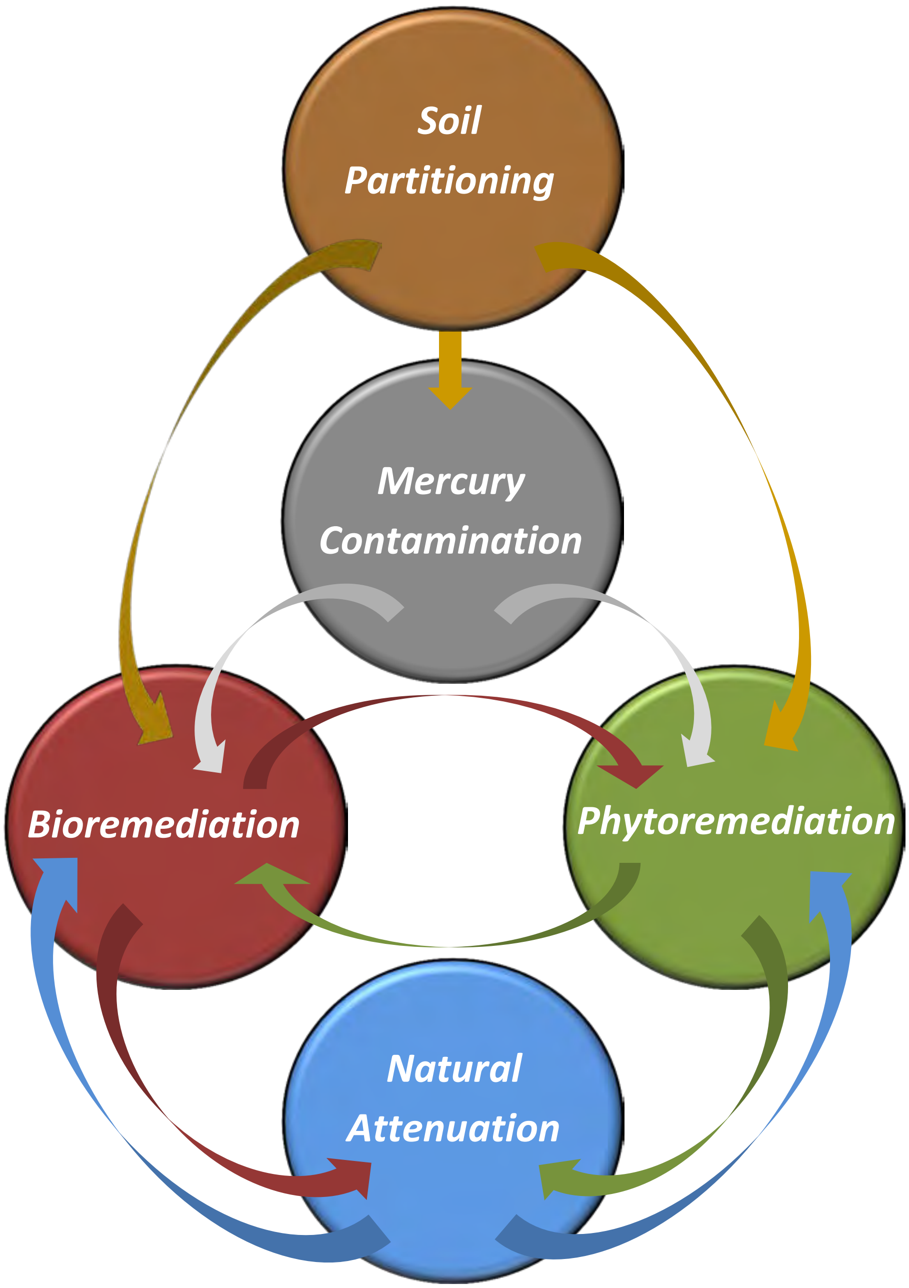
Master Work Plan

Soil Treatability Studies

Area IV Santa Susana Field Laboratory

Ventura County, California



Master Work Plan
Soil Treatability Studies
Area IV Santa Susana Field Laboratory
Ventura County, California

Comprehensive Soil Treatability Work Plan

Prepared for:

Department of Energy
Energy Technology and Engineering Center
4100 Guardian Street
Simi Valley, California 93063

Prepared by:

CDM Federal Programs Corporation (CDM Smith)
555 17th Street, Suite 1200
Denver, Colorado 80202

Prepared under:

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CDM Smith

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Area IV Santa Susana Field Laboratory
Ventura County, California

Comprehensive Soil Treatability Work Plan

Contract DE-EM0001128
CDM Smith Task Order DE-DT0003515

Prepared by: ______________________ October 21, 2013
Keegan L. Roberts, Ph.D. Date
CDM Smith Environmental Engineer

REGISTERED GEOLOGIST
MICHAEL J. HOFFMAN
REGISTERED
GEOLOGIST
NO. 7735
Exp Oct 2014
STATE OF CALIFORNIA

Approved by: ______________________ October 21, 2013
Michael Hoffman, P.G. Date
CDM Smith Geologist

Approved by: ______________________ October 21, 2013
John Wondolleck Date
CDM Smith Project Manager

CDM Smith

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Acronyms and Abbreviations

AI	Atomics International
AIP	Agreement in Principle
AOC	Administrative Order on Consent
Boeing	The Boeing Company
Cal Poly	California Polytechnic State University, San Luis Obispo
CDM Smith	CDM Federal Programs Corporation
COI	contaminant of interest
DOE	United States Department of Energy
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
ETEC	Energy Technology Engineering Center
NASA	National Aeronautics and Space Administration
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
QAPP	Quality Assurance Project Plan
RFI	RCRA Facility Investigation
RMHF	Radioactive Materials Handling Facility
Sandia	Sandia National Laboratories
SOP	standard operating procedure
SSFL	Santa Susana Field Laboratory
STIG	Soil Treatability Investigation Group
TPH	total petroleum hydrocarbons
UC Riverside	University of California, Riverside

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Section 1
Introduction

This document details the overall objectives and associated activities and requirements of the five treatability studies being conducted by the United States Department of Energy (DOE) for Area IV of the Santa Susana Field Laboratory (SSFL). The goal of the five treatability studies is to identify technologies that can either reduce the levels of Area IV soil contaminants to regulatory limits or reduce the volume of contaminated soil requiring treatment or disposal. The treatability studies are being conducted in compliance with the Administrative Order on Consent (AOC) that DOE signed with the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) in 2010.

Under a contract with DOE, Sandia National Laboratories (Sandia) performed an evaluation of possible soil treatability technologies and then made recommendations on which technologies should be tested using Area IV soil and conditions. DOE, based on a recommendation made by the community, then decided to have local universities conduct the treatability studies.

The treatability studies are interrelated. This means that the results of one of the studies can provide information useful to how another study is conducted, can inform the conclusions of the efficacy of another study, and can affect the final decision regarding the use of any of the technologies as part of site cleanup. This Work Plan has been developed to describe the studies and these inter-study relationships. Each study will be conducted under the technical guidance of a Study Plan drafted specifically for that study. Each Study Plan will follow the general guidance provided in this Work Plan.

The soil treatability studies will be implemented by California Polytechnic State University, San Luis Obispo (Cal Poly) and University of California, Riverside (UC Riverside). CDM Federal Programs Corporation (CDM Smith), under direct contract with DOE, will be responsible for subcontracting the universities and providing technical support as described in this Work Plan. This Work Plan has been developed under CDM Smith DOE contract No. DE-EM0001128, Task Order DE-DT0003515.

1.1 Purpose of Soil Treatability Studies

The primary purpose of the treatability studies is to identify on-site soil remediation technologies that can reduce Area IV soil contaminant levels to the AOC soil Look-up Table values. The use of on-site treatment technologies is intended to reduce the volume of Area IV soil requiring excavation and hauling offsite during Area IV soil remediation. The treatability studies will focus on the following contaminants of interest (COI): polyaromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), polychlorinated biphenyls (PCBs), perchlorate, polychlorinated dibenzo dioxins (dioxins) and polychlorinated dibenzo furans (furans), and metals, with one treatability study specifically targeting mercury.

1.2 AOC Requirements

Section 2.6 of the AOC reads as follows:

"Treatability Studies. To the extent DOE considers the use of in situ or other onsite treatment technologies or methods to achieve the cleanup levels specified in the AIP [Agreement in Principle], DOE shall conduct treatability testing to develop data for assessing treatment on-site that could achieve the cleanup goals. Treatability testing is required to demonstrate the implementability and effectiveness of such technologies, unless DOE can show DTSC that similar data, documentation or information exists. The required deliverables are: a work plan, a sampling and analysis plan, and a treatability evaluation report. To the extent practicable, treatability studies shall be proposed and implemented during the latter part of Chemical Data Gap investigation."

As noted above, section 2.6 of the AOC requires three deliverable types: work plan, sampling and analysis plan, and a treatability evaluation report. This document serves as the required work plan deliverable. The requirements for the sampling and analysis plans are discussed within this document as well as in the individual treatability study plans that will be followed when implementing the studies. A comprehensive treatability evaluation report will be prepared after all five individual treatability study reports are completed. DTSC has the regulatory authority for approving and accepting this workplan, the individual soil treatability study plans, work implementation, the results of the soil treatability studies, and the comprehensive treatability evaluation report.

1.3 History and Overview of Studies

In May of 2011 DOE contracted Sandia to evaluate potential soil treatability options and to make recommendations as to what treatment technologies may be applicable to remediating soils in Area IV. The six treatability study options recommended by Sandia are:

- Identifying how soil contaminants are partitioned to soil particles: the *Soil Partitioning Study*
- Determining mercury valence state in soils: the *Mercury Contamination Study*
- Evaluating phytoremediation potential: the *Phytoremediation Study*
- Evaluating bioremediation potential: the *Bioremediation Study*
- Evaluating thermal treatment potential: the *Thermal Treatment Study*
- Evaluating natural attenuation potential: the *Natural Attenuation Study*

DOE chose to have California universities implement five of the soil treatability studies. DOE decided not to conduct the thermal treatment study at this time. A brief description of the five treatability studies to be conducted is provided below. More detailed descriptions of each treatability study are provided in Section 4 of this Work Plan. Figure 1-1 illustrates the relationships of the individual studies and provides examples of how one study can inform another (i.e., are interrelated).

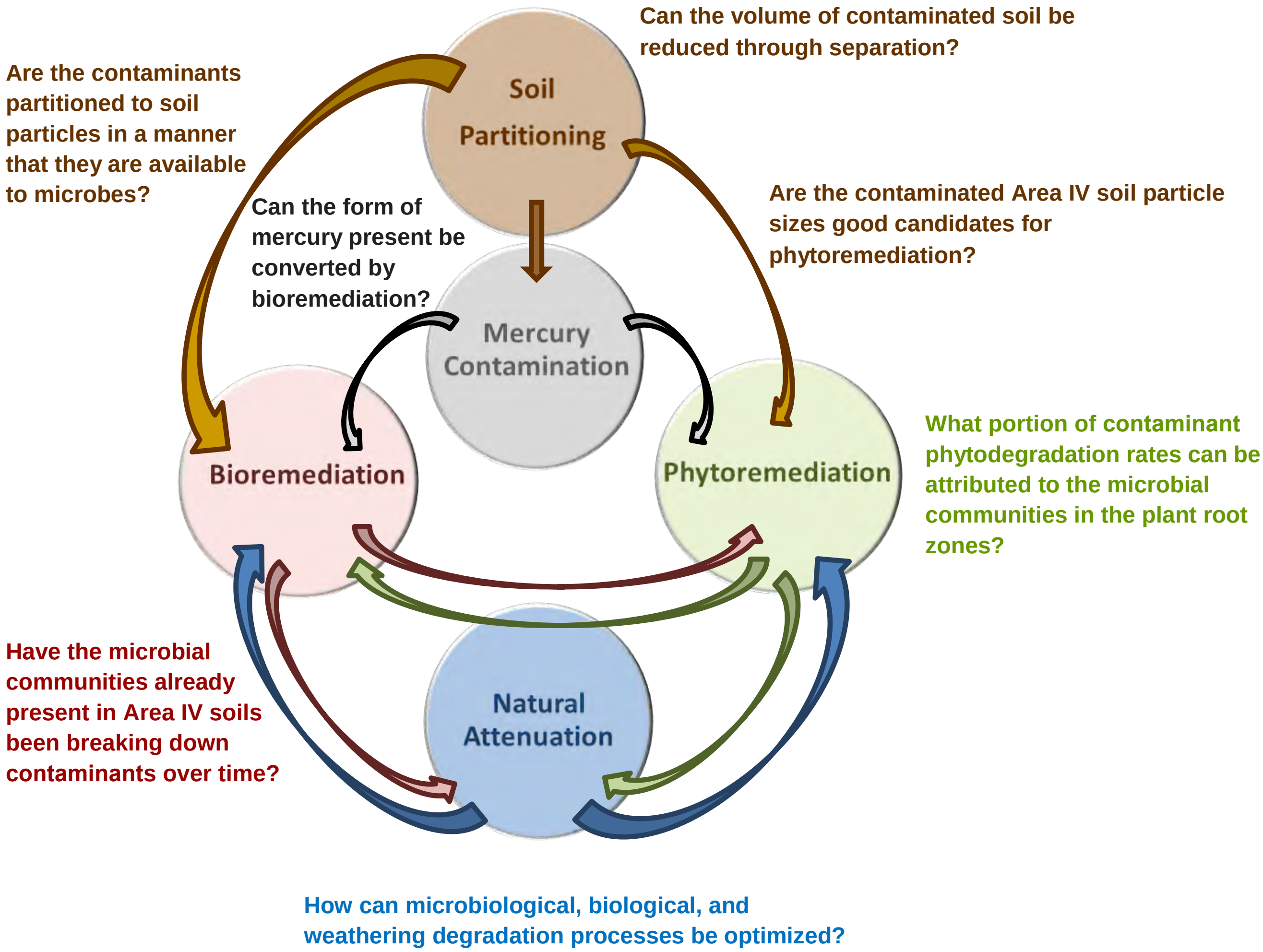

Figure 1-1 Treatability study relationships

1.3.1 Soil Partitioning Study

The soil partitioning study is expected to determine within which soil particle size(s) (e.g., sands, silts, clay particles) contaminants may have preferentially absorbed (partitioned) and will answer three major questions:

- Can the volume of contaminated soil requiring treatment or disposal be reduced by separating the contaminated size fractions from the rest of the soil?
- Are the contaminated Area IV soil particle sizes good candidates for phytoremediation?
- Are the contaminants partitioned to soil particles available to microbes?

The soil partitioning study is being led by Dr. Mark Matsumoto of UC Riverside and is proposed to be conducted in three phases. Phase 1 will investigate the soil particle size distributions and their associated COI concentrations for select Area IV study plots. Phase 2 will quantify the strength of contaminant-soil particle bonding to determine if the COIs are available to microbes and plants for use or uptake. Phase 3 will investigate the spatial heterogeneity of soil at the site and the implementability of soil washing as a possible full-scale remediation technology. Only Phase 1 is currently scoped.

The COIs investigated by this study will include PAHs, TPH, Metals, dioxins, and PCBs.

1.3.2 Mercury Contamination Study

Mercury has unique properties that need to be understood in order to identify effective mercury remediation technologies. Elemental mercury exists as a liquid, is volatile, and can be removed from soil using thermal (soil heating) methods. However, elemental mercury can "weather" or oxidize into other chemical states, termed valence states, while in the soil. Each valence state has distinctly different chemical properties that can affect how it is remediated The changes in valence states can make mercury much less volatile and change its solubility and bioavailability to microbes and plants. Knowing the valence state of mercury helps the bioremediation and phytoremediation study researchers optimize their studies to maximize mercury remediation.

The mercury contamination study is being led by Dr. Haizhou Liu of UC Riverside and is designed to determine the valence state of mercury in Area IV soils. The mercury study will also work with the bioremediation study to determine if non-elemental mercury can be converted biologically to elemental mercury by native bacteria.

1.3.3 Phytoremediation Study

Plants can uptake many elements and chemicals from the soil into their roots, including soil contaminants. Depending on what the chemical is, it can be used as a metabolite, incorporated into plant tissue, or released into the air if volatile. Use of plants to uptake (or "treat") contaminants in soil has been demonstrated at many locations world-wide. However, it is not known if plants growing at Area IV are effective at contaminant uptake, nor is it known to what soil COI concentration the plants would be able to "treat" the soil. The focus of the phytoremediation study is to answer these two questions. The phytoremediation study will also use results of the soil partitioning and bioremediation studies to assess bioavailability of the soil bound COIs. Figure 1-2 shows the relationship of phytoremediation with the root-soil environment and phytoremediation processes, as well as the classes of contaminants that have been noted in the literature as associated with each phytoremediation process.

The phytoremediation study is being led by Dr. Yarrow Nelson of Cal Poly and will be conducted in two phases. Phase 1 will determine if phytoremediation is currently occurring at Area IV by analyzing for COIs in plant tissues and in the soils where the plants are growing. Phase 2 will determine the rates and mechanism(s) of Area IV phytoremediation by growing Area IV plant species in laboratory microcosms and measuring changes in COI soil and vapor concentrations. The COIs for both phases of the phytoremediation study are PCBs, Dioxins, PAHs, TPH, and metals, including mercury and methyl mercury.

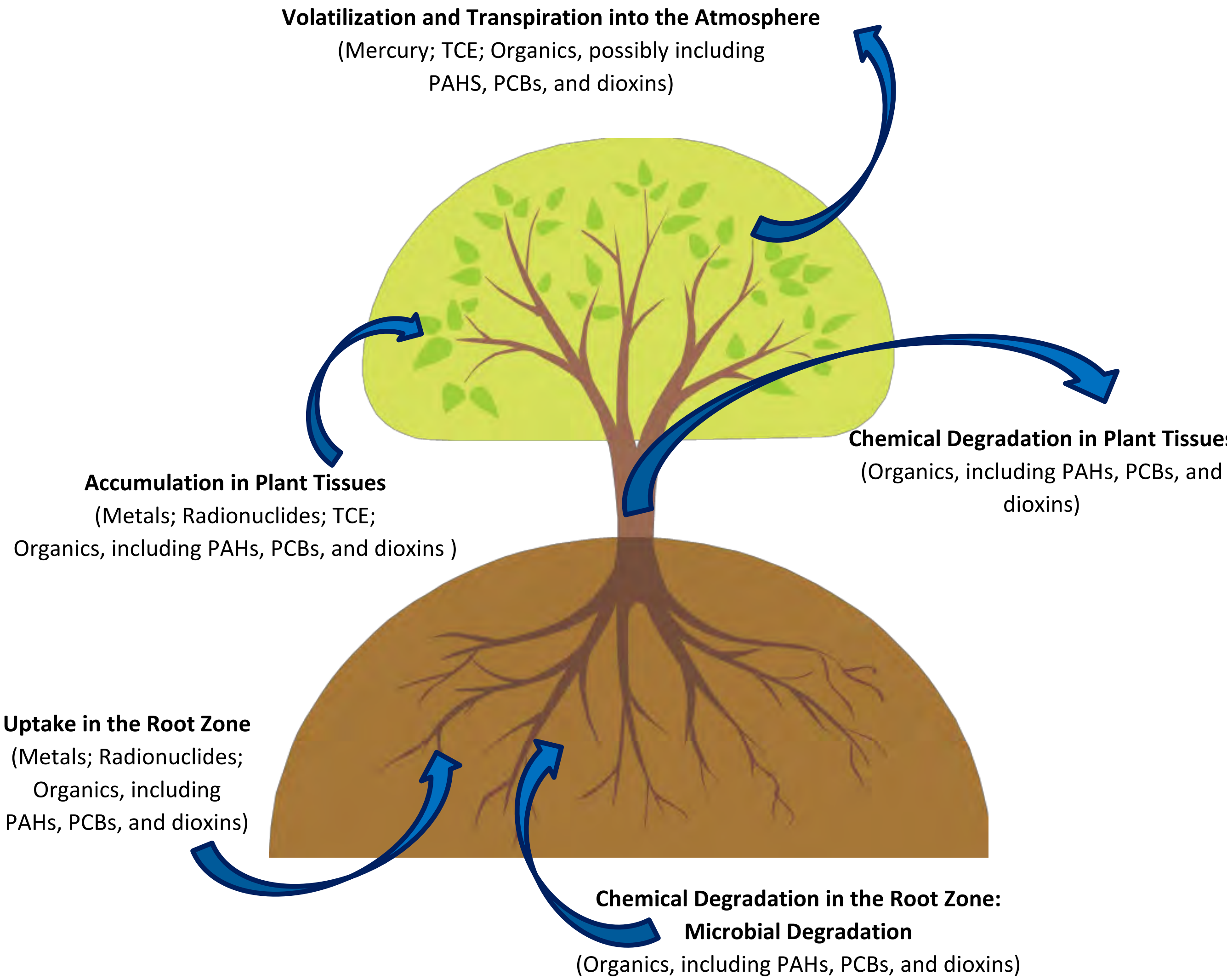

Figure 1-2 Phytoremediation processes

1.3.4 Bioremediation Study

Soil naturally contains a large number of microbes capable of degrading organic chemicals, including many organic chemicals observed at Area IV. The processes of microbes using organic chemicals as energy sources (breaking down chemicals to carbon dioxide, water, and salts) are well understood. The identification of Area IV microbial communities capable of using site COIs and, consequently, degrading them is a focus of the study. The bioremediation study will also draw upon results of the soil partitioning and phytoremediation studies in evaluating the effectiveness of bioremediation as a remediation technology.

The bioremediation study is being led by Dr. Nelson of Cal Poly and will have two phases. Phase 1 will involve field studies to isolate and identify the microbial communities currently present in Area IV soils. Phase 2 will use laboratory microcosms to determine the bioremediation rates associated with these microbial communities. The study will also examine the potential for biostimulation. TPH, PCBs, PAHs and dioxins will be the COIs for the bioremediation study.

1.3.5 Natural Attenuation Study

All organic chemicals eventually breakdown, typically to carbon dioxide, water, and salts. The rates of degradation vary greatly depending on the stability of the chemical molecule. Chemicals such as PCBs can take long periods to degrade; other chemicals such as those that make up petroleum can degrade much quicker. Understanding the processes that lead to the natural degradation of chemicals, whether those processes are active at Area IV, and the possible rates and pathways of chemical degradation are important to know should those natural processes be considered as a soil treatment technology. Because plants and microbes are part of the natural processes that degrade chemicals, results of the bioremediation and phytoremediation studies will also support the findings of the natural attenuation study, and vice versa.

The natural attenuation study is being led by Dr. Nelson of Cal Poly and will be conducted in two phases. Phase 1 will involve both a literature review and field sampling program to determine if natural attenuation is occurring in Area IV soils. The field sampling program will compare soil COI concentrations at the same locations over time. Phase 2 will use the results from the concurrent phytoremediation and bioremediation treatability studies to calculate site specific attenuation rates. The COIs for the natural attenuation study are PAHs, TPH, PCBs, dioxins, and perchlorate.

1.4 Organization of the Work Plan

The remainder of this work plan is organized as follows:

- Site background
- Roles and responsibilities of study team
- Description of studies
  - Study objectives and activities
  - General structure of study plans
  - Limitations of individual studies

- Overview of soil treatability study implementation
  - Background information search and literature review
  - Field data collection activities
  - University lab activities
  - Contract lab activities
  - Data review
  - University laboratory sampling requirements
  - Quality Assurance/Quality Control requirements
  - Health and safety requirements
- General structure of study reports
- General structure of comprehensive treatability evaluation report
- Schedule
- References

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Section 2
Site Background

SSFL was established in 1947 by North America Aviation as a facility to test liquid propulsion rocket engines. This testing was first conducted for the Department of Defense and subsequently for the National Aeronautics and Space Administration (NASA) as part of the manned-spaced program. The testing of rocket engines was performed in Areas I, II, and III of SSFL and lasted until about the year 2006.

Area IV of SSFL was used for conventional and nuclear energy and liquid metals research from the mid-1950s until approximately 2000. Atomics International (AI), a subsidiary of North America Aviation, began establishing Area IV for energy research in 1954. A 90-acre portion of Area IV (Area IV is 290-acres in size) was leased first to the Atomic Energy Commission and subsequently to DOE for nuclear energy and other research. This 90-acre portion of Area IV was termed the Energy Technology Engineering Center (ETEC) and also served as DOE's Liquid Metals Center of Excellence. Ten small nuclear reactors were tested in Area IV during ETEC operations. The most active period of nuclear research was from 1956 until approximately 1970, and the last nuclear reactor was shut down in 1974. Research and handling of nuclear materials in Area IV ceased in 1988.

AI supported commercial clients in conducting nuclear research during the same period of operations. This research included operating one of the first commercially available hot laboratories for the inspection and processing of nuclear fuels. The 1970s marked the beginning of demolition and removal of the nuclear research facilities and these demolition/removal activities continued through the 1990s.

The last non-nuclear research in Area IV ended in 2001 with the closure of the Sodium Pump Test Facility. Since then all nuclear materials have been removed from ETEC and only the shells of a few reactor buildings remain. The Radioactive Materials Handling Facility (RMHF) is the only existing facility that will support final building demolition and soil cleanup activities should radioactive materials be encountered during cleanup of SSFL.

The Boeing Company (Boeing) currently owns most of Area I and all of Areas III and IV of SSFL. The federal government (administered by NASA) owns part of Area I and all of Area II. DOE was responsible for the construction and ownership of the buildings it used within Area IV, but DOE does not own the land.

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Section 3

Roles and Responsibilities of Study Team

The treatability study team consists of seven entities. These entities, and their roles and responsibilities, are briefly described below.

DOE is a responsible party at the site and is providing funding for these treatability studies.

CDM Smith will provide overall project management and contracting and prepared this Work Plan. They are jointly responsible for preparing all treatability study plans and study reports and conducting the treatability studies with Cal Poly and UC Riverside. CDM Smith will prepare a comprehensive treatability evaluation report at the conclusion of the treatability studies and will work with DTSC to gain regulatory acceptance of the Work Plan, study plans, study reports, and comprehensive treatability evaluation report.

Cal Poly is the lead university for the phytoremediation, bioremediation and natural attenuation treatability studies. They are jointly responsible for preparing the study plans and study reports for these three studies with CDM Smith, will conduct the studies with CDM Smith, and will present the study reports to the Soil Treatability Study Investigation Group (STIG).

UC Riverside is the lead university for the soil partitioning and mercury contamination treatability studies. They are jointly responsible for preparing the study plans and study reports for these two studies with CDM Smith, will conduct the studies with CDM Smith, and will present the study reports to the STIG.

DTSC is the regulatory agency over Area IV of SSFL and retains ultimate approval authority of the Work Plan, study plans, study reports, and comprehensive treatability evaluation report.

Science Applications International Corporation (SAIC) has been conducting biological surveys of Area IV since 2009. SAIC botanists will assist Cal Poly scientists with identifying plant species and plant communities in Area IV.

Contract laboratories will be State of California-approved laboratories and will perform particle size analyses (for the soil partitioning study) and chemical analyses of soils, liquids, and plant tissues for the treatability studies.

DOE established a community group, termed the *STIG*, to provide guidance and input on the development and implementation of the treatability studies. The STIG will continue to participate in the progress of the study and will be updated on progress and results.

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Section 4
Description of Studies

The following sections provide descriptions of the five treatability studies. Each study will require specific experimental procedures and activities. These specific procedures and activities will be discussed in detail in the individual study plans. Study-specific standard operating procedures (SOP) will also be provided in the individual study plans.

4.1 Study Objectives and Activities

4.1.1 Soil Partitioning Study

The soil partitioning study will determine a) if the volume of contaminated soil requiring treatment or disposal can be reduced by separating the contaminated size fractions from the rest of the soil, b) if the contaminated Area IV soil particle sizes are good candidates for phytoremediation, and c) if the contaminants partitioned to soil particles are available to microbes. This study will involve collecting soil samples from Area IV, sieving the soil samples into grain size categories, and analyzing the size fractions for COIs. The size fractions for sieve analyses are presented in Table 4-1. If preferential partitioning exists, mechanical particle size separation could be used at Area IV during site remediation to separate the contaminated soil size fraction(s) from the non- or less-contaminated size fractions, reducing the overall volume of Area IV soil requiring treatment. Furthermore, information about the contaminated soil size fraction(s) will help to determine if the contaminated soil particle sizes are good candidates for phytoremediation, and if the contaminants are partitioned to the soil particles in a manner that they are available to microbes.

Table 4-1 Soil fractions and corresponding size ranges

Designation	Size Range (mm)	U.S. Sieve Mesh
Coarse sand	2.00 – 4.75	+10m /-4m
Medium sand	0.425 – 2.00	+40m/-10m
Fine sand	0.075 – 0.425	+200m/-40m
Silts/Clays (Fines)	<0.075	-200m

Soil samples for the soil partitioning study will be collected by CDM Smith geologists and technicians based on procedures outlined in the *Work Plan for Chemical Data Gap Investigation Phase 3 Soil Sampling at Area IV* (*Phase 3 Data Gap Work Plan*[1]). UC Riverside will not collect soil samples due to site safety protocols. A contract laboratory will perform sieving of the soil samples per an SOP provided in the Soil Partitioning Study Plan. This contract laboratory will determine the grain size distributions of the soil samples and analyze the sieved soil for COI concentrations by each grain size fraction. Chemical analytical procedures will be based on those procedures prescribed in the *Phase 3 Data Gap Work Plan* Quality Assurance Project Plan (QAPP). UC Riverside will observe all sample collection activities and soil analyses and will interpret the data produced by the contract laboratories.

