVC)
__ 12. Slug test water displacement tube
__ 13. Vacuum hand pump
__ 14. Electric vacuum pump
__ 15. Displacement hand pump

EXHIBIT 1-1 (Continued)

__	16.	Mechanical pump (centrifugal, submersible, bladder)
__	17.	Portable generator
__	18.	Gasoline for generator
__	19.	Hose
__	20.	Calibrated buckets
__	21.	Stop watch
__	22.	Orifice plate or equivalent flow meter
__	23.	Data logger and pressure transducers
__	24.	Strip chart recorders
X	25.	Sample bottles (currently to be provided by PRP contractor)
__	26.	0.45-micron filters (prepackaged in holders)
X	27.	Sample preservatives (nitric, hydrochloric, sulfuric acid/sodium hydroxide) (currently to be provided by PRP contractor)
__	28.	Heavy-duty aluminum foil
X	29.	Coolers
	30.	Ice packs/Ice
__	31.	Large seal top poly bags
X	32.	Heavy-duty garbage bags
X	33.	Duct tape
X	34.	Strapping tape
X	35.	Paper towels
X	36.	"Bubble" pack, foam pellets, or shredded paper
__	37.	Vermiculite
X	38.	Stainless steel bowls
__	39.	SW scoop
__	40.	Peristaltic pump/tubing
X	41.	Sample tags
X	42.	SOPs

<u>Decontamination Equipment</u>

X	1.	Non-phosphate detergent (alconox or liquinox)
__	2.	Selected high purity, contaminant free solvents
X	3.	Long-handled brushes
__	4.	Drop cloths (plastic sheeting)
X	5.	Trash container
X	6.	Galvanized tubs or equivalent (e.g., baby pools)
X	7.	Tap Water
X	8.	Contaminant free distilled/deionized water
__	9.	Metal/plastic container for storage and disposal of contaminated wash solutions
__	10.	Pressurized sprayers, H_2O
__	11.	Pressurized sprayers, solvents
__	12.	Aluminum foil
__	13.	Sample containers
X	14.	Emergency eyewash bottle

EXHIBIT 1-1 (Continued)

<u>Documentation Supplies</u>

X	1.	Field Log Books
__	2.	Daily Drilling Report forms
X	3.	Field Borehole Log forms (Historic Logs)
X	4.	Monitoring Well Installation Log forms (Historic Logs)
__	5.	Well Development Data forms
	6.	Groundwater Sampling Log forms
__	7.	Aquifer Test Data forms
X	8.	Sample Chain-of-Custody forms
X	9.	Custody seals
X	10.	Cooler labels ("This Side Up," "Hazardous Material," "Fragile")
X	11.	Federal Express/DHL labels
__	12.	Communication Record forms
X	13.	Documentation of Change forms
X	14.	Digital Camera or Camera and film
X	15.	Paper
X	16.	Pens/pencils
X	17.	Felt tip markers (indelible ink)

<u>Project Specific Equipment</u>

X	1.	Ludlum Model 2221 Gamma Survey Logger
X	2.	Ludlum Model 44-1 Gamma Survey Logger
X	3.	Laptop
X	4.	GPS
X	5.	Geoprobe drill rig
X	6.	Hard hats
X	7.	Snake gaiters

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SOP No. 16

Surface and Shallow Depth Soil Sampling

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STANDARD OPERATING PROCEDURE

16. SURFACE AND SHALLOW DEPTH SOIL SAMPLING

1.0 PURPOSE

The purpose of this procedure is to describe the equipment and operations used for sampling surface and shallow depth soils. This procedure outlines the methods for surface and shallow depth soil sampling for the Santa Susana Radiological Background Study.

2.0 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

Soil: All unconsolidated materials above bedrock.

Surface Soils: Soils located zero to six inches below ground surface.

Shallow Depth Soils: Soils located above the bedrock surface and from six inches to 10 feet below ground surface.

2.2 Abbreviations

FSP	Field Sampling Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
SOP	Standard Operating Procedure
HGL	HydroGeoLogic, Inc.

3.0 RESPONSIBILITIES

Sampling personnel are responsible for performing the applicable tasks and procedures outlined herein when conducting work related to environmental projects.

The Project Leader or an approved designee is responsible for ensuring that performance standards specified by this SOP are achieved. This will be accomplished by reviewing all documents, exhibits and field procedures.

4.0 PROCEDURES

4.1 Introduction

The objective of surface and shallow depth soil sampling for this study is to determine background radionuclide concentrations within surface and subsurface soils underlying the two geologic formations that are present at the SSFL (Chatsworth and Santa Susana Formation).

4.2 Sampling Equipment

Surface and shallow soil sampling equipment includes:

- Stainless steel mixing bowl;

- Stainless steel trowels or spoons;
- Stainless steel hand auger;
- Stainless steel core sampler which uses stainless steel or Lexan® liners (optional);
- Stainless steel shovel; and
- Appropriate sample containers.

4.3 Decontamination

Before initial use, and after each subsequent use, all sampling equipment must be decontaminated using the procedures outlined in HGL Standard Operating Procedure (SOP) 11, Equipment Decontamination.

4.4 Sampling Location/Site Selection

Refer to Section 1.3 of the Field Sampling Plan (FSP) for sampling locations and site selection.

4.5 Sampling Approaches

The specific sampling approach is in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Refer to Section 1.4 of the FSP for more information.

4.6 General

Surface sampling pits will be filled in with the material removed during sampling. Where a vegetative turf has been established, fill in with native soil or potting soil and replace the turf if practical in all holes or trenches when sampling is completed. Each logging/sampling borehole will be sealed with high-solids bentonite grout chips after completion of activities at each location. Grouting will occur as quickly as possible to minimize the possibility of contaminant migration. Each borehole will be patched at the surface with native soil.

4.6.1 Homogenizing Samples

Homogenizing is the mixing of a sample to provide a uniform distribution of the contaminants. Proper homogenization ensures that the containerized samples are representative of the total soil sample collected. All samples to be composited or split should be homogenized after all aliquots have been combined.

4.6.2 Compositing Samples

Compositing is the process of physically combining and homogenizing several individual soil aliquot of the same volume or weight. Compositing samples provides an average concentration of contaminants over a certain number of sampling points.

4.6.3 Splitting Samples

Splitting samples (after preparation) is performed when multiple portions of the same samples are required to be analyzed separately. Fill the sample containers for the same analyses one after another in a consistent manner.

4.7 Surface Soil Sampling

Perform the following steps for surface soil sampling:

- Prior to sampling, remove leaves, grass, and surface debris using decontaminated stainless steel trowel;
- Label the lid of the sample container with an indelible pen or affix the sample label to the side of the jar and tape as to make it impervious to water prior to filling the container with soil.
- Collect surface soil samples with a decontaminated stainless steel trowel, spoon or hand auger and transfer to a decontaminated stainless steel bowl for homogenizing.
- Collect samples in the order of volatilization sensitivity. The most common collection order is as follows:
    - Volatile organic compounds (VOC);
    - Purgeable organic carbon (POC);
    - Purgeable organic halogens (POX);
    - Total organic halogens (TOX);
    - Total organic carbon (TOC);
    - Extractable organics;
    - Total metals;
    - Dissolved metals;
    - Phenols;
    - Cyanide;
    - Sulfate and chloride;
    - Turbidity;
    - Nitrate and ammonia; and
    - Radionuclides.
- Immediately transfer the sample into a container appropriate to the analysis being performed (HGL SOP 2, Sample Preservation, Containers and Maximum Holding Times);
- Place the samples in a cooler for transport to an analytical laboratory;
- Immediately after the sample is collected, record applicable information in the field log book as outlined in HGL SOP 6, Use and Maintenance of Field Log Books. This information may also be entered on Exhibit 16-2, Surface/Shallow Soil Sampling Log.
- Excess soil sample media shall be placed in the soil boring or pit and filled to grade with native soil or potting soil.
- Decontaminate all sampling equipment (HGL SOP 11, Equipment Decontamination); and
- Complete the Chain-of-Custody Record and associated documentation (HGL SOP 3, Chain of Custody).

4.9 Shallow Depth Soil Sampling using a Hand Auger

Perform the following steps to collect shallow depth soil samples:

- Use a decontaminated stainless steel shovel to remove the top layer of soil.
- Remove leaves, grass, and surface debris that may have contacted the shovel using a decontaminated stainless steel trowel;
- Excavate soil to the pre-determined sampling depth by using a decontaminated hand auger. Periodically, remove the cuttings from the auger;
- When the proper sample depth is reached, remove the hand auger and all cuttings from the hole;
- Lower the decontaminated hand auger to the bottom of the hole.

- Mark the sample interval (i.e., one foot above ground level) on the auger;
- Advance the auger until it is flush with the interval mark at ground level;
- When the auger has been advanced the total depth of the required sample, remove it from the bottom of the hole;
- Immediately transfer the sample into a container or stainless steel bowl for compositing and homogenizing as specified in the project-specific Field Sampling Plan appropriate to the analysis being performed using a stainless steel spoon or trowel.
- Samples will be identified and label as per HGL SOP 4, Sample Identification, Labeling, and Packaging;
- Samples will be preserved and held as per HGL SOP 2, Sample Containers, Preservation and Maximum Holding Times;
- Complete the Chain-of-Custody Record and associated documentation (HGL SOP 3, Chain of Custody).
- Record applicable information in the field log book as outlined in HGL SOP 6, Use and Maintenance of Field Log Books. This information can also be entered on Exhibit 16-2, Surface/Shallow Soil Sampling Log.
- Decontaminate all sampling equipment (HGL SOP 11, Equipment Decontamination).

4.10 Abandonment Procedures

Surface sampling pits will be filled in with the material removed during sampling. Where a vegetative turf has been established, fill in with native soil or potting soil and replace the turf if practical in all holes or trenches when sampling is completed. Each logging/sampling borehole will be sealed with high-solids bentonite grout chips after completion of activities at each location. Grouting will occur as quickly as possible to minimize the possibility of contaminant migration. Each borehole will be patched at the surface with native soil.

4.11 Review

The Project Leader or an approved designee shall check all Exhibits and field log books used to record information during sampling for completeness and accuracy. Any discrepancies will be noted and the documents will be returned to the originator for correction. The reviewer will acknowledge that these review comments have been incorporated by signing and dating the checked by and date blanks on the Exhibits and at the applicable places in the log book.

5.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1989. “Soil Sampling Quality Assurance User's Guide.” EPA/600/8-89/046, U.S. Environmental Protection Agency, Washington, DC.

HydroGeoLogic, Inc. 2007. Standard Operating Procedure 1, Use and Maintenance of Field Log Books. Standard Operating Procedures.

HydroGeoLogic, Inc. 2007. “ Standard Operating Procedure 2, Sample Preservation, Containers, and Maximum Holding Times. Standard Operating Procedures.

HydroGeoLogic, Inc. 2007. Standard Operating Procedure 3, Chain of Custody. Standard Operating Procedures.

HydroGeoLogic, Inc. 2007. Standard Operating Procedure 4, Sample Identification, Labeling, and Packaging. Standard Operating Procedures.

HydroGeoLogic, Inc. 2007. Standard Operating Procedure 5, Sample Location Documentation. Standard Operating Procedures.

HydroGeoLogic, Inc. 2007. Standard Operating Procedure 6, Use and Maintenance of Field Log Books. Standard Operating Procedures.

HydroGeoLogic, Inc. 2007. Standard Operating Procedure 11, Equipment Decontamination. Standard Operating Procedures.

6.0 EXHIBITS

Exhibit 16-1 Figures for Different Forms of Grid Sampling
Exhibit 16-2 Surface/Shallow Soil Sampling Log

EXHIBIT 16-1
Figures for Different Forms of Grid Sampling

Soil Sampling

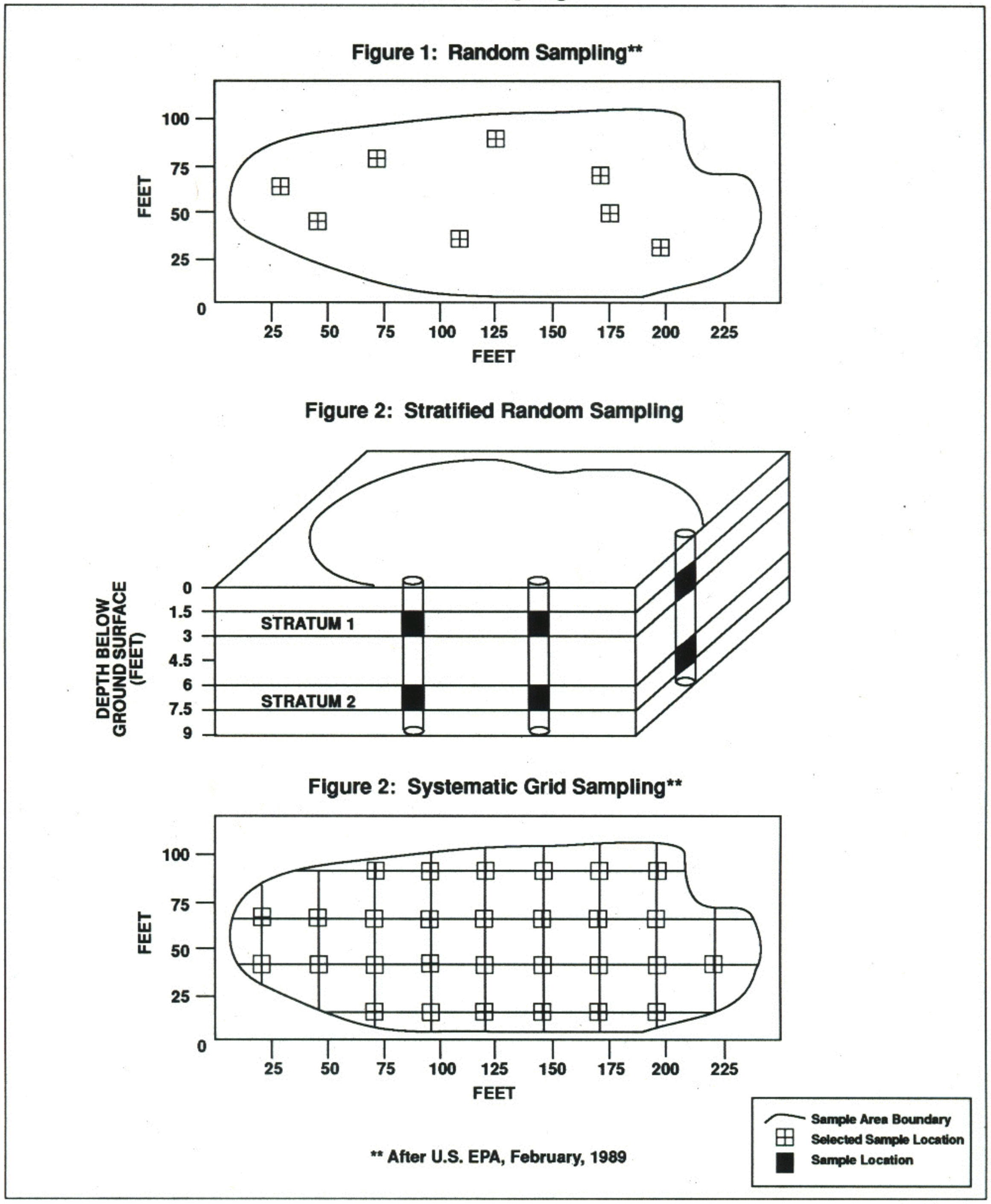


EXHIBIT 16-1 (Continued)
Figures for Different Forms of Grid Sampling

Soil Sampling

Figure 4: Systematic Random Sampling

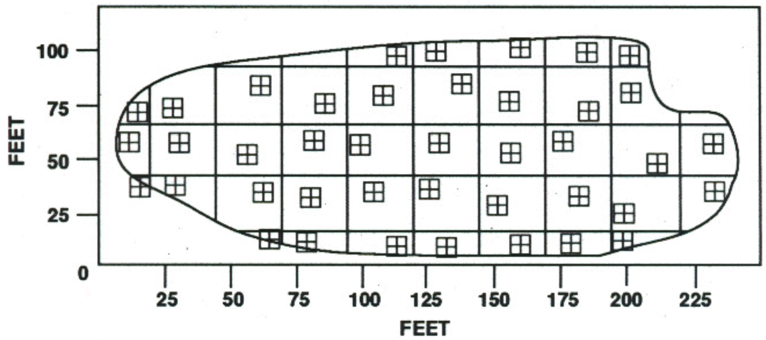


Figure 5: Search Sampling

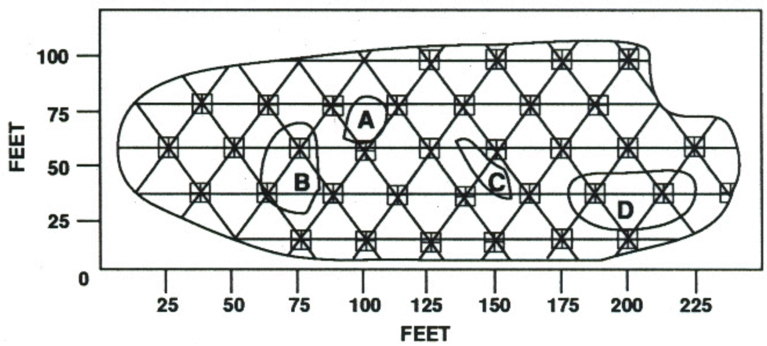
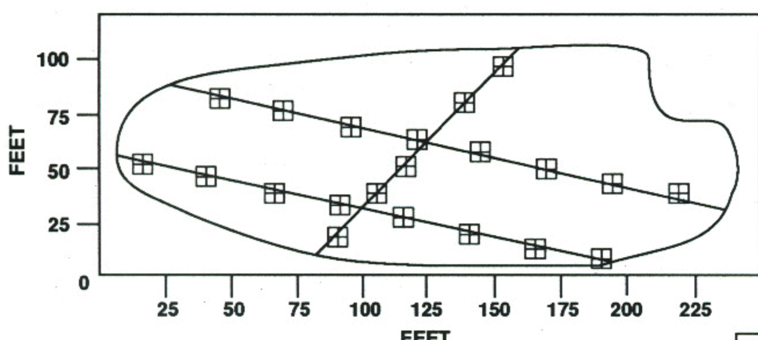


Figure 6: Transect Sampling



After: U.S. EPA, February, 1989

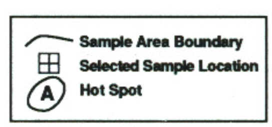


EXHIBIT 16-2
Surface/Shallow Soil Sampling Log

HGL HydroGeoLogic, Inc Exceeding Expectations	Surface and Shallow Soil Sampling Log	Records Management Data
Project Number	Project Name	Page ____ of _____

General Info			
	Location		
	Surface Elevation ft.	Date Started	Date Completed
	Field Investigator		C of Cr
	Sampling Excavation Method	Sampling Method	
	Depth of Excavation ft.	Depth Water First Encountered ft.	Backfill Material

Sampling Info	Sample Number	Depth (ft)	Lithologic Description[1]	Sample Container	Analyses Requested

Plan View		Legend
		Soil Sampling Location

Recorded By:	Date	Checked By:	Date:

[1] Include such data as OVM, pH, blow counts, or other physical reading observations.

SOP No. 24

Geologic Borehole Logging

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STANDARD OPERATING PROCEDURE

24. GEOLOGIC BOREHOLE LOGGING

1.0 PURPOSE

The purpose of this procedure is to describe the methods for geological borehole logging of soil and data collection.

This procedure provides guidance for routine field operations for the Santa Susana Radiological Background Study. Deviations from the methods presented herein must be approved by the Project Leader and HydroGeoLogic, Inc. (HGL) Quality Assurance Officer.

2.0 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

Plasticity: The property of permanently changing shape without movement on any visible fractures

2.2 Abbreviations

AGI	American Geologic Institute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System

3.0 RESPONSIBILITIES

Personnel conducting exploratory soil boring and monitoring well borehole logging are responsible for performing the applicable tasks outlined in this procedure when conducting work related to environmental projects.

The Project Leader or an approved designee is responsible for checking all work performance and verifying that the work satisfies the applicable tasks required by this procedure. This will be accomplished by reviewing all documents (Exhibits) and data produced during work performance.

4.0 PROCEDURE

4.1 Introduction

A major portion of the work produced at an environmental site is geologic in nature and is concerned with characterizing the physical subsurface and the geologic and hydrologic processes operating at the site. A properly prepared borehole log serves as an essential tool in making these assessments and correlations. This Standard Operating Procedure (SOP) defines the methodology of collecting pertinent data so that all borehole logs made at a site can create a consistent, uniform database from which interpretive conclusions can be made with confidence. Large-scale inferences such as vertical and horizontal extent of strata, facies changes, attitude of bedding or layering, structural features (faults, folds, fractures, dikes, etc.), location of the water table, lithologic characterizations, and the extent of subsurface contamination are made from small-scale observations recorded on the borehole log. These observations include bedding, grain size, degree of sorting, shape of grains, color, hardness, organic vapor levels, and other observable physical characteristics including visible evidence of contamination.

Logging should document both general and specific lithologic information about the borehole. In all cases, the lithologic log should be identified by the specific site number; well/boring number; drilling method; location; date of drilling; individual logger (geologist); drilling contractor; significant organic vapor reading; visible evidence of contamination; depth to water first encountered; final depth of water level; well/boring elevation (if data is available); total depth in feet; graphic log; and lithologic description.

Lithologic descriptions for unconsolidated materials often use the Unified Soil Classification System (USCS) or standard geologic field description methods, Compton 1962. Descriptions of bedrock should follow applicable U.S. Geologic Survey Standards.

Lithologic descriptions of unconsolidated material should contain the following characteristics when possible:

- Soil or formation name;
- Gradation degree of sorting;
- Principal constituent;
- Specific descriptors for principal constituents (e.g., plasticity, grain size, and shape);
- Firmness/hardness;
- Minor constituents;
- Moisture content;
- Color;
- Particle morphology; and
- Other descriptors (i.e., visual evidence of contamination, specific monitoring equipment readings including gamma detector readings).

4.2 Classification System

Sections 4.24-1 through 4.24-2 will describe in detail the parameters and descriptive terminology used to classify each sample for the bore log.

4.2.1 Soil or Formation Name

The soil or formation name will include the major constituent(s) and may be preceded by a single-word modifier indicating the subordinate constituent. Percentages of each constituent will be used to classify the material without actually recording constituent percentage. The textural terms used to classify a soil are shown in Exhibit 24-1, Triangular Diagram Showing Percentage of Sand, Silt, and Clay in Each Textural Class.

4.2.2 Gradation (Degree of Sorting)

Size sorting describes the extent to which grain size is uniform. The comparison chart listed in Exhibit 24-2, “Comparison Chart for Estimating Degree of Sorting,” will be used to describe soils being logged from a borehole.

4.2.3 Principal Constituent

Principal constituents recorded during borehole logging include an identification of the following unconsolidated material types:

- Clay;
- Sand;
- Cobbles;
- Silt;
- Gravel; and
- Boulders.

If known, an identification of the potential source of the material should be made (i.e., alluvium, colluvium, artificial fill, or residual material).

4.2.4 Principal Constituent Descriptors

Additional descriptors for the principal material constituents may be added to the log in order to further delineate or accurately record subtle changes in the lithologic structure. Modifiers such as grain size, shape, and plasticity of materials (i.e., high, medium, and low plasticity).

4.2.5 Consistency/Density/Rock Hardness

The characteristics of unconsolidated material are often determined by the Standard Penetration Test (SPT). The SPT involves driving a split spoon sampler into the material by dropping a 140 pound weight from a height of 30 inches. The resistance of the material is reported in the number of blows of the weight required to drive the spoon one foot and translates into the following descriptors:

# of Blows/Foot	Cohesive Consistency (Clay)
0-2	Very soft
2-4	Soft
4-8	Medium
8-15	Stiff
15-30	Very stiff
30+	Hard

# of Blows/Foot	Cohesive Consistency (Gravel)
0-4	Very loose
4-10	Loose
10-30	Medium dense
30-50	Dense
50+	Very Dense

# of Blows/Foot	Rock Hardness
<20	Weathered
20-30	Firm
30-50	Medium Hard
50-80	Hard

80+	Very Hard

4.2.6 Minor Constituents

Constituents not previously described in the principal constituent description may be described as a percentage or by weight. Typically, modifiers for minor constituents conform to the following standards:

- No modifier < 5%
- Slightly 5-12%
- Moderately (i.e. add (y) or (ey) such as silty clay) 12-40%
- Very 40-50%

4.2.7 Moisture Content

Terms in a wide range, from dry to saturated, are used to describe the relative moisture content of a field soil sample. These terms are described as follows:

- Dry - The sample is completely without moisture. Dry, silty sands, for example, will produce suspended particles when dropped by hand.
- Damp - Samples containing a very slight amount of water.
- Moist - Soils in this range are near the maximum water content for their maximum compactibility or density. Moist soils will form a ball when compressed in the hand.
- Wet - The soil samples are wet enough to produce free water upon shaking but still contain unoccupied air voids. Fine-grained soils close to the liquid limit would be termed wet.
- Saturated - Soils with zero air voids. Samples placed in sample jars or bags will probably have standing water after a short period of time.