[1] The *Phase 3 Data Gap Work Plan* also includes a Master Field Sampling Plan establishing standardized field sampling activities, a Quality Assurance Project Plan describing analytical and quality control protocols, and a Worker Safety Plan describing safety protocols. Unless otherwise stated in this Work Plan, the procedures within the Phase 3 Data Gap Work Plan will be followed when collecting field samples for the treatability studies.

4.1.2 Mercury Contamination Study

The mercury contamination study will determine the mercury valence state(s) present in Area IV soils. The valence state determines the mercury's solubility, toxicity, and bioavailability. As such, identifying the valence state helps to determine if the mercury contamination is available for biological uptake by plants, transformation by microbial communities, or if another in situ remediation technology would be better suited for mercury treatment.

The mercury contamination study will involve collecting representative soil samples for specialized testing in the analytical laboratory. The locations and rationale for sampling will be addressed in the Mercury Contamination Study Plan. Soil sampling procedures will be per the Phase 3 Data Gap Work Plan. The specialized analytical procedure methods and quality control limits will also be provided in the Mercury Contamination Study Plan. The mercury contamination study will be coordinated closely with the soil partitioning study so the mercury contamination in Area IV can be correlated with the soil fractions of the soil partitioning study.

A contract laboratory will analyze the study soil samples to determine the valence state of mercury present. UC Riverside will observe all sample collections and analyses and will interpret the data produced by the contract laboratories.

4.1.3 Phytoremediation Study

The phytoremediation study is a two phase study designed to determine if plants are currently accumulating/degrading COIs at the site and, if so, what are the plant tissue COI accumulation/degradation rates. Phase 1 will entail collecting soils and tissue samples from ten plant species already growing at Area IV. These ten species will be selected based on their potential for COI uptake, abundance in Area IV (to allow for adequate sampling), growth rate, and status as a species that is native to SSFL. Plant species determined to be potential candidates for phytoremediation are presented in Table 4-2. The soils and plant tissues will be analyzed to determine if the plants are accumulating COIs from the soil that they are growing in. Phase 1 will also include the collection of seeds from certain Area IV plant species. These seeds will be used to grow plants in microcosms during Phase 2 of this study.

During Phase 2, the researchers will grow certain plant species in microcosms filled with Area IV soils at a Cal Poly laboratory. Soil and vapor (for phytovolatilization measurements) samples will be periodically taken from the microcosms to measure any changes in soil COI concentrations. The plant tissues from the microcosms will also be collected at the end of the experiment and analyzed to determine if the COIs were degraded in the microcosms, or if they were accumulated by the plants. Cal Poly will also determine if the addition of nutrients or other additives (e.g., chelating agents) to the plants can increase the phytoremediation rates.

CDM Smith geologists and technicians will collect all field soil and plant tissue samples for analyses, and will collect and homogenize the soil samples for use in the laboratory microcosms. The Phytoremediation Study Plan will include the soil and plant tissue collection SOPs. Cal Poly will collect seeds for the Phase 2 microcosms from Area IV plants, operate the Phase 2 microcosms, and collect soil, plant tissue, and vapor samples from the microcosms for analyses. Contract laboratories will perform soil, plant tissue, and vapor COI analyses, including analyses for contaminant degradation intermediates and end products. The Phytoremediation Study Plan will address all sampling procedures not provided in the Phase 3 Work Plan and analytical procedures not addressed in the Phase 3 Data Gap QAPP.

Table 4-2 Candidate plant species and selection rationale

2012 Jepson Manual Name[a]	Common Name	Origin	Habit	Duration[b]	Restoration[c]	Abundance[d]	Annual Growth Rate	Dioxin	PCB	PAH	TPH	Metals	Hg
Sambucus nigra	Blue Elderberry	Native	Shrub/Tree	Perennial	Yes	Low	Medium						
Malosma laurina	Laurel Sumac	Native	Shrub	Perennial	Yes	Medium	Medium						
Artemisia californica	California Sagebrush	Native	Shrub	Perennial	Yes	Medium	Low					A	
Baccharis salicifolia	Mule-Fat	Native	Shrub	Perennial	Yes	High	Medium					A	
Deinandra minthornii	Santa Susanna Tarweed	Native	Shrub	Perennial	Yes	Medium	Low					A	
Ericameria palmeri	Palmer Goldenbush	Native	Shrub	Perennial	Yes	High	Medium					A	
Heterotheca grandiflora	Telegraph weed	Native	Forb	Annual	NO	Medium	High					A	
Hirschfeldia incana	Summer Mustard	Alien	Forb	Perennial	NO	High	High					A	A
Acmispon americanus	Spanish Lotus	Native	Forb	Annual	Yes	Low	Medium		A	A	A		
Acmispon glaber	Common Deerweed	Native	Shrub	Perennial	Yes	Medium	Medium		A	A	A		
Eriogonum fasciculatum	California Buckwheat	Native	Shrub	Perennial	Yes	High	Medium						
Salix lasiolepis	Arroyo Willow	Native	Tree/Shrub	Perennial	Yes	Low	Medium	A	A				A
Avena fatua	Wild Oat	Alien	Grass	Annual	NO	High	High					A	
Stipa cernua	Nodding Needlegrass	Native	Grass	Perennial	Yes	Medium	Low						
Stipa pulchra	Purple Needlegrass	Native	Grass	Perennial	Yes	Low	Low						

Table 4-2 Candidate plant species and selection rationale

2012 Jepson Manual Name[a]	Common Name	Origin	Habit	Duration[b]	Restoration[c]	Abundance[d]	Annual Growth Rate	Dioxin	PCB	PAH	TPH	Metals	Hg
Rhus ovata	Sugar Bush	Native	Shrub	Perennial	Yes	Low	Medium						
Asclepias fascicularis	Narrowleaf Milkweed	Native	Forb	Perennial	Yes	Low	Medium						
Baccharis pilularis	Coyotebrush	Native	Shrub	Perennial	Yes	Medium	Medium					A	
Brickellia californica	California Bricklebush	Native	Shrub	Perennial	Yes	Low	Medium					A	
Corethrogyne filaginifolia	Common Sandaster	Native	Forb	Perennial	Yes	Medium	Medium					A	
Erigeron canadensis	Canadian Horseweed	Native	Forb	Annual	NO	Medium	High					A	
Pseudognaphalium californicum	California Cudweed	Native	Forb	Perennial	Yes	Medium	High					A	
Eriodictyon crassifolium	Thickleaf Yerba Santa	Native	Shrub	Perennial	Yes	High	Medium						
Ribes malvaceum	Chaparral Current	Native	Shrub	Perennial	Yes	Low	Medium						
Salvia leucophylla	Purple Sage	Native	Shrub	Perennial	Yes	Medium	Medium						
Salvia mellifera	Black Sage	Native	Shrub	Perennial	Yes	Medium	Medium						
Rhamnus ilicifolia	Hollyleaf Redberry	Native	Shrub	Perennial	Yes	Low	Medium						
Prunus ilicifolia	Hollyleaf Cherry	Native	Tree/Shrub	Perennial	Yes	Medium	Medium						
Avena barbata	Slender Wild Oat	Alien	Grass	Annual	NO	High	High					A	
Bromus diandrus	Ripgut Brome	Alien	Grass	Annual	NO	High	High			A		A	
Bromus hordeaceus	Soft Chess	Alien	Grass	Annual	NO	High	High			A		A	
Bromus madritensis	Red Brome	Alien	Grass	Annual	NO	High	High			A		A	

[a] :Scientific name from the 2012 Jepson Manual: Vascular Plants of California (Baldwin et al., 2012)
[b] :Duration indicates the life expectance of the plant
[c] :These plants could be used to restore the vegetation of Area IV
[d] :The plant abundance in Area IV as observed during May 30th, 2013 site visit
A :The 'A' indicates that the plant is analogous to a species shown to uptake this contaminant as identified by the Sandia Study (2012b)

4.1.4 Bioremediation Study

The bioremediation study is designed to determine what microbial communities are present in Area IV soils; if these microbes are known to degrade the COIs; establish a baseline of Area IV COI biodegradation rates; and explore if the microbes can be stimulated to increase their COI degradation rates. Biodegradation (in this context) involves bacteria and/or fungi degrading COIs in the Area IV soils.

The bioremediation study will include collecting Area IV soil samples, culturing microbes from these soils for laboratory studies, conducting DNA sequencing and other studies on the cultures to learn how they function under natural field conditions, and using microcosms to test ways to increase the biodegradation rates. All soil sampling methods specific for chemical analyses will be per the Phase 3 Data Gap Work Plan and QAPP. The SOPs for collection and analysis of the soil for the laboratory bioremediation microcosm studies will be addressed in the Bioremediation Study Plan.

CDM Smith geologists and technicians will collect all field soil samples for chemical baseline analyses. CDM Smith will also collect and homogenize the soil for the microcosm portion of the study, but Cal Poly will be responsible for preparing the microcosms. Cal Poly will perform all microbial culturing and microbial analyses, as well as operate the laboratory microcosms. Contract laboratories will perform soil COI analyses, including analyses for contaminant degradation intermediates and end products. Any special analytical procedures and SOPs will be presented in the Bioremediation Study Plan.

4.1.5 Natural Attenuation Study

The natural attenuation study will be conducted in two phases. Phase 1 will be a literature review of prior research at other sites to determine if the COIs present in Area IV soils can be degraded by biological or weathering processes, what chemical intermediates and end products can be formed during these degradation processes, and what natural attenuation rates for these COIs have been observed in other studies. Also during Phase 1, DOE will resample locations identified during the RCRA Facility Investigation (RFI) to determine if reductions in COIs have occurred over the last five years (per a recommendation by Sandia). Phase 2 of the natural attenuation study will estimate COI natural attenuation rates in Area IV soils based on the results of the concurrent bioremediation and phytoremediation soil treatability studies.

CDM Smith geologists and technicians will collect all field soil samples for chemical analyses based on procedures in the Phase 3 Data Gap Work Plan. Contract laboratories will perform soil COI analyses per requirements in the Phase 3 Work Plan QAPP. Cal Poly will observe soil sampling, perform the literature review and calculate the site-specific attenuation rates.

4.2 General Structure of Study Plans

Each soil treatability study plan will be structured as follows. Due to the unique aspects of the studies, each study plan will require some level of customization.

1. Introduction
    a. Purpose of Study

   b. Overview of Study
   c. Study Plan Structure
2. Roles and Responsibilities of Study Team
3. Study Basis
   a. Study Objectives
   b. Study Phases
   c. Limitations of Study
4. Study Implementation
   a. Process for Identification of Study Plot Locations
   b. Sampling Procedures
   c. Experimental Procedures
   d. Analytical Procedures/Chemical Analyses
   e. Data Review
   f. Health and Safety Requirements
   g. Quality Assurance/Quality Control Requirements
5. Schedule
6. Recommendations and Next Steps
7. References

4.3 Limitations of Individual Studies

The limitations of each treatability study will be discussed in the individual study plans and the comprehensive treatability evaluation report.

Section 5

Overview of Soil Treatability Study Implementation

This section details the general activities and requirements associated with implementing each treatability study. Key activities and requirements may vary from study to study. Key activities and requirements of each treatability study are addressed in detail in the individual study plans.

5.1 Background Information Search and Literature Review

The background information search and literature review will be conducted according to the following procedure, with study-specific modifications included as necessary:

1. Relevant scientific databases will be searched for information regarding the particular remediation technology and the Area IV COIs (e.g., Science Citation Index, Science Direct, BIOSIS, and Google Scholar).

2. Journals with specific relevance to the treatability study will be searched (e.g., Environmental Science and Technology, Environmental Toxicology and Chemistry, and Chemosphere).

3. Papers and abstracts from relevant conference proceedings will also be searched (e.g., Battelle Conference on Chlorinated and Recalcitrant Compounds).

4. Review articles (articles providing critical evaluation of previously published studies) will be searched to identify the most important studies and provide a broad perspective and identify important prior publications.

5. All information cited will be obtained from the original papers in which information was published (not as cited by subsequent publications).

6. All publications will be indexed into a database (e.g., Endnote).

7. Colleagues and professionals with experience in the individual treatability field will be contacted via email and telephone for guidance in identifying other current researchers in this area and identifying field sites with similar Area IV COIs.

5.2 Field Data Collection Activities

Specific field activities will be identified in each treatability study plan and conducted according to the applicable SOPs. For soil sampling that is consistent with what is currently being performed under the Phase 3 Data Gap Work Plan, the established Phase 3 SOPs will be followed for soil collection, documentation, and shipment. Each treatability study plan will list the standard Phase 3 SOPs that will be used for that study. For field data collection activities not addressed in the Phase 3 Work Plan (e.g. plant harvesting, soil root zone sampling, homogenizing soil for microcosm studies), study-specific SOPs will be developed and presented in the individual study plans. Field samples will also adhere to the Quality Assurance and Quality Control requirements addressed in Section 5.7 of this document.

Some of the general SOPs from the Phase 3 Data Gap Work Plan that will be followed are listed below and provided in Appendix D.

- SSFL SOP 1, *Procedures for Locating and Clearing Phase 3 Samples*
- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection Sampling*
- SSFL SOP 6, *Field Measurement of Total Organic Vapors*
- SSFL SOP 7, *Field Measurement of Residual Radiation*
- SSFL SOP 8, *Field Logbook Content and Control*
- SSFL SOP 9, *Lithologic Logging*
- SSFL SOP 10, *Sample Custody*
- SSFL SOP 11, *Packaging and Shipping of Environmental Samples*
- SSFL SOP 12, *Field Equipment Decontamination*
- SSFL SOP 13, *Guide to Handling Investigation Derived Waste*
- SSFL SOP 14, *Geophysical Survey*
- SSFL SOP 15, *Photographic Documentation of Field Activities*
- SSFL SOP 16, *Control of Measurement and Test Equipment*
- SSFL SOP 17*, Laboratory Homogenization of Phase 3 Soil Samples*
- Additional SOPS will be provided in individual study plans as needed

Expected field activities and study-specific SOPs already developed for individual treatability studies are identified below:

- Soil Partitioning Study: Soil sample collection for geotechnical and COI analyses
  - Study-specific SOPS to be provided in the Soil Partitioning Study Plan study plan
- Mercury Contamination Study: Soil sample collection for COI analyses
  - Phase 3 Data Gap Work Plan SOPS will be followed for soil sample collection for the Mercury Contamination Study
- Phytoremediation Study: Soil sample and plant tissue sample collection for COI analyses; soil nutrient analyses; seed collection for use in microcosm studies; soil sample collection for use in microcosm studies

- SSFL SOP ST PHY 1, Plant Sampling and Root-Zone Soil Sampling
- SSFL SOP ST PHY 2, Seed Collection
- SSFL SOP ST PHY 3, Phytoremediation Microcosm Preparation and Operation
- SSFL SOP ST PHY 4, Use and Sampling of Sorbent Tubes for Phytovolatilization Measurement
- SSFL SOP ST PHY 5, Laboratory Homogenization of Phytoremediation Treatability Plant Tissue Samples
- SSFL SOP ST PHY 6, Field Homogenization of Soil Samples
- SSFL SOP ST PHY 7, Laboratory Sampling Equipment Decontamination
- SSFL SOP ST PHY 8, Bulk Soil Sampling
- SSFL SOP ST PHY 9, Bulk Soil Homogenization
- SSFL SOP ST PHY 10, Cal Poly Laboratory Data Collection, Documents, Content, and Control
- SSFL SOP ST PHY 11, Guide to Handling Investigation- and Experiment-Derived Waste

- Bioremediation Study: Soil sample collection for COI analyses and use in microcosm studies
  - Study-specific SOPS to be provided in the Bioremediation Study Plan study plan
- Natural Attenuation Study: Soil sample collection for COI analyses
  - Phase 3 Sampling SOPs will be followed for soil sample collection activities

5.3 University Laboratory Activities

Specific university laboratory activities will be identified in each treatability study plan. General university laboratory activities for each treatability study are identified below:

- Soil Partitioning Study: None
- Mercury Contamination Study: None
- Phytoremediation Study: Microcosm studies to determine rates and mechanisms of phytoremediation
- Bioremediation Study: Identification of microbial communities in Area IV soil samples; microcosm studies to determine rates of biodegradation
- Natural Attenuation Study: None

5.4 Contract Laboratory Activities

Specific contract laboratory activities will be identified in each treatability study plan. General contract laboratory activities for each treatability study are identified below:

- Soil Partitioning Study: Grain size analyses, soil COI analyses
- Mercury Contamination Study: Soil mercury analyses
- Phytoremediation Study: Soil nutrient analyses, soil COI analyses, soil amendment COI analyses, plant tissue COI analyses, vapor COI analyses
- Bioremediation Study: Soil COI analyses, soil amendment COI analyses
- Natural Attenuation Study: Soil COI analyses

5.5 Data Review

Data review will be conducted in accordance with Section 9 (Data Reduction, Validation, and Reporting) of the Phase 3 Data Gap Work Plan QAPP (April 2012).

5.6 University Laboratory Sampling Requirements

All samples collected in the university laboratories will follow the relevant SOPs contained in each individual treatability study plan.

5.7 Quality Assurance and Quality Control Requirements

Sampling and analytical methods will follow procedures stated in the Phase 3 Data Gap QAPP for routine activities. Each individual study plan will include study-specific sampling and analytical procedures, and quality control limits not provided in the Phase 3 Data Gap QAPP.

5.8 Health and Safety Requirements

Health and safety requirements for activities in the field will follow procedures from the Worker Safety and Health Program for Chemical Data Gap Investigation Phase 3 Soil Chemical Sampling at Area IV, Santa Susana Field Laboratory, Ventura County, California (CDM Federal Programs Corporation, March 2012).

Health and safety requirements for activities in the Cal Poly laboratory will follow applicable Cal Poly procedures.

Health and safety requirements for activities in the contract laboratory will follow applicable contract laboratory procedures.

Section 6

General Structure of Study Reports

Each treatability study report will be structured as follows. Each study report will require some level of customization.

1. Introduction
    a. Purpose of study
    b. Summarized conclusions
2. Roles and responsibilities of study team
3. Basis of studies
    a. Study objectives
    b. Study phases
    c. Study limitations
4. Study materials and methods
    a. Background information/literature review and observations
    b. Field activities and observations
    c. Laboratory activities and observations
    d. Analytical procedures/chemical analyses and observations
    e. Health and safety requirements and observations
    f. Quality assurance/quality control requirements and observations
5. Study findings
    a. Data presentation
    b. Data review and discussion
6. Conclusions
    a. Implications for other studies
    b. Recommendations
7. References

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Section 7

General Structure of Comprehensive Treatability Evaluation Report

The comprehensive treatability evaluation report will be structured as follows:

1. Introduction
    a. Purpose of studies
    b. Summarized conclusions
2. Roles and responsibilities of study teams
3. Basis of studies
    a. Study objectives
    b. Study phases
    c. Study limitations
4. Study materials and methods
    a. Background information/literature review and observations
    b. Field activities and observations
    c. Laboratory activities and observations
    d. Analytical procedures/chemical analyses and observations
    e. Health and safety requirements and observations and observations
    f. Quality assurance/quality control requirements and observations and observations
5. Study findings
    a. Data presentation
    b. Data review and discussion
6. Conclusions
    a. Recommendations
7. References

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Section 8

Schedule

TASK	2013		2014			
	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Soil Partitioning Study Plan preparation and review	■	■				
Soil Partitioning Study activities	■	■				
Soil Partitioning Study Report preparation and review		■				
Mercury Contamination Study Plan preparation and review	■	■				
Mercury Contamination Study activities	■	■	■			
Mercury Contamination Study Report preparation and review		■	■			
Phytoremediation Study Plan preparation and review	■	■				
Phytoremediation Study activities	■	■	■	■	■	■
Phytoremediation Study Report preparation and review						■
Bioremediation Study Plan preparation and review	■	■				
Bioremediation Study activities	■	■	■	■	■	■
Bioremediation Study Report preparation and review						■
Natural Attenuation Study Plan preparation and review	■	■				
Natural Attenuation Study activities	■	■	■	■	■	■
Natural Attenuation Study Report preparation and review						■

Note: Detailed schedules will be included in the individual study plans.

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Section 9

References

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CDM Smith. (2012b). "Data Gap Work Plan QAPP For Chemical Data Gap Investigation Phase 3 Soil Chemical Sampling at Area IV, Santa Susana Field Laboratory, Ventura County, CA." Prepared for Department of Energy, Energy Technology and Engineering Center. April.

CDM Smith. (2012c). "Worker Safety and Health Program For Chemical Data Gap Investigation Phase 3 Soil Chemical Sampling at Area IV, Santa Susana Field Laboratory, Ventura County, California." Prepared for Department of Energy, Energy Technology and Engineering Center. March.

Sandia. (2012). ""Investigations Recommended for Resolving Uncertainty About Soil Remediation at ETEC." Soil Treatability Study Update. September 18.

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Appendix A

Analytical Method Reporting Limits

Modified from *CDM Smith. (2012). "Data Gap Work Plan QAPP For Chemical Data Gap Investigation Phase 3 Soil Chemical Sampling at Area IV, Santa Susana Field Laboratory, Ventura County, CA." Prepared for Department of Energy, Energy Technology and Engineering Center. April.*

Modifications to the Data Gap Work Plan QAPP include the addition of plant tissue sample method reporting limits, and soil analyses for total nitrogen and organic carbon.

CDM Smith

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Analytical Method Reporting Limits

Analyte	Soils	Plant Tissue	Unit	Waters	
	Reporting Limit	Reporting Limit		Reporting Limit	Unit
Dioxins/Furans by EPA Method 1613B					
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	8.1	8.1	ng/kg	20	pg/L
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	140	140	ng/kg	20	pg/L
1,2,3,4,6,7,8-Heptachlorodibenzofuran	2.5	2.5	ng/kg	10	pg/L
1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	13	13	ng/kg	10	pg/L
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.19	0.19	ng/kg	10	pg/L
1,2,3,4,7,8-Hexachlorodibenzofuran	0.73	0.73	ng/kg	10	pg/L
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.34	0.34	ng/kg	10	pg/L
1,2,3,6,7,8-Hexachlorodibenzofuran	0.3	0.3	ng/kg	10	pg/L
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.95	0.95	ng/kg	10	pg/L
1,2,3,7,8,9-Hexachlorodibenzofuran	0.43	0.43	ng/kg	10	pg/L
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1.1	1.1	ng/kg	10	pg/L
1,2,3,7,8-Pentachlorodibenzofuran	0.59	0.59	ng/kg	10	pg/L
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.18	0.18	ng/kg	10	pg/L
2,3,4,6,7,8-Hexachlorodibenzofuran	0.45	0.45	ng/kg	10	pg/L
2,3,4,7,8-Pentachlorodibenzofuran	0.64	0.64	ng/kg	10	pg/L
2,3,7,8-Tetrachlorodibenzofuran	1.8	1.8	ng/kg	2	pg/L
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.5	0.5	ng/kg	2	pg/L
TCDD TEQ[9]	0.87	0.87	ng/kg	2	pg/L
Metals by EPA Method 6010C/6020A					
Aluminum	20000	20000	mg/kg	0.2	mg/L
Antimony	8.7	8.7	mg/kg	0.001	mg/L
Arsenic	15	15	mg/kg	0.002	mg/L
Barium	140	140	mg/kg	0.002	mg/L
Beryllium	1.1	1.1	mg/kg	0.0005	mg/L
Boron	9.7	9.7	mg/kg	0.05	mg/L
Cadmium	1	1	mg/kg	0.0005	mg/L
Calcium	20	20	mg/kg	0.2	mg/L
Chromium	36.8	36.8	mg/kg	0.002	mg/L
Cobalt	21	21	mg/kg	0.0005	mg/L
Copper	29	29	mg/kg	0.002	mg/L
Iron	28000	28000	mg/kg	0.2	mg/L
Lead	34	34	mg/kg	0.001	mg/L
Lithium	37	37	mg/kg	0.02	mg/L
Magnesium	10	10	mg/kg	0.1	mg/L
Manganese	495	495	mg/kg	0.005	mg/L
Molybdenum	5.3	5.3	mg/kg	0.0005	mg/L
Nickel	29	29	mg/kg	0.002	mg/L
Phosphorus	10	10	mg/kg	0.1	mg/L
Potassium	6400	6400	mg/kg	0.5	mg/L
Selenium	0.655	0.655	mg/kg	0.002	mg/L
Silver	0.79	0.79	mg/kg	0.0005	mg/L
Sodium	110	110	mg/kg	1	mg/L
Strontium	0.495	0.495	mg/kg	0.005	mg/L
Thallium	0.46	0.46	mg/kg	0.0005	mg/L
Tin	10.9	10.9	mg/kg	0.02	mg/L
Titanium	0.995	0.995	mg/kg	0.01	mg/L
Vanadium	62	62	mg/kg	0.0005	mg/L
Zinc	110	110	mg/kg	0.015	mg/L
Zirconium	8.6	8.6	mg/kg	0.05	mg/L
Nitrogen by ASTM D5373					
Total Nitrogen	0.5	0.5	%	0.5	%
Organic Carbon by ASTM D5310					
Organic Carbon	1	1	mg/kg	1	mg/L
Mercury by EPA Method 7471B/7470A/3200					
Mercury	0.09	0.09	mg/kg	0.0002	mg/L
Methyl Mercury by EPA Method 1630					
Methyl Mercury	0.12	0.12	pg/g	0.06	ng/L

Analytical Method Reporting Limits

Analyte	Soils Reporting Limit	Plant Tissue Reporting Limit	Unit	Waters Reporting Limit	Waters Unit
Miscellaneous Analyses					
Percent Moisture (D2216)	0.1	0.1	%	NA	NA
pH (9040C and 9045D)	8.86	0.1	pH	0.01	pH
PCBs and PCTs by EPA Method 8082A					
Aroclor 1016	20.5	20.5	µg/kg	0.5	µg/L
Aroclor 1221	20.5	20.5	µg/kg	0.5	µg/L
Aroclor 1232	20.5	20.5	µg/kg	0.5	µg/L
Aroclor 1242	20.5	20.5	µg/kg	0.5	µg/L
Aroclor 1248	20.5	20.5	µg/kg	0.5	µg/L
Aroclor 1254	20.5	20.5	µg/kg	0.5	µg/L
Aroclor 1260	20.5	20.5	µg/kg	0.5	µg/L
Aroclor 1262	7.7	7.7	µg/kg	0.5	µg/L
Aroclor 1268	7.7	7.7	µg/kg	0.5	µg/L
Aroclor 5432	51.6	51.6	µg/kg	0.5	µg/L
Aroclor 5442	51.6	51.6	µg/kg	0.5	µg/L
Aroclor 5460	77	77	µg/kg	0.5	µg/L
Polynuclear Aromatic Hydrocarbons (PAHs) and NDMA (8270C/D SIM)					
1-Methylnaphthalene	21.1	21.1	µg/kg	0.05	µg/L
2-Methylnaphthalene	21.1	21.1	µg/kg	0.05	µg/L
Acenaphthene	21.1	21.1	µg/kg	0.05	µg/L
Acenaphthylene	21.1	21.1	µg/kg	0.05	µg/L
Anthracene	21.1	21.1	µg/kg	0.05	µg/L
Benzo(a)anthracene	19.9	19.9	µg/kg	0.05	µg/L
Benzo(a)pyrene	21.1	21.1	µg/kg	0.05	µg/L
Benzo(b)fluoranthene	21.1	21.1	µg/kg	0.05	µg/L
Benzo(g,h,i)perylene	21.1	21.1	µg/kg	0.05	µg/L
Benzo(k)fluoranthene	20.4	20.4	µg/kg	0.05	µg/L
Chrysene	21.3	21.3	µg/kg	0.05	µg/L
Dibenz(a,h)anthracene	20	20	µg/kg	0.05	µg/L
Fluoranthene	20.5	20.5	µg/kg	0.05	µg/L
Fluorene	21.1	21.1	µg/kg	0.05	µg/L
Indeno(1,2,3-cd)pyrene	21.3	21.3	µg/kg	0.05	µg/L
Naphthalene	21.1	21.1	µg/kg	0.05	µg/L
Phenanthrene	21.1	21.1	µg/kg	0.05	µg/L
Benzo(e)pyrene	1.96	1.96	µg/kg	5	µg/L
N-Nitrosodimethylamine	25	25	µg/kg	0.05	µg/L
Benzo(a)pyrene [BaP] TEQ	21.1	21.1	µg/kg	0.05	µg/L
TPH by EPA Method 8015B/C/D					
EFH (C12-C14)	5.05	5.05	mg/kg	0.6	mg/L
EFH (C15-C20)	5.09	5.09	mg/kg	0.6	mg/L
EFH (C21-C30)	5.09	5.09	mg/kg	0.6	mg/L
EFH (C30-C40)	1.4	1.4	mg/kg	0.6	mg/L
EFH (C8-C11)	5.05	5.05	mg/kg	0.6	mg/L

DRO - diesel range organics
EFH – extractable fuel hydrocarbons
EPA - United States Environmental Protection Agency
GRO - gasoline range organics
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
ng/kg - nanograms per kilogram
ng/L - nanograms per liter
pg/L – picogram per liter
µg/L – microgram per liter
* - 1,2 dimethylhydrazine is very unstable, monitoring for this compound using azobenzene.
** - These compounds are tentatively identified compound (TICs) quantified using a single point calibration.
-- = no value

Appendix B

Quality Control Objectives for Analytical Methods

Modified from *CDM Smith. (2012). "Data Gap Work Plan QAPP For Chemical Data Gap Investigation Phase 3 Soil Chemical Sampling at Area IV, Santa Susana Field Laboratory, Ventura County, CA." Prepared for Department of Energy, Energy Technology and Engineering Center. April.*

Modifications to the Data Gap Work Plan QAPP include the addition of plant tissue sample analytical methods, and soil analyses for total nitrogen and organic carbon.