4.2.8 Color

The color of soil and associated materials will be recorded on the borehole log. Color descriptors should include but are not limited to the following descriptors: black, grey-black, brown, olive, mottled, streaked, etc. Color charts should be used to provide general logging guidance but specific use is not necessary for adequately describing lithology.

4.2.9 Particle Morphology

The key elements of particle morphology are roundness and sphericity. Roundness is a measure of the curvature of grain corners. Sphericity is a measure of how equal the three axial lengths (x, y, z) of an object are. Determination of both properties is facilitated by the use of a hand lens. Estimate grain roundness and sphericity by using the American Geologic Institute (AGI) Data Sheet (Exhibit 24-4).

4.2.10 Other Descriptors

Field screening data collected during the drilling process may help further characterize site conditions during subsurface investigations. Readings from on-site monitoring equipment such as the borehole gamma detector should be recorded at each sample interval. Other useful information includes the organic content and the presence or absence of waste material in samples.

4.2.11 Particle Size Distribution

An estimate of particle sorting by grain size is often useful for borehole logging purposes. Precise estimates of percent composition of the sample are not necessary.

USCS Grain Size Categories

Exact Size Limits	Approximate Inch Equivalents	Name of Loose Aggregate
>256 mm	>10 in.	Boulder gravel
64 – 256 mm	2.5 – 10 in.	Cobble gravel
32 – 64 mm	1.2 – 2.5 in.	Very coarse pebble gravel
16 – 32 mm	0.6 – 1.2 in.	Coarse pebble gravel
8 – 16 mm	0.3 – 0.6 in.	Medium pebble gravel
4 – 8 mm	0.15 – 0.3 in.	Fine pebble gravel
2 – 4 mm	0.08 – 0.15 in.	Granule (or very fine pebble) gravel
1 – 2 mm	0.04 – 0.08 in.	Very coarse sand
1/2 – 1 mm	0.02 – 0.04 in.	Coarse sand
1/4 – 1/2 mm	0.01 – 0.02 in.	Medium sand
1/8 – 1/4 mm	0.005 – 0.01 in.	Fine sand
1/16 – 1/8 mm	0.002 – 0.005 in.	Very fine sand
1/256 – 1/16 mm	0.00015 – 0.002 in.	Silt
<1/256 mm	<0.00015 in.	Clay (clay-size materials)

From Wentworth Scale, Compton 1962.

The Comparison Chart for Estimating Percentage Composition (Exhibit 24-3) can be used to estimate the percentage of various grain sizes present in a sample. However, visual estimates usually provide sufficient information for characterizing site lithology.

4.3 Borehole Logs

Record data collected during exploratory boring soil logging in the field log book and on Exhibit 24-5, Borehole Log. Use this Exhibit on all applicable field drilling and subsurface sampling operations.

Geologic correlation and aquifer properties prediction are dependent on good exploratory boring sample descriptions. Rotary drilling with fluids is generally unacceptable since the drilling fluids may potentially contaminate the aquifer under investigation. High quality borehole data are generally acquired with a split-spoon or pitcher core barrel. This method of sampling provides detailed logging. The lithofacies interpreted from cuttings logs may lack the accuracy necessary for detailed correlation. Where possible, techniques such as geophysical borehole logging will be used to supplement cuttings descriptions. Note on the log any geologic description determined from borehole cuttings. The cuttings are often mixed over the entire length of the boring.

In bedrock formations, cuttings may be acquired from a reverse circulation, air rotary or from a dual wall rotary boring. These cuttings do not provide information on the in situ properties of the materials, but do provide adequate sample description information.

In summary, close sample spacing or continuous sampling in a boring provide the best material for descriptive geology. Use traditional geologic terminology and supplement with the USCS descriptive system when appropriate. Provide sufficient data on layering and other sedimentary structures and undisturbed textures. Sample numbers, depths, and analytes should be included in each description. The applicable field methods described by Compton (1962) and AGI (1982) are recommended. These methods are fully referenced in Section 5.0.

4.4 Review

Personnel conducting borehole logging of soil will record field data on Exhibit 24-5, Borehole Log, and will record a chronological summary in the project log book. The applicable methods outlined in this procedure shall be used to record the data on this Exhibit. The personnel conducting these operations will sign and date the "logged by" and "date" blanks on Exhibit 24-5, Borehole Log.

The Project Leader or designee shall check all field generated data and Exhibit 24-5, Borehole Log, for completeness and accuracy. Any discrepancies will be noted and the Exhibits will be returned to the originator for correction. The reviewer will acknowledge that corrections have been incorporated by signing and dating the "reviewed by" and "date" blanks on Exhibit 24-5, Borehole Log.

5.0 REFERENCES

American Geological Institute. 1982. "AGI Data Sheets." Falls Church, Virginia.

ASTM 1984. "ASTM D1586, Description and Identification of Soils, Visual-Manual Procedure" in the Annual Book of ASTM Standards. V.04.08

Compton, R. R. 1962. "Manual of Field Geology." John Wiley and Sons, Inc., New York, New York, 378p.

Munsell. 1988. Munsell Soil Color Charts." Macbeth Division, Kollmorgen Instruments Corporation, Baltimore, Maryland, 1988 edition.

U.S. Environmental Protection Agency (EPA). 1987. "A Compendium of Superfund Field Operations Methods." EPA/540/P-87/001 (OSWER Directive 9355.0-14). December 1987.

6.0 EXHIBITS

Exhibit 24-1 Triangular Diagram Showing Percentage of Sand, Silt and Clay in Each Textural Class
Exhibit 24-2 Comparison Chart for Estimating Degree of Sorting
Exhibit 24-3 Comparison Chart for Estimating Percentage Composition
Exhibit 24-4 Comparison Chart for Estimating Roundness and Sphericity
Exhibit 24-5 Borehole Log

EXHIBIT 24-1
Triangular Diagram Showing Percentage of Sand, Silt and Clay in Each Textural Class

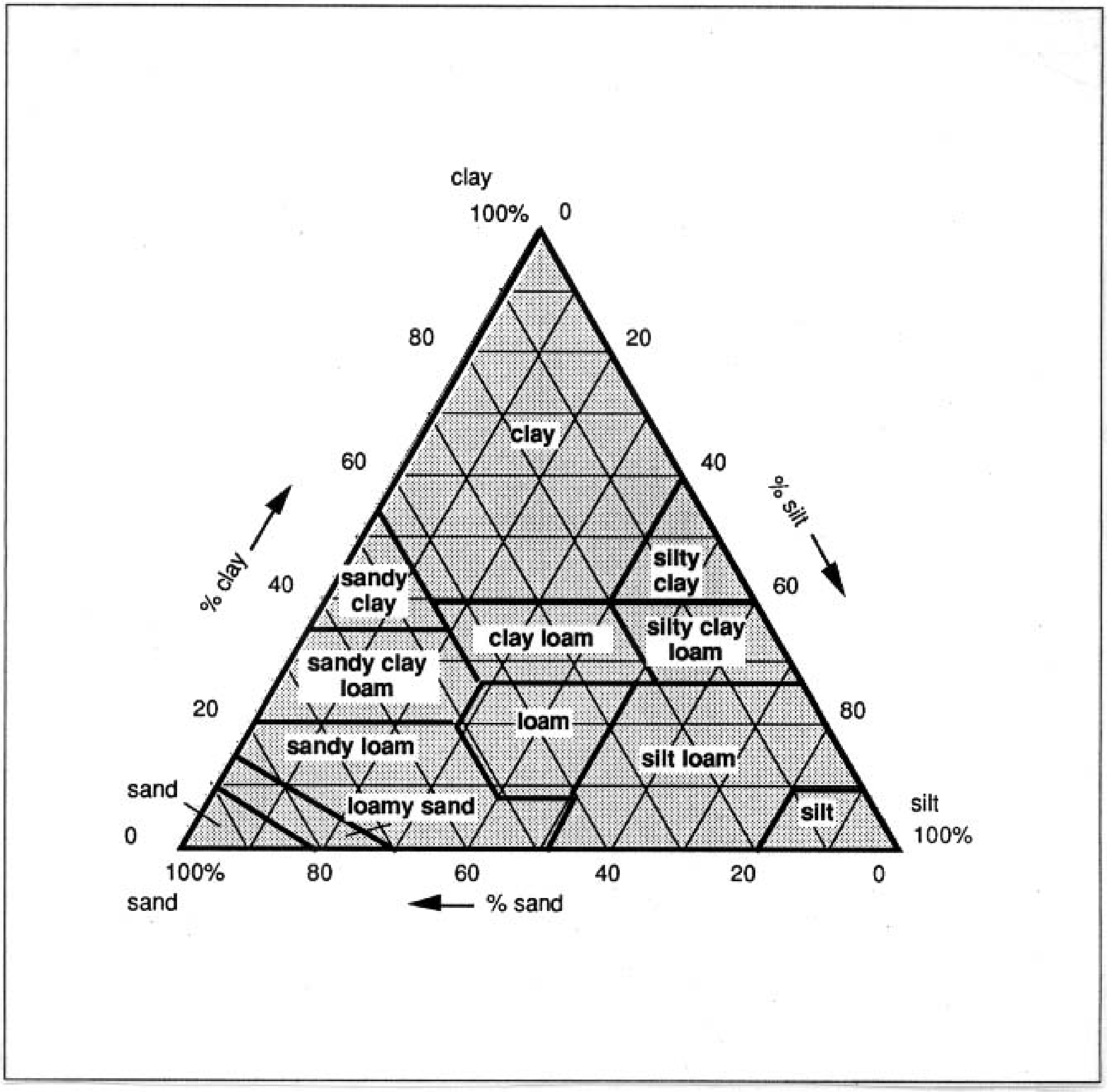
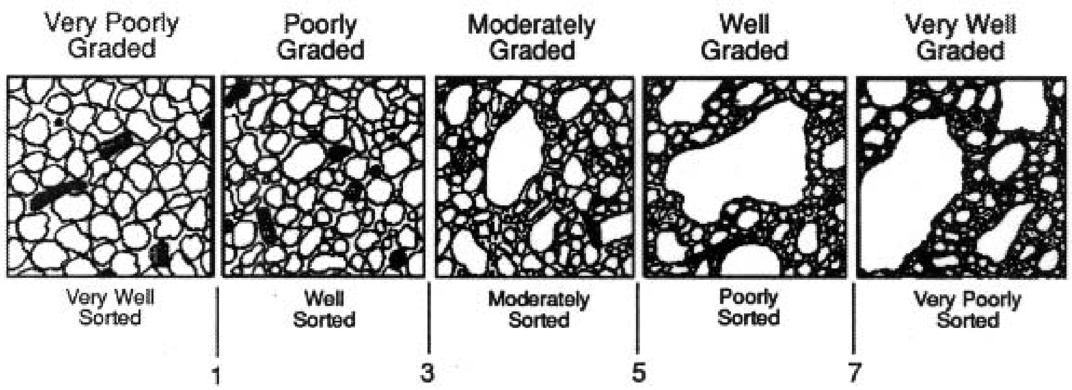


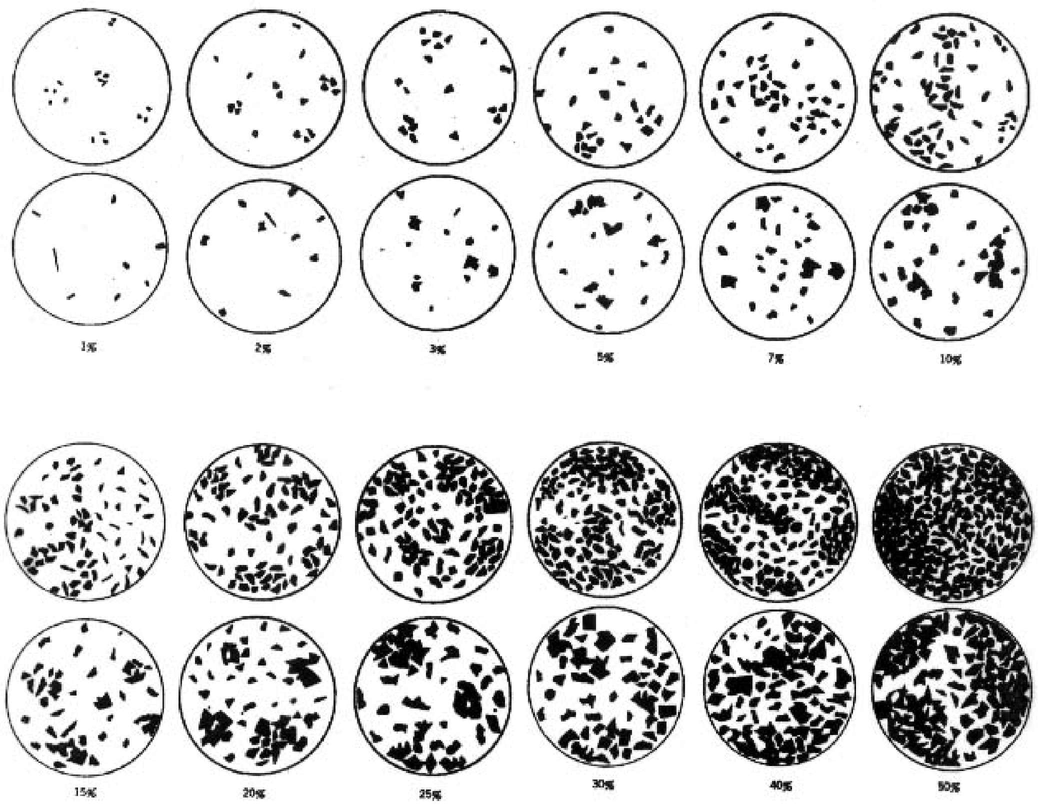
EXHIBIT 24-2
Comparison Chart for Estimating Degree of Sorting



Terms for degrees of sorting. The numbers indicate the number of size-classes included by the bulk (80 percent) of the material. The drawings represent sandstones as seen with a hand lens. Silt and clay-size materials are shown diagrammatically by the fine stipple.

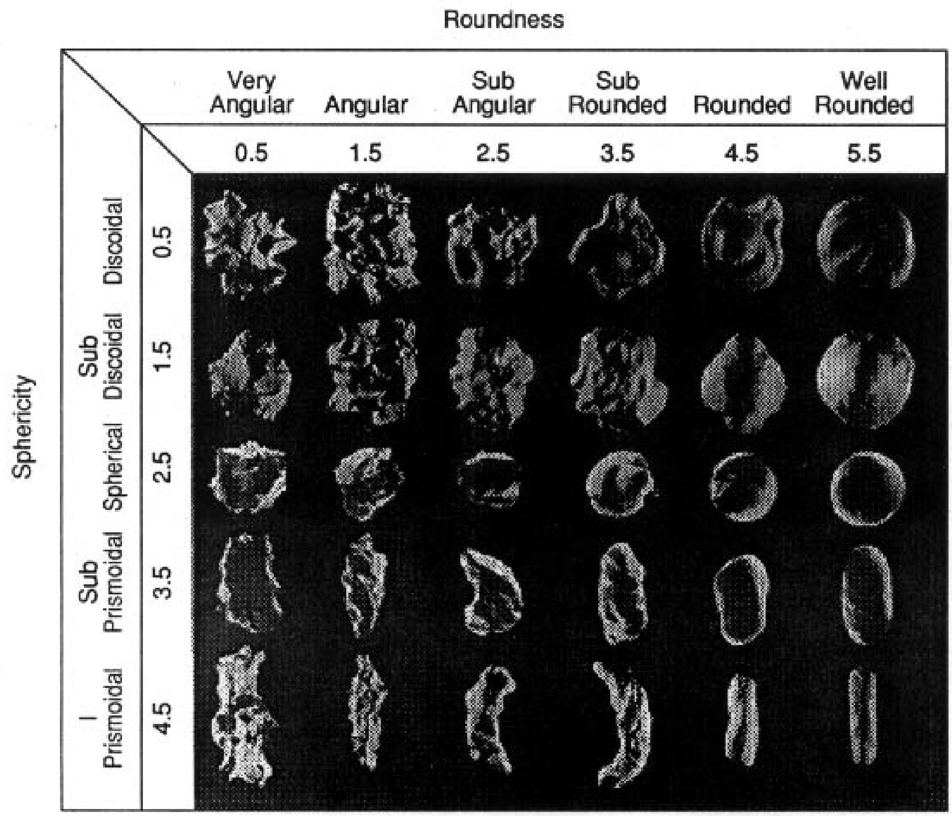
Reference: Compton, R.R. 1962. *Manual of Geology.* John Wiley & Sons, Inc. New York, N p. 214

EXHIBIT 24-3
Comparison Chart for Estimating Percentage Composition



Reference: Compton, R.R. 1962. *Manual of Geology*. John Wiley & Sons, Inc. New York, NY p. 332-333

EXHIBIT 24-4
Comparison Chart for Estimating Roundness and Sphericity



Reference: American Geological Institute. 1982. "AGI Data Sheet 18.1" in *AGI Data Sheets*. Fall Church, VA

EXHIBIT 24-5
Borehole Log

HGL HydroGeoLogic, Inc.	**Borehole Log**	Records Management Data

Project Number -	Project Name -	Page 1 of -
Well/Borehole Number -	Well/Borehole Location -	

Elevation - ft. msl	Date Started -	Date Completed -
Field Investigator -	Drilling Company -	Drilling Personnel -
Drilling Method -	Drilling Rig (Type/Model) -	Bit Type/Size -
Sampling Method -	Completion Depth - ft.	Depth of Water First Encountered - ft.

Depth	Graphic Log	Blow Counts per 6"	OVA Readings (Unit Deflections)	LITHOLOGY AND PHYSICAL CONDITION	NOTES
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

Recorded By:	Date:	Checked By:	Date:

EXHIBIT 24-5 (Continued)

HGL HydroGeoLogic, Inc.

HGL HydroGeoLogic, Inc.	**Borehole Log**	Records Management Data

Project Number -	Project Name -	Page 1 of -
Well/Borehole Number -	Well/Borehole Location -	

Elevation - ft. msl	Date Started -	Date Completed -
Field Investigator -	Drilling Company -	Drilling Personnel -
Drilling Method -	Drilling Rig (Type/Model) -	Bit Type/Size -
Sampling Method -	Completion Depth - ft.	Depth of Water First Encountered - ft.

Depth	Graphic Log	Blow Counts per 6"	OVA Readings (Unit Deflections)	LITHOLOGY AND PHYSICAL CONDITION	NOTES
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

Recorded By:	Date:	Checked By:	Date:

SOP No. 27

Basic Geoprobe® Operations

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STANDARD OPERATING PROCEDURE

27. BASIC GEOPROBE® OPERATIONS

1.0 PURPOSE

This procedure provides general guidance for operating the Model 5410 Geoprobe® system for subsurface exploration. The unit includes tools that can be used for collecting soil core samples, groundwater samples, and soil gas samples. This Standard Operating Procedure (SOP) is a brief overview of Geoprobe® operation. Consult the “Owner’s Manual” published by Kejr Engineering, Inc. for more complete information. Geoprobe® operations should be conducted only by trained and experienced personnel.

2.0 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

Geoprobe®: A vehicle-mounted, hydraulically-powered, soil probing machine that utilizes static force and percussion to advance small diameter sampling tools into the subsurface for collecting soil core, soil gas, or groundwater samples. (Geoprobe® is a registered trademark of Kejr Engineering, Inc., Salina, Kansas).

Macro-Core® Sampler: A 48-inch long sampling device capable of recovering a soil sample contained inside a removable liner. (Macro-Core® is a registered trademark of Kejr Engineering, Inc., Salina, Kansas).

Liner: A removable/replaceable, thin-walled clear plastic tube inserted inside a Macro-Core® sampling device for the purpose of containing and storing soil samples.

Soil Gas Post Run Tubing (PRT) Sampler: A threaded fitting attached to the retractable point at the head of a drive rod string that permits collection of soil gas samples at specified depths.

2.2 Abbreviations

ID	Inside Diameter
OD	Outside Diameter
PID	Photo-ionization Detector
PRT	Post Run Tubing
TSOP	Technical Standard Operating Procedures

3.0 RESPONSIBILITIES

Field personnel are responsible for performing the applicable tasks and procedures outlined herein when conducting work related to environmental projects. The Project Leader or an approved designee is responsible for checking all work performance and verifying that the work satisfies the applicable tasks required by this procedure. This will be accomplished by reviewing all documents and procedures.

4.0 PROCEDURES

4.1 General Considerations

The planning and implementation of Geoprobe® exploration requires consideration of the specific site conditions including soil types, topography, and site accessibility. Soils containing larger rocks, cobble, concrete debris, or similar materials may cause damage to the sampling equipment or result in penetration refusal at much shallower depths than required. Sampling locations on slopes and on loose or soft soils require special caution. As with any other subsurface soil exploration techniques, a utility locate must be conducted prior to the start of field operations to ensure the safe operation of the equipment and protect the operator and other field crew.

Other Geoprobe® equipment and methods not described in this SOP are also available for specific applications such as the carbide-tipped steel drill used to hammer through concrete and asphalt cover material or the use of the on-board vacuum system for assisting in soil gas sampling. There is also a new dual-wall core system and a screen point sampler for groundwater.

IMPORTANT: Read all safety precautions before attempting to operate the Geoprobe®. See Safety Instructions, Appendix A. <u>This applies to Operators AND Helpers.</u>

Before operating the Geoprobe®, take a few minutes to visually inspect the major components (Exhibit 27-1). From the rear of the vehicle open all doors, gates, and other enclosures to fully expose the Geoprobe® components. This will ensure that the movements of the Geoprobe® apparatus will not damage the Geoprobe® components or other vehicle parts. Look for worn or damaged parts that may require attention or items that may hinder the movement of the equipment.

4.2 Remote Engine Ignition

The Geoprobe® is equipped with a remote engine ignition. This device allows starting and stopping of the vehicle motor from the probe operating position at the right rear of the vehicle. There are a few steps to follow when using this remote ignition:

1) Put the vehicle transmission in "park."
2) Set the emergency brake. (The high speed ("fast") will not work unless the brake is set.)
3) Shut off the engine using the ignition switch in the vehicle cab.
4) Set the Geoprobe® master switch to the ON position. This switch is located on floor to the left of the driver's-side seat.
5) Block the front and back of one front wheel to prevent vehicle movement when the Geoprobe® is in operation.
6) Open the tailgate and slide the roof of the utility box all the way forward.

4.3 Hydraulic System Activation

A belt-driven hydraulic pump operates off the vehicle's engine and supplies power to the Geoprobe®. A three-position toggle switch located on the right hand side at the operator's position at the right rear of the vehicle controls pump operation. The "off" position deactivates the hydraulic system. The "slow" position activates the pump while the vehicle engine remains at idle speed. Engine speed, and therefore hydraulic flow, is increased by placing the switch in the "fast" position. The fast position increases the engine speed to a pre-set level by activating a remote hydraulic throttle control. The "slow" position is depicted with the outline of a tortoise and the "fast" position is depicted with the outline of a rabbit (Exhibit 27-2).

1) Ensure that the hydraulic control toggle switch is in the “off” position prior to starting the vehicle with the remote ignition. Start the engine using the remote engine ignition switch. This is a switch that works like the regular vehicle ignition. Rotate the switch clockwise a quarter turn to engage the starter. Once the engine starts, release the switch. It will automatically fall back into the operating position.

2) Push the hydraulic control toggle switch to the slow position. Precaution should be taken to avoid damage to the hydraulic system when operating at temperatures below 10 degrees Fahrenheit (°F) (-12° Celsius (°C)). Run the hydraulic pump at slow speed for at least 15 minutes before starting probing operations. This will warm the hydraulic fluid sufficiently to allow adequate flow and prolong pump life.

3) The regen switch is located on the upper right of the control panel. If the switch is moved to the full “up” position, the retractor “lift” speed of the probe will be doubled, allowing rods to be lifted much more quickly. However, when the regen switch is in the “up” position, the pulling power of the probe is also cut in half. If rods are sticking or not lifting from the boring, move the regen switch to the full “down” position to use the maximum available pulling power of the probe.

4.4 Hydraulic System Control, Derrick Positioning

At the operator's position there are four hydraulic levers that control the positioning movements of the derrick. They are located at the bottom right side of the control panel and are labeled FOOT, SWING, EXTEND, and FOLD (Exhibit 27-2). Pushing or pulling on these levers will activate valves on various hydraulic pistons on the Geoprobe® derrick causing these components to move. Movement of the Geoprobe® components is controlled by the amount of movement of the levers. Partial movement of the levers results in partial opening of the hydraulic valves and a slower movement of that particular piston.

To position the Geoprobe® derrick for operation:

1) From the operator's position, slowly pull on the EXTEND control lever and laterally extend the derrick unit out as far as possible. Failure to fully extend the derrick unit could cause it to hit the roof and possibly dent the tailgate.

2) Pull the FOLD control lever to pivot the derrick unit until it is perpendicular to the ground. This can be gauged visually or by using the bubble level mounted on the side of the derrick. Once the derrick is in this position the operator's control panel will be vertically oriented.