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Quality Control Objectives for Analytical Methods

Analytical Category	Method Number and Reference	MS/MSD or Surrogate Accuracy Criterion (% Recovery)		BS/LCS Accuracy Criterion (% Recovery)		Precision Criterion (Maximum RPD)	
		Soil and Tissue	Water	Soil and Tissue	Water	Soil and Tissue	Water
pH	**EPA Method 9040C/9045D**						
pH		NA	NA	95-105	90-110	5	
TPH	**EPA Method 8015B/C/D**						
EFH (C12-C14)		—	—	—	—	—	—
EFH (C15-C20)		—	—	—	—	—	—
EFH (C21-C30)		—	—	—	—	—	—
EFH (C30-C40)		—	—	—	—	—	—
EFH (C8-C11)		—	—	—	—	—	—
Polychlorinated biphenyls and PCTs	**EPA Method 8082A**						
Aroclor 1016		—	—	—	—	—	—
Aroclor 1221		—	—	—	—	—	—
Aroclor 1232		—	—	—	—	—	—
Aroclor 1242		—	—	—	—	—	—
Aroclor 1248		—	—	—	—	—	—
Aroclor 1254		—	—	—	—	—	—
Aroclor 1260		—	—	—	—	—	—
Aroclor 1262		—	—	—	—	—	—
Aroclor 1268		—	—	—	—	—	—
Aroclor 5432		—	—	—	—	—	—
Aroclor 5442		—	—	—	—	—	—
Aroclor 5460		—	—	—	—	—	—
Surrogate		—	—	—	—	—	—
Decachlorobiphenyl		45-120	45-120	45-120	45-120	NA	NA
Metals	**EPA Method 6010 C/6020A**						
Aluminum		75-125	75-125	—	80-120	20	
Antimony		75-125	75-125	—	80-120	20	
Arsenic		75-125	75-125	—	80-120	20	
Barium		75-125	75-125	—	80-120	20	
Beryllium		75-125	75-125	—	80-120	20	
Cadmium		75-125	75-125	—	80-120	20	
Calcium		75-125	75-125	—	80-120	20	
Chromium		75-125	75-125	—	80-120	20	
Cobalt		75-125	75-125	—	80-120	20	
Copper		75-125	75-125	—	80-120	20	
Iron		75-125	75-125	—	80-120	20	
Lead		75-125	75-125	—	80-120	20	
Magnesium		75-125	75-125	—	80-120	20	
Manganese		75-125	75-125	—	80-120	20	
Nickel		75-125	75-125	—	80-120	20	
Potassium		75-125	75-125	—	80-120	20	
Selenium		75-125	75-125	—	80-120	20	

Quality Control Objectives for Analytical Methods

Analytical Category	Method Number and Reference	MS/MSD or Surrogate Accuracy Criterion (% Recovery)		BS/LCS Accuracy Criterion (% Recovery)		Precision Criterion (Maximum RPD)	
		Soil and Tissue	Water	Soil and Tissue	Water	Soil and Tissue	Water
Silver		75-125	75-125	—	80-120	20	
Sodium		75-125	75-125	—	80-120	20	
Thallium		75-125	75-125	—	80-120	20	
Vanadium		75-125	75-125	—	80-120	20	
Zinc		75-125	75-125	—	80-120	20	
Miscellaneous Analyses							
Percent Moisture	D2216	—	—	—	—	—	
pH	9040C and 9045D	—	—	—	—	—	—
Total Nitrogen	ASTM D5373	75-125	75-125	—	80-120	20	
Organic Carbon	ASTMD 5310	75-125	75-125	—	80-120	20	
Dioxins/Furans	**EPA Method 1613B**						
2,3,7,8-TCDD		40-135	40-135	67-158	60-150	20	
1,2,3,7,8-PeCDD		40-135	40-135	70-142	60-150	20	
1,2,3,4,7,8-HxCDD		40-135	40-135	70-164	60-150	20	
1,2,3,6,7,8-HxCDD		40-135	40-135	76-134	60-150	20	
1,2,3,7,8,9-HxCDD		40-135	40-135	64-162	60-150	20	
1,2,3,4,6,7,8-HpCDD		40-135	40-135	70-140	60-150	20	
OCDD		40-135	40-135	78-144	60-150	20	
2,3,7,8-TCDF		40-135	40-135	75-158	60-150	20	
1,2,3,7,8-PeCDF		40-135	40-135	80-134	60-150	20	
2,3,4,7,8-PeCDF		40-135	40-135	68-160	60-150	20	
1,2,3,4,7,8-HxCDF		40-135	40-135	72-134	60-150	20	
1,2,3,6,7,8-HxCDF		40-135	40-135	84-130	60-150	20	
2,3,4,6,7,8-HxCDF		40-135	40-135	70-156	60-150	20	
1,2,3,7,8,9-HxCDF		40-135	40-135	78-130	60-150	20	
1,2,3,4,6,7,8-HpCDF		40-135	40-135	82-122	60-150	20	
1,2,3,4,7,8,9-HpCDF		40-135	40-135	78-138	60-150	20	
OCDF		40-135	40-135	63-170	60-150	20	
Mercury	**EPA Method 7471B/7470A**						
Mercury		65-135	75-125	85-120	90-115	20	
Methyl Mercury	**EPA Method 1630**						
Methyl mercury		70-130	75-125	70-130	77-123	30	25
PAH	**EPA Method 8270C/D SIM**						
Acenaphthene		—	—	—	—	—	—
Acenaphthylene		—	—	—	—	—	—
Anthracene		—	—	—	—	—	—
Benzo(a)anthracene		—	—	—	—	—	—
Benzo(a)pyrene		—	—	—	—	—	—
Benzo(b)fluoranthene		—	—	—	—	—	—
Benzo(g,h,i)perylene		—	—	—	—	—	—
Benzo(k)fluoranthene		—	—	—	—	—	—

Quality Control Objectives for Analytical Methods

Analytical Category	Method Number and Reference	MS/MSD or Surrogate Accuracy Criterion (% Recovery)		BS/LCS Accuracy Criterion (% Recovery)		Precision Criterion (Maximum RPD)	
		Soil and Tissue	Water	Soil and Tissue	Water	Soil and Tissue	Water
Chrysene		—	—	—	—	—	—
Dibenzo(a,h)anthracene		—	—	—	—	—	—
Fluoranthene		—	—	—	—	—	—
Fluorene		—	—	—	—	—	—
Indeno(1,2,3-cd)pyrene		—	—	—	—	—	—
n-Nitrosodimethylamine		—	—	—	—	—	—
Naphthalene		—	—	—	—	—	—
Phenanthrene		—	—	—	—	—	—
Pyrene		—	—	—	—	—	—
1-Methylnaphthalene		—	—	—	—	—	—
2-Methylnaphthalene		—	—	—	—	—	—
Surrogates							
Phenol-d5		25-120	20-120	25-120	20-110	NA	NA
2-Fluorophenol		25-130	20-130	25-130	20-110	NA	NA
2,4,6-Tribromophenol		35-130	30-130	35-130	30-110	NA	NA
Nitrobenzene-d5		40-130	40-130	40-130	40-130	NA	NA
2-Fluorbiphenyl		45-130	45-130	45-130	45-130	NA	NA
Terphenyl-d14		45-135	45-135	45-130	45-130	NA	NA

Acronyms and Abbreviations:

BFB = Bromofluorobenzene
BS/LCS = Blank Spike/Laboratory Control Sample
EPA = U.S. Environmental Protection Agency
MS/MSD = Matrix Spike/Matrix Spike Duplicate
NA = not applicable
RPD = Relative Percent Difference
PAH = polycyclic aromatic hydrocarbons
SIM = selected ion monitoring
"—" = Laboratory-specific lower control limit-upper control limit or laboratory specific maximum RPD

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Appendix C

AOC Chemical Look-Up Table Values

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AOC Chemical Look-up Table Values (6/11/2013)

Chemical Class	Chemical Name	CAS #	Analytical Method	Look-up Table Value (06/11/2013)	Units
PAH	1-Methyl naphthalene	90120	EPA 8270	2.5	µg/kg
	2-Methylnaphthalene	91576	EPA 8270	2.5	µg/kg
	Acenaphthene	83329	EPA 8270	2.5	µg/kg
	Acenaphthylene	208968	EPA 8270	2.5	µg/kg
	Anthracene	120127	EPA 8270	2.5	µg/kg
	Benzo(ghi)perylene	191242	EPA 8270	2.5	µg/kg
	Fluoranthene	206440	EPA 8270	5.2	µg/kg
	Fluorene	86737	EPA 8270	3.8	µg/kg
	Naphthalene	91203	EPA 8270	3.6	µg/kg
	Phenanthrene	85018	EPA 8270	3.9	µg/kg
	Pyrene	129000	EPA 8270	5.6	µg/kg
	BaP TEQ	BaP TEQ	EPA 8270	4.47	µg/kg
PCB	Aroclor 1016	12674112	EPA 8082	17	µg/kg
	Aroclor 1221	11104282	EPA 8082	33	µg/kg
	Aroclor 1232	11141165	EPA 8082	17	µg/kg
	Aroclor 1242	53469219	EPA 8082	17	µg/kg
	Aroclor 1248	12672296	EPA 8082	17	µg/kg
	Aroclor 1254	11097691	EPA 8082	17	µg/kg
	Aroclor 1260	11096825	EPA 8082	17	µg/kg
	Aroclor 1262	37324235	EPA 8082	33	µg/kg
	Aroclor 1268	11100144	EPA 8082	33	µg/kg
Perchlorate	Perchlorate	14797730	EPA 6850/6860	1.63	µg/kg
Dioxin	2,3,7,8-TCDD TEQ	1746016-TEQ	EPA 1613	0.912	ng/kg
Mercury	Mercury	7439976	EPA 7471	0.13	mg/kg
Methyl Mercury	Methyl Mercury	22967926	1630 (Mod)	0.05	µg/kg
TPH	Gasoline (C4-C12)	GROC5C12	EPA 8015	- -	mg/kg
	EFH(C8-C11)	PHCC8C11	EPA 8015	- -	mg/kg
	EFH(C12-C14)	PHCC12C14	EPA 8015	- -	mg/kg
	EFH(C15-C20)	PHCC15C20	EPA 8015	5	mg/kg
	EFH(C21-C30)	PHCC21C30	EPA 8015	- -	mg/kg
	Oil (C30-C40)	PHCC30C40	EPA 8015	- -	mg/kg

Chemical Class	Chemical Name	CAS #	Analytical Method	Look-up Table Value (06/11/2013)	Units
Metals	Aluminum	7429905	EPA 6010/6020	58,600	mg/kg
	Antimony	7440360	EPA 6010/6020	0.86	mg/kg
	Arsenic	7440382	EPA 6010/6020	46	mg/kg
	Barium	7440393	EPA 6010/6020	371	mg/kg
	Beryllium	7440417	EPA 6010/6020	2.2	mg/kg
	Boron	7440428	EPA 6010/6020	34	mg/kg
	Cadmium	7440439	EPA 6010/6020	0.7	mg/kg
	Chromium	7440473	EPA 6010/6020	94	mg/kg
	Cobalt	7440484	EPA 6010/6020	44	mg/kg
	Copper	7440508	EPA 6010/6020	119	mg/kg
	Lead	7439921	EPA 6010/6020	49	mg/kg
	Lithium	7439932	EPA 6010/6020	91	mg/kg
	Manganese	7439965	EPA 6010/6020	1,120	mg/kg
	Molybdenum	7439987	EPA 6010/6020	3.2	mg/kg
	Nickel	7440020	EPA 6010/6020	132	mg/kg
	Potassium	7440097	EPA 6010/6020	14,400	mg/kg
	Selenium	7782492	EPA 6010/6020	1	mg/kg
	Silver	7440224	EPA 6010/6020	0.2	mg/kg
	Sodium	7440235	EPA 6010/6020	1,780	mg/kg
	Strontium	7440246	EPA 6010/6020	163	mg/kg
	Thallium	7440280	EPA 6010/6020	1.2	mg/kg
	Vanadium	7440622	EPA 6010/6020	175	mg/kg
	Zinc	7440666	EPA 6010/6020	215	mg/kg
	Zirconium	7440677	EPA 6010/6020	19	mg/kg

Appendix D

Identified Phase 3 SOPs

CDM Smith

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Procedures for Locating and Clearing Phase 3 Samples	SSFL SOP 1 Revision: 1 Date: July 2013

Prepared:	P. Hartman	**Technical Review:**	C. Werden
QA Review:	J. Oxford	**Approved and Issued:**	John T Wondolleck *Signature/Date*

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to describe the sample location and utility clearance protocols for the Phase 3 - Chemical Data Gap Investigation at the Santa Susana Field Laboratory (SSFL) site. Because this phase of investigation is targeted at minimizing data gaps in the understanding of the nature and extent of chemical contaminants in surface (0 to 0.5 foot) and subsurface (0.5 to 20 feet) soil, the precise location of each soil sample location is very important.

2.0 Background

2.1 Definitions

Data Gap Analysis–An analysis that identifies specific soil sample locations and depths for which insufficient data exists. The analysis is to minimize the data gap and ensure that collected data are representative of the study area. MWH, Inc. (MWH; under a separate agreement with Department of Energy [DOE]) is performing this effort.

Staked Location–Proposed sample location marked on the ground surface either with fluorescent paint (on concrete or asphalt), metal pins with fluorescent nylon whiskers, or wooden stakes marked with the sample location identifier installed at the exact sample locations identified through the MWH data gap analysis.

GPS– Global Positioning System that measures east-west and north-south coordinates of sample locations.

GeoExplorer 6000 Series Handheld Unit–GPS field unit used to survey proposed and actual sample locations.

Utility Locate–A survey of all proposed sample locations for underground utilities, including, but not limited to, water lines, sewer lines, storm sewer lines, gas lines, electric lines, and telecommunication lines. Performed by subcontractor.

Fisher TW-6-M-Scope Pipe and Cable Locator (or equivalent)-A field unit used to identify detectable electrically conductive conduits or piping which may have no surface expression.

Radiodetection RD4000 Utility Locator (or equivalent)-A field unit used to locate the surface trace of a variety of buried utilities.

Metrotech 50/60 Power Line Locator (or equivalent)–A field unit used to detect conduits that carry 60-cycle current.

3M Dynatel 2250 Cable Locator (or equivalent)-A field unit used to detect the surface trace of telephone and other narrow gauge wiring.

2.2 Associated Procedures

- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology (DPT) Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*
- SSFL SOP 6, *Field Measurement of Total Organic Vapor*
- SSFL SOP 7, *Field Measurement of Residual Radiation*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*
- SSFL SOP 14, *Geophysical Survey*

- SSFL SOP 16, *Control of Measurement and Test Equipment*

2.3 Discussion

Geographic Information System (GIS) sample location files will be received from MWH for field verification and those locations staked using global GPS location identification procedures. Office and field verification of GPS coordinates is necessary for determining the precise location of each sample point and to ensure the adequacy of signal strength of the GPS equipment. Inaccessible locations due to underground utilities, site geology, or that do not target the identified site will be assigned alternate locations by CDM Smith. Using GPS, site coordinate data will be collected at the alternative location and the updated surveyed location data will be electronically provided to MWH for updating the Area IV GIS. All proposed sample locations will be marked in the field using fluorescent paint, metal pins, or wooden stakes. Following MWH review of the relocated marked sample locations, CDM Smith will complete any additional required utility/geophysics clearances of the sample location and initiate sampling. In addition, protection of cultural and natural resources is an integral portion of locating sample points. Cultural, biological, and Native American monitors will be engaged throughout the process. Quality control measures will be implemented during GPS field collection and during post processing of confirmed or relocated sample locations. Staff responsible for GPS field collection will receive training on data collection and handling of data files that will be documented in a logbook.

3.0 General Responsibilities

Field Team Leader - The field team leader (FTL) is responsible for ensuring that field personnel collect soil and sediment samples in accordance with this SOP and other relevant procedures.

Site Health and Safety Technician– The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation's (SAIC's) Certified Health Physicist (CHP).

Site Geologist – The person responsible for attending sample location efforts and collecting and logging the soil sample.

Utility Locator Subcontractor – The subcontractor is responsible for identifying all buried utilities in the vicinity of soil borings, trenches, and test pits.

4.0 Required Equipment

4.1 General

- Site-specific plans (e.g., Field Sampling Plan [FSP] Addendum, health and safety)
- Mapping of proposed sample locations
- Mapping of known utilities
- Fluorescent paint and metal pins or wooden stakes
- Field logbook
- 2-way radios
- Monitoring and screening instruments per the health and safety plan
- 3M Dynatel 2250 Cable Locator (or equivalent) to detect the surface trace of telephone and other narrow gauge wiring
- Fisher TW-6-M-Scope Pipe and Cable Locator (or equivalent)
- Radiodetection RD4000 Utility Locator (or equivalent)
- Metrotech 50/60 Power Line Locator (or equivalent) to detect conduits that carry 60-cycle current
- GeoExplorer 6000 Series Handheld GPS Unit
- Sample rationale table (Table 1 of FSP Addendum)

5.0 Procedures

5.1 Field Staking

1. MWH provides specific data gap sample location information (i.e., GIS coordinates, map, and table) to CDM Smith for field use. The sample information includes:
   - Sample rationale (sampling objective)
   - Sample location
   - Depth interval
   - Analytical suite

2. The figures showing proposed sample locations are provided to the cultural, biological, and Native American monitors in advance of field verification so they can review their records for any cultural or biological resources in the vicinity of the sampling areas.

3. A minimum of four working days advanced notice of field work is required for the cultural and biological resource reviews. CDM Smith will meet with the monitors to discuss concerns. Sample locations in areas of resource concern are reported back to CDM Smith and revised sample locations are discussed with DOE, the California Department of Toxic Substances Control (DTSC) and MWH.

4. Once all locations have been reviewed, the GIS sample location coordinates are loaded into the GPS (See Section 5.2) for field staking.

5. CDM Smith's Sample Location Team mobilizes to each proposed sampling location. This Team consists of:
   - CDM Smith's FTL/Geologist
   - CDM Smith Site Health and Safety Technician
   - Utility Location Technician
   - Science Applications International Corporation's (SAIC's) Archaeological/Cultural Resource Compliance representative
   - SAIC's Natural Resource Compliance representative
   - Native American monitor

6. The FTL locates each sample station using the GPS. The FTL verifies that the location addresses the sampling rationale stated for the location in the FSP Addendum (Table 1). If it does, the location is marked with fluorescent paint and metal pins with fluorescent nylon whiskers or wooden stakes at the precise GIS/GPS coordinates.

7. If the location is identified by the cultural, natural resource, or Native American monitor as a location of concern, they will demarcate restricted areas as necessary and determine the degree of support necessary for each sample location during the intrusive investigation (soil boring or excavation). Each proposed sample location is also preliminarily screened for radiation.

8. Once staked, the FTL will escort the subcontract utility locator (See Section 5.3) to clear all proposed sample locations for underground utilities. Samples locations affected by underground utilities will be noted, and an alternative location staked to avoid the utility. All adjusted sample locations will be reviewed with DOE, DTSC, and MWH; and the cultural and natural resource, and Native American monitors.

9. Proposed locations may be adjusted based on the following considerations:
   - sample locations that are impacted by overhead/underground utilities
   - sample locations that are impacted by steep or non-accessible terrain or exposed bedrock
   - sample locations that are impacted by archaeological/cultural resources
   - sample locations that are impacted by biological resources
   - sample locations that did not meet the intent of the MWH sample rationale

10. Using the final GPS coordinates, CDM Smith will provide the updated the sample location data to MWH for updating the Area IV GIS. Staff responsible for collecting GPS data for the sample locations will receive training specific on data collection and data file management including the following:
    - Transferring data files from and to GPS unit
    - Opening new files in GPS unit, collecting new points and properly closing data files
    - Checking data files in GPS unit and on computer after daily download
    - Field check of maps showing sample locations during sample event for consistency with sample identifiers, numbering, and locations.

    This training will be documented in a logbook. A revised sample location map will be incorporated into the FSP Addendum and provided to DOE and DTSC.

11. DOE, DTSC, and MWH will have the opportunity to review all sample locations in the field and approve/accept the locations. Locations noted to be impacted or not meeting the intent of the sample collection rationale will be reviewed and direction will be provided to the FTL. Coordinates for adjusted samples locations will be immediately collected using the GPS unit and marked in the field as described above. Markers/paint of samples locations that will not be used will be destroyed at that time.

12. At each location, additional field-check of the sample location (coordinates) will be performed using the GPS unit at the time of sample collection.

5.2 GPS Survey

5.2.1 General

The following equipment is required to load and use GPS waypoint data for field surveys.

- ESRI ArcGIS Software
- Trimble Pathfinder Office Software
- TerraSync Software
- GeoExplorer 6000 Series Handheld Unit

The procedure to load and use GPS data consists of:

1. Load 2009 U.S. Department of Agriculture (USDA)National Agricultural Imagery Program (NAIP) color imagery onto GPS with the Pathfinder Office data transfer utility

2. Prepare GPS unit for data logging based on Chapter 9 (Setup Section) in “TerraSync Software Getting Started Guide”, which are as follows:

   a. 2.0 meter antenna height
   b. 30 positions logged and averaged for each collected sample location
   c. Required accuracy < 1.0 meter
   d. Quality of Global Navigation Satellite Systems (GNSS) positions logged will be controlled by the Trimble default “Smart Settings” referenced on page 181 of Chapter 9 of the Software Guide.

5.2.1 Method for Importing Sample Point Location Data

The following steps are used to load the data to the TerraSync software and should be done prior to navigating to a point (Chapters 5 and 6 of “TerraSync Software Getting Started Guide” can be referenced for further help):

1. Open TerraSync software on GPS unit and select ‘Data’ in the section list button
2. Tap ‘Manager – Existing File’
3. Select ‘MWH_SampleLoc.ssf’
4. Select ‘Map’ in the section list button
5. Tap ‘Layers – Background Files’
6. Check the box next to ‘SSFL_Aerial.sid’ and return to map view
7. Current location is denoted by a red x and the points on the map represent the MWH chosen sample locations.

The following steps must be taken to navigate to a given point (Chapter 7 of “TerraSync Software Getting Started Guide” can be referenced for further help):

1. Walk toward the nearest sample location with the FSP Addendum mapping and aerial photo as a reference
2. Select the point with the ‘select’ tool from the map tool dropdown list

3. Tap ‘Options – Set Nav Target’
4. Determine distance and bearing to target through the direction dial screen
5. A close-up screen will appear once target is within close proximity
6. Move toward the target and stop when the red x is within the center of the circle
7. Place the sample location pin or wooden stake at the base of the antenna

5.2.2 Coordinate Collection for Revised Sample Locations

The following steps will be taken to survey revised sample locations where the proposed location was deemed inaccessible due to underground utilities or the presence of archaeological/cultural, natural resource, or Native American considerations. CDM Smith will determine an alternate location for the sample and the coordinate data set will be updated using the GPS unit (Chapter 6 of “TerraSync Software Getting Started Guide” can be reference for further help):

1. Select ‘Data’ in the section list button
2. Select ‘Update’ from the sub-section list button
3. Tap ‘Options – Logging Options’ and confirm it is set to ‘Update Feature (Replace)’
4. Return to the update features screen and select the sample location you intend to modify from the ‘Choose Feature’ list
5. Upload revised sample location files daily from hand-held GPS unit and send files to GIS specialists weekly for review.
6. FTL will field check maps of revised locations provided by GIS specialists for appropriate placement of sample locations.

5.2.3 Quality Assurance/Quality Control

Proper operation of the GPS unit will be demonstrated prior to and at the conclusion of each day’s field activity. The following two permanent survey control points located within the SSFL Area IV will used to confirm the accuracy of the GPS unit:

Permanent Survey Control Point	Northing	Easting	Elevation
Set 2x2 w/ MG Tag #1	1907959.668000	6346660.571000	1825.270
Set 2x2 w/ MG Tag #2	1909915.202000	6350452.377000	1854.230
Set 1-in Pipe w/ MG Plastic Cap #3	1906485.748000	6344437.803000	1870.060
Set 1-in Pipe w/ MG Plastic Cap #4	1905107.447000	6344791.648000	2134.570
Set 1-in Pipe w/ MG Plastic Cap #5	1908215.335000	6348977.693000	1816.780

At the beginning and end of day, the GPS unit will be positioned directly over the Control Point and the coordinates recorded in the GPS unit. The GPS coordinates will be compared to the above stated survey control point coordinates. If comparison of the coordinates is within the acceptable required accuracy (< 1.0 meter) of the instrument, the GPS unit is locating properly and this information will be recorded in the logbook. If the coordinates are outside of the acceptable required accuracy (< 1.0 meter), then the SSFL SOP 16 should be consulted. Generally, if any field equipment fails to operate properly or provides inaccurate results, the field work will be temporarily suspended and the concern will be entered on the calibration log form and field logbook (SSFL SOP 8). Work will not resume until proper calibration is achieved or replacement equipment is received.

5.3 Utility Location and Clearance

Prior to survey activities, all subcontractor equipment will be inspected by the FTL to ensure that the equipment meets Occupational Safety and Health Act (OSHA) or other contract or SSFL health and safety requirements. Following inspection, the utility locate survey will be conducted by the utility locator subcontractor:

1. Review GIS mapping of known utilities for utility types in vicinity of each proposed sampling location.

2. Using the geophysical instrumentation, search and mark on the ground the identified underground utilities, including, but not limited to, water lines, sewer lines, storm sewer lines, gas lines, electric lines, and telecommunication lines within a 10-foot radius of the sample location. Verify the proximity of any buried natural gas lines within 25-feet of the sampling point.

3. Search and mark, if identified, any anomalies representing potential subsurface structures or obstructions (such as, but not limited to, boulders, rebar, underground storage tanks, sinkholes, voids, buried artifacts, concrete pipes, etc.). Where possible, the concrete slab thickness shall also be estimated.

4. Additional soil boring/test pit utility clearing of all locations within a 10-foot radius of an identified utility or anomaly. Any identified utilities and anomalies shall be marked on the ground surface, on a hand-drawn sketch, and on a scaled site map. ***Note***: All test pit excavations require coordination and onsite oversight of the cultural, natural resource, and Native American monitors.

5. Provide field notes, hand-drawn sketches and scaled maps of each survey location to the FTL at the conclusion of each day. CDM Smith will make available to the subcontractor scaled base maps for the site.

All known surface and subsurface utilities located within the Area IV GIS will be used, in part, to determine the level of effort for clearing individual boring/test pit locations in (a) non-developed areas and (b) developed or previously developed areas or areas with known utilities. These areas and effort are discussed below.

5.3.1 Non-Developed Areas

The utility subcontractor will perform a reconnaissance survey of all areas that have no historic record of development and are absent of known utilities (as illustrated by the Area IV GIS). The subcontractor will physically inspect all or a portion of the area as necessary to provide assurance that the area does not contain utilities. The subcontractor will determine the identification method and effort necessary and communicate this information to the FTL prior to commencing of sampling activities in those areas. Following approval from the FTL or geologist, the utility subcontractor will clear soil boring/test pit locations. The utility subcontractor will mark utilities/features on the ground within the designated areas using a color code established by the American Public Works Association (and provided by the subcontractor).

5.3.2 Developed Areas and Areas with Know Utilities

In developed areas, the exteriors of the buildings, curbsides, streets, and/or land where building demolishing and dismantling activities have taken place, the utility subcontractor will visually inspect proposed sample/test pit locations for evidence of utilities. Exposed tracer wire or portions of metallic conduits and pipe will be used to conduct a signal with the instrument appropriate for a given type of utility. All utilities/features identified using conductive signals will be marked on the ground within the designated areas using a color code established by the American Public Works Association (and provided by the subcontractor).

The utility subcontractor will physically inspect all or a portion of the proposed sampling/test pit area as necessary to provide assurance that the area does not contain utilities and to identify any surface features (depressions, pits, trenches, etc.) or anomaly representing potential subsurface structures or obstructions (such as, but not limited to, boulders, rebar, underground storage tanks, voids, buried artifacts, concrete pipes, etc.).

For areas where soil borings are located within 10 feet, and test pits are within 50 feet, of an identified utility or identified subsurface features or anomaly, additional clearing of the soil boring/test pit location will be required. The utility subcontractor will provide additional clearing activities at these locations as described below.

Equipment/instruments that do not use an induced current via pipe/conduit/wire will be swept over the ground surface within the designated clearance area. The signals will be traced at the surface and the underground utility or features will be delineated.