3) Push the FOOT control lever down to lower the derrick assembly until it is just a few inches above the ground surface.

4) Lift up on the EXTEND control to slowly move the derrick assembly back toward the vehicle. Stop when the foot cylinder rod is approximately 8 to 10 inches from the vehicle tailgate.

CAUTION - Always position the derrick with the hydraulic control switch at SLOW speed. Ensure that the foot cylinder does not contact the vehicle tailgate because extensive damage to the cylinder rod may result.

5) Push down on the FOOT control lever to extend the foot and put slight vehicle weight on the probe unit. Stop when the foot contacts the ground surface. It is not necessary to significantly raise the rear of the vehicle.

CAUTION - Always keep the rear wheels of the vehicle on the ground surface when putting weight on the probe unit. The vehicle may shift sideways during probing if the wheels do not contact the ground.

6) Some left and right movement of the derrick is possible by using the swing lever. Normal placement of the derrick is in the center of the bed. Movement of the derrick may be necessary when there is slight movement of the vehicle during operations because of vibrations and shifting of the vehicle weight. Repositioning over a previous Geoprobe® location may also be easier using the swing mount. **Recenter the derrick before storing the derrick to avoid damage to the Geoprobe®**. Watch the levers on the right side!

4.5 Hydraulic System Control, Probe Operation

There are three levers mounted on the derrick that are used to perform the static push and percussion action to advance the Geoprobe® sampling equipment into the ground. The two main PROBE operation levers are located on the left side of the operator's control panel (Exhibit 27-2). These levers advance the main probe piston toward the ground and activate the percussion head to hammer the drive rod into the ground. The third lever to control the hammer or tool rotation action is located on the hammer.

To perform the probe operation:

1) Position the appropriate drive rod or sampling device on the ground. This is centered approximately two inches from the three sides of the derrick foot (Exhibit 27-5).

2) Check to make sure the anvil and the anvil retainer cap assembly is in place and intact before hammering.

3) Lower the hammer to allow the drive cap end of the drive rod or sampling device to enter the drive head on the probe. This is done by pushing down on the PROBE control lever. Minor adjustments can be made by adjusting the drive rod or sampler to further center it so that it is parallel to the main probe drive piston.

4) Once the rod or sampler is centered, push down on the PROBE control lever to drive the rod or sampler into the ground. When the main probe drive is all the way down, lift up on the PROBE control lever to raise the probe off the drive rod or sampler. If the drive rod or sampler is to be removed from the ground the main probe drive needs only to be moved one foot above the drive cap to allow for its removal by hand and its replacement with a pull cap.

5) If greater depth is required, raise the hammer, remove the drive cap from the rod in the ground, and thread an additional drive rod onto the one in the ground. Make sure the drive cap is then threaded onto the top of the new drive rod. Continue as in step 2. This process is repeated until the desired depth is reached.

6) To remove the sampler or drive rod from the ground retract the probe approximately one foot from the top of the drive cap on the drive rod or sampler. Unthread the drive cap and thread on a pull cap. Lift the hammer latch located on the end of the main drive probe and lower the probe over the pull cap (Exhibit 27-6). Push the hammer latch down to catch the flanged rim on the pull

cap and slowly raise the probe until the latch catches the flange on the pull cap (Exhibit 27-7). Raise the probe all the way up and then slightly lower it to release the tension on the pull cap and flip the hammer latch outward to release the pull cap. Raise the probe all the way up to allow the pull cap and the drive rod to be unthreaded from the drive rod string.

7) Normal friction against the drive rod by the soil in the ground will usually hold the rest of the drive rod string and prevent it from slipping back down the drive hole. However, to ensure that the string does not slip back down the hole, attach vice grips, a pipe wrench, or a Regen Pull Ring to the uppermost drive rod near the ground surface as a precaution.

8) In addition to the static push from the main hydraulic probe piston, the drive rods can be hammered into the soil using the percussion drive head located at the end of the probe. To activate the percussion drive head make sure that the HAMMER/rotation control lever located on the probe drive head is in the hammer position. This means the lever is pulled forward completely and is parallel to the ground. This ensures that all of the hydraulic pressure is being directed to activate the hammer.

9) The HAMMER control lever is located next to the PROBE control lever on the operator's control panel. The hammer is activated only when the lever is pushed completely down.

10) Use the percussion drive head to hammer the drive rod into the ground when the static push is insufficient to advance the drive rod. This becomes apparent when the resistance on the drive rod causes the foot, derrick, and rear of the vehicle to rise slightly off the ground. The foot should be allowed to rise no more than six inches off the ground before use of the percussion drive head is warranted. At no time should the rear wheels of the vehicle be allowed to lose contact with the ground surface. The Geoprobe® will likely shift in this situation, and could fall off the drive rods creating a serious safety hazard.

4.6 Soil Sampling Using a Macro-Core® Open Tube Soil Sampler

The Geoprobe® system offers a variety of options for performing soil sampling. The Macro-Core® Open Tube Soil Sampler is a 4-foot-long steel tube that is threaded on both ends to allow the attachment of a cutting shoe on one end and a drive head on the other (Exhibit 27-8). A clear plastic or acetate liner is placed inside the Macro-Core® to collect a 3- to 4-foot continuous soil core as the device is driven into the ground. Once removed from the steel sheath the clear liner provides an intact visual representation of the various soil layers that can be further examined or sampled. It is important to clean the soil from the threads and the inside of the Macro-Core® prior to use.

To use the Macro-Core® Open Tube Soil Sampler:

a. Thread the drive head into one end of the Macro-Core® tube, and then thread a drive cap onto the threaded fitting at the end of the drive head.

b. Place a plastic spacer ring onto the acetate liner. Insert the clear plastic liner approximately three-quarters of the way into the Macro-Core® tube. If desired a plastic core catcher can be used in place of a spacer ring to prevent loose material from falling out of the liner.

c. Snap the plastic spacer or core catcher onto the cutting shoe. Slide the assembled cutting shoe/spacer/liner into the sampler tube and thread the cutting shoe into the sampler tube.

d. The Macro-Core® Open Tube Soil Sampler is now ready to be used. Follow the instructions for use as described above in Section 4.5, Hydraulic System Control, Probe Operation.

e. The Macro-Core® assembly is longer than the travel length of the main probe piston. For the initial drive into the ground extend the probe to its maximum travel distance and then raise the foot of the derrick approximately one foot off the ground to allow for the Macro-Core® assembly to be inserted into the drive head of the probe. Use the FOOT control lever to perform the initial push into the soil. The hammer drive can also be used with the FOOT control to perform this drive. When the foot does make contact with the ground surface, switch to operating the PROBE control lever to complete the drive.

f. To remove the Macro-Core®, retract the probe to its maximum travel distance to pull the Macro-Core® out of the ground. To remove the final foot of the Macro-Core® it may be possible to pull it out by hand or use the FOOT control lever to raise the foot off the ground and completely extract the Macro-Core® from the soil.

g. Once the Macro-Core® is removed from the ground it can be placed on a level work surface and the cutting shoe/spacer/liner assembly unthreaded and removed from the steel sample tube. This may be possible by hand or the sampler can be placed in a vise and the Macro-Core® wrench used. The cutting shoe has a notched groove along its outer shoulder. The Macro-Core® wrench has a tab on one end that fits into this notched groove and allows the cutting shoe to be unthreaded off the steel sample tube.

h. Following appropriate decontamination procedures, the cutting shoe can be reused on subsequent sampling drives. New plastic spacers (or core catchers) and liners are used for each additional sample core.

i. For additional sampling deeper than four feet place the Macro-Core® assembly into the original excavated hole. It may be possible to push the Macro-Core® part way into the hole so that the foot of the derrick does not need to be moved. Use the main probe drive to push the Macro-Core® into the original 4-foot-deep hole. Fully retract the main probe, unthread the drive cap, thread a drive rod on to the drive head of the Macro-Core®, and then thread the drive cap onto the top of the drive rod. Lower the main probe drive onto the drive cap and use it, with the hammer if necessary, to drive the Macro-Core®/drive rod string into the ground. Use the procedure described in step 5 to remove the Macro-Core® and drive rods from the ground. Note that the drive rods are 3 feet long and not 4 feet long like the Macro-Core®. Use this same procedure to place additional drive rods to advance the Macro-Core® to the maximum desired sampling depths. Make sure to recover and empty the core barrel every three to four feet.

j. Repeatedly pulling the Macro-Core® in and out of a hole during deep sampling may enlarge the hole allowing the core and rods to drop. Use a vise-grip, wrench, or Regen Pull Ring to hold the rod.

k. Never drive the core more than four feet per sample. If sloughing/caving is suspected, only drive one rod three feet. Overfilling the core may cause the liner to collapse causing jamming.

l. Be advised that as additional drive rods are added more play and flex occurs in the drive rod string. When positioning the drive cap into the main probe drive head be sure to keep your fingers out of this pinch point. Grab the top drive rod at least one foot away from the top and wear leather gloves when handling these objects. Since these rods and the Macro-Core® are driven into the ground they may contact rocks or other hard items that may cause sharp burrs and scratches on the metal and contact with bare skin can cause painful cuts.

4.7 Installing PVC for the Borehole Gamma Logging Survey

After subsurface soil sampling activities are completed, the drive apparatus will be assembled and advanced down the previously sampled borehole to 10 feet bgs. Once the drive apparatus has advanced to 6 feet bgs, polyvinyl chloride (PVC) piping with an inner diameter of at least 1.5 inches and an end cap will be lowered to the bottom of the borehole. Then, downward pressure will be applied to the PVC piping to dislodge the disposable tip of the drive apparatus. The drive apparatus will then be retracted while continually applying downward pressure to the PVC piping ensuring the PVC remains at least 6 feet bgs. After the drive apparatus has been fully retracted, the remaining PVC piping will be measured to document the final completion depth. The borehole gamma survey will be executed in accordance with SOP No. 36.

5.0 REFERENCES

Kejr Engineering, Inc. 2000. The Yellow Field Book (0100A).

Kejr Engineering, Inc. 2003. Geoprobe® Systems Tools Catalog. 601 North Broadway, Salina, Kansas 67401. 1-800-GEOPROBE, 785-825-1842, Fax: 785-825-2097, www.geoprobe.com.

Kejr Engineering, Inc. 2003. Geoprobe® Systems. Operator's Manual, Geoprobe® Model 5410 Direct Push Machine – "The Tools for Site Investigation."

U.S. Environmental Protection Agency (EPA). 1987. "A Compendium of Superfund Field Operations Methods." EPA/540/P-87/001. (OSWER Directive 9355.0-14.) December 1987.

6.0 EXHIBITS

Exhibit 27-1	Basic Geoprobe® Parts
Exhibit 27-2	Location of Controls and Gauges on the Control Panel of the Geoprobe® Model 5410
Exhibit 27-3	Master Switch
Exhibit 27-4	Emergency Stop Button
Exhibit 27-5	Probe Rod and Derrick in Vertical Position
Exhibit 27-6	Raising the Hammer Latch
Exhibit 27-7	Closing the Hammer Latch under the Pull Cap
Exhibit 27-8	Macro-Core® Open-Tube Sampler Assembly
Exhibit 27-9	Screen Point Groundwater Sampler
Exhibit 27-10	Mill Slot Groundwater Sampler
Exhibit 27-11	Soil Gas Post Run Tubing (PRT) Assembly Cross Section

APPENDIX A Safety Instructions

EXHIBIT 27-1
Basic Geoprobe® Parts

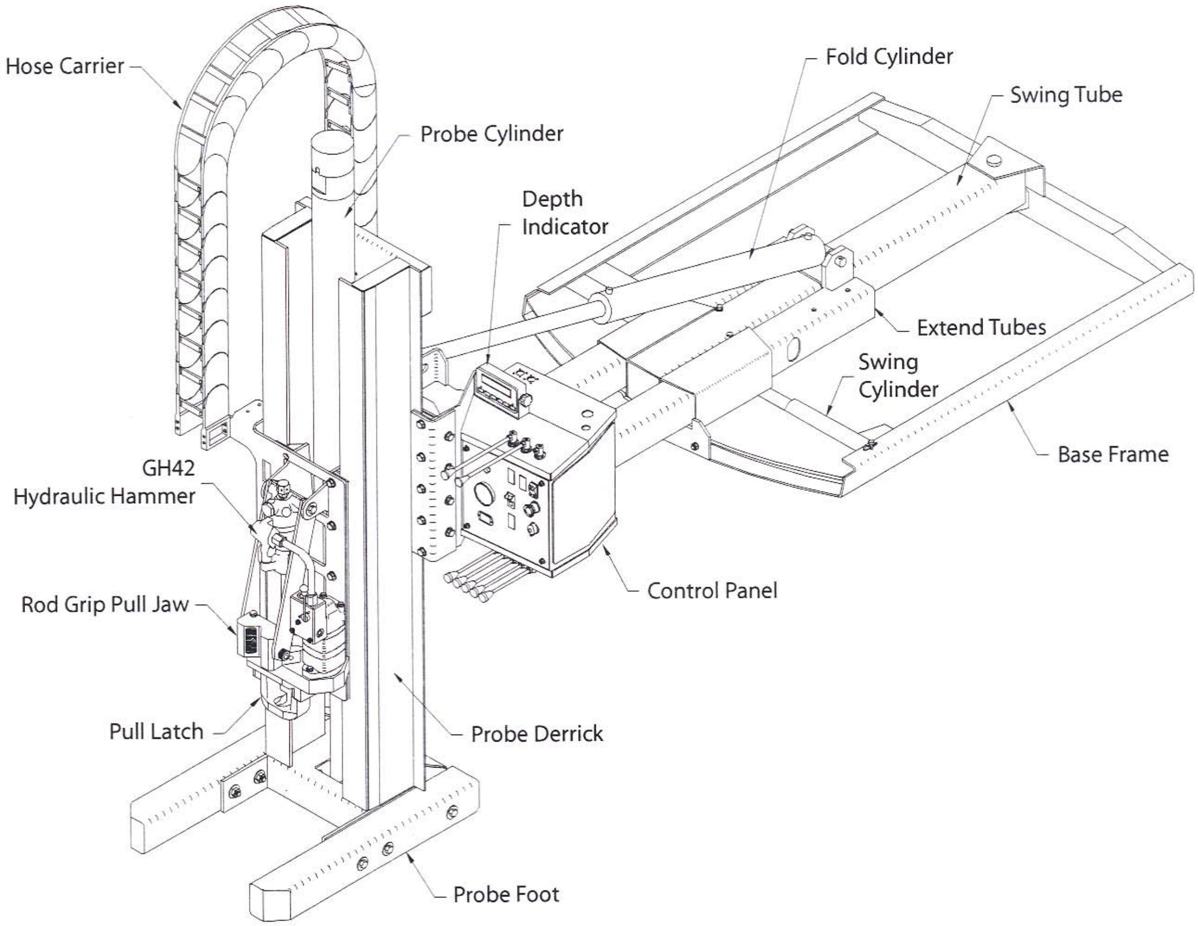


EXHIBIT 27-2

Location of Controls and Gauges on the Control Panel of the Geoprobe® Model 5410

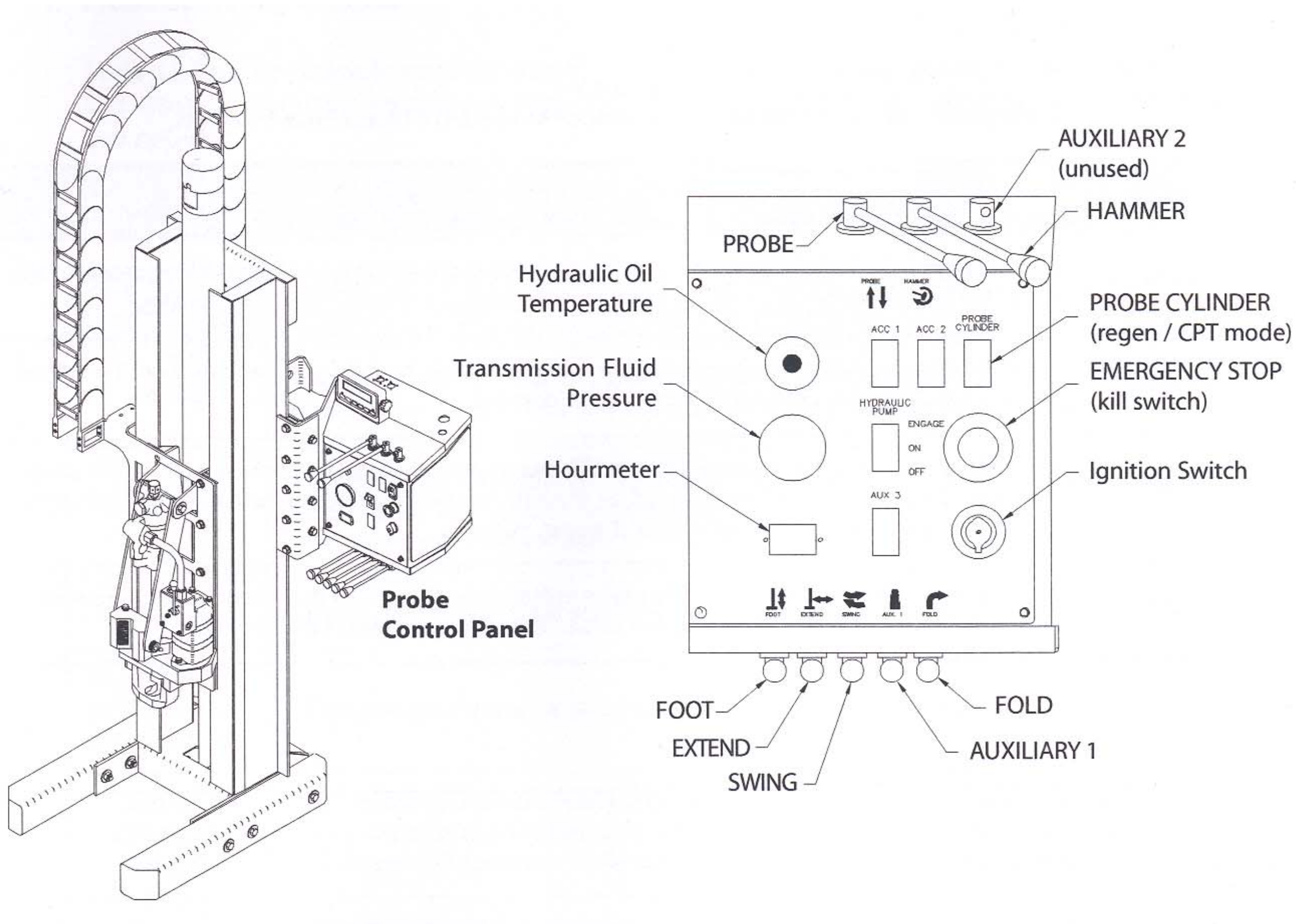
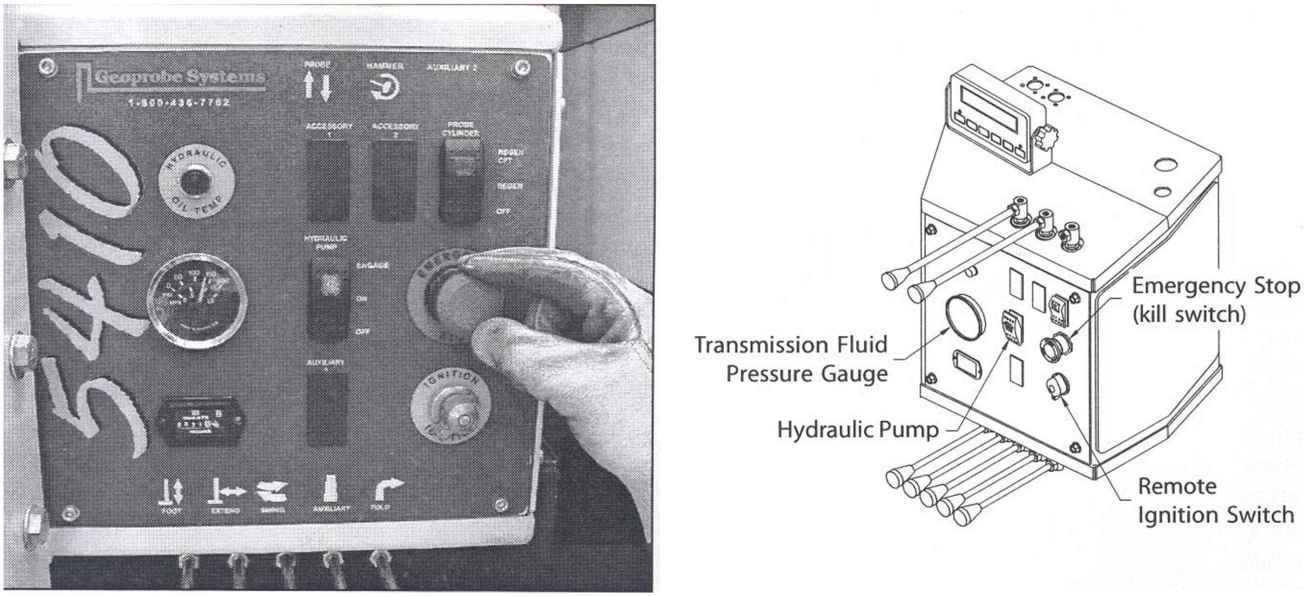


EXHIBIT 27-3
Master Switch

The Master Switch is mounted on the cab floor just inside of the driver-side door.

EXHIBIT 27-4
Emergency Stop Button



The Emergency Stop Button is located on the 5410 control panel.