At a minimum, two 20-foot transects that are perpendicular to each other will be run within the diameter of each survey area. The transects will be centered on the boring/test pit location. Any surface features and anomaly representing potential subsurface structures or obstructions shall be identified and marked as appropriate. Where possible, the concrete slab thickness shall also be estimated.

5.4 Onsite Equipment and Vehicle Requirements

All equipment will be cleaned prior to entering and leaving SSFL. Vehicles are restricted to asphalt roads and parking lots and will be free of leaks. If vehicles or any equipment is leaking it will be taken out of service immediately and the fluids will be contained. Under CDM Smith's direction, the subcontractor will immediately clean up any petroleum or hydrocarbon fluid spills. Boeing, DOE, and DTSC will be immediately notified of any spills at the site.

6.0 Restrictions/Limitations

6.1 GPS Survey Instruments

External factors with the potential to degrade the quality of GPS data and the locating capabilities of the GPS are inherent within the GPS environment. A low signal to noise ratio (SNR), a high Position Dilution of Precision (PDOP), a multipath (GPS signal hits a physical barrier, thus reducing reflectivity), and a changing satellite constellation can all impact the quality of the GPS data. Because the equipment and logging settings are pre-determined for this project, inaccurate data due to the aforementioned external factors and potential human input errors should be minimized. The quality control procedures outlined in Section 5.2.3 will be followed to reduce GPS data quality issues/concerns.

7.0 References

National Geodetic Survey. 2012. "What We Do". http://www.ngs.noaa.gov/INFO/WhatWeDo.shtml

Trimble. 2012. "GPS Pathfinder Office Software". http://www.trimble.com/mappingGIS/PathfinderOffice.aspx?dtID=applications&

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Surface Soil Sampling	SSFL SOP 2 Revision: 1 Date: December 2012

Prepared: J. Sobol

Technical Review: C. Werden

QA Review: J. Oxford

Approved and Issued: 12/31/2012
Signature/Date

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to define the general techniques and requirements for the collection of surface soil samples at the Santa Susana Field Laboratory (SSFL) site.

2.0 Background

2.1 Definitions

Grab Sample - A discrete portion of soil or an aliquot taken from a specific sample location at a given point in time.

Slide Hammer- A sampling tool used to drive and retract a 6-inch long thin-walled stainless steel sample collection sleeve (approximately 2-inches in diameter).

Surface Soil- Soil that occurs at 0 to 6 inches below ground surface (bgs).

EnCore® Sampler- A single-use plastic sampling device, typically with a capacity of 5 grams, used to obtain undisturbed, unconsolidated material samples (e.g., soil) for laboratory analyses. The sampler is inserted into a metal T-handle and the open end of the sampler pushed directly into the soil.

2.2 Associated Procedures

- SSFL SOP 1, *Procedures for Locating and Clearing Phase 3 Samples*
- SSFL SOP 6, *Field Measurement of Total Organic Vapors*
- SSFL SOP 7, *Field Measurement of Residual Radiation*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*
- SSFL SOP 9, *Lithologic Logging*
- SSFL SOP 10, *Sample Custody*
- SSFL SOP 11, *Packaging and Shipping Environmental Samples*
- SSFL SOP 12, *Field Equipment Decontamination*
- SSFL SOP 13, *Guide to Handling Investigation Derived Waste*
- SSFL SOP 15, *Photographic Documentation of Field Activities*
- SSFL SOP 16, *Control of Measurement and Test Equipment*

2.3 Discussion

Soil samples will be collected to determine the type(s) and level(s) of contamination in surface soil. All SOPs will be on hand with the field sampling team.

3.0 General Responsibilities

Field Team Leader - The field team leader (FTL) is responsible for ensuring that field personnel collect surface soil samples in accordance with the Field Sampling Plan (FSP) Addendum and this SOP.

Site Geologist – The person responsible for collecting and logging the soil samples.

Site Health and Safety Technician– The person who will use field screening instruments to monitor all field activities for (VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation's (SAIC's) Certified Health Physicist (CHP).

Surface Soil Sampling	SSFL SOP 2 Revision: 1 Date: December 2012

4.0 Required Equipment at the Sampling Location

- Site-specific plans (including Field Sampling Plan [FSP Addendum, health and safety plan, and all SOPs)
- Insulated cooler
- Plastic zip-top bags
- Personal protective clothing and equipment
- Slide hammer with stainless steel sleeves
- EnCore samplers and T-handle
- Securely-sealed bags of ice
- Plastic sheeting
- Appropriate sample containers
- Global Positioning System (GPS) unit
- Trash Bags
- Monitoring/screening instruments required by health and safety plan
- Nitrile or other appropriate protective gloves
- Field logbook
- Indelible blue or black ink pen and/or marker
- Decontamination supplies
- Paper towels or Kim wipes
- Disposable plastic spoons and knives
- Sample labels
- Teflon squares and sleeve end caps
- 2-way radios

5.0 Procedures

5.1 Preparation

The following steps must be followed when preparing for sample collection:

1. Review site-specific health and safety plan and project plans (FSP Addendum) before initiating sampling activity.

2. Don the appropriate personal protective clothing as specified in the site-specific health and safety plan.

3. Locate sampling location(s) in accordance with FSP Addendum and document pertinent information in the field logbook (SSFL SOP 8). Confirm GPS coordinates of each location (SSFL SOP 1).

4. Use clean (decontaminated) sampling tools to obtain sample material from each specified sample location.

5. Carefully remove stones, vegetation, debris, etc. from the ground surface in the sampling location area. Clear the sample location using a new and/or appropriately decontaminated tool as described to expose a fresh sampling surface.

6. The Site Health and Safety Technician will perform contaminant screening using hand-held instruments at each sample location before sampling and for each sample collected (SSFL SOPs 6 and 7*).* The most recent spoils materials will be segregated to minimize cross-contamination. The breathing zone and excavated materials will be monitored continuously. If levels are detected above health and safety plan action levels (HASP page 8), work will be temporarily discontinued, the Department of Energy (DOE), The Boeing Company (Boeing), and the California Department of Toxic Substances Control (DTSC) will be contacted. Site work will not resume at that location until further guidance is provided by DOE or Boeing. Contact information is in the health and safety plan.

The following steps must be taken to prepare the slide hammer for sampling.

1. Obtain the slide hammer, sample tube with the shoe, and stainless steel liners.

2. Remove the sample tube shoe and insert a clean liner. Screw the shoe back onto the sample tube.

3. Screw the assembled sample tube onto the slide hammer.

4. After sampling, remove the sampling liner from the sample tube for sample collection.

5. Decontaminate the sample tube and shoe.

5.2 Sample Collection

The following general steps must be followed when collecting surface soil samples.

1. Wear new, clean gloves during handling of all sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected, to avoid cross-contamination.

2. Document the sampling process by recording applicable information in the designated field logbook. Document any and all deviations from the SOPs and the sampling plan in the field logbook and include rationale for changes. See SSFL SOP 8 for guidance on entering information into field log books.

3. Because sampling for volatile organic compounds (VOCs) is not anticipated for most surface soil locations, the procedure for non-VOC sample collection is described first (Section 5.2.1). When sampling of VOCs is required (i.e., identified in Table 1 of FSP Addendum, observed stained soil, petroleum odor, or elevated photoionization detector [PID] reading) at any location, collect the required sample aliquot for volatile analyses (Section 5.2.2) first, as well as any other samples that may be degraded by aeration, followed by the collection of samples for other analyses.

5.2.1 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analyses

The requirements for collecting samples of surface soil for nonvolatile organic or inorganic analyses are as follows:

1. Use a clean slide hammer and decontaminated stainless steel sleeves to drive a sample from 0 to 6-inches bgs. Several sleeves may be required from this interval to collect the amount of surface soil to satisfy the analytical protocol (refer to Table 1 in the FSP Addendum. Quickly screen the open end of the sleeve and the sample borehole for VOCs and radioactivity (SSFL SOPs 6 and 7).

2. Collect subsamples for chromium (Cr^{3+}) and/or hexavalent chrome (Cr^{6+}) and/or pH from the center of the stainless steel sleeve into a glass jar using a disposable plastic spoon or knife. Ensure that the soil that was in contact with the sleeve is not collected in the jar.

3. Prior to capping the sleeve for the remaining non-volatile parameters, place a Teflon® cover sheet over each end of the sample. Secure the respective cap on each sample container immediately after collection. Label the sample sleeve with “top” and “bottom” designations.

4. Wipe the sample containers with a clean paper towel or Kimwipe to remove any residual soil from the sample container surface.

5. Fill out the sample label with the appropriate sample information (i.e., sample identification, date/time of sample collection, requested analyses) per FSP Addendum Table 1 and attach to sample sleeve.

6. Place sample containers in individual zip-top plastic bags and seal the bags. Place baggies onto ice in an insulated cooler to maintain at 4°C (±2°C).

7. Decontaminate all non-disposable sampling equipment in accordance with SSFL SOP 12.

5.2.2 Method for Collecting Soil Samples for Volatile Organic Compound Analysis

The following text contains the recommended SW-846 Test Method 5035 procedure for sampling and field preservation of soil samples for VOC analysis, which includes the EnCore™ Sampler Method for low-level VOC analyses.

1. When collecting grab sampling for VOC analysis, it is necessary to minimize sample disturbance and consequently minimize analyte loss.

2. Wear new, clean gloves during handling of all sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected, to avoid cross-contamination.

3. VOC samples shall be collected first as grab samples. After clearing sample site, use a clean slide hammer and decontaminated stainless steel sleeves to drive a sample from 0 to 6-inches bgs. Once the sleeve is retrieved, quickly

screen the open end of the sleeve and the sample borehole for VOCs and radioactivity (SSFL SOPs 6 and 7). EnCore samplers will be used to collect subsamples for the required analytical protocol (e.g., VOCs/1,4-dioxane and/or total petroleum hydrocarbons-gasoline range organics [TPH-GRO]). The VOC sample will be collected from the bottom of the 6-inch stainless steel sleeve. Several slide hammer samples (stainless steel liners) may be required at the location to obtain the required sample volume for all VOC samples.

4. Remove the EnCore sampler and cap from package and attach T-handle to sampler body. Ensure that the sampler is locked into the T-Handle before sampling.

5. Push the sampler into the freshly-exposed soil in the bottom of the sampler sleeve until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

6. Extract the sampler and wipe the sampler sides with a clean paper towel or Kimwipe so that the sampler cap can be tightly attached.

7. While still locked into the T-handle, push the sampler cap on the head of the sampler with a twisting motion to secure it to the sampler body.

8. Remove the sampler from the T-handle and rotate the sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.

9. Repeat procedure for each of the remaining samplers.

10. When collecting soil samples using the EnCore Sampler method, collection of soil for moisture content analysis is required. Results of the moisture analysis are used to adjust “wet” concentration results to “dry” concentrations to meet analytical method requirements. The moisture sample will be collected in a separate 4 oz. glass jar. Following EnCore sample collection (, fill one 4 oz. jar with soil from bottom of a stainless steel sleeve for moisture analysis using a disposable plastic spoon or knife.

11. Any remaining soil may be used for the non-volatile analyses (Section 5.3).

12. Complete the sample labels by filling in the appropriate information (.., sample identification, date and time of sample collection, and requested analyses [per FSP Addendum]) and secure the label to the container.

13. Store samples at 4°C (±2°C) until samples are delivered to the FTL or sample coordinator (per SOP 10) for sample packing and shipment (per SOP 11) to the designated analytical laboratory. Encore samplers must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

14. Decontaminate all non-disposable sampling equipment in accordance with SSFL SOP 12.

Note: A water trip blank will be included with sample coolers containing VOC samples.

5.2.3 DPT Procedure for Surface Soil Collection

Collection of surface soil samples with the Direct Push Technology (DPT) is allowed when hard soil conditions prevent collection of soil via slide hammer. Refer to SOP 4, Section 5.4 for procedures.

6.0 Restrictions/Limitations

Before conducting the soil sampling at each location, underground utilities and structures must be demarcated on the ground surface. In addition, archeological and cultural resources as well as Native American cultural concerns must be cleared. A subcontractor will be used to locate and mark the utility lines. The selected sampling location shall be a safe distance from the demarcated utility. In some cases, records regarding utility locations may not exist.

Also, as presented in Section 5.2.2 of this SOP, when grab sampling for VOC analysis or other compound(s) that may be compromised by aeration, it is necessary to minimize sample disturbance and consequently minimize analyte loss. The representativeness of a VOC grab sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

U.S. Department of Energy. 1996. Hazardous Waste Remedial Actions Program. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2. September.

__________. Hazardous Waste Remedial Actions Program. *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R1. September 1996 or current revision.

U. S. Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Updates I, II, IIA, IIB, III, and IIIA, June 1997). Method 5035 (***Note***: § 6.2.1.8 of this method says samples stored in EnCore™ samplers shall be analyzed within 48 hours or transferred to soil sample vials in the laboratory within 48 hours): December 1996, Revision O, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

SSFL Phase 3 Chain of Custody

CDM Smith
DateShipped:
CarrierName:
AirbillNo:

Contact Name:
Contact Phone:

COC No:
Cooler #:
Lab:
Lab Phone:
Lab Address

Sample	Date/ Time	Matrix	Preserv.	Type/No of Containers	Turn Around Time	Metals 6010 and 6020	Mercury 7471 (Soil)	Mercury 7470 (Water)	Fluoride 300.0/9056	SVOC 8270	TIC 8270	PAHs 8270 SIM	1,4 Dioxane 8270 SIM	Dioxins 1613	PCBs/PCTs 8082	Perchlorate 314.0/331	Perchlorate Confirm 6850/6860	pH 9045 (Soil)	pH 9040 (Water)	Hex Cr 7196/7199	Herbicides 8151	Pesticides 8081	VOCs 8260	1,4 Dioxane 8260 SIM	TPH-GRO 8015	TPH-EFH 8015	Glycols 8015	Alcohols 8015	Terphenyls 8015	Nitrates 300.0/9056	Energetics 8330	Cyanide 9012	Formaldehyde 8315	NDMA 1625	Organotin	Methyl Mercury 1630	Other Analysis/Notes

Special Instructions:	**Sampler:**

Relinquished by	Date	Time	Received by	Date	Time	Relinquished by	Date	Time	Received by	Date	Time

Subsurface Soil Sampling With Hand Auger	SSFL SOP 3 Revision: 1 Date: December 2012

Prepared:	J. Sobol	**Technical Review:**	C. Werden
QA Review:	J. Oxford	**Approved and Issued:**	12/13/2012 *Signature/Date*

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to define the techniques and requirements for collecting shallow subsurface soil samples for environmental characterization purposes from the unconsolidated subsurface. The sampling techniques discussed in this SOP involve use of hand augers at the Santa Susana Field Laboratory (SSFL) site.

2.0 Background

2.1 Definitions

Slide Hammer- A drive tool is used to drive and retract a 6-inch long and approximately 2-inches in diameter, thin-walled stainless steel sleeve.

Hand Auger - A stainless steel cylinder (bucket) approximately 3 to 4 inches (in) in diameter and 1 foot (ft) in length, open at both ends with the bottom edge designed to advance perpendicular to the ground surface with a twisting motion into unconsolidated subsurface material to obtain a soil sample. The auger has a T-shaped handle (fixed or ratchet used for manual operation) attached to the top of the bucket by extendable stainless steel rods.

EnCore® Sampler- A disposable plastic sampling device, typically with a capacity of 5 grams, used to obtain undisturbed, unconsolidated material samples (e.g., soil) for laboratory analyses. The sampler is inserted into a metal T-handle and the open end of the sampler pushed directly into the soil.

Subsurface Soil - The unconsolidated, or non-lithified, material that exists deeper than approximately 6 inches below the ground surface (bgs).

Unconsolidated Zone - A layer of non-lithified earth material (soil) that has no mineral cement or matrix binding its grains.

2.2 Associated Procedures

- SSFL SOP 1*, Procedures for Locating and Clearing Phase 3 Samples*
- SSFL SOP 6, *Field Measurement of Total Organic Vapors*
- SSFL SOP 7, *Field Measurement of Residual Radiation*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*
- SFSL SOP 9, *Lithologic Logging*
- SSFL SOP 10, *Sample Custody*
- SSFL SOP 11, *Packaging and Shipping Environmental Samples*
- SSFL SOP 12, *Field Equipment Decontamination*
- SSFL SOP 13, *Guide to Handling Investigation Derived Waste*
- SSFL SOP 15, *Photographic Documentation of Field Activities*
- SSFL SOP 16, *Control of Measurement and Test Equipment*

2.3 Discussion

Subsurface soil samples, or those taken from depths below 6 inches, are collected using a hand auger to depths up to 10 ft bgs or bedrock refusal. Subsurface samples in locations inaccessible to a DPT rig will be collected by drilling using hand augers to the sample depth, and then sample collection from the auger hole using a slide hammer and stainless steel sleeves. The maximum depth of hand auger samples is typically 10 feet bgs. All sample locations and sample materials will be screened by the Site Health and Safety Technician using hand-help instruments. In addition, all SOPs will be on hand with the field sampling team.

3.0 General Responsibilities

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect subsurface soil samples in accordance with the Field Sampling Plan (FSP) Addendum and this SOP.

Site Geologist – The person responsible for collecting and logging the soil sample.

Site Health and Safety Technician– The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation's (SAIC's) Certified Health Physicist (CHP).

4.0 Required Equipment at the Sampling Location

4.1 General

- Site-specific plans (e.g., FSP Addendum, health and safety) including all SOPs
- Field logbook
- Appropriate sample containers
- EnCore samplers and T-handle
- Insulated cooler(s)
- Bags of ice
- Nitrile or appropriate gloves
- 2-way radios
- Indelible black ink pens and markers
- Slide hammer with stainless steel sleeves
- Global Positioning System (GPS) unit
- Monitoring/screening equipment per health and safety plan
- Personal protective clothing and equipment
- Plastic sheeting
- Plastic zip-top bags
- Trash bags
- Disposable plastic spoons or knives
- Sample labels
- Decontamination supplies
- Kimwipes or paper towels
- Teflon squares and sleeve end caps

4.2 Manual (Hand) Auger Sampling

- T-handle
- Hand auger: extensions, bucket-, or tube-type auger as required by the site-specific plans
- Extension rods
- Wrench(es), pliers

5.0 Procedures

5.1 Preparation

1. Review site-specific health and safety plan and FSP Addendum before initiating sampling activity.

2. Don the appropriate personal protective clothing as indicated in the site-specific health and safety plan.

3. Locate sampling location(s) in accordance with FSP Addendum and document pertinent information in the appropriate field logbook (SSFL SOP 8). Confirm GPS coordinates of each location (SSFL SOP 1).

4. Use clean, (decontaminated) sampling tools per SSFL SOP 12 used to obtain sample material from each specified sample location.

5. Carefully remove stones, vegetation, debris, etc. from the ground surface in the sampling location area. Clear the sample location using a new and/or appropriately decontaminated tool as described to expose a fresh sampling surface.

6. The Site Health and Safety Technician will perform contaminant screening using hand-held instruments at each sample location before sampling and for each sample collected (SSFL SOPs 6 and 7*).* The most recent spoils materials will be segregated to minimize cross-contamination. The breathing zone and excavated materials will be monitored continuously. If levels are detected above health and safety plan action levels (HASP page 8), work will be temporarily discontinued. If radiation levels exceed two-times (2X) background levels (HASP page 8), the Department of Energy

(DOE),The Boeing Company (Boeing), and the California Department of Toxic Substances Control (DTSC) will be contacted. Site work will not resume at that location until further guidance is provided by DOE or Boeing. Contact information is in the health and safety plan.

The following steps must be taken to prepare the slide hammer for sampling.

1. Obtain the slide hammer, sample tube with the shoe and stainless steel liners.
2. Remove the sample tube shoe and insert a clean liner. Screw the shoe back onto the sample tube.
3. Screw the assembled sample tube onto the slide hammer.
4. After sampling remove the sampling liner from the sample tube for sample collection.
5. Decontaminate the sample tube and shoe.

5.2 Sample Collection

The following general steps must be followed when collecting all subsurface soil samples. Soil samples will be preserved by placing the samples on ice.

1. Wear clean gloves during handling of sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected, to avoid cross-contamination.
2. VOC samples or samples that may be degraded by aeration will be collected first and with the least disturbance possible to minimize sample disturbance and consequently minimize analyte loss.
3. While advancing the hand auger, the subsurface lithology shall be described according to SSFL SOP 9.
4. Specific sampling devices are identified in the FSP Addendum and will be recorded in the field logbook. Document any and all deviations from the SOPs and the sampling plan in the field logbook and include rationale for changes. See SSFL SOP 8 for guidance on entering information into field log books.
5. Care must be taken to prevent cross-contamination and misidentification of samples as described in subsequent subsections of this SOP.

5.2.1 Manual (Hand) Auger Sampling Using a Slide Hammer

The following steps must be followed when collecting environmental soil samples using a hand-auger and slide hammer:

1. Auger to the depth required for sampling, per the FSP Addendum. Place cuttings on plastic sheeting. If possible, lay out the cuttings in stratigraphic order.
2. During auger advancement and sample collection, record observations made of the geologic features of the soil or sediments per SSFL SOP 9.
3. Stop advancing the auger when the top of the specified sampling depth has been reached. Remove the auger from the hole and set aside for future decontamination (see line item 11 below).
4. Obtain the subsurface soil sample by driving the sample sleeve through the specified sample interval with the slide hammer. Remove the stainless steel liner from the slide hammer and quickly screen the sleeve for VOCs and radiation (SSFL SOPs 6 and 7).
5. Immediately subsample for VOCs (if required) by FSP Addendum Table 1, observe stained soil, petroleum odor, or elevated PID reading) by pushing the EnCore sampler into the soil in the bottom end of the sampling sleeve. See

Section 5.2.2.

6. Decontaminate the auger bucket, sample tube and shoe, and repeat the preceding steps for sample collection from deeper depths as required by the FSP Addendum.

7. When sampling is complete, place cuttings back into the borehole, and top off with bentonite pellets, and hydrate as necessary to bring former borehole to ground surface. Place plastic sheeting and gloves in garbage bag and transfer decontamination water to storage container as specified SSFL SOP 13.

8. Decontaminate all equipment between each sample according to SSFL SOP 12.

9. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the sample location.

5.2.2 Method for Collecting Soil Samples for Volatile Organic Compound Analysis

The following text contains the recommended SW-846 Test Method 5035 procedure for sampling and field preservation of soil samples for volatile organic compound (VOC analyses, which includes the EnCore® Sampler Method for low-level VOC analyses.

1. When collecting grab sampling for VOC analysis, it is necessary to minimize sample disturbance and consequently minimize analyte loss.

2. Wear new, clean gloves during handling of sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected, to avoid cross-contamination.

3. VOC samples shall be collected first as grab samples. EnCore samplers will be used to collect subsamples for the required analytical protocol (e.g., VOCs1,4-dioxane and total petroleum hydrocarbon-gasoline range organics [TPH-GRO) from sample sleeves collected at depth. The VOC samples will be collected from the bottom of the 6-inch stainless steel sleeve. Several slide hammer samples (stainless steel liners) may be required to obtain the required sample volume for all VOC analyses.

4. Once the sleeve is retrieved, quickly screen the open end of the sleeve and the sample borehole for VOCs and radioactivity (SSFL SOPs 6 and 7).

5. Remove EnCore sampler and cap from package and attach T-handle to sampler body. Ensure that the sampler is locked into the T-handle before sampling.

6. Push the sampler into the freshly-exposed soil in the bottom of the sampler sleeve until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

7. Extract the sampler and wipe the sampler sides with a clean paper towel or Kimwipe so that the sampler cap can be tightly attached.

8. While still locked into the T-handle, push the sampler cap on the head of the sampler with a twisting motion to secure it to the sampler body.

9. Remove the sampler from the T-handle and rotate the sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.

10. Repeat procedures for each of the remaining Encore Samplers.

11. When collecting soil samples using the EnCore Sampler Method, collection of soil for moisture content analysis is required. Results of the moisture analysis are used to adjust “wet” concentration results to “dry” concentrations to meet analytical

method requirements. The moisture sample will be collected in a separate 4 oz. glass jar. If only VOCs/1,4-dioxane are to be sampled at a location, after collecting the required number of EnCore samples, fill one 4 oz. jar with soil from bottom of stainless steel sleeve for moisture analysis using a disposable plastic spoon or knife.

12. Remaining material in the sleeve may be used for any required non-volatile analyses (Section 5.2.3)

13. Complete the sample labels by filling in the appropriate information (i.e., sample identification, date and time of sample collection, and requested analyses per FSP Addendum Table 1 and securing the label to the container.

14. Store samples at 4°C (±2°C) until samples are delivered to the FTL or sample coordinator (per SOP 10) for sample packing and shipment (per SOP 11) to the designated analytical laboratory. EnCore samplers must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

15. Decontaminate all non-disposable sampling equipment in accordance with SSFL SOP 12.

Note: A water trip blank will be included with sample coolers containing VOC samples.

5.2.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analyses

The requirements for collecting samples of subsurface soil for nonvolatile organic or inorganic analyses are as follows:

1. Use a clean slide hammer and decontaminated stainless steel sleeves to drive a sample through a 6-inch interval at the prescribed depth. Several sleeves may be required from this interval to collect the necessary amount of subsurface soil to satisfy the analytical protocol (refer to sampling rationale Table 1 in the FSP Addendum). Quickly screen the open end of the sleeve and the sample borehole for VOCs and radioactivity (SSFL SOPs 6 and 7).

2. Collect sub samples for hexavalent chrome (Cr^{6+}) and or pHfrom the center of the stainless steel sleeve into a glass jar using a disposable plastic spoon or knife. Ensure that the soil that was in contact with the sleeve is not collected in the jar.

3. Prior to capping the sleeve for the remaining non-volatile parameters, place a Teflon® cover sheet over each end of the sample. Secure the respective cap on each sample container immediately after collection.

4.

5. Label the sample sleeve with “top” and “bottom” designations.

6. Wipe the sample containers with a clean paper towel or Kimwipe to remove any residual soil from the sample container surface.

7. Fill out the sample label with the appropriate sample information (e.g., sample identification, date/time of sample collection, requested analyses per FSP Addendum Table 1 and attach to sample sleeve.

8. Place sample containers in individual zip-top plastic bags and seal the bags. Place baggies onto ice in an insulated cooler to maintain at 4°C (±2°C) until samples are delivered to the FTL or sample coordinator (per SOP 10) for sample packing and shipment (per SOP 11) to the designated analytical laboratory.

9. Decontaminate all non-disposable sampling equipment in accordance with SSFL SOP 12.

6.0 Restrictions/Limitations

Before conducting the soil sampling at each location, underground utilities and structures must be demarcated on the ground surface. In addition, archeological and cultural resources as well as Native American cultural concerns must be cleared. A subcontractor will be used to locate and mark the utility lines. The selected sampling location shall be a safe distance from the demarcated utility. In some cases, records regarding utility locations may not exist.

Also, when grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and analyte loss. The representativeness of a VOC grab sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

American Society for Testing and Materials. 1999. *Standard Test Method for Penetration Test and Split Barrel Sampling of Soils*. Standard Method D1586-99.

__________.2000. *Standard Test Method for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes*. Standard Method D1587-00.

U. S. Department of Energy.1996. Hazardous Waste Remedial Actions Program. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2. September.

__________. Hazardous Waste Remedial Actions Program. *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R1. September 1996 or current revision.

U.S. Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Updates I, II, IIA, IIB, III, and IIIA, June 1997). Method 5035 (***Note***: § 6.2.1.8 of this method says samples stored in EnCore™ samplers shall be analyzed within 48 hours or transferred to soil sample vials in the laboratory within 48 hours): December 1996, Revision O, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

Direct Push Technology (DPT) Sampling	SSFL SOP 4 Revision: 1 Date: November 2012

Prepared:	P. Hartman	**Technical Review:**	C. Werden
QA Review:	C. Sayler	**Approved and Issued:**	[signature] 11/20/2012 *Signature/Date*

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to define the requirements for collecting subsurface soil using direct push technology (DPT) sampling techniques at the Santa Susana Field Laboratory (SSFL) site.

2.0 Background

2.1 Definitions

DPT rig- A hydraulically-operated hammer device installed on the back of a van, pickup truck, or skid used to advance a hollow-stem rod and sampler into the subsurface soil (up to bedrock refusal) to collect subsurface soil samples.

Probe-Driven Sampler - A sampling device used to collect soil samples with a DPT rig. The sampler is 5-foot steel core barrel with an acetate liner to contain the sample.

Extension Rod - Stainless steel rod used to remove stop-pin and drive-point assembly.

Drive Point - Solid steel retractable point used to advance sample collection device to the required sample depth.

Probe Rod - Hollow, flush-threaded, steel rod similar to a drill rod.

Stop-Pin - Steel plug that threads into the top of the drive cap to hold the drive point in place during advancement of the probe rods.

Drive Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when advancing the probe rods with the hydraulic hammer.

Pull Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when retracting the probe rods.

2.2 Associated Procedures

- SSFL SOP 1, *Procedures for Locating and Clearing Phase 3 Samples*
- SSFL SOP 6, *Field Measurement of Total Organic Vapors*
- SSFL SOP 7, *Field Measurement of Residual Radiation*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*
- SSFL SOP 9, *Lithologic Logging*
- SSFL SOP 10, *Sample Custody*
- SSFL SOP 11, *Packaging and Shipping Environmental Samples*
- SSFL SOP 12, *Field Equipment Decontamination*
- SSFL SOP 13, *Guide to Handling Investigation Derived Waste*
- SSFL SOP 15, *Photographic Documentation of Field Activities*
- SSFL SOP 16, *Control of Measurement and Test Equipment*

2.3 Discussion

The DPT rig consists of a hydraulically-operated hammer device mounted on the back of a van, a pickup truck or a skid. The DPT system hydraulically advances small-diameter hollow rods and sampler to the desired sampling depth. The specific type of DPT sampling equipment for soil sample collection is then deployed. This work will be performed by a subcontractor with CDM Smith oversight.

The use of DPT technology is a cost-effective alternative to using conventional drilling techniques for collecting subsurface soil samples given the site-specific geologic and hydrogeologic conditions and sample requirements.

Advantages of using the DPT system include:

- Areas usually considered inaccessible by drill rigs because of terrain and vegetation, overhead wires, size constraints, etc., may be accessed with a van or pickup truck-mounted DPT rig.
- Investigation-derived wastes such as soil cuttings and purge water are minimized due to its small diameter rods and its displacement of soil horizontally, not vertically.
- Areas where traditional surface sampling equipment (e.g., Slide Hammer or Hand Auger) cannot penetrate the hard surface, a DPT rig may be used to obtain the sample(s).

In addition, all SOPs will be on hand with the field sampling team.

3.0 General Responsibilities

DPT Subcontractor–Subcontractor retained to perform all DPT drilling activities.

Field Team Leader (FTL)-The FTL is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and the Field Sampling Plan (FSP) Addendum and this SOP.

Site Health and Safety Technician–The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation's (SAIC's) Certified Health Physicist (CHP).

Site Geologist–The person responsible for overseeing sample collecting, recording sampling information and for logging the soil sample.

4.0 Required Equipment at the Sampling Location

General

- Site-specific plans (e.g., FSP Addendum, health and safety plan, and all SSFL SOPs)
- Field logbook
- Appropriate sample containers
- Insulated coolers
- Bags of ice
- Indelible black or blue ink pens and markers
- Plastic zip-top bags
- Nitrile or appropriate gloves
- Personal protective equipment
- Global Positioning System (GPS)
- 2-way radios
- Monitoring/screening instruments required by the health and safety plan
- Plastic sheeting
- Decontamination supplies
- Trash bags
- Sample labels
- Kimwipes or paper towels
- Stainless steel trowel
- EnCore samplers and T-handle
- Plastic spoons or knives

DPT Soil Sampling Equipment

- DPT rig (tracked vehicle, van or truck-mounted) with the following:
  - Probe rods 5-foot [ft]) lengths
  - Extension rods (5-ft) lengths, couplers, and handle
  - Piston stop-pins (two each per rig, minimum)
  - Drive caps and pull caps (two each per rig, minimum)
  - Carbide-tipped drill bit for working in concrete- or asphalt-covered areas

- O-rings
- Assembled soil samplers (5-foot long continuous split-barrel with acetate sleeve)

5.0 Procedures

Subsurface and surface soil sampling procedures are discussed below. CDM Smith will oversee DPT operations and handle the samples. It is the DPT subcontractor's responsibility to operate the DPT equipment.

1. Review site-specific health and safety plan and FSP Addendum before initiating sampling activity.

2. Don the appropriate personal protective clothing as indicated in the site-specific health and safety plan.

3. Locate sampling location(s) in accordance with FSP Addendum and document pertinent information in the appropriate field logbook (SSFL SOP 8). Confirm GPS coordinates of each location (SSFL SOP 1).

4. Use clean (decontaminated) sampling tools to obtain sample material from each specified sample location.

5. Carefully remove stones, vegetation, debris, etc. from the ground surface in the sampling location area. Clear the sample location using a new and/or appropriately decontaminated tool as described to expose a fresh sampling surface.

6. The Site Health and Safety Technician will perform contaminant screening using hand-held instruments at each sample location before sampling and for each sample collected (SSFL SOPs 6 and 7*).* The most recent spoils materials will be segregated to minimize cross-contamination. The breathing zone and excavated materials will be monitored continuously. If levels are detected above health and safety plan action levels (HASP page 8), work will be temporarily discontinued, the Department of Energy (DOE), The Boeing Company (Boeing), and the California Department of Toxic Substances Control (DTSC) will be contacted. Site work will not resume at that location until further guidance is provided by DOE or Boeing. Contact information is in the health and safety plan.

7. If the sampling site is in an asphalt-covered area, drill a hole using the rotary function and a specially designed (1.5-inch or 2.0-inch diameter) carbide-tipped drill bit. Otherwise, the area needs to be cleared of heavy underbrush and immediate overhead obstructions.

5.1 Subsurface Soil Sampling

Assembly

1. Assemble the sampling device as follows:
   - Screw the cutting shoe to the bottom end of the sample tube, unless using standard probe drive sampler which has a built-in cutting edge.
   - Screw the piston tip onto the piston rod.
   - Screw the drive head onto the top end of the sample tube.
   - Insert the acetate liner into sample tube.
   - Slide the piston rod into the sample tube, leaving the piston tip sticking out of the bottom end of the sample tube.
   - Screw the piston stop-pin onto the top end of the piston rod in a counter-clockwise direction.

2. Attach the assembled sampler onto the leading probe rod.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler.

4. Advance the sampler using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth (see Table 1 in FSP Addendum).

Stop-Pin Removal

5. Move the probe unit back from the top of the probe rods and remove the drive cap.

6. Lower the extension rods into the inside diameter of the probe rods using extension rod couplers to join the extension rods.

7. Attach the extension rod handle to the top extension rod and rotate the handle clockwise until the leading extension rod is screwed into the piston stop-pin. Continue to rotate the handle clockwise until the stop-pin disengages from the drive head.

8. Remove the extension rods and attached piston stop-pin from the probe rods.

Continuous Sampling

Direct push sampling will be performed with a dual–tube sampling method using a specialty continuous coring sampler (4-ft with inner acetate sleeve). The sampler is driven in 4-ft intervals slightly ahead of stainless steel casing, and retrieved after each interval push as described above.

9. Replace the drive cap.

10. Advance the probe rods using the hydraulic hammer the length of the sample tube (4 ft).

11. Replace the drive cap with the pull cap and retract the probe rod(s). Secure the rod(s) with a clamp or by hand during removal so they do not fall back down the resulting borehole.

12. Detach the sampler from the lead probe rod, verifying that sufficient sample volume was recovered (Note: The length of sample contained within the tube is approximately equal to the length of exposed piston rod).

13. Disassemble the sampler. Remove the acetate liner. Use cutting tool to cut length of liner (2 times) to remove an approximate 1-inch strip to access the sample material.

14. The Site Health and Safety Technician will perform contaminant screening along the length of the acetate liner using hand-held instruments (SSFL SOPs 6 and 7*).* The most recent spoils materials will be segregated to minimize cross-contamination. The breathing zone and excavated materials will be monitored continuously. If levels are detected above health and safety plan action levels (HASP page 8), work will be temporarily discontinued and DOE, Boeing, and DTSC will be contacted. Site work will not resume at that location until further guidance is provided by DOE or Boeing. Contact information is in the health and safety plan.

15. If the PID indicates elevated VOCs or there is staining or discoloration evident, immediately collect VOC/1,4-dioxane and total petroleum hydrocarbons-gasoline range organics (TPH-GRO) samples using EnCore samplers per Section 5.2.

16. If there is no indication of contamination, collect the required number of Encore samplers for TPH-GRO analysis (if required by Table 1 of the FSP Addendum), then collect soil from the target interval as stated in the FSP Addendum Table 1, and place into glass jars using disposable plastic spoons or knives.

17. Wipe sealed jars with a clean Kimwipe or paper towel.

18. Fill out the sample label with the appropriate sample information (e.g., sample identification, date/time of sample collection, requested analyses per Table 1 of FSP Addendum) and attach to sample container.

19. Place sample containers in zip-top plastic bags and seal the bags. Place samples in a cooler with ice to maintain a temperature of 4°C (±2°C).

20. Proceed with additional sample depth collection as required by the FSP Addendum.

21. When sampling is complete, place cuttings back into the borehole and top off with bentonite pellets, as necessary, to bring former borehole to ground surface. Place plastic sheeting and gloves in garbage bag and transfer decontamination water to storage container as specified in SSFL SOP 13.

22. Decontaminate the sampling equipment according to SSFL SOP 12.

23. Complete the field logbook entry (SSFL SOP 8), field sample data sheet for each sample, and lithologic log (SSFL SOP 9), being sure to record all relevant information before leaving the sample location.

24. Demobilize from sample location.

5.2 Method for Collecting Soil Samples for Volatile Organic Compound Analysis

The following text contains the recommended SW-846 Test Method 5035 procedure for sampling of soil samples for volatile organic compound (VOC) analysis, which includes the EnCore™ Sampler Method for low-level VOC analyses.

1. When collecting grab samples for VOC analysis, it is necessary to minimize sample disturbance and minimize analyte loss.

2. Wear new, clean gloves while handling sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected to avoid cross-contamination.

3. The VOC samples shall be collected first as grab samples. EnCore samplers will be used to collect subsamples for the required analytical protocol (e.g., VOCs/1,4-dioxane and/or TPH-GRO). The VOC samples will be collected directly from the appropriate interval within the acetate sleeve – in a section of staining, odor, and/or PID response, or at the target depth per the FSP Addendum Table 1. Additional DPT cores may be necessary for all analyses.

4. Once the sleeve is retrieved, quickly screen the open end of the sleeve and the sample borehole for VOCs and radioactivity (SSFL SOPs 6 and 7).

5. Remove EnCore sampler and cap from package and attach T-handle to sampler body. Ensure the sampler is locked into the T-handle before sampling.

6. Push the sampler into the freshly-exposed sample in the acetate liner until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

7. Extract the sampler and wipe the sampler sides with a clean paper towel or Kimwipe so that the sampler cap can be tightly attached.

8. While locked into the T-handle, push the sampler cap on the head of the sampler with a twisting motion to secure it to the sampler body.

9. Remove the sampler from the T-handle and rotate the sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.

10. **Repeat** procedure for each of the remaining samplers.

11. When collecting soil samples using the EnCore Sampler Method, collection of soil for moisture content analysis is required. Results of the moisture analysis are used to adjust “wet” concentration results to “dry” concentrations to meet analytical method requirements. The moisture sample will be collected in a separate 4 ounce (oz.) glass jar. If only VOCs/1,4-dioxane are to be sampled at a location, following EnCore sample collection, fill one 4 oz. jar with soil from the liner in close proximity to the VOC samples for moisture analysis using a disposable plastic spoon or knife.

12. Complete the sample labels by filling in the appropriate information (i.e., sample identification, date and time of sample

collection, requested analyses [per Table 1 of FSP Addendum]) and securing the label to the container.

13. Store samples at 4°C (±2°C) until samples are delivered to the FTL or sample coordinator (per SSFL SOP 10) for sample packing and shipment (per SSFL SOP 11) to the designated analytical laboratory. Encore samplers must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

14. Decontaminate all non-disposable sampling equipment in accordance with SSFL SOP 12.

Note: A water trip blank will be included with sample coolers containing VOC samples.

5.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analyses

The requirements for collecting samples of subsurface soil for nonvolatile organic or inorganic analyses are as follows:

1. Wear new, clean gloves while handling sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected to avoid cross-contamination.

2. The non-VOC samples will be collected after VOCs; a separate sampler with acetate liner will likely be needed. Collect the sample from a 6-inch section from the appropriate interval within the acetate sleeve – in a section of staining, odor, or PID response, or at the target depth per the FSP Addendum. Before sampling, quickly screen the length of the acetate liner for VOCs and radioactivity (SSFL SOPs 6 and 7).

3. Using a decontaminated stainless steel or plastic spoon or trowel, scoop soil from the acetate liner (from the 6-inch target interval) into the required glass sample jars.

4. Wipe the sample containers with a clean paper towel or Kimwipe to remove any residual soil from the sample container surface.

5. Fill out the sample label with the appropriate sample information (e.g., sample identification, date/time of sample collection, requested analyses per FSP Addendum Table 1, and attach to sample jar(s).

6. Place sample containers in individual zip-top plastic bags and seal the bags. Place baggies onto ice in an insulated cooler to maintain at 4°C (±2°C) until samples are delivered to the FTL or sample coordinator (per SSFL SOP10) for sample packing and shipment (per SSFL SOP 11) to the designated analytical laboratory.

7. Decontaminate all non-disposable sampling equipment in accordance with SSFL SOP 12.

5.4 Method for Surface Soil Collection by Direct Push Technology

Collection of surface soil samples with the Direct Push Technology (DPT) is allowed when hard soil conditions prevent collection via slide hammer. The following text contains the recommended procedure for sampling

Follow steps 1 thru 7 under SOP 4 paragraph 5.0 (Procedures) prior to sampling.

Assembly

1. Assemble the sampling device (sampler) as follows:
   - Screw the cutting shoe to the bottom end of the sampler, unless using standard probe drive sampler which has a built-in cutting edge.
   - Screw the piston tip onto the piston rod.
   - Screw the drive head onto the top end of the sampler.
   - Insert a stainless steel sleeve (5 ¾ inches x 1 ¾ inches each) into the sampler.
   - Slide the piston rod into the sample tube, leaving the piston tip sticking out of the bottom end of the sampler.
   - Screw the piston stop-pin onto the top end of the piston rod in a counter-clockwise direction.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler.

4. Advance the sampler using the hydraulic hammer 6-inches into the surface to collect the sample and retrieve the sampler (step 5).

Stop-Pin Removal

5. Move the probe unit back from the top of the probe rods and remove the drive cap.

6. Lower the extension rods into the inside diameter of the probe rods using extension rod couplers to join the extension rods.

7. Attach the extension rod handle to the top extension rod and rotate the handle clockwise until the leading extension rod is screwed into the piston stop-pin. Continue to rotate the handle clockwise until the stop-pin disengages from the drive head.

8. Remove the extension rods and attached piston stop-pin from the probe rods.

9. Disassemble the sampler. Remove the stainless steel sleeve representing the surface sample.

10. The Site Health and Safety Technician will perform contaminant screening at the top and bottom of the stainless steel sleeve using hand-held instruments (SSFL SOPs 6 and 7*)*. The breathing zone and extracted materials will be monitored continuously. If levels are detected above health and safety plan action levels (HASP page 8), work will be temporarily discontinued, the DOE, Boeing, and DTSC will be contacted. Site work will not resume at that location until further guidance is provided by DOE or Boeing. Contact information is in the health and safety plan.

11. If the PID indicates elevated VOCs or there is staining or discoloration evident, immediately collect VOC/1,4-dioxane and total petroleum hydrocarbons-gasoline range organics (TPH-GRO) samples from the bottom of the stainless steel sleeve using EnCore samplers per SOP 2, Section 5.2.2

12. If there is no indication of contamination, collect the required number of Encore samplers for TPH-GRO analysis (if required by Table 1 of the FSP Addendum), immediately cap both ends of the stainless steel ring with Teflon and caps. Label the top and bottom of the sample.

13. Wipe the capped sleeve with a clean Kimwipe or paper towel.

14. Fill out the sample label with the appropriate sample information (e.g., sample identification, date/time of sample collection, requested analyses per Table 1 of FSP Addendum) and attach to sample container.

15. Place sample containers in zip-top plastic bags and seal the bags. Place samples in a cooler with ice to maintain a temperature of 4°C (±2°C). Store samples at 4°C (±2°C) until samples are delivered to the FTL or sample coordinator (per SSFL SOP 10) for sample packing and shipment (per SSFL SOP 11) to the designated analytical laboratory

16. Repeat surface sampling process with steps 1 through 4 if additional volume is needed at the location to address the analytical requirement per Table 1 of the FSP Addendum. Move the sample tool entry point 6 inches away from initial sample point and collect the next sample. Repeat steps 5 through 15 to retrieve and process the sample.

Proceed with additional subsurface sample depth collection per Paragraph 5.1 above as required by the FSP Addendum.

17. When sampling is complete, place cuttings back into the borehole and top off with bentonite pellets, as necessary, to bring former borehole to ground surface. Place plastic sheeting and gloves in garbage bag and transfer decontamination water to storage container as specified in SSFL SOP 13.

18. Decontaminate the sampling equipment according to SSFL SOP 12.

19. Complete the field logbook entry (SSFL SOP 8), field sample data sheet for each sample, and lithologic log (SSFL SOP 9), being sure to record all relevant information before leaving the sample location.

20. Demobilize from sample location.

6.0 Restrictions/Limitations

Before conducting the DPT sampling event, underground utilities and structures must be demarcated on the ground surface. In addition, archeological and cultural resources as well as Native American cultural concerns must be cleared. A subcontractor will be used to locate and mark the utility lines. The selected sampling location shall be a safe distance from the demarcated utility. In some cases, records regarding utility locations may not exist. In any event, a good practice is to slowly push the probe rods the first few feet (rather than hammering) to ensure that no utilities, underground storage tanks, or other subsurface structures are present.

Also, when grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and analyte loss. The representativeness of a VOC grab sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

Geoprobe® Systems. 1991. *The Probe-Drive Soil Sampling System.* September.

Backhoe Trenching/Test Pits for Sample Collection	SSFL SOP 5 Revision: 0 Date: April 2012

Prepared:	J. Sobol	**Technical Review:**	C. Werden
QA Review:	J. Oxford	**Approved and Issued:**	[signature] 4/6/2012 *Signature/Date*

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to define the techniques and requirements for collecting soil samples and for characterizing the type of soil and debris from the unconsolidated subsurface zone using a backhoe at the Santa Susana Field Laboratory (SSFL) site. Two types of trenching activities will be conducted (1) trenching to observe debris and collect samples and (2) test pits to characterize subsurface soil, identify geophysical anomalies, and to determine if debris is present or not. In most cases, test pits are not expected to be sampled. General sampling techniques discussed in this SOP include use of sampling with a slide hammer and stainless steel sleeves from the side walls of the trench or from the backhoe bucket. Samples for will be contained in the EnCore® sampler or in the sleeves.

2.0 Background

2.1 Definitions

Backhoe - An excavator to which a shovel bucket is attached to a hinged boom and is drawn backward to excavate materials.

EnCore® Sampler- A single use plastic sampling device, typically with a capacity of 5 grams, used to obtain undisturbed, unconsolidated material samples (e.g., soil) for laboratory analyses. The sampler is inserted into a metal T-handle and open end of the sampler is pushed directly into the soil.

Grab Sample - A discrete portion or aliquot of material taken from a specific location at a given point in time.

Slide Hammer- A drive tool is used to drive and retract a 6-inch long thin-walled stainless steel sampler.

Subsurface Soil - The unconsolidated, or non-lithified, material that exists deeper than 6 inches below the ground surface (bgs).

Unconsolidated Zone - A layer of non-lithified earth material (soil) that has no mineral cement or matrix binding its grains.

2.2 Associated Procedures

- SSFL SOP 1, *Procedures for Locating and Clearing Phase 3 Samples*
- SSFL SOP 6, *Field Measurement of Total Organic Vapors*
- SSFL SOP 7, *Field Measurement of Residual Radiation*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*
- SSFL SOP 9, *Lithologic Logging*
- SSFL SOP 10, *Sample Custody*
- SSFL SOP 11, *Packaging and Shipping Environmental Samples*
- SSFL SOP 12, *Field Equipment Decontamination*
- SSFL SOP 13, *Guide to Handling Investigation Derived Waste*
- SSFL SOP 14, *Geophysical Survey*
- SSFL SOP 15, *Photographic Documentation of Field Activities*
- SSFL SOP 16, *Control of Measurement and Test Equipment*

2.3 Discussion

Trenches and test pits will be excavated using a backhoe for visual observations of buried debris material (particularly that observed through geophysics) and to access the subsurface for soil sampling. A backhoe will also be used to provide access to subsurface materials, including building debris and rubble that a DPT rig cannot penetrate, or where test pits are required to observe geophysical anomalies. Soil samples will be collected from trenches (and possibly test pits) either at depths specified in Field Sampling Plan (FSP) Addendum or at locations with observed discoloration, staining, petroleum odors, or elevated photoionization detector (PID) readings.

3.0 General Responsibilities

Excavation Subcontractor – All backhoe trenching and test pits will be performed by a subcontractor.

Field Team Leader-The field team leader (FTL) is responsible for ensuring that field personnel collect trenching and test pit subsurface soil samples in accordance with this SOP and the FSP Addendum.

Site Geologist–The person responsible for overseeing sample collecting, recording sampling information and for logging the soil sample.

Site Health and Safety Technician–The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation's (SAIC's) Certified Health Physicist (CHP).

4.0 Required Equipment

4.1 General

- Site-specific plans (e.g., FSP Addendum, health and safety)
- Field logbook
- Indelible black ink pens and markers
- Clear, waterproof tape
- Appropriate sample containers
- Bags of ice
- Sample labels
- Chain of custody forms
- Insulated cooler(s)
- Global Positioning System (GPS) unit
- 2-way radios
- Trash Bags
- Monitoring/screening instruments as required by the health and safety plan
- Plastic zip-top bags
- Personal protective clothing
- Plastic sheeting
- Nitrile or appropriate gloves
- Slide hammer and stainless steel sleeves
- EnCore sampler and T-handle
- Decontamination supplies
- Kimwipes or paper towels
- Custody seals
- Teflon squares and sleeve end caps
- 300-ft tape measure
- Disposable plastic spoons and knives

4.2 Backhoe Sampling

- Backhoe with a sufficient length boom to extend to 10+ft bgs
- Samples collected to a depth of 5 feet (ft) will be collected from the side walls of the trench/test pit using a slide hammer and stainless steel sleeves, as long as the side wall can be safely accessed at that depth. In some instances, safely reaching the sidewall at 5 ft bgs may not be possible and the bucket of the backhoe will be used to access soil material.
- Samples collected deeper than 5 ft bgs will be collected directly from the backhoe bucket using a slide hammer and stainless steel sleeves of soil material contained in the bucket that is not in contact with the bucket walls.
- VOC samples will be subsampled from the stainless steel sleeve using an EnCore sampling device.

Note: Personnel will not enter an excavation of any depth.

5.0 Procedures

5.1 Preparation

1. Review site-specific health and safety plan and FSP Addendum before initiating sampling activity.

2. Don the appropriate personal protective clothing as indicated in the site-specific health and safety plan.

3. Locate sampling point(s) in accordance with project documents (e.g., FSP Addendum) and document pertinent information in the appropriate field logbook (SSFL SOP 8). Confirm GPS coordinates of each location (SSFL SOP 1).

4. The depth of sampling will be verified with a tape measure.

5. Use clean (decontaminated) sampling tools to obtain sample material from each specified sample location.

6. The Site Health and Safety Technician will perform contaminant screening using hand-held instruments at each sample location before sampling and for each sample collected (SSFL SOPs 6 and 7*).* The most recent spoils materials will be segregated to minimize cross-contamination. The breathing zone and excavated materials will be monitored continuously. If levels are detected above health and safety plan action levels (HASP page 8), work will be temporarily discontinued. If radiation levels exceed two-times (2X) background levels (HASP page 8), the Department of Energy (DOE), The Boeing Company (Boeing), and the California Department of Toxic Substances Control (DTSC) will be contacted. Site work will not resume at that location until further guidance is provided by DOE or Boeing. Contact information is in the health and safety plan.

The following steps must be taken to prepare the slide hammer for sampling.

1. Obtain the slide hammer, sample tube with the shoe and stainless steel liners.

2. Remove the sample tube shoe and insert a clean liner. Screw the shoe back onto the sample tube.

3. Screw the assembled sample tube onto the slide hammer.

4. After sampling remove the sampling liner from the sample tube for sample collection.

5. Decontaminate the sample tube and shoe (SSFL SOP 12).

5.2 Sample Collection

The following general steps must be followed when collecting all subsurface soil samples. Refer to Section 5.3 of this SOP for additional guidance on field sampling and preservation methods.

1. Wear clean gloves during handling of all sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected, to avoid cross-contamination.

2. VOC samples or samples that may be degraded by aeration shall be collected first and with the least disturbance possible and consequently minimize analyte loss.

3. Record all sampling information, including environmental and/or soil and debris characterization, and sample depth in the field logbook (SSFL SOP 8) and on lithologic log forms as specified in the FSP Addendum. Describe sample lithology according to SSFL SOP 9. Document with photographs, as appropriate, per SSFL SOP 15.

4. Record specific sampling devices identified in the FSP Addendum in the field logbook. Document any and all deviations from the SOPs and the sampling plan in the field logbook and include rationale for changes. See SSFL SOP 8 for guidance on entering information into field log books.

5. Care must be taken to prevent cross-contamination and misidentification of samples as described in subsequent subsections of this SOP.

5.2.1 Backhoe Sampling

Note: Steps 2, 7, and 8 describe activities to be performed by a licensed heavy equipment operator, not CDM Smith personnel.

Backhoe Trenching/Test Pits for Sample Collection

SSFL SOP 5
Revision: 0
Date: April 2012

The following steps must be followed when collecting environmental samples using a backhoe:

1. Verify that the parts of the backhoe that will come in contact with the soil to be sampled have been decontaminated per SSFL SOP 12 before excavation begins.
2. Excavate to the depth specified in the FSP Addendum.
3. Visually inspect and log the soil profile in accordance with SSFL SOP 9, and record the types of debris (if present) within the trench. Screen for VOCs and radiation in accordance with SSFL SOPs 6 and 7.
4. If it can be performed safely, collect soil samples from the sidewalls of backhoe trench/test pit at the specified depth using a slide hammer sampler and stainless steel sleeves. If the sample will be deeper than 5 feet bgs, the sample will be collected from the backhoe bucket (from the middle of the bucket and untouched by the bucket) using a slide hammer and stainless steel sleeves. Personnel will not enter excavations under any circumstances.
5. Soil sample depths and sample volumes to address required analyses are presented in Table 1 of FSP Addendum.
6. When sample collection has been completed in the trench, backfill the trench with the excavated material. Compact the surface of the former excavation/test pit with backhoe bucket and/or tires. Spread any extra excavation spoils on the ground surface in the vicinity of the trench and test pit.
7. Once the trench has been backfilled, decontaminate backhoe in accordance to SSFL SOP 12.
8. Place sampling PPE in a plastic trash bag and transfer decontamination fluids to a storage container per SSFL SOP13.
9. Complete the field logbook entries (SSFL SOP 8), being sure to record all relevant information before leaving the site.

5.2.2 Sampling With a Slide Hammer

Follow the steps below when collecting environmental soil samples using a slide hammer:

1. Obtain the sample by driving the slide hammer into side wall of test pit (depths above 5 ft bgs) or into sample material in backhoe bucket (depths below 5 ft). Retract hammer and remove the stainless steel liner from the tube. Collect and handle the sample in accordance with 5.2.3 and 5.2.4.
2. Proceed with additional sample collection as identified for the sampling location in Table 1 of FSP Addendum.
3. Decontaminate all equipment according to SSFL SOP 12 between each sample.
4. Complete the field logbook (SSFL SOP 8) entry and lithologic log form (SSFL SOP 9), being sure to record all relevant information before leaving the site.

5.2.3 Method for Collecting Soil Samples for Volatile Organic Compound Analysis

The following text contains the recommended SW-846 Test Methods 5035 procedure for sampling and field preservation of soil samples for volatile organic compound (VOC) analysis, which includes the EnCore® Sampler Method for low-level VOC analyses. Equipment requirements in addition to the equipment specified in Section 4.0 of this SOP for each method are indicated at the beginning of each subsection.

1. When collecting grab sampling for VOC analysis, it is necessary to minimize sample disturbance and consequently minimize analyte loss.
2. Wear new, clean gloves during handling of all sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected, to avoid cross-contamination.
3. VOC samples shall be collected first as grab samples. After clearing sample site, use a clean slide hammer and decontaminated stainless steel sleeves to drive and retract the sample sleeve into and from the trench wall. EnCore samplers will be used to collect subsamples for the required analytical protocol (e.g., VOCs, 1,4-dioxane, and total

petroleum hydrocarbons-gasoline range organics [TPH-GRO]) . The VOC sample will be collected from the bottom 6-inch interval of the stainless steel sleeve. Collection of VOC sample may require several slide hammer samples (stainless steel liners) to obtain the required sample volume.)

4. Once the sleeve is retrieved, quickly screen the open end of the sleeve and the sample borehole for VOCs and radioactivity (SSFL SOPs 6 and 7).

5. Remove EnCore sampler and cap from package and attach T-handle to sampler body. Ensure that the sampler is locked into the T-handle before sampling.

6. Push the sampler into the freshly-exposed sampling from the bottom of the sampler sleeve until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

7. Extract the sampler and wipe the sampler sides with a clean paper towel or Kimwipe so that the sampler cap can be tightly attached.

8. While still locked into the T-handle, push the sampler cap on the head of the sampler with a twisting motion to secure it to the sampler body.

9. Remove the sampler from the T-handle and rotate the sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.

10. Repeat procedure for each of the remaining samplers.

11. When collecting soil samples using the EnCore Sampler Method, collection of soil for moisture content analysis is required. Results of the moisture analysis are used to adjust “wet” concentration results to “dry” concentrations to meet analytical method requirements. The moisture sample will be collected in a separate 4 ounce (oz.) glass jar. After collecting the required number of EnCore samples (typically five), fill one 4 oz. jar with soil from bottom of stainless steel sleeve for moisture analysis using a disposable plastic spoon or knife.