EXHIBIT 27 - 5
Probe Rod and Derrick in Vertical Position

EXHIBIT 27 - 6
Raising the Hammer Latch

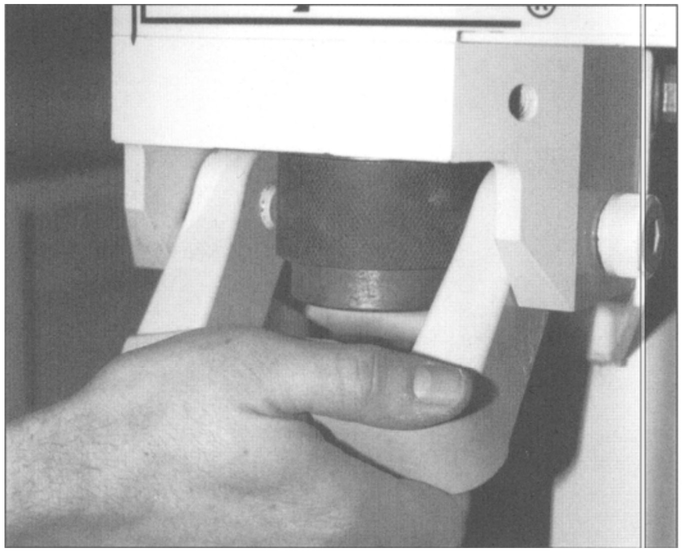


EXHIBIT 27 - 7
Closing the Hammer Latch Under the Pull Cap

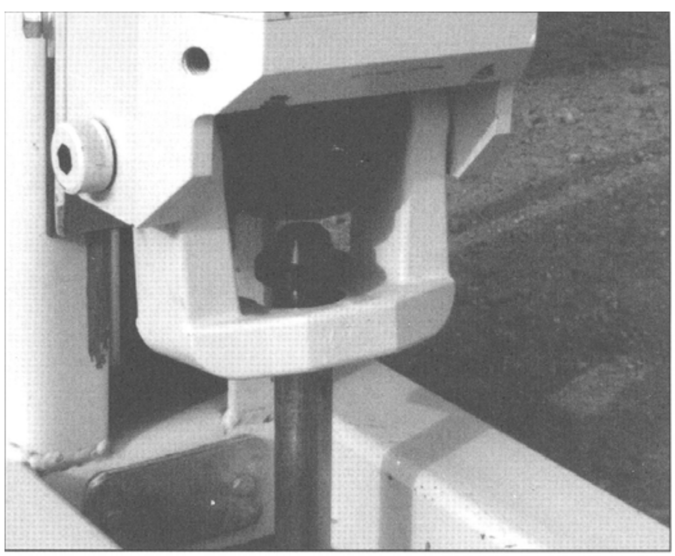


EXHIBIT 27 - 8

Macro-Core® Open-Tube Sampler Assembly

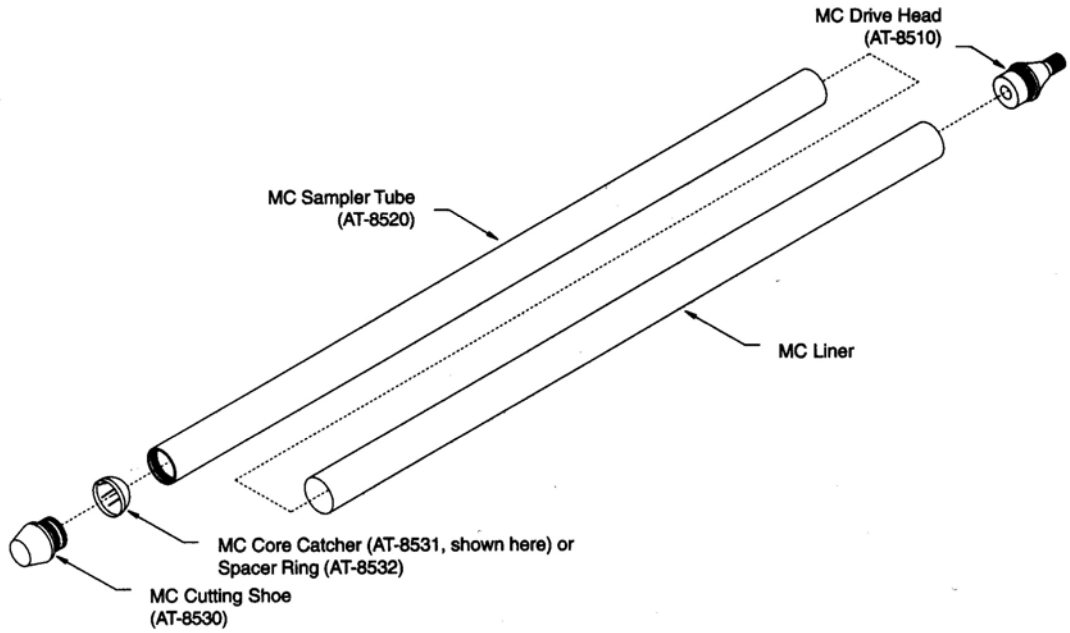


EXHIBIT 27-9
Screen Point Groundwater Sampler

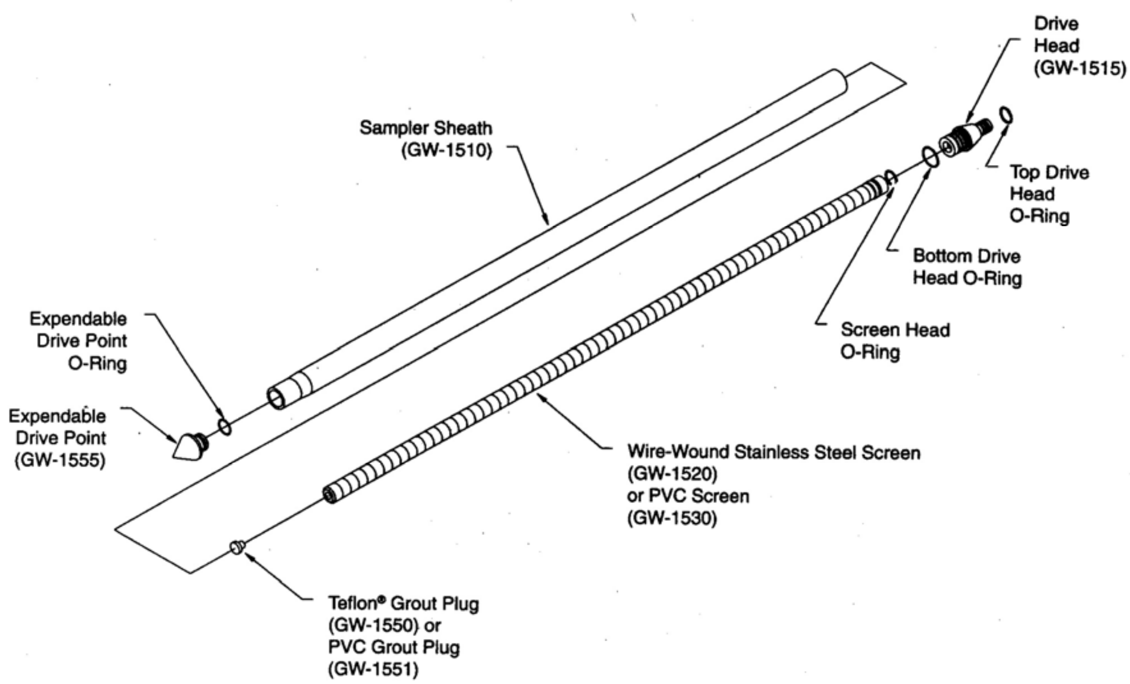


EXHIBIT 27-10
Mill Slot Groundwater Sampler

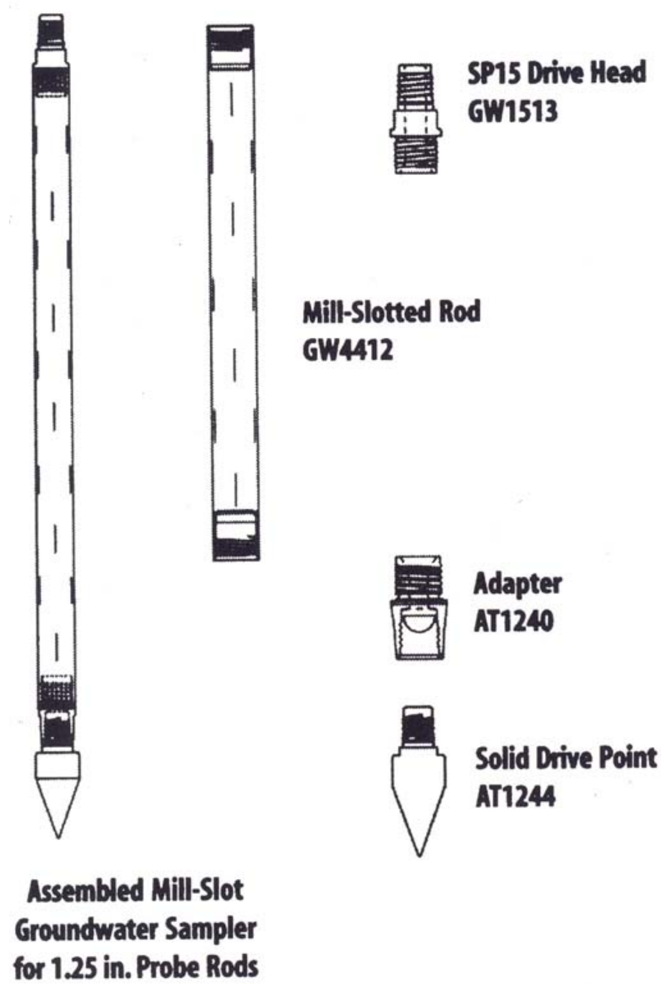
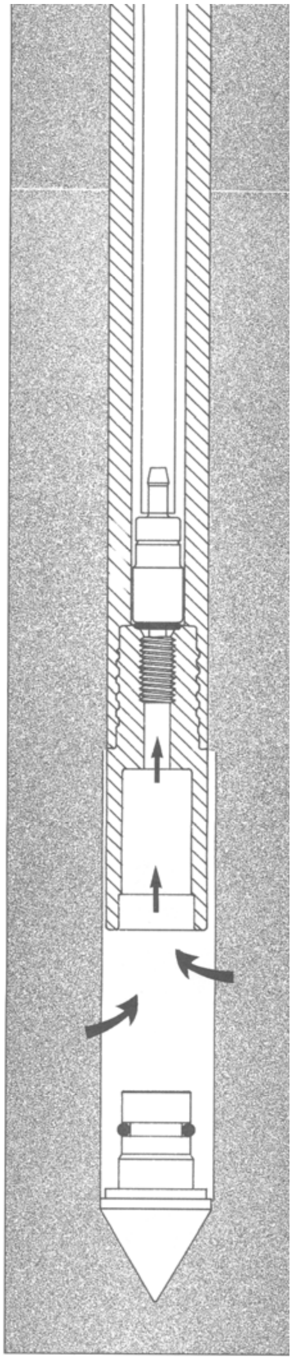


EXHIBIT 27 - 11
Soil Gas Post Run Tubing (PRT) Assembly Cross Section



A cross section of the PRT System showing how soil gas (arrows) is drawn through the inner tubing system.

SOP No. 35

Gamma Radiation Screening Walkover Survey for Surface Soil

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STANDARD OPERATING PROCEDURE

35. GAMMA RADIATION SCREENING WALKOVER SURVEY FOR SURFACE SOILWITH A LUDLUM MODEL 44-20 DETECTOR

1.0 PURPOSE

This procedure describes the techniques used to conduct gamma radiation screening walkover surveys of surface soil to identify gamma radiation anomalies in shallow surface soil.

This procedure provides guidance for the Santa Susana Radiological Background Study. Deviations from the methods presented herein must be approved by the Project Leader and the HydroGeoLogic, Inc. (HGL) Quality Assurance Officer.

2.0 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

Anomaly – Gross gamma radiation measurements based on professional judgment that appear to be significantly different than measurements in the general vicinity. An increase in a gamma measurement of twice the surrounding area will constitute an anomaly; however, a lower threshold may be deemed appropriate depending on the situation.

Equipment – Those items (variously referred to a "field equipment" or "sample equipment") necessary for sampling activities that do not directly contact the samples.

2.2 Abbreviations

DTL	Distance Test Location
PPs	Project plans
RBRA	Radiological Background Reference Area
SOP	Standard Operating Procedures

3.0 RESPONSIBILITIES

Field personnel are responsible for performing the applicable tasks outlined in this procedure when conducting work related to environmental projects.

The Project Leader or an approved designee is responsible for checking all work performance and verifying that the work satisfies the applicable tasks required by this procedure. This will be accomplished by reviewing all documents (Exhibits) and data produced during work performance.

4.0 PROCEDURES

4.1 Methods

Step 1: Setup a Ludlum Model 44-20 sodium iodide scintillator detector with a Ludlum Model 2221 ratemeter. Refer to the SOP and/or manufacturer's operation manual for details on the operation of the Ludlum Model 2221 and Ludlum Model 44-20. It is important to conduct the field investigation and determine the instrument quality control limits with the length of cable that was used in the calibration (the high voltage is affected by cable length).

Step 2: Fix the detector height at six inches above the ground surface by attaching a strap for hand-held use.Detector geometry is very important and must remain constant to ensure accurate measurements.

Step 3: Before conducting survey, mark the boundary of the survey area.

Step 4: Move the detector in a serpentine (S-shape) motion to form a three foot wide transect. The detector scan rate should be approximately one to two feet per second. A consistent scan rate is important to ensure comparable detection sensitivity. Walk in a straight line from one side of the survey area to the opposite side. Periodically verify scan rate by placing a tape measure on the ground and time scan rate over a 30 foot section. Adjust scan rate as necessary. A slower scan rate is acceptable.

Step 5: Observe the measurements (in units of counts per minutes) while conducting the scanning walkover survey. If measurements increase by a factor of two, flag the location as possible anomaly.
Step 6: Upon completion of each transect, move three feet from the transect centerline to an adjacent transect. Continue scanning on transects until 100% of the area has been scanned.

Step 7: If flags were placed at potential anomalies, return to each location and carefully resurvey the locations to determine if the anomaly is a concern or was due to natural background fluctuations. Record results of each anomaly survey in the field logbook.

Step 8: Record the approximate minimum, maximum, and average measurements observed during the survey in a field logbook.

4.2 Distance Test Location (DTL) Surface Gamma Radiation Screening Walkover Survey

At each Distance Test Locations (DTLs), a 50-foot by 50-foot area will be surveyed. Measurements will be reviewed in the field to determine the presence of any anomalies.

4.3 Radiological Background Reference (RBRA) Area Surface Gamma Scanning

At each Radiological Background Reference Areas (RBRAs) a ½-acre or 1-acre area will be surveyed. Measurements will be reviewed in the field to determine the presence of any anomalies.

4.4 Review

The Project Leader or designee shall check the field log books for completeness and accuracy. Any discrepancies in these documents will be noted and returned to the originator for correction. The reviewer will acknowledge that corrections have been incorporated by signing and dating in the appropriate manner.

5.0 REFERENCES

See applicable manufacturer’s operation manual.

SOP No. 36

Borehole Gamma Logging

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STANDARD OPERATING PROCEDURE

36. BOREHOLE GAMMA LOGGING

1.0 PURPOSE

This procedure describes the techniques used to conduct a gamma survey of a borehole to log the gamma radiation measurements in subsurface soil.

This procedure provides guidance for the Santa Susana Radiological Background Study. Deviations from the methods presented herein must be approved by the Project Leader and the HydroGeoLogic, Inc. (HGL) Quality Assurance Officer.

2.0 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

Anomaly – Gross gamma radiation measurements based on professional judgment that appear to be significantly different than measurements in the general vicinity. An increase in a gamma measurement of twice the surrounding area will constitute an anomaly; however, a lower threshold may be deemed appropriate depending on the situation.

Equipment – Those items (variously referred to a “field equipment” or “sample equipment”) necessary for sampling activities that do not directly contact the samples.