12. After VOC and moisture sampling, discard the remaining soil within the stainless steel sleeves to the plastic sheets or back to the borehole, if completed.

13. Complete the sample labels by filling in the appropriate information (e.g., sample identification, date and time of sample collection, and requested analyses [per Table 1 of FSP Addendum]) and securing the label to the container.

14. Store samples at 4°C (±2°C) until samples are delivered to the designated analytical laboratory. Determine sample holding times with the appropriate analytical laboratory. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

15. Pack all samples per SSFL SOP 11 and/or laboratory requirements. Include properly completed documentation and affix signed and dated custody seals to the cooler lid. See SSFL SOP 10 for guidance on sample custody procedures.

16. Decontaminate all non-disposable sampling equipment in accordance with SSFL SOP 12.

Note: A water trip blank will be included with sample coolers containing VOC samples.

5.2.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analyses

The requirements for collecting samples of subsurface soil for nonvolatile organic or inorganic analyses are as follows:

1. Use a clean slide hammer and decontaminated stainless steel sleeves to drive the sampler into the trench wall (above 5 ft. bgs) or soil in the backhoe bucket (depths below 5 ft bgs). Several sleeves may be required from this interval to collect the necessary amount of subsurface soil to satisfy the analytical protocol (refer to sampling rationale table in Table 1 of FSP Addendum). Quickly screen the open end of the sleeve and the sample borehole for VOCs and radioactivity (SSFL

SOPs 6 and 7).

2. Collect sub samples for chromium (Cr^{3+}) and/or hexavalent chrome (Cr^{6+}) and/or pH from the center of the stainless steel sleeve into a glass jar using a disposable plastic spoon or knife. Ensure that the soil that was in contact with the sleeve is not collected in the jar.

3. Prior to capping the sleeve for the remaining non-volatile parameters, place a Teflon® cover sheets over each end of the sample. Secure the respective cap on each sample container immediately after collection.

4. Label the sample sleeve with “top” and “bottom” designations.

5. Wipe the sample containers with a clean paper towel or Kimwipe to remove any residual soil from the sample container surface.

6. Fill out the sample label with the appropriate sample information (e.g., sample identification, date/time of sample collection, requested analyses per FSP Addendum Table 1) and attach to sample sleeve.

7. Place sample containers in individual zip-top plastic bags and seal the bags. Place baggies onto ice in an insulated cooler to maintain at 4°C (±2°C).

8. Decontaminate all non-disposable sampling equipment in accordance with SSFL SOP 12.

5.3 Sample Packing and Shipment

1. Store samples at 4°C (±2°C) until samples are delivered to the designated analytical laboratory.

2. Pack all samples per SSFL SOP 11 and/or laboratory requirements. Include properly completed documentation and affix signed and dated custody seals to the cooler lid. See SSFL SOP 10 for guidance on sample custody procedures.

6.0 Restrictions/Limitations

Extreme care must be taken when working around open excavations. Maintain safe distances from trench sidewalls to avoid injury should a sidewall of the trench sloughing back into the excavation. Personnel will not enter any trenches/test pits at any time.

Also, when grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and consequently minimize analyte loss. The representativeness of a VOC grab sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

American Society for Testing and Materials (ASTM).2000. *Standard Test Method for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes*. Standard Method D1587-00.

U. S. Department of Energy.1996. Hazardous Waste Remedial Actions Program. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2. September.

__________. Hazardous Waste Remedial Actions Program.*Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R1. September 1996 or current revision.

U.S. Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Updates I, II, IIA, IIB, III, and IIIA, June 1997). Method 5035 (***Note***: § 6.2.1.8 of this method says samples stored in EnCore™ samplers shall be analyzed within 48 hours or transferred to soil sample vials in the laboratory within 48 hours): December 1996, Revision O, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

Field Measurement of Total Organic Vapors	SSFL SOP 6 Revision: 1 Date: June 2012

Prepared:	J. Sobol	**Technical Review:**	C. Werden
QA Review:	J. Oxford	**Approved and Issued:**	[signature] 6/12/2012 *Signature/Date*

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to define the techniques and the requirements for the measurement of total organic vapors in the breathing zone and in field samples at the Santa Susana Field Laboratory (SSFL) site.

2.0 Background

2.1 Definitions

Photoionization detector (PID) – A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the photoionization of organic vapors.

2.2 Associated Procedures

- SSFL SOP 1, *Procedures for Locating and Clearing Phase 3 Samples*
- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology (DPT) Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*
- SSFL SOP 9, *Lithologic Logging*

2.3 Discussion

The measurement of organic vapors is a required step during numerous field activities. The measurement of organic vapors is being performed for two purposes. The first objective is to address health and safety concerns to determine if the breathing zone in a work area is acceptable or if personal protective equipment such as a respirator or a supplied air device is necessary for field personnel. The second objective is to assist in the identification of contamination and possible sample intervals for field judgment decisions on where samples for volatile organic compounds (VOCs) should be collected.

Samples to be screened include excavation spoils, hand auger cuttings, sample material from an acetate liner or stainless steel sleeve, as well as in situ screening. All sample material will be screened for the presence of volatile organic chemicals.

2.3.1 PID Operation

The PID is preferred when the compounds of interest are aromatics or halogenated VOCs. The PID ionizes the sampled vapors using an ultraviolet lamp that emits light energy at a specific electron voltage (eV - labeled on the lamp). Every organic compound has a specific ionization potential (measured in electron volts). The energy emitted by the lamp must be higher than the ionization potential of the compound for the compound to become ionized and emit an electron. If the ionization potential of the compound is higher than the eV of the lamp, there will be no response on the instrument. Therefore, the ionization potential of the known or suspected compounds shall be checked against the energy of the ultraviolet lamp (i.e., typically 10.2 eV, 10.7 eV, or 11.7 eV) to verify that the energy provided by the lamp is greater. Consult the manufacturer’s manual to determine the appropriate ultraviolent lamp to be used and obtain the appropriate correction factors for known or suspected contaminants.

Water vapor associated with samples can interfere with the PID detector and cause the instrument to stop responding. This can be caused by using the PID on a rainy day or when sampling headspace samples that have been in the sun. If moisture is suspected, use the calibration gas to check the instrument response by inserting the gas as a check sample, not by recalibrating. If the response is lower than the gas level, then dry out the probe and the ionization chamber before reusing the instrument.

Do not insert the sampling probe directly into soil samples or dusty areas, as the instrument vacuum will pull dirt into the ionization chamber. Under particularly dirty or dusty conditions, the lamp may become covered with a layer of dust. If dirty conditions are encountered, or if the instrument response seems to have decreased, then clean the lamp. The instrument comes with an inlet filter that can be used to control dust and moisture. The instrument manual provides instructions on removing the instrument cover to access the lamp, and cleaning the screen in the ionization chamber as well as the surface of the lamp. In addition, the ultraviolet lamp in the PID is sensitive to shock, especially when using the higher eV lamps. Therefore, handle and transport the equipment carefully.

Finally, make sure the battery is fully charged before use. The average battery life is on the order of 8 to 12 hours of continuous use. Also, make sure the unit is allowed to equilibrate to ambient outdoor temperatures.

3.0 Responsibilities

Field Team Leader– The field team leader (FTL) is responsible for ensuring that field personnel conduct field activities in accordance with this SOP and the Field Sampling Plan (FSP) Addendum.

Site Geologist – The person responsible for overseeing soil sample collection, documentation, and lithologic logging.

Sampling Personnel – Field team members responsible for physically collecting samples and decontamination of equipment.

Site Health and Safety Technician – The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers.

4.0 Required Equipment

- Site-specific plans (i.e., FSP Addendum)
- Health and safety plan
- Field logbook
- Photoionization detector with appropriate lamp rating
- Calibration gases in a range appropriate for the expected use
- Pint- to quart-sized zip-top plastic bags
- Waterproof black ink pen
- Personal protective clothing and equipment

5.0 Procedures

5.1 Direct Reading Measurement

1. Charge the instrument overnight.

2. Connect the measurement probe to the instrument (if necessary), turn on the probe, and make necessary operational checks (e.g., battery check) as outlined in the manufacturer's manual.

3. Calibrate the instrument using appropriate calibration gas and following the applicable manufacturer's manual.

4. Make sure the instrument is reading zero and all function and range switches are set appropriately.

5. Prior to the start of sampling, a background reading shall be made at the surface of the location to be sampled. Read the total organic vapor concentration in parts per million (ppm) from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.

6. While sampling, hold the tip of the probe within the samplers breathing zone, and read the total organic vapor concentration in parts per million (ppm) from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.

7. For samples collected using a slide hammer, measurements will be made from the bottom end of the sampling liner or

from auger cuttings placed into a plastic bag. Record the measurements in the field logbook or on appropriate field form.

8. For subsurface samples, once the acetate sleeve is split open, the entire cut surface of the core will be screened with the PID. Based on the measurements, the soil in the sleeve will be sampled in accordance with SSFL SOP 4. If measurements are made on any soil sample above background, headspace measurements will be made in accordance with the next section to determine the maximum VOC reading achieved. Record all measurements in the field logbook or on the appropriate field form.

5.2 Headspace Measurement

1. Once on and operational, calibrate the instrument (as needed) following the appropriate manufacturer's manual.

2. Make sure the instrument is reading zero and all function and range switches are set appropriately.

3. Fill one zip-top plastic bag approximately one-half full of the sample to be measured. Quickly seal the bag minimizing volume of air in bag.

4. Allow headspace to develop for approximately 10 minutes. It is generally preferable to knead the bag for 10 to 15 seconds to break apart the sample and maximize sample surface area.

Note: When the ambient temperature is below 0 degrees Celsius (32 degrees Fahrenheit), perform the headspace development and subsequent measurement within a heated vehicle or building.

5. Quickly puncture the bag wall and insert the probe, wrapping the bag wall around the probe stem to minimize loss of vapors. Insert the instrument probe to a point approximately one-half of the headspace depth. Do not let the probe contact the soil, and ensure the probe does not get plugged by the plastic during puncturing. If using a PID and there is condensation on the inside of the bag, only leave the probe in the jar or bag long enough to obtain a reading. Remove the probe and allow fresh air to flow through the instrument to avoid excess water vapor build-up.

6. Read the total organic vapor concentration in ppm from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.

7. Immediately record the reading in the field logbook or on the appropriate field form.

6.0 Restrictions/Limitations

The PID provides quantitative measurement of total organic vapors, but generally is not compound-specific. The typical measurement range of the PID is 0 to 2,000 ppm. In addition, the instrument will not detect/measure VOCs with an associated ionization potential (in eVs) above the rating of the lamp, so lamp rating is critical to monitoring for selected VOCs.

Note: The presence of methane will cause erratic PID measurements.

7.0 References

No references were used in development of this SOP.

Field Measurement of Residual Radiation	SSFL SOP 7 Revision: 0 Date: April 2012

Prepared:	J. Sobol	**Technical Review:**	D. Chambers, C. Zakowski
QA Review:	J. Oxford	**Approved and Issued:**	[signature] 4/6/2012 *Signature/Date*

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to define the techniques and the requirements for the detection of residual radiation in the breathing zone and in soil at the Santa Susana Field Laboratory (SSFL). The Department of Energy (DOE) surface contamination criteria are also defined herein with footnotes which reflect acceptable approaches for demonstrating achievement of such criteria.

2.0 Background

2.1 Definitions

MicroR detector–A portable, hand-held scintillation counter that measures gamma radiation in air. Although measurements are typically made about one meter above the ground surface, such sodium iodide scintillation detectors can also be used qualitatively measure radiation emitted from soil samples and soil cores. In this instance the detectors will be held about 0.5 to 1 inch above the samples. When used to evaluate soil sample activity, measurements will be compared against background count rates for the same material taken in a consistent manner (i.e., 0.5 to 1 inch above soil material). Background is established by taking measurements in an area that produced count rates that are relatively low and uniform.

Dual Phosphor Alpha Beta Scintillator–A portable, hand-held field radiation survey instrument that may detect alpha and beta emissions and, with proper calibration, can measure gamma emissions.

2.2 Associated Procedures

- SSFL SOP 1, *Procedures for Locating and Clearing Phase 3 Samples*
- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology (DPT)Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*
- SSFL SOP 9, *Lithologic Logging*

2.3 Discussion

Radiation screening of soil samples and ambient air is necessary because of the prior use of Area IV for nuclear research. Radiation measurement data will be used pursuant to health and safety monitoring to determine if radiation exposure rates for field personnel in a work area is acceptable or if additional personal protective equipment or exposure limitations are necessary for field personnel. In addition to health and safety monitoring, radiation monitoring will be used to screen surface and subsurface soil and sediment samples for levels above background. Background readings are important because they provide a point of departure for elevated readings.

Two types of instruments will be used to measure residual radiation: the MicroR gamma detector and Dual Phosphor alpha/beta detector.

2.3.1 MicroR Operation

The MicroR detector is a scintillation meter used to measure low levels of gamma radiation. Although sodium iodide detectors can be set up to operate as a single channel analyzer, thereby reporting a specific radionuclide, the instruments for this project will be set up to report all gamma emissions, irrespective of radionuclide. The instrument has a speaker which provides an audible measure of the radiation emitted, as an audible click. The rate at which the clicks occur allows real-time monitoring of the strength of the radiation sources. Readout is generally in terms of microroentgens per hour (μR/hr).These instruments are energy dependant, commonly over-responding by as much as a factor of 8 or more for lower energy gamma emissions and under-responding by about 20 percent for cobalt-60.

2.3.2 Dual Phosphor Alpha Beta Scintillation Operation

For this project a Model 43-89 Dual Phosphor alpha/beta scintillation detector will be primarily used to detect alpha/beta emissions.

Although these detectors can also detect alpha emissions, alpha particles generally have a range of about an inch or less in air with relatively few able to penetrate the detector window such that they are counted. Alpha/beta detectors are generally calibrated to the gamma emissions of cesium-137 with instrument response being energy dependent. Beta efficiency also varies with energy such that 4 pi efficiency ranges from about 13 percent to 50 percent for beta particles with average energies of 50 and 550 kiloelectron volts (keV), respectively. If the instrument has a speaker, the pulses also give an audible click. The readout can be displayed in multiple different units (e.g., roentgens per hour (R/hr), milliroentgens per hour (mR/hr), rem per hour (rem/hr), millirem per hour (mrem/hr), and counts per minute (cpm)) when the control switch is in the “Ratemeter” position. Alpha/beta probes including, the pancake type, are commonly used with a variety of different hand held scalers/ratemeters for contamination measurements. Given the energy dependence of the instruments and their variable response to different types of radiation, radiation control/health physics personnel should be consulted if any activity exceeding instrument background is detected.

3.0 Responsibilities

Field Team Leader–The field team leader (FTL) is responsible for ensuring that field personnel conduct field activities in accordance with this SOP and the Field Sampling Plan [FSP] Addendum.

Site Health and Safety Technician–The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation’s (SAIC’s) Certified Health Physicist (CHP).

Certified Health Physicist–The person who oversee radiation survey activities, confirm background levels, and provide field direction when background levels are exceeded per the Health and Safety Plan.

4.0 Required Equipment

- Ludlum Model 19 or Model 192 Micro R Detector (or equivalent)
- Ludlum Model 43-89 Dual Phosphor Alpha/Beta Scintillation Detector (or equivalent)[1]
- Site-specific plans (i.e., FSP Addendum)
- Health and safety plan (HASP)
- Field logbook
- Waterproof black ink pen
- Personal protective clothing and equipment

5.0 Determination of Radiation Background

As set forth in the HASP (health and safety plan monitoring and action levels) and for the selection of soil sample intervals (SSFL SOP 2, 3, 4, and 5), background radiation levels for various media will be established prior to soil sampling. Because radiation levels vary based on composition of the media and multimedia that will effect radiation measurements at the site, the following background radiation levels will be developed initially at the site.

- Unconsolidated soil
- Bedrock

[1] Ludlum Model 2360, Ludlum Model 26

- Concrete slab/rubble
- Asphalt

Additional media may be added as it is encountered in the field. Background of these media will be established using the following procedure.

1. Ensure instrument is functioning properly and check source readings are acceptable per requirements of this SOP.
2. Demarcate background radiation SAMPLE AREA for each media with wooden Stakes. The Area IV background survey location established by EPA will serve as a starting point. Minimum requirements for the background SAMPLE AREA is as follows:
   a. 20 square feet of surface area
   b. made up of 80% intended media
   c. area does not consist of imported fill or debris
   d. area is absent of contamination (identified by visually inspection, and from EPA HSA, EPA gamma surveys, EPA soil sample results, RFI and Co-located Chemical data)
3. Obtain and Record GPS coordinates of SAMPLE AREA
4. Using appropriate radiation instrument (Micro R Meter Model 19/192, Dual Phosphor Alpha/Beta Detector Model 43-89) collect 10 gamma, alpha, and beta measurement about 0.5 to 1 inch above the media, equally distribute throughout the SAMPLE AREA. Each measurement will be at least 1 minute in duration.
5. Record the ten radiation measurements in log book.
6. Following collection of background measurements, ensure instrument is functioning properly and check source readings are acceptable per this SOP.
7. Discuss readings with site Certified Health Physicist (SAIC) for review and receive approval of background radiation level.
8. The Certified Health Physicist will provide approved background radiation level for the media to DOE and CDM Smith. This will include background level, mean, and standard deviation.
9. CDM Smith FTL will record the Certified Health Physicist's recommendations and discuss the background action level with all field personnel as part of safety briefings.
10. Following establishment of, and periodical renewal of background readings throughout project, background radiation levels will be discussed during project meetings and daily tailgate safety meetings.

6.0 Procedures

6.1 MicroR Detector

Background Gamma Scan

1. Prepare the instrument and check batteries. The meter needle should move to area on scale marked battery, indicating the batteries are good.
2. Measure background radiation level away from sample and source area. Measure the background radiation for approximately 60 seconds to allow determination of the range and relative mean background exposure rates and write

down the readings. Note that background commonly ranges from about 5 to 20 µR/h, but can be higher as a result of increased elevation or higher concentrations of naturally occurring radioactive materials. In addition, it is often necessary to reevaluate background for different areas within the site. Upon completion of background determination, verify proper instrument operation using a National Institute of Standards and Technology (NIST) traceable check source to confirm proper instrument operation.

Surface Soil Gamma Scan

1. Beginning at the highest scale, proceed to lower scales until a reading is encountered. Set the instrument selector switch to the most sensitive range of the instrument. Holding the probe approximately 0.5 to 1 inch from the surface soil sample, move the detector slowly (about 1 inch per second) over the core and/or sample being evaluated with the detector parallel to the length of the core.

2. Do not let the probe touch anything and try to maintain a constant distance.

3. Areas that register more than background levels may be considered contaminated and a health physicist should be consulted.

6.2 Dual Phosphor Alpha/Beta Scintillation Detector

Background Alpha/Beta Scan

1. Prepare the instrument and check batteries. The meter needle should move to area on scale marked battery, indicating the batteries are good. Measure background radiation level away from source area.

2. Measure the background radiation at 0.5 to 1 inch above the media for ten 2-minute counting periods and record each of the readings. Background commonly ranges from about 5 to 20 µR/h but can be higher as a result of increased elevation or higher concentrations of naturally occurring radioactive materials.

3. Obtain ten 1-minute source activity measurements using a NIST traceable source of the appropriate beta energy.

4. Upon completion of the background and source efficiency counts, input the associated data into the spreadsheet provided to determine parameter limits (e.g., background and source efficiency within 20 percent of the mean). Subsequent counts of both background and source efficiency should be performed daily before instrument use, at the end of each duty day, and any time that instrument operation is questionable.

Soil Sample Beta Scan

1. Set the instrument selector switch to the most sensitive range of the instrument.

2. Holding the probe approximately 0.5 to 1 inch from the sample and move the probe slowly (about 1 inch per second). (***Note***: Alpha emissions are reliably detectable only with the detector as close as practicable to the item being surveyed. In addition, it should be noted that variation in beta background can preclude the ability to detect alpha emissions at levels prescribed in 10 CFR 835, Appendix D.)

3. Do not let the probe touch anything and try to maintain a constant distance.

4. Areas that register more than background level may be considered contaminated and a health physicist should be consulted.

Surface Contamination Scanning

In addition, every sample, piece of equipment, and container of material used at the site and/or that leaves the site will be surveyed and results will be used to document that residual total and removable surface contamination are compliant with criteria contained in Appendix D, 10 CFR 835. I

Surface Contamination Values[1] in dpm/100 cm² Radionuclide	Removable [2, 4]	Total (Fixed + Removable) [2, 3]
U-nat, U-235, U-238, and associated decay products	1,000[7]	5,000[7]
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above [5]	1,000	5,000
Tritium and STCs [6]	10,000	See Footnote 6

1. The values in this appendix, with the exception noted in footnote 6 below, apply to radioactive contamination deposited on, but not incorporated into the interior or matrix of, the contaminated item. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides apply independently.

2. As used in this table, disintegrations per minute (dpm) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

3. The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) from measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds three times the applicable value.

4. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note—The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

5. This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

6. Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value provided in this appendix is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a “Total” value does not apply. In certain cases, a “Total” value of 10,000 dpm/100 cm^2 may be applicable either to metals, of the types which form insoluble special tritium compounds that have been exposed to tritium; or to bulk materials to which particles of insoluble special tritium compound are fixed to a surface.

7. These limits only apply to the alpha emitters within the respective decay series.

[58 FR 65485, Dec. 14, 1993, as amended at 63 FR 59688, Nov. 4, 1998; 72 FR 31940, June 8, 2007; 74 FR 18116, Apr. 21, 2009]

7.0 Restrictions/Limitations

Micro R and Dual Phosphor detectors are principally used for the detection of presence of radionuclides above background, not measurement devices. They are prone to breaking if the thin entrance window (found on pancake and end-window designs) is punctured. This can easily occur if the window comes in contact with a variety of objects (such as a blade of grass, paper clip, nail, and paint flecks). Once the window is broken the instrument ceases to operate and must, therefore, be returned for repair and calibration.

8.0 References

Integrated Environmental Management, Inc., 1998, *Measuring Radioactivity*

Oak Ridge Institute for Science and Education and Radiation Emergency Assistance Center/Training Site (REAC/TS), 1992, *Using a Typical Geiger-Mueller (GM) Counter to Survey*

Title 10, Code of Federal Regulations, Part 835, Occupational Radiation Protection

DOE Standard Radiological Control, DOE-STD-1098-2008 with change 1 dated May 2009

DOE Order 426.2, Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities, 21 April 2010

DOE Standard 1107-97 with Change 1 dated November 2007, Knowledge, Skills, and Abilities for Key Radiation Protection Positions

Ludlum Measurements, Inc. Operators Manuals for Model 2241 Survey Meter with Model 19/192 Detector

Ludlum Measurements, Inc. Operators Manuals for Model 43-80 Alpha/Beta Scintillator

Field Data Collection Documents, Content, and Control

SSFL SOP 8
Revision: 1
Date: December 2012

Prepared: D. Lange

Technical Review: C. Werden

QA Review: J. Oxford

Approved and Issued: 12/11/2012
Signature/Date

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to set criteria for content entry and form of field logbooks and the SSFL Field Sample Data Sheet (FSDS) used to document field work at the Santa Susana Field Laboratory (SSFL) site. The FSDS is also used for data entry into the Scribe database.

2.0 Background

A permanently bound and consecutively paginated field logbook will be maintained daily by the CDM Smith field team in accordance with the procedures below.

2.1 Discussion

Information recorded in field logbooks includes field team member names, visitors, observations, data, calculations made onsite, date/time, weather, and description of the data collection activity, methods, instruments, and results. Additionally, the logbook must contain deviations from plans, observations of fill, and site features including sketches, maps, or drawings as appropriate. In addition, all SOPs will be on hand with the field sampling team.

2.2 Associated Procedures

- SSFL SOP 1, *Procedures for Locating and Clearing Phase 3 Samples*
- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*
- SSFL SOP 9, *Lithologic Logging*
- SSFL SOP 14, *Geophysical Survey*
- SSFL SOP 15, *Photographic Documentation of Field Activities*
- SSFL SOP 16, *Control of Measurement and Test Equipment*

3.0 General Responsibilities

Field Team Leader (FTL)–The FTL is responsible for ensuring that the format and content of data entries are in accordance with this procedure. The FTL will provide field logbooks and FSDSs to the site geologist who will be responsible for their care and maintenance while in his or her possession.

Site Geologist–The site geologist is responsible for documenting site activities into the logbook and completing a FSDF for each soil sample collected. .

Other Site Personnel–All CDM Smith employees who make entries in field logbooks during onsite activities are required to read this procedure before engaging in this activity. Site personnel will return field logbooks to the FTL at the end of the assignment.

4.0 Required Equipment

- Site-specific plans (Field Sampling Plan [FSP] Addendum, health and safety plan, and all SSFL SOPs)
- Field logbook
- Scribe Version 3.8 (or later)
- Indelible black or blue ink pen
- SSFL Field Sample Data Sheet (FSDS)

5.0 Procedures

5.1 Preparation

In addition to this SOP, site personnel responsible for maintaining logbooks must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation. These procedures should be located at the field office and field vehicle for easy reference.

Field logbooks are bound, with lined and consecutively numbered pages. All markings and notes will be made with indelible black or blue ink pen. All pages must be numbered before initial use of the logbook. Before use in the field, the FTL will title and sequentially number each page of each logbook and set up the table of contents (TOC). Record the following information on the cover of the logbook:

- Field logbook number (if applicable).
- Site name and location.
- Activity (if the logbook is to be activity-specific).
- Start date of entries.
- End date of entries.
- Name of CDM Smith contact and phone number(s) (typically the project manager).

The first few (approximately two) pages of the logbook will be reserved for a TOC. Mark the first page with the heading “Table of Contents” and enter the following:

Table of Contents

Date/Description	Pages
(Start Date)/Reserved for TOC	1-2

The remaining pages of the TOC will also be designated as such with “Table of Contents” written on the top center of each page. The TOC should be completed as activities are completed and before returning the logbook back to the FTL.

5.2 Log Book Requirements

Documentation requirements for logbooks are:

- Record work, observations, quantity of materials, field calculations and drawings, and related information directly in the logbook. If data collection forms are specified by an activity-specific plan, this information does not need to be duplicated in the logbook. However, forms (e.g., SSFL-FSDSs) used to record site information must be referenced in the logbook.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not erase or blot out any entry at any time. Indicate any deletion by a single line through the material to be deleted. Initial and date each deletion. Take care to not obliterate what was written previously.
- Do not remove any pages from the book.

Specific requirements for field logbook entries include:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial and date all changes.
- If authors change within the course of the day, the original author must insert the following:
  Above notes authored by:
  - (Sign name)
  - (Print name)
  - (Date)
- The new author must sign and print his/her name before additional entries are made.
- Draw a diagonal line through the remainder of the final page at the end of the day.

- Record the following information on a daily basis:
  -Date and time
  -Name of individual making entry
  -Names of field team and other persons onsite
  -Description of activity being conducted including station or location (i.e., boring, sampling location number) if appropriate
  -Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction and speed) and other pertinent data
  -Level of personal protection used
  -Serial numbers of instruments
  -Equipment calibration information (initial and ongoing date and time activity)
  -Serial/tracking numbers on documentation (e.g., carrier air bills)

Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded.

A sketch of station location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator.

Other events and observations that should be recorded include:
- Changes in weather that impact field activities.
- Deviations from procedures outlined in any governing documents. Also, record the reason for any noted deviation.
- Problems, downtime, or delays.
- Upgrade or downgrade of personal protection equipment.
- Visitors to the site.

5.3 Field Sample Data Sheets

- An example FSDS that will be use to record the sample details and subsurface conditions is included as Attachment 1 to SOP 8.
- The FSDS will be completed by the Site Geologist and include general from observations of the soil core, cuttings, and sidewalls of trenches and test pits.
- The FSDS is a single page, double-sided form that will be completed in indelible ink.
- All portions of the form will be completed. If any portion is not applicable to the activity being recorded, that portion will be crossed out with a single line and initialed by the Site Geologist.
- The FSDS must be reviewed and signed by another field team member before being copied into a pdf file.
- The pdf file will be transferred to CDM Smith's main database weekly by the sample coordinator. The original of the FSDS will be maintained in a binder at the site office until completion of all field activities.
- Sample description information (sample characteristics, presence of fill, staining, odor, etc.) will be transferred to the electronic database on a weekly basis by the FTL or sample coordinator or his/her designee.
- Copies of the FSDS documents will be included in the data report presenting the findings of the investigation.
- The completed FSDS form will be kept as a quality record in CDM Smith's SSFL project file for period of 10 years as stated in Section 7.9 of the Administrative Order on Consent.

5.4 Scribe Database Requirements

The Scribe database will be used to capture the data from the FSDS and perform the following tasks (at a minimum):
  - Document field sample collection
  - Generate chain of custody forms
  - Track field samples to laboratories
  - Query database and produce reports

- The FSDS information is entered into the field database, Scribe.
- The Scribe data entry is reviewed by another staff.
- The Scribe database is backed up daily off-site to CDM Smith servers. In the event of internet outages, the backups will

be made to an external device such as an external hard-drive, thumb drive or CD/DVD. Once internet service is restored the most current backup will be used and placed on the CDM Smith servers.

- Changes to the finalized FSDS are documented on the FSDS and Scribe.

5.5 Photographs

Photography is restricted at SSFL. All cameras require permits from The Boeing Company (Boeing) to be onsite. Photographs may be taken at the site to visually document field activities and site features, as needed and in accordance with SSFL SOP 15. Digital photographs will be submitted to the electronic project files.

All digital photographs will be documented on a photographic log in the logbook or on a separate form (reference in the logbook). Captions must be added to the file name after the photographs are downloaded. The caption should be a unique identifier – number or date and short description. The photographic log should contain the following information:

- Photograph sequence number
- Description of activity/item shown (e.g., SSFL and sampling activity)
- Date and time
- Direction (if applicable)
- Name of photographer

5.6 Post-Operation

To guard against loss of data as a result of damage or disappearance of logbooks, photocopy or scan completed pages daily and forward to the field or project office weekly (at a minimum). Photocopy or scan other field records (e.g., Field Sample Data Sheets, photographic logs) weekly and upload to CDM Smith servers weekly (at a minimum), or as requested.

At the conclusion of each day, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated and that corrections were made properly (single lines drawn through incorrect information then initialed and dated). Completed logbooks will be returned to the FTL.

6.0 Restrictions/Limitations

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by CDM Smith personnel and their subcontractors. They may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these logbooks should be factual, clear, precise, and non-subjective. Field logbooks, and entries within, are not to be used for personal use.

7.0 References

No references used.

8.0 Attachments

Attachment A – SSFL Phase 3 – Field Sample Data Sheet

SSFL Phase 3 – Field Sample Data Sheet

CDM Smith

FSDS Checked By ______________________

Sample ID ______________________ **Date/Time** ______________________

Matrix (circle one)
Soil Sediment Water

Start Depth ______________________

End Depth ______________________

Depth Units (circle one)
Inches Feet

Check if Composite ☐

Collection Method (circle one)
DPT Slide Hammer Hand Auger/Slide Hammer Trenching Sediment

QC Type (circle one)
N FD FB RB

Parent Sample ID ______________________

Field Geologist ______________________

Sampler ______________________

Analysis

	Parameters	Method	Analyze?
	Metals	EPA 6010	
		EPA 6020	
		EPA 7471 (Soil)	
		EPA 7470 (Water)	
	Fluoride	EPA 300.0/9056	
	SVOCs	EPA 8270	
	TIC	EPA 8270	
	PAHs	EPA 8270 SIM	
	1,4 Dioxane	EPA 8270 SIM	
	Dioxins	EPA 1613	
	PCBs/PCTs	EPA 8082	
	Perchlorate	EPA 314.0/331	
	Perchlorate Confirmation	EPA 6850/6860	
	pH	EPA 9045 (Soil)	
		EPA 9040 (Water)	
	Hexavalent Chromium	EPA 7196/7199	
	Herbicides	EPA 8151	
	Pesticides	EPA 8081	

	Parameters	Method	Analyze?
Encores	VOCs	EPA 8260	
	1,4 Dioxane	EPA 8260 SIM	
	TPH-GRO	EPA 8015	
	TPH-EFH	EPA 8015	
	Glycols	EPA 8015	
	Alcohols	EPA 8015	
	Terphenyls	EPA 8015	
	Nitrates	EPA 300.0/9056	
	Energetics	EPA 8330	
	Cyanide	EPA 9012	
	Formaldehyde	EPA 8315	
	NDMA	EPA 1625	
Sediment	Organotin	NOAA Status and Trends, Krone et al.	
	Methyl Mercury	EPA 1630	

NA – Not Applicable

SSFL Phase 3 – Field Data Sample Sheet (Sample Descriptions)

Soil Classification (circle one)

MAJOR DIVISION			GROUP SYMBOL	LETTER SYMBOL	GROUP NAME
COARSE GRAINED SOILS CONTAINS MORE THAN 50% FINES	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVEL WITH * 5% FINES		GW	Well-graded GRAVEL
				GP	Poorly graded GRAVEL
		GRAVEL WITH BETWEEN 5% AND 15% FINES		GW-GM	Well-graded GRAVEL with silt
				GW-GC	Well-graded GRAVEL with clay
				GP-GM	Poorly graded GRAVEL with silt
				GP-GC	Poorly graded GRAVEL with clay
		GRAVEL WITH ≥ 15% FINES		GM	Silty GRAVEL
				GC	Clayey GRAVEL
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SAND WITH * 5% FINES		SW	Well-graded SAND
				SP	Poorly graded SAND
		SAND WITH BETWEEN 5% AND 15% FINES		SW-SM	Well-graded SAND with silt
				SW-SC	Well-graded SAND with clay
				SP-SM	Poorly graded SAND with silt
				SP-SC	Poorly graded SAND with clay
		SAND WITH ≥ 15% FINES		SM	Silty SAND
				SC	Clayey SAND
FINE GRAINED SOILS CONTAINS MORE THAN 50% FINES	SILT AND CLAY	LIQUID LIMIT LESS THAN 50		ML	Inorganic SILT with low plasticity
				CL	Lean inorganic CLAY with low plasticity
				OL	Organic SILT with low plasticity
		LIQUID LIMIT GREATER THAN 50		MH	Elastic inorganic SILT with moderate to high plasticity
				CH	Fat inorganic CLAY with moderate to high plasticity
				OH	Organic SILT or CLAY with moderate to high plasticity
HIGHLY ORGANIC SOILS				PT	PEAT soils with high organic contents

Fill Material

1. Is Fill Material Present Yes No

2. Percentage Fill (%)____________________

3. Fill Description (circle all that apply)

Asphalt Metal Plastic

Concrete Wood Glass

Igneous/Metamorphic Gravel N/A

Other ____________________

Is Staining Present Yes No

Color ____________________

Odor

1. Odor Strength (circle one)

None Slight Strong

2. Odor Description (circle one)

Organic Petroleum Chemical

N/A Other ____________________

Moisture Condition (circle one)

Dry Moist Wet

PG Signature ____________________ **PG Registration #** ____________________

Additional Comments ____________________

NA – Not Applicable

Lithologic Logging	SSFL SOP 9 Revision: 1 Date: June 2012

Prepared:	D. Lange	**Technical Review:**	C. Werden
QA Review:	J. Oxford	**Approved and Issued:**	6/12/2012 *Signature/Date*

1.0 Objective

This technical standard operating procedure (SOP) governs basic lithologic logging of surface and subsurface soil samples collected during field operations at the Santa Susana Field Laboratory (SSFL) site. The purpose of this SOP is to present a protocol and standardized documentation format for lithologic observations. Protocols for recording basic lithologic data including, but not limited to, soil types (per the Unified Soil Classification System [USCS] classification), presence of fill (and associated deleterious materials), lithologic names, color, moisture, density, contacts, and secondary features such as organic material and fractures.

The goal of this SOP is to have consistent descriptions of the subsurface materials.

2.0 Background

The local geology of SSFL is well characterized; thousands of shallow boreholes and excavations have been completed. Lithologic information about soil, rock, and fill assists in the understanding of subsurface conditions, moisture infiltration, groundwater flow, and potential contaminant migration pathways.

As such, detailed lithologic logs are not necessary. The primary goal of lithologic logging at SSFL is to document the stratigraphic sequence, the presence of fill or native soil, occurrence and type of debris and/or staining, associated PID and radiological screening values, and deviations from the normal or anticipated stratigraphic section.

2.1 Definitions

The following list corresponds to the description sequences outlined in Section 5.2.1. An example lithologic log is included in Attachment A.

Name of Sediment or Rock – In naming unconsolidated sediments, the logger shall describe the grain size, distribution, color, and moisture content, and determine the presence of fill materials. In naming sedimentary rocks (only type of bedrock anticipated at SSFL), the logger shall examine the specimen for mineralogy and use the appropriate rock description.

Color - Color will be determined using the appropriate Munsell color chart (soil or rock) and listing the Munsell number that corresponds to the color. If an unconsolidated material is mottled in color, the ranges in color shall be described. When describing core samples with several individual colors, individual color names shall be listed and an overall best color name shall be given.

Degree of Consolidation – The degree of consolidation refers to how well the material has been indurated. Unconsolidated sediments may be compacted somewhat and should be described as loose, moderately compacted, or strongly compacted. In some cases they may be slightly cemented by caliche and should be described as slightly cemented, moderately cemented, or strongly cemented. Sedimentary rocks are typically indurated, but may vary in the degree of cementation. These rocks should be described as friable, moderately friable, or well indurated. If the logger believes he/she can identify the cementing material, then it shall be included in the description.

Moisture Content – Moisture content refers to the amount of water within the sediment or the matrix. Sedimentary rocks and unconsolidated sediments may have associated moisture within and should be described as dry, moist, or wet.

Evidence of Contamination – The logger should examine the sample/core and note any obvious signs of contamination such as streaking, free product, odor, or discoloration. These observations will be noted in the field book and on the lithologic log, as well as screening measurements from the photoionization detector (PID) and radiation (alpha, beta) probes.

Description of Contacts – The logger will note changes in lithology. These changes may be gradational contacts within sediments or may be sharp contacts such as sediments over rocks. The logger should describe whether the contacts are gradational or sharp, and note the depth below the surface.

Composition – The composition of the rock refers to the mineralogy of the material encountered. The logger should describe the mineralogy, if it can be determined.

2.2 Associated Procedures

- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*

2.3 Discussion

The subsurface sampling techniques used at SSFL (i.e., slide hammer, hand auger, DPT rigs, and trenching) all result in soil/rock being brought to the surface for description and logging. The soil boring, core retrieval, and lithologic logging will be conducted under the guidance of a California professional geologist or engineer. An important aspect of soil sampling is the identification and differentiation of native soil/rock from fill material. To help in this task, it is important to use the USCS classification scheme, and uniform and consistent descriptions. Soil and rock descriptions will be consistent with ASTM D2488-09a (Standard Practice for Description and Identification of Soils – Visual Manual Procedure). This SOP also provides a sequence for recording information on a standardized log form to make descriptions as uniform and consistent as possible. All SOPs will be in the possession of the field crew during drilling.

3.0 General Responsibilities

Field Team Leader (FTL) – The FTL is responsible for maintaining logbooks and qualified field staff.

Site Geologist – Individual responsible for describing and logging of all soil cuttings/samples and all rock per this SOP. A California professional geologist or engineer is required to lead this project work.

4.0 Required Equipment

The description of subsurface lithologies requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used by the lithologic logger but does not include equipment such as drill rigs, PID, sampling equipment, and personal protective equipment. The following is a general list of equipment that may be used:

- Field logbook and lithologic log form
- Clipboard
- Munsell color chart for soil
- Munsell color chart for rock
- Dilute (10 percent) hydrochloric acid, as desired
- Waterproof pens
- 10x magnifying hand lens
- Knife or cutting tool
- Zip-top baggies
- Reference field charts, as desired

5.0 Procedures

5.1 Office

- Obtain field logbook and lithologic log forms
- Coordinate schedules/actions with FTL
- Obtain necessary field equipment (see above)
- Review field support documents (i.e., Field Sampling Plan [FSP] Addendum, health and safety plan)
- Review applicable geologic references such as historic lithologic logs from the site and/or geologic maps, as needed

5.1.1 Documentation

Record observations at each sampling location on individual SSFL lithologic log forms (Attachment A). In preparing the logging form, the site geologists (i.e., lithologic loggers) will follow the general procedures for keeping a field logbook (SSFL SOP 8). All blanks in the lithologic log form must be filled out; if an item is not applicable, an "NA" shall be entered.

The Lithologic Log Form shall be filled out according to the following instructions. The front page of the form contains general information including, but not limited to:

- The project name, sample location, and subarea.
- Date that the drilling activity was started and completed
- Name of the person logging along with the beginning depth-end depth (in feet)
- Borehole diameter(s) and drilling methods
- Name and company of the driller and the type of sampling tool used

A map showing the soil sampling location may be attached.

The continuation page(s) of the log form should be completed according to the instructions provided within this section and according to the sequence provided in Section 5.2.1. The depth column refers to the depth below ground surface (bgs) in feet. The tick marks can be arbitrarily set to any depth interval depending on the scale needed except where client requirements dictate the spacing. The "USCS" column shall contain the USCS soil type/rock type; schematic symbols are not required. Use a single X to mark the area where no core was recovered, and notes shall be recorded as to why the section was not recovered. Sharp or abrupt contacts between lithologies will be indicated by a solid horizontal line. Gradational changes in lithologic composition should be noted. PID and radiation measurements will be recorded within the "PID" and "Radiological" columns at the appropriate depths. The "Description of Materials" column, where the lithology is described, is the most important part of the lithologic log. In completing this section, use the applicable reference charts and complete according to the sequence in Section 5.2.1. The "Sample Name" column is reserved for noting any samples taken and submitted to the laboratory. The sample number shall be filled in at the appropriate depth. The "Recovery" column is where the core recovery is noted as feet recovered over the sample interval (i.e., "4/4" means that all four feet of core was recovered over the four foot core interval).

In addition to the information on the log form, the geologist will record the appropriate information into the logbook when there is a rig shutdown, rig problems, failure to recover core, or other issues.

5.2 General Guidelines for Using and Supplementing Lithologic Descriptive Protocols

This SOP is intended to serve as a guide for recording basic lithologic information. The descriptive protocol presented here must be followed in making basic observations. Selected information charts may be used for classification and naming of rock, sediment, and soil. Some observations will be common to all rock and soil descriptions. All descriptions shall include as appropriate: name of sediment or rock, color (using the Munsell color charts), moisture content, composition, significant inclusions, and degree of consolidation or induration, and the presence and type of fill materials, if identified. The description of each category shall be separated by a semicolon.

Describe all unconsolidated sediment and soil according to the USCS. Abbreviations may be used for often-repeated terminology when recording lithologic descriptions. Several commonly used abbreviations are included at the bottom of the log. Additional abbreviations and their meaning must be added to this list. Loggers are cautioned to limit the use of abbreviations to avoid a lithologic log that is cryptic.

5.2.1 Protocols for Lithologic Description of Discrete Soil or Rock Cores

This section describes the protocols for completing a lithologic description based on discrete soil or rock core samples. For instance, in a 5-foot soil core, the dominant lithology may be siltstone that is interrupted by several thin beds of another lithology such as gravel. This section description can be simplified by writing: 5-10 bgs = siltstone (with other descriptors) except as noted; 7-8 foot gravel zone (with descriptors); 8-9 foot pebble zone (with descriptors); etc. This also aids in "seeing" the thickest unit designations possible for use in modeling.

Description of Unconsolidated Material

Unconsolidated material comprises the majority of the subsurface interval for the Phase 3 investigation. The shallow subsurface is very important to the chemical characterization because of infiltration and migration. Soils are to be described as unconsolidated material and will include:

- Name of sediment (sand, silt, clay, etc.)
- Grain size and distribution
- Composition of larger-grained sediments
- Color (per Munsell color chart)
- Degree of consolidation and cementation
- Moisture content
- Density
- Description of contacts

In accordance with the USCS on naming unconsolidated sediment, the particle size with the highest percentage is the root name. When additional grains are present in excess of 15 percent, the root name is modified by adding a term in front of the root name. For instance, if a material is 80 percent sand and 20 percent gravel, then it is gravelly sand. If the subordinate grains comprise less than 15 percent but greater than 5 percent, the name is written: ____________________(dominant grain) with ________________(subordinate grain). For example, a soil with 90 percent sand and 10 percent silt would be named a sand with silt. If a soil contains greater than 15 percent of four particle sizes, then the name is comprised of the dominant grain size as the root name and modifiers as added before. For example, if a material is 60 percent sand, 20 percent silt, and 20 percent clay the name would be a silty clayey sand. If a material is 70 percent sand, 20 percent silt, and 10 percent clay, it would be a silty sand with clay. When large cobbles or boulders are present, their percentage shall be estimated and their mineralogy recorded.

5.3 Post-Operation

On a weekly basis, all boring logs produced during that week shall be sent to the CDM Smith California PG. The PG will review the logs to ensure that they have been prepared in accordance with this SOP. If any revisions need to be made to any logs, they shall be returned to the field geologist for revision. If the boring log is acceptable, it will be signed by the PG and their registration number noted. All signed boring logs will be returned to the SSFL field office for the remainder of the field work.

6.0 Restrictions/Limitations

Only geologists, or similarly qualified persons trained in lithologic description, are qualified to perform the duties described in this SOP. The FTL for a project will have the authority to decide whether or not an individual is qualified.

7.0 References

ASTM D2488-09a Standard Practice for Description and Identification of Soils – Visual Manual Procedure

8.0 Attachments

Attachment A - SSFL Lithologic Log
Attachment B - Example of Unified Soil Classification System (USCS)
Attachment C - ASTM D2844-09a Standard

Attachment A
Lithologic Log

Location ID:	Subarea:	Date Started:	Date Completed:
Client: DOE	Project Name/#: SSFL-65258-63376.1203.002.223.02231.SSPH3		Total Depth:
Company Name: CDM SMITH	Drill Contractor/Driller: NA		
GPS:	Drill Method:		Depth Drilled into Bedrock:
Radiological Background:	Borehole diameter:		
PID Background:	Depth to GW:		Sampling Method:
Radiological Equipment Used: ✓ MicroR ✓ Alpha/Beta ✓ Pancake	PG Review & No.:		Geologist: N.Begay

Depth (feet) bgs	Recovery (feet)	PID (ppm)	Radiological (µR/cpm)	Sample Name	Sample Time	USCS	Description of Materials

CDM Smith — BORING LOG AND SAMPLING RECORD — Page 1 of ___

ABBREVIATIONS:

amt: amount	gr: grained	pg: poorly graded	t: trace
c: coarse	lt: light	rnd: rounded	v: very
dk: dark	m: medium	sa: subangular	wg: well graded
f: fine	mod: moderate	sr: subrounded	ϕ: diameter

Location ID:	Subarea:	Date Started:	Date Completed:
Project: SSFL		Geologist:	Total Depth:

Depth (feet) bgs	Recovery (feet)	PID (ppm)	Radiological (µR/cpm)	Sample Name	Sample Time	USCS	Description of Materials

CDM Smith **BORING LOG AND SAMPLING RECORD** Page___of ___

Attachment B
Example of Unified Soil Classification System (USCS)

<table>
<tr><th colspan="8">Summary of USCS Field Identification Tests</th></tr>
<tr><td rowspan="8">Coarse-Grained Soils
More than half the material (by weight) is individual grains visible to the naked eye.</td><td colspan="2" rowspan="4">Gravelly Soils
More than half of coarse fraction is larger than 4.75 mm.</td><td rowspan="2">Clean Gravels
Will not leave a stain on a wet palm</td><td colspan="3">Substantial amounts of all grain particle sizes</td><td>GW</td></tr>
<tr><td colspan="3">Predominantly one size or range of sizes with some intermediate sizes missing</td><td>GP</td></tr>
<tr><td rowspan="2">Dirty Gravels
Will leave a stain on a wet palm</td><td colspan="3">Non-plastic fines (to identify, see ML below)</td><td>GM</td></tr>
<tr><td colspan="3">Plastic fines (to identify, see CL below)</td><td>GC</td></tr>
<tr><td colspan="2" rowspan="4">Sandy Soils
More than half of coarse fraction is smaller than 4.75 mm.</td><td rowspan="2">Clean Sands
Will not leave a stain on a wet palm</td><td colspan="3">Wide range in grain size and substantial amounts of all grain particle sizes</td><td>SW</td></tr>
<tr><td colspan="3">Predominantly one size or a range of sizes with some intermediate sizes missing</td><td>SP</td></tr>
<tr><td rowspan="2">Dirty Sands
Will leave a stain on a wet palm</td><td colspan="3">Non-plastic fines (to identify, see ML below)</td><td>SM</td></tr>
<tr><td colspan="3">Plastic fines (to identify, see CL below)</td><td>SC</td></tr>
<tr><td rowspan="5">Fine-Grained Soils
More than half the material (by weight) is individual grains not visible to the naked eye.

(<0.074 mm)</td><td>Ribbon</td><td>Liquid Limit</td><td>Dry Crushing Strength</td><td>Dilatancy Reaction</td><td>Toughness</td><td>Stickiness</td><td></td></tr>
<tr><td>None</td><td><50</td><td>None to Slight</td><td>Rapid</td><td>Low</td><td>None</td><td>ML</td></tr>
<tr><td>Weak</td><td><50</td><td>Medium to High</td><td>None to Very Slow</td><td>Medium to High</td><td>Medium</td><td>CL</td></tr>
<tr><td>Strong</td><td>>50</td><td>Slight to Medium</td><td>Slow to None</td><td>Medium</td><td>Low</td><td>MH</td></tr>
<tr><td>Very Strong</td><td>>50</td><td>High to Very High</td><td>None</td><td>High</td><td>Very High</td><td>CH</td></tr>
<tr><td>Highly Organic Soils</td><td colspan="6">Readily identified by color, odor, spongy feel, and frequently by fibrous texture</td><td>OL
OH
Pt</td></tr>
</table>

Attachment C
ASTM D2488-09a
Standard Practice for Description and Identification of Soils – Visual Manual Procedure

Designation: D2488 – 09a

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (either intact or disturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D1452 Practice for Soil Exploration and Sampling by Auger Borings
D1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils
D1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
D2113 Practice for Rock Core Drilling and Sampling of Rock for Site Investigation
D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard.

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-µm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

fine—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

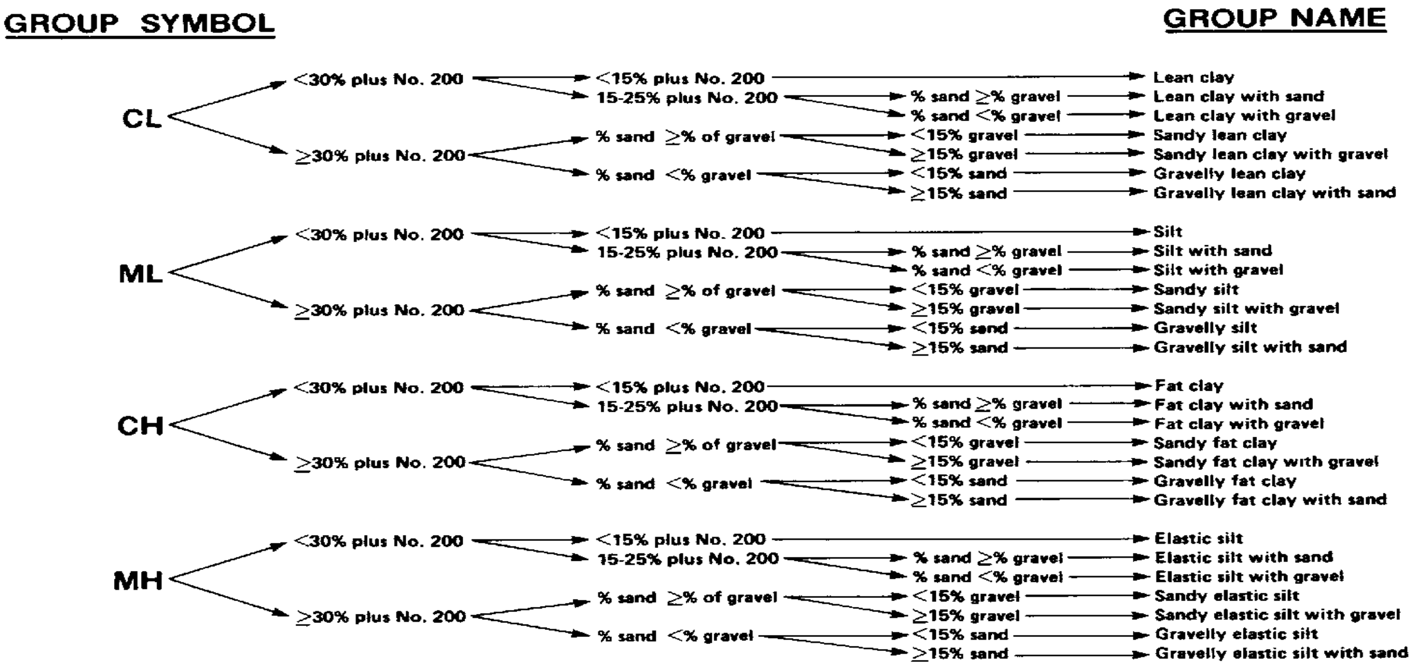
5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

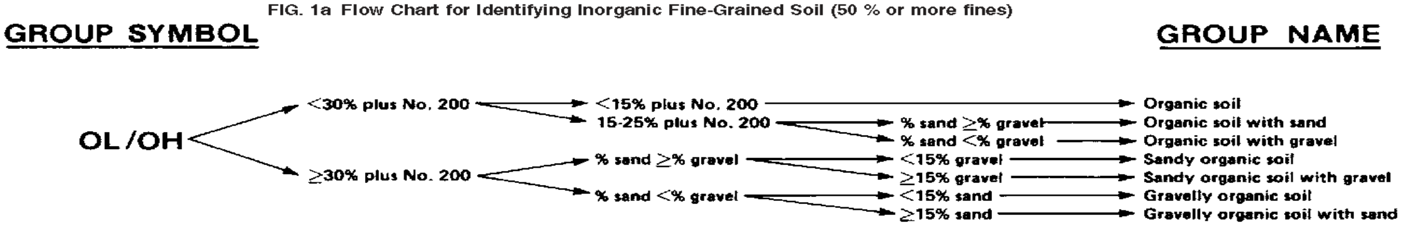
5.7 This practice may be used in combination with Practice D4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D3740 provides a means for evaluating some of those factors.



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula*.

6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Test Tube and Stopper* (or jar with a lid).

6.2.2 *Hand Lens*.

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

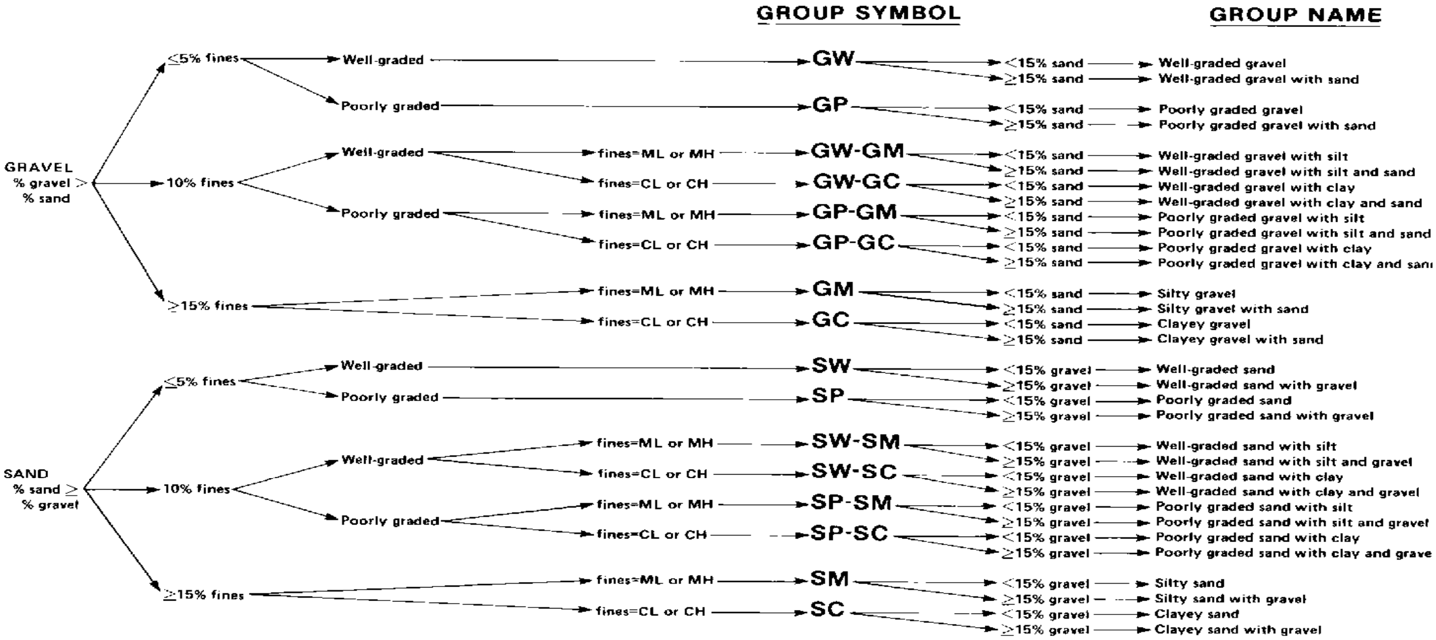
9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D1452, D1587, or D2113, or Test Method D1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (3⁄8 in.)	200 g (0.5 lb)
19.0 mm (3⁄4 in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table

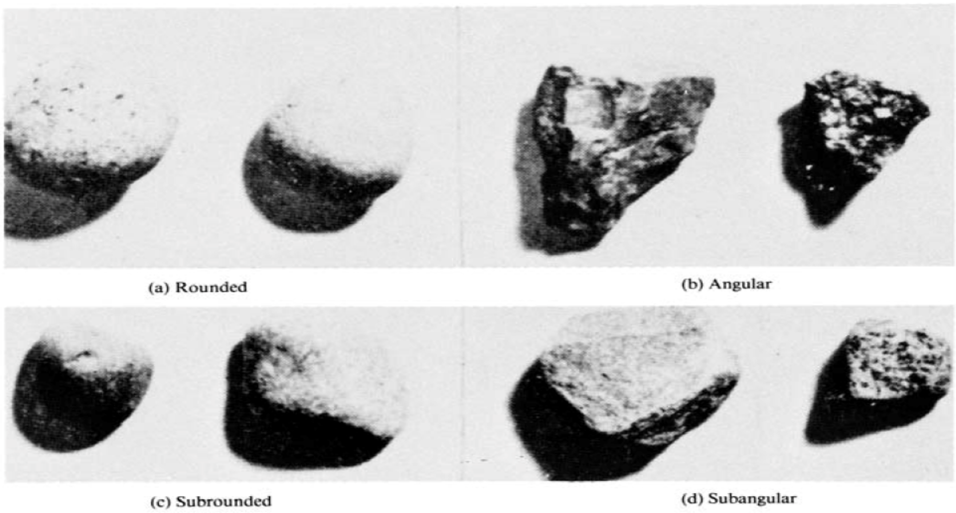


FIG. 3 Typical Angularity of Bulky Grains

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

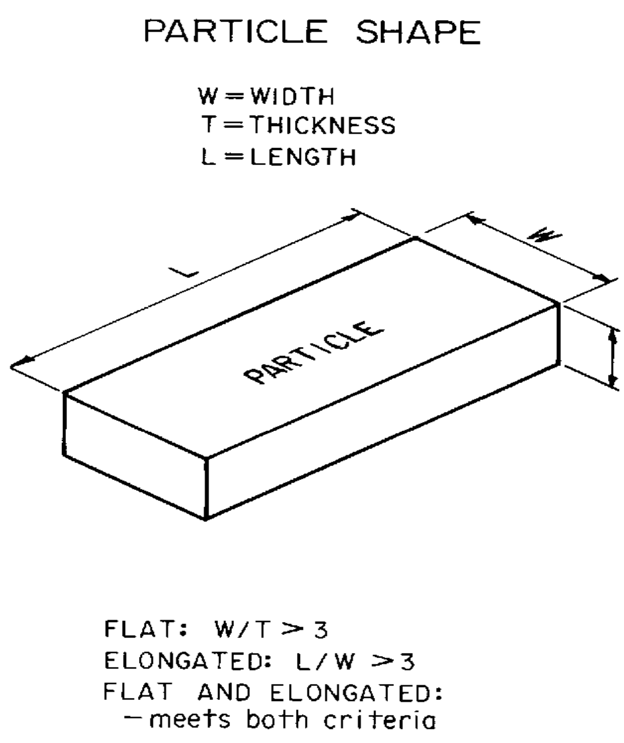


FIG. 4 Criteria for Particle Shape

4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maxi-

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

mum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. “Hard” means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

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14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness and Plasticity
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %

Few—5 to 10 %

Little—15 to 25 %

Some—30 to 45 %

Mostly—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown.