2.2 Abbreviations

I.D.	inside diameter
O.D.	outside diameter
PPs	Project plans
PVC	polyvinylchloride
SOP	Standard Operating Procedures

3.0 RESPONSIBILITIES

Field personnel are responsible for performing the applicable tasks outlined in this procedure when conducting work related to environmental projects.

The Project Leader or an approved designee is responsible for checking all work performance and verifying that the work satisfies the applicable tasks required by this procedure. This will be accomplished by reviewing all documents (Exhibits) and data produced during work performance.

4.0 PROCEDURES

4.1 Methods

Step 1: Select an appropriate meter and detector for making gamma measurements in a borehole. The borehole diameter will limit the detector diameter. In addition, a PVC pipe or similar will be placed into the borehole to protect the detector from borehole collapse. The largest detector that can fit into the PVC pipe should be used to maximize detection sensitivity. The following table summarizes the various detectors with required size of PVC pipe and borehole.

Manufacturer	Detector Model	Detector Size (inch)	Detector O.D. (inch)	Minimum I.D. for PVC Pipe (inch)	Schedule 40 PVC Pipe Nominal I.D. (inch)	Schedule 40 PVC Pipe Nominal Size (inch)	Minimum I.D. of Borehole (inch)
Ludlum	44-62	½ by 1	0.9	1.15	1.380	1.25	1.7
Ludlum	44-2	1 by 1	2.0	2.2	2.469	2.5	2.9
Ludlum	44-11	2 by 2	2.5	2.75	3.068	3	3.5
Ludlum	44-10	2 by 2	2.6	2.85	3.068	3	3.5
Ludlum	44-20	3 by 3	3.27	3.52	4.026	4	4.5

Key:
O.D. outside diameter
PVC polyvinylchloride
I.D. inside diameter

The cable length must be sufficient to enable the detector to reach the bottom of the borehole; e.g. a 10 foot borehole requires a 12 foot cable. Mark the cable at 6-inch interval starting from the center of the detector.

Step 2: Setup the selected meter and detector. Refer to the SOP and/or manufacturer's operation manual for details on the operation of the selected meter and detector. It is important to conduct the field investigation and determine the instrument quality control limits with the length of cable that was used in the calibration (the high voltage is affected by cable length).

Step 3: Measurement will be made in ratemeter and scaler modes; refer to the meter SOP and/or manufacturer's operation manual for details.

Step 4: After completion of borehole, place a PVC pipe inside the hole; the pipe prevent loss of the detector in the event that the hole collapses. The pipe must have an inside diameter sufficient for the detector is move freely in the pipe. The pipe can protrude from the hole as long as the detector can be inserted into the pipe and the length of cable is sufficient for the detector to reach the bottom of the borehole, or else cut the pipe at ground level. The largest pipe that can fit into the borehole should be used so the largest detector possible can be used to increase detection sensitivity.

Step 5: Insert a groundwater lever indicator into the PVC pipe and determine the depth to groundwater, if present. Record the depth; this represents the maximum depth for the bottom of the detector unless the detector and attached cable have been waterproofed.

Step 6: Switch the meter to scaler mode, hold the detector 6 inches above the hole, and take a one minute static integrated measurement. Record the measurement in counts per minute. Do not hold the detector by the cable; attach an appropriate length line securely to the detector for lowering the detector into the PVC pipe.

Step 7: Switch the meter to ratemeter mode and descend the detector into the PVC pipe slowly at a rate of approximately 1-inch per second while observing the count rate (counts per minute). As the detector is descending stop if the rate starts to increase, this may indicate the presence of an anomaly. Record elevated readings with the associated depth. Stop at 6-inches below ground surface (bgs) and take a one minute static integrated measurement with the meter in scaler mode. A measurement at ground surface does not provide relevant data due to variable geometry. The count rate will likely increase due to geometric effects of the subsurface—this is normal. Professional judgment will be used to determine if geometric affects are the cause for increased measurements at the first interval at 6-inches below ground surface or at the bottom of the borehole.

Step 8: Repeat Step 6, stopping at each 6-inch interval until the bottom of the borehole is reached. The last measurement at the bottom may be slightly elevated due to geometric affects.

Step 9: After completion of gamma logging, measurements can be reviewed to determine the location of potential anomalies.

Step 10: Record the measurements in a field logbook.

Step 11: The detector may come in contract with the soil at the bottom of the borehole, thus should be appropriately cleaned before measurement of a subsequent borehole.

4.2 Review

The Project Leader or designee shall check the field log books for completeness and accuracy. Any discrepancies in these documents will be noted and returned to the originator for correction. The reviewer will acknowledge that corrections have been incorporated by signing and dating in the appropriate manner.

5.0 REFERENCES

See applicable manufacturer’s operation manual.

APPENDIX C

FIELD FORMS

- Boring Log
- Field Sampling Report
- Waste Inventory Tracking Form
- Chain of Custody Record
- Safety Inspection Report
- Site Safety Briefing Form
- HGL Change Request Form
- Nonconformance Report

HGL HydroGeoLogic, Inc

BORING LOG

Borehole ID: __________
Sheet _____ of ____

AFIID			LOCID		
Project Name	Project Number		LTCCODE	Site ID	LPRCODE (IRPIMS)
Drilling Company DRL Code	Driller		Ground Elevation	Total Drilled Depth	EXCODE
Drilling Equipment	Drill/Excav Method	Borehole Diameter	Date/Time Drilling Started	Date/Time Total Depth Reached	
Type of Sampling Device			Water Level (bgs) First/Final	Site Name	
Sample Hammer Type Driving Wt. Drop			Hydrogeologist	Checked by/Date	SITEXREF

Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, minerology, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

BORING LOG (cont'd)

Borehole ID: __________
Sheet _____ of ____

Project Name					Project Number			Location
Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, minerology, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

FIELD SAMPLING REPORT

LOCATION:	**PROJECT NAME:**
SITE:	**PROJECT No.:**

SAMPLE INFORMATION

SAMPLE ID:	**DATE:**	**TIME:**
MATRIX TYPE:	**Enter sample numbers below for QC samples and/or blanks associated with this sample:**	
SAMPLING METHOD: (Circle one below)		
B / BR / CS / G / H / HA	MATRIX SPIKE (MS):	
HP / SP / SS	MATRIX SPIKE DUP (SD):	
	FIELD DUP (FD):	
SAMPLE BEG. DEPTH (FT):	AMBIENT BLANK (AB):	
SAMPLE END DEPTH (FT):	EQUIPMENT BLANK (EB):	
GRAB ( ) COMPOSITE ( )	TRIP BLANK (TB):	

CONTAINER		**PRESERVATIVE PREPARATION**	**ANALYTICAL METHOD**	**ANALYSIS**
SIZE/TYPE	**#**			

NOTABLE OBSERVATIONS

PID READINGS	**SAMPLE CHARACTERISTICS**	**MISCELLANEOUS**
1st:	COLOR:	
2nd:	COLOR:	
	OTHER:	

PHYSICAL PARAMETERS

Temperature ______(ºC) Dissolved Oxygen _______(mg/L) Specific Conductivity ________(UMHOS/CM)

Iron _____(mg/L) pH ______________ Turbidity __________ Oxidation/Reduction Potential ________(mv)

GENERAL INFORMATION

WEATHER: SUN/CLEAR ________ OVERCAST/RAIN _________ WIND DIRECTION ___________

AMBIENT TEMPERATURE ___________

SHIPMENT VIA: FEDEX ____________ HAND DELIVER __________ COURIER ____________

OTHER ___________________________

SHIPPED TO:

COMMENTS:

SAMPLER: **OBSERVER:**

MATRIX TYPE CODES		**SAMPLING METHOD CODES**	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	HA=HAND AUGER
WG=GROUNDWATER	SO=SOIL	BR=BRASS RING	HP=HYDRO PUNCH
SH=HAZARDOUS SOLID WASTE	SW=SWAB/WIPE	CS=COMPOSITE SAMPLE	SP=SUBMERSIBLE PUMP
WS=SURFACE/WATER	GS=SOIL GAS	G=GRAB	SS=SPLIT SPOON
LH=HAZARDOUS LIQUID WASTE	SE=SEDIMENT	H=HOLLOW STEM AUGER	

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WASTE INVENTORY TRACKING FORM

LOCATION : ____

PROJECT NAME:____

ACTIVITIES: ____

Date Waste Generated	Activity Generating Waste (borehole # / well #)	Description of Waste	Field Evidence of Contamination	Estimated Volume	Type of Container (storage ID#)	Location of Container	Waste Characterization	Comments

Note: Describe whether soil or water samples have been collected for waste characterization, include date, if known.

Signature: ______________________________________

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CHAIN OF CUSTODY RECORD

HGL HydroGeoLogic, Inc
Northway 10 Executive Park
313 Ushers Road
Ballston Lake, NY 12019

Client: ______

Project Name/No.: ______

Project Manager: ______

Sampler: ______

Phone: (518) 877-0390 Fax: (518) 877-0414

APPLICABLE REGULATION
- ☐ RCRA
- ☐ ECRA
- ☐ CERCLA
- ☐ NPDES
- ☐ CWA
- ☐ SDWA
- ☐ OTHER

SAMPLE IDENTIFICATION	DATE COLL.	TIME COLL.	GRAB	COMPOSITE	MATRIX: SOIL	MATRIX: WATER	MATRIX: OTHER	TOTAL NO. OF CONTAINERS	ANALYSIS REQUIRED								REMARKS OR SAMPLE LOCATION

Special Instructions

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return to Client ☐ Disposal by Lab ☐ Archive for ______ Months

Turn Around Time Required
☐ Normal ☐ Rush

QC Level
☐ I. ☐ II. ☐ III.

Project Specific (specify)

1. Relinquished by	Date	Time	1. Received by	Date	Time
2. Relinquished by	Date	Time	2. Received by	Date	Time
3. Relinquished by	Date	Time	3. Received by	Date	Time

Comments

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HydroGeoLogic, Inc.
Safety Inspection Report

CUSTOMER/ADDRESS:	
DATE/TIME:	
JOB NAME/JOB NO.:	
JOB LOCATION:	
WORK DESCRIPTION:	
COMMENTS/OTHER:	
OBSERVATIONS	
SAFETY CONDITIONS:	**CORRECTIVE ACTION:**
REVIEW	
FIELD SUPERVISOR:	
SAFETY INSPECTOR:	
REPORT DISTRIBUTION:	

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HGL
HydroGeoLogic, Inc
Exceeding Expectations

SITE SAFETY BRIEFING FORM

Project ____ **Location** __________________________
Date____ **Time** ______________________________
Type of Work ____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment ____
____

Chemical Hazards____
____

Physical Hazards ____
____

Biological Hazards ____
____

Emergency Procedures Refer to Site Safety and Health Plan ______________________________

Hospital/Clinic ____________________________________ **Phone** ____________________
Hospital Address ____
Special Equipment ____
Other ____
____

ATTENDEES

Name (Printed)	**Signature**
____________________________________	____________________________________
____________________________________	____________________________________
____________________________________	____________________________________
____________________________________	____________________________________
____________________________________	____________________________________

Meeting Conducted by: ____

Site Safety Officer: ____

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HGL
CHANGE REQUEST FORM

Contract/Project: ______________________ Date: __________

Requested by: ______________________

Description of requested change: ______________________

____

____

____

____

Reason for change: ______________________

____

____

____

____

Expected results or impact: ______________________

____

____

____

Submit this form to the project manager immediately.

Required before implementation of major changes:

Approved by: ______________________(Project Manager) Date: __________

Approved by: ______________________ (Title: __________) Date: __________

cc: QA Staff Member

12/2005

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NONCONFORMANCE REPORT	DATE OF NCR	NCR NUMBER
	LOCATION OF NONCONFORMANCE	PAGE ___ OF ___
INITIATOR (NAME/ORGANIZATION/PHONE)	FOUND BY	DATE FOUND
RESPONSIBLE ORGANIZATION/INDIVIDUAL		PROGRAM
		PROJECT
DESCRIPTION OF NONCONFORMANCE	CATEGORY: H&S Sampling/Analysis	

[A] INITIATOR: DATE QA/QC OFFICER DATE CAR REQ'D YES NO

DISPOSITION:

PROBABLE CAUSE:

ACTIONS TAKEN TO PREVENT RECURRENCE:

[B] PROPOSED BY: NAME DATE

JUSTIFICATION FOR ACCEPTANCE

[C] INITIATOR: NAME DATE

VERIFICATION OF DISPOSITION AND CLOSURE APPROVAL

REINSPECTION/RETEST REQUIRED YES NO IF YES;

DATE RESULT

[D] QUALITY ASSURANCE:

NAME DATE

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