X2.4.3 *Broken Shells*—About 60 % uniformly graded gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % nonplastic fines; "Poorly Graded Gravel with Silt and Sand (GP-GM)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D2488 – 09) that may impact the use of this standard. (Approved June 15, 2009.)

(*1*) Revised Section 1.2.3.

Sample Custody	SSFL SOP 10 Revision: 1 Date: November 2012

Prepared:	J. Sobol	**Technical Review:**	C. Werden
QA Review:	J. Oxford	**Approved and Issued:**	[signature] 11/20/2012 *Signature/Date*

1.0 Objective

Because of the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are used to support remedial or other decisions. To maintain and document sample possession, sample custody procedures, as described in this technical standard operating procedure (SOP) are followed. All paperwork associated with the sample custody procedures at the Santa Susana Field Laboratory (SSFL) site will be retained in CDM Smith files unless Department of Energy (DOE) requests that it be transferred to them.

2.0 Background

2.1 Definitions

Sample – A sample is material to be analyzed that is contained in single or multiple containers representing a unique sample identification number.

Sample Custody–A sample is under custody if:

1. It is in your possession
2. It is in your view, after being in your possession
3. It was in your possession and you locked it up
4. It is in a designated secure area
5. It is in transit by a delivery or courier service

Chain-of-Custody Record–A chain-of-custody record is a form used to document the transfer of custody of samples from one individual to another. The forms are electronic and managed in the Scribe software. An example form is included in the Field Sampling Plan (FSP) Addendum and attached to this SOP.

Custody Seal–A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping. Custody seals are placed on coolers not individual samples.

Sample Label– A sample label is an adhesive label placed on sample containers to designate a sample identification number and other sampling information.

2.2 Associated Procedures

- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*

3.0 General Responsibilities

Field Team Leader–The field team leader (FTL) is responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events. The FTL is also responsible for coordinating with the subcontract laboratory to ensure that adequate information is recorded on custody records. The FTL determines whether proper custody procedures were followed during the fieldwork.

Field Sample Coordinator–The field sample coordinator, designated by the FTL, is responsible for accepting custody of samples from the sampler(s) and properly packing and shipping the samples to the laboratory assigned to do the analyses.

Sampler–The sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

Site Health and Safety Technician– The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation's (SAIC's) Certified Health Physicist (CHP).

4.0 Required Supplies

- Chain-of-custody record forms
- Sample labels
- Computer
- Waterproof pen
- Custody seals
- Clear tape
- Printer and paper
- Ball point ink pen

5.0 Procedures

5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a chain-of-custody record. This procedure will be followed for all samples collected.

Field Custody

1. The quantity and types of samples to be collected and the proposed sample locations are documented in the Field Sampling Plan Addendum.

2. Complete sample labels for each sample using waterproof ink.

3. Maintain personal custody of the samples (in your possession) at all times until custody is transferred to the FTL or sample coordinator for sample shipment.

Transfer of Custody and Shipment

1. Complete a chain-of-custody record for all samples (see Attachment A).To transfer the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the laboratory sample manager in the appropriate laboratory.

   - The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. In all cases, it must be readily apparent that the person who received custody is the same person who relinquished custody to the next custodian.
   - If samples are left unattended or a person refuses to sign, this must be documented and explained on the chain-of-custody record.

   Note: The FTL or field sample coordinator will initiate the chain-of-custody record, sign, and date as the relinquisher. The individual sampler(s) must sign in the appropriate block, but does (do) not need to sign and date as a relinquisher.

2. Package samples properly for shipment and dispatch to the appropriate laboratory for analysis. Each shipment must be accompanied by a separate chain-of-custody record. If a shipment consists of multiple coolers, the original, or a copy of the chain-of-custody record shall accompany each cooler in the shipment.

3. The original record will accompany the shipment. Copies are retained by the FTL and distributed to the appropriate sample coordinator(s). Freight bills will also be retained by the FTL as part of the permanent documentation. The shipping number from the freight bill shall be recorded on the applicable chain-of-custody record and field logbook (in accordance with SSFL SOP 8).

Completing Chain-of-Custody Record

Scribe generates a COC that shall include the following information:

1. Site name, CDM Smith contact name and phone number, COC number.
2. Name, phone number and address of the laboratory where the samples are being shipped.
3. Date shipped, courier's name, and airbill number (if applicable).
4. Sample ID number.
5. Sample date and military time.
6. Matrix and preservative.
7. Type and Number of Containers.
8. Turnaround times.
9. Analyses requested.
10. List any special instructions. Also, note which samples may have high PID or RAD concentrations as advanced notice for the laboratory.
11. Sign the COC record in the space provided, including the date and time relinquished.
12. The sampler must sign each original COC.

Review the form to ensure that all information is completed and that all entries are correct.

5.2 Sample Labels

Sample labels will be used for all samples collected at the SSFL site.

1. Complete one label with the following information for each sample container collected. For Encore Samplers, the label will be placed on the zip-top bag that contains all Encores for one sample:

   - sample identification number.
   - Date (i.e., month, day, and year of collection).
   - Time (i.e., military) of sample collection.
   - Mark to indicate soil or water sample.
   - Sampler will place their initials in the space provided.
   - List preservative type.

List or mark the "Analyses" for which the sample is to be analyzed.

2. Place adhesive labels directly on the sample containers so that the label is completely below the lid of the container. Place clear tape over the label to protect from moisture.

Note: The EnCore sampler is very small; therefore, the sample label is placed on the zip-top bag that contains the samplers.

3. Double-check that the information recorded on the sample label is consistent with the information recorded on the chain-of-custody record.

5.3 Custody Seals

Two custody seals must be placed on opposite corners of all shipping containers (e.g., cooler) before shipment. The seals shall be signed and dated by the shipper.

5.4 Sample Shipping

SSFL SOP 11 defines the requirements for packaging and shipping environmental samples. Following packing, all coolers must be screened for radiation by the Site Health and Safety Technician (SSFL SOP 7).

6.0 Restrictions/Limitations

There are no identified restrictions/limitations.

Sample Custody	SSFL SOP 10 Revision: 1 Date: November 2012

7.0 References

U. S. Environmental Protection Agency. Revised March 1992 or current revision. *National Enforcement Investigations Center, Multi-Media Investigation Manual*, EPA-330/9-89-003-R. p.85.

__________. 2006-2011. Scribe Manuals. http://www.ertsupport.org/scribe_home.htm and http://www.epaosc.org/scribe

__________. 2011 or current revision. *Sampler's Guide, Contract Laboratory Program Guidance for Field Samplers*, EPA-540-R-09-03. January.

8.0 Attachments

Attachment A – Example Chain of Custody Form

Attachment A

Example Chain of Custody Form

SSFL Phase 3 Chain of Custody

CDM Smith

DateShipped:

CarrierName:

AirbillNo:

Contact Name:

Contact Phone:

COC No:

Cooler #:

Lab:

Lab Phone:

Lab Address

Sample	Date/ Time	Matrix	Preserv.	Type/No of Containers	Turn Around Time	Metals 6010 and 6020	Mercury 7471 (Soil)	Mercury 7470 (Water)	Fluoride 300.0/9056	SVOC 8270	TIC 8270	PAHs 8270 SIM	1,4 Dioxane 8270 SIM	Dioxins 1613	PCBs/PCTs 8082	Perchlorate 314.0/331	Perchlorate Confirm 6850/6860	pH 9045 (Soil)	pH 9040 (Water)	Hex Cr 7196/7199	Herbicides 8151	Pesticides 8081	VOCs 8260	1,4 Dioxane 8260 SIM	TPH-GRO 8015	TPH-EFH 8015	Glycols 8015	Alcohols 8015	Terphenyls 8015	Nitrates 300.0/9056	Energetics 8330	Cyanide 9012	Formaldehyde 8315	NDMA 1625	Organotin	Methyl Mercury 1630	Other Analysis/Notes

Special Instructions:	Sampler:

Relinquished by	Date	Time	Received by	Date	Time	Relinquished by	Date	Time	Received by	Date	Time

Packaging and Shipping Environmental Samples	SSFL SOP 11 Revision: 1 Date: December 2012

Prepared:	D. Lange	**Technical Review:**	C. Zakowski
QA Review:	K. Zilis	**Approved and Issued:**	12/18/2012 *Signature/Date*

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to outline the requirements for the packaging and shipment of environmental samples for the Santa Susana Field Laboratory (SSFL) site. Additionally, Sections 2.0 and 3.0 outline requirements for the packaging and shipping of regulated environmental samples under the Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations for shipment by air and apply only to domestic shipments. This SOP does not cover the requirements for packaging and shipment of equipment (including data or bulk chemicals) that are regulated under the DOT, IATA, and ICAO. However, packaging and shipment of hazardous material and radioactive samples is not expected.

1.1 Packaging and Shipping of All Samples

This SOP applies to the packaging and shipping of all environmental samples. Samples displaying radioactivity above background concentrations will not be collected or shipped.

Note: This SOP does not address shipment of hazardous or radioactive materials. Do not ship a hazardous or radioactive material unless you have received training that meets the requirements of the Department of Energy (DOE), The Boeing Company (Boeing), CDM Smith, and the DOT.

2.0 Background

2.1 Definitions

Environmental Sample - An aliquot of sample representative of the site. This definition applies only to environmental samples that contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Custody Seal - A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the container (i.e., cooler) before offsite shipment. Custody seals are used to demonstrate that sample integrity has not been compromised during transportation from the field to the analytical laboratory.

Inside Container - The container, normally made of glass or plastic, that actually contacts the shipped material. Its purpose is to keep the sample from mixing with the ambient environment.

Outside Container - The container, normally made of metal or plastic, that the transporter contacts. Its purpose is to protect the inside containers.

Secondary Containment - The outside container provides secondary containment if the inside container breaks (i.e., plastic over packaging if liquid sample is collected in glass).

Excepted Quantity - Excepted quantities are limits to the mass or volume of a hazardous material below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

Limited Quantity - Limited quantity is the amount of a hazardous material exempted from DOT labeling or packaging requirements in 49 CFR. Authorized exemptions are noted under column 8A in the Hazardous Materials Table in 49 CFR 172.101.

Qualified Shipper - A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

2.2 Associated Procedures

- SSFL SOP 10, *Sample Custody*

2.3 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. These shipments are potentially subject to regulations published by DOT. Failure to abide by these rules places both CDM Smith and the individual employee at risk of serious fines. The analytical holding times for the samples must not be exceeded. If necessary, the samples shall be packed in time to be shipped for overnight delivery or for pick-up by the laboratory courier. Make arrangements with the laboratory before sending samples for weekend delivery.

3.0 General Responsibilities

Field Team Leader–The field team leader (FTL) is responsible for:

- Ensuring that field personnel package and ship samples in accordance with this SOP.
- Ensuring samples are shipped such that holding times can be met by the laboratory.
- Ensuring normal samples collected and QC samples are documented on the Chain of Custody (CoC).

Site Health and Safety Technician–The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation's (SAIC's) Certified Health Physicist (CHP).

4.0 Required Equipment

The following equipment will be needed in the field trailer to conduct sample packing and shipping:

- Site-specific plans (e.g., Field Sampling Plan [FSP] Addendum, health and safety plan)
- Insulated coolers
- Heavy-duty plastic bags
- Plastic zip-top bags, small and large
- Clear tape
- Duct tape
- Nylon reinforced strapping tape
- Rubber bands (optional)
- Bubble wrap (optional)
- Ice in bags
- Custody seals
- Chain-of-custody record
- This End Up and directional arrow labels
- Overnight courier airbills

5.0 Procedures

5.1 Packaging Environmental Samples

Preservatives in samples are not anticipated to meet threshold criteria to be classified as hazardous materials for shipping purposes. The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager shall be observed.

2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic bag.

3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SSFL SOP 10).

4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. Bottles may be wrapped in bubble wrap or placed into foam bottle holders.

Note: Trip blanks must be included in coolers containing VOA samples.

5. Place bubble wrap in the bottom of an empty cooler followed by a large plastic bag, and place the sample containers in the bag with sufficient space to allow for the addition of packing material between any glass containers. It is preferable to place glass sample bottles and jars into the cooler vertically. Glass containers are less likely to break when packed vertically rather than horizontally. The containers may alternatively be placed into foam or cardboard holders that fit within the coolers.

6. While placing sample containers into the cooler, conduct an inventory of the contents of the shipping cooler against the chain-of-custody record.

7. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° Celsius (C) ± 2° C . Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large plastic bag with fiber or duct tape or a zip tie.

8. Print copies of the electronic CoC form. Place one copy of the completed CoC record for the laboratory into a plastic zip-top bag, seal the bag, and tape the bag to the inner side of the cooler lid. Retain a second copy of the CoC for sample management records. Close the cooler lid.

9. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the opening of the cooler on opposite sides. The custody seals shall be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.

10. The shipping container lid must be marked **"THIS END UP"** and arrow labels that indicate the proper upward position of the container shall be affixed to the cooler. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory is included on the shipping label (i.e., overnight delivery service label).

11. Screen the cooler with the radiation meter before shipment and document that a background level (at most) exists. The cooler will be surveyed by the RAD Technician to ensure that Radiation flux on exterior surfaces does not exceed 0.5 mrem/hr on all sides. This survey will be documented and the results reviewed by the qualified shipper, as needed.

5.2 Packaging of Limited-Quantity Radioactive Samples

Samples containing radioactivity above background will be handled in accordance with DOT shipment regulations and the requirements of the analytical laboratory receiving the samples. Per DOT shipment regulations, packages cannot exceed 200 millirem per hour and/or 2,200 disintegrations per minute as measured at any point on the package surface. Samples with exceedence of radiological screening levels (per the health and safety plan or SSFL SOP 7) will be set aside and the DOE, California Department of Toxic Substance Control (DTSC), and Boeing will be contacted. Screening limits are 30 millirem per hour and 200 disintegrations per minute.

6.0 Restrictions/Limitations

This SOP addresses the packing and shipping of environmental samples exhibiting typical radioactivity for SSFL (less than 30 millirem per hour for gamma emitters and 200 disintegrations per minute for alpha/beta emitters). Being a site that has a history of radioactive occurrences, the sample locations, samples, and coolers will be screened for radioactivity. However, CDM Smith will not handle, package, or ship samples with radioactivity that exceeds DOT regulations or the requirements of the receiving laboratory. If radioactivity above these levels is detected, packing and shipping work will be temporarily suspended and DOE, DTSC, and Boeing will be contacted for further direction. The cooler or samples will be set aside, and work with those samples will not resume until approved for shipment by DOE. Any effort beyond stop work will require modified SOPs.

7.0 References

U. S. Environmental Protection Agency. (EPA). 2007 or current revision. *Sampler's Guide, Contract Laboratory Program, Guidance for Field Samplers*, EPA-540-R-07-06.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Hazardous Materials Table, Special Provisions, Hazardous, Materials Communications, Emergency Response Information, and Training Requirements*, 49 CFR 172.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Shippers General Requirements for Shipments and Packaging*, 49 CFR 173.

Field Equipment Decontamination	SSFL SOP 12 Revision: 1 Date: November 2012

Prepared:	R. Kaspzyk	**Technical Review:**	C. Werden
QA Review:	J. Oxford	**Approved and Issued:**	[signature] 11/26/2012 *Signature/Date*

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to describe the general procedures required for decontamination of non-disposable field equipment for the Santa Susana Field laboratory (SSFL) site. Given the history of radioactive material usage at SSFL, screening for radioactive materials will occur with all field operations. Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross-contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants off site.

2.0 Background

Decontamination of equipment will occur before sampling begins and between each sample collection (for sampling equipment). All decontamination water will be collected for future disposal.

2.1 Definitions

ASTM Type II Water – Reagent grade water defined by American Society for Testing and Materials (ASTM) that is used in the final rinse of surfaces of contaminated equipment.

Clean – Free of contamination and when decontamination has been completed in accordance with this SOP.

Cross-Contamination – The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or non-contaminated samples or areas.

Decontamination – The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross-contamination of samples or exposure of personnel.

Material Safety Data Sheets – These documents discuss the proper storage and physical and toxicological characteristics of a particular substance used during decontamination. These documents, generally included in site health and safety plans, shall be kept on site at all times during field operations.

Potable Water – Potable water is provided by local city sources and is safe for consumption. Chemical analysis of the water source will not be required before it is used.

Site Health and Safety Technician–The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation’s (SAIC’s) Certified Health Physicist (CHP).

Sampling Equipment – Equipment that comes into direct contact with the sample media.

Soap – Low-sudsing, non-phosphate detergent such as Liquinox™.

2.2 Associated Procedures

- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*

- SSFL SOP 6, *Field Measurement of Total Organic Vapors*
- SSFL SOP 7, *Field Measurement of Residual Radiation*
- SSFL SOP 13, *Guide to Handling Investigation-Derived Waste*

3.0 Responsibilities

Field Team Leader (FTL)-ensures that field personnel are trained in the performance of this procedure and that decontamination is conducted in accordance with this SOP. The FTL may also be required to collect and document rinsate samples (also known as equipment blanks) to provide quantitative verification that these procedures have been correctly implemented.

Field Team Member-performs decontamination of field sampling equipment and/or or oversees subcontractors performing decontamination activities. Ensures the procedures are followed, equipment is clean, and collects field equipment rinseate blanks.

4.0 Required Equipment

- Stiff-bristle scrub brushes
- Plastic buckets and troughs
- Portable hot-water/steam, high pressure spray cleaners
- Soap
- Nalgene or Teflon sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting, plastic bags, and/or aluminum foil to keep decontaminated equipment clean between uses
- Disposable wipes, rags, or paper towels
- Potable water
- ASTM Type II water
- Trough or collection pool to contain wash waters during decontamination
- Sheet plastic to place beneath trough to contain any splash water
- Gloves, safety glasses, and other protective clothing as specified in the health and safety plan
- Tools for equipment assembly and disassembly (as required)
- 55-gallon drums for temporary storage of decontamination water
- Drum labels
- Pallets for drums holding decontamination water
- Pump to transfer water to drums (as needed)

5.0 Procedures

Decontaminate all reusable equipment (non-dedicated) used to collect and/or handle samples before coming into contact with any sampled media or personnel using the equipment. Screen all used equipment for radioactivity before transport to the decontamination area (SSFL SOP 7). Decontaminate equipment at portable decontamination stations set up at the sampling location. Transport equipment to and from the decontamination station in a manner to prevent cross-contamination of equipment and/or area. Take precautions such as enclosing large equipment (rods) in plastic wrap while being transported .

Construct the decontamination area so that contaminated water is either collected directly into appropriate containers (5-gallon buckets or steel wash tubs) suitable for collecting the decontamination water. If needed construct small soil berm or depression lined with plastic to collect any overspray or splash. Transfer water from the collection pool and containment area into 55-gallon drums for temporary storage. Stage decontamination water until sampling results or waste characterization results are obtained and evaluated and the proper disposition of the waste is determined (SSFL SOP 13).

Decontaminate all items that come into contact with potentially contaminated media before use and between sampling and/or drilling locations. If decontaminated items are not immediately used, cover them with either clean plastic or aluminum foil depending on the size of the item. Decontamination procedures for equipment are as follows:

Field Equipment Decontamination	SSFL SOP 12 Revision: 1 Date: November 2012

General Guidelines

- Potable and ASTM Type II water will be free of all contaminants of concern.
- Decontaminated equipment will be allowed to air dry before being used.
- Equipment type, date, time, and method of decontamination along with associated field quality assurance sampling shall be recorded in the appropriate logbook.
- Gloves, boots, safety vest, safety glasses, and any other personnel protective clothing and equipment shall be used as specified in the health and safety plan.

5.1 Heavy Equipment Decontamination

The following steps will be used when decontaminating heavy equipment (i.e., backhoes):

1. Establish a decontamination area (e.g., large troughs or plastic sheeting with temporary wood bermed sides) that is large enough to fully contain the equipment to be cleaned. All decontamination areas must be upwind of the area under investigation.

2. Screen the backhoe bucket and arm for radioactivity. If measured above background, take measures to contain decontamination water separately from non-radioactive-impacted water.

3. With the heavy equipment in place, spray areas (e.g., bucket of the backhoe) exposed to contaminated media using a hand-handle sprayer. Be sure to spray down all surfaces that contact soil.

4. Use brushes, soap, and potable water to remove dirt whenever necessary.

5. Remove equipment from the decontamination pool and allow it to air dry before returning it to the work site.

6. After decontamination activities are completed, collect all contaminated wastewater, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles (i.e., solids and liquids). A decontamination area may be used for multiple day/weeks provided the containment integrity is maintained. All receptacles containing contaminated items must be properly labeled for disposal. Liquids must be separated from solids and drummed.

5.2 Downhole Equipment Decontamination

Downhole equipment includes rods, stems, etc. Follow these steps when decontaminating this equipment:

1. Set up a centralized decontamination area (e.g., large trough or plastic bermed area), if possible. This area shall be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.

2. Set up a “clean” area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover tables or other surfaces on which decontaminated equipment is to be placed. All decontamination areas shall be upwind of any areas under investigation.

3. Screen all equipment for radioactivity before decontamination. If measured above background, take measures to contain decontamination water separately from non-radioactive-impacted water.

4. Place the object in a 5-gallon bucket or tub for detergent wash. If needed, longer equipment may be placed on aluminum foil or plastic-covered wooden sawhorses or other supports. The objects to be cleaned shall be at least 2 feet above the ground to avoid splash back when decontaminating.

5. Using soap and potable water wash the contaminated equipment. When using hand-held sprayers aim nozzle downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.

6. Move the equipment to a second bucket and rinse the equipment using clean, potable water.

7. Using a suitable sprayer, conduct a final rinse of the equipment thoroughly with ASTM Type II water.

8. Remove the equipment from the decontamination area and place in a clean area upwind to air dry.

9. After decontamination activities are completed, collect all contaminated wastewaters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids must be separated from solids and drummed. Any radioactive decontamination water must be contained in separate drums.

5.3 Sampling Equipment Decontamination

Follow these steps when decontaminating sampling equipment:

1. Set up a decontamination line (e.g., buckets or trough). The decontamination line shall progress from "dirty" to "clean." A clean area shall be established upwind of the decontamination wash/rinse activities to dry the equipment. At a minimum, clean plastic sheeting must be used to cover the tables or other surfaces that the decontaminated equipment is placed for drying.

2. Disassemble any items that may trap contaminants internally. Do not reassemble the items until decontamination and air drying are complete.

3. Wash the items with potable water and soap using a stiff brush as necessary to remove particulate matter and surface films.

4. Thoroughly rinse the items with potable water.

5. Rinse the items thoroughly using ASTM Type II water.

6. Allow the items to air dry completely.

7. After drying, reassemble the parts as necessary and wrap the items in clean plastic wrap, place in plastic baggies or in aluminum foil if not used immediately.

8. After decontamination activities are completed, collect all contaminated waters, plastic sheeting, and disposable personal protective equipment. Separate solid waste from liquid investigation-derived waste. Place solid items in trash bags for municipal disposal. Liquids must be separated from solids and drummed. Any radioactive decontamination water must be contained in separate drums. Refer to site-specific plans for labeling and waste management requirements.

5.4 Waste Disposal

Refer to site-specific plans and SSFL SOP 13 for waste disposal requirements. The following are guidelines for disposing of wastes:

- All wash water, rinse water, and decontamination solutions that have come in contact with contaminated equipment are to be handled, packaged (55-gallon drums), labeled, marked, stored, and disposed of as investigation-derived waste.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.
- Unless otherwise required, plastic sheeting and disposable protective clothing may be treated as solid, nonhazardous waste and placed in trash bags for disposal.
- Waste liquids shall be sampled, analyzed for contaminants of concern in accordance with disposal regulations, and disposed of accordingly.

6.0 Restrictions/Limitations

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow.

7.0 References

American Society for Testing and Materials (ASTM). 2002. *Standard Practice for Decontamination of Field Equipment at Nonradioactive Waste Sites*, ASTM D5088-02. January 10.

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.1.

Guide to Handling Investigation-Derived Waste	SSFL SOP 13 Revision: 1 Date: November 2012

Prepared:	R. Kaspzyk	**Technical Review:**	C. Werden
QA Review:	J. Oxford	**Approved and Issued:**	John T Wondolleck 11/26/2012 *Signature/Date*

1.0 Objective

This technical standard operating procedure (SOP) presents guidance for the management of investigation-derived waste (IDW) generated at the Santa Susana Field Laboratory (SSFL) site during soil sampling, trenching, and equipment decontamination activities. The primary objectives for managing IDW during field activities include:

- Leaving the site in no worse condition than existed before field activities
- Removing wastes that pose an immediate threat to human health or the environment
- Segregating radiological wastes above background or "permissible" concentrations
- Complying with federal, state, local, regulations
- Minimizing the quantity of IDW

2.0 Background

2.1 Definitions

Hazardous Waste - Discarded material that is regulated listed waste, or waste that exhibits ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.3 or state regulations.

Investigation-Derived Wastes - Discarded materials resulting from field activities such as sampling, surveying, drilling, excavation, and decontamination processes that, in present form, possess no inherent value or additional usefulness without treatment. Wastes will be personal protective equipment, (e.g., nitrile gloves, paper towels, polyethylene sheeting) and decontamination fluids that may be classified as hazardous or nonhazardous.

Mixed Waste - Any material that has been classified as both hazardous and radioactive.

Radioactive Wastes - Discarded materials that are contaminated with radioactive constituents with specific activities in concentrations greater than the latest regulatory criteria (i.e., 10 CFR 20).

Treatment, Storage, and Disposal Facility (TSDF) - Permitted facilities that accept hazardous waste shipments for further treatment, storage, and/or disposal. These facilities must be permitted by the U.S. Environmental Protection Agency (EPA) and appropriate state and local agencies.

2.2 Discussion

Field investigation activities result in the generation of waste materials that may be characterized as hazardous or radioactive. IDWs may include solutions from decontaminating sampling equipment; and other wastes or supplies used in sampling and testing potentially hazardous or radiological contaminated material. Personal protective equipment (PPE) and other solid waste (paper towels, plastic sheeting, etc) are not considered IDW. DPT cuttings, excess sample spoils, and excavated soil will be returned to the borehole/excavation and are not considered IDW.

3.0 General Responsibilities

Field Team Leader-The field team leader (FTL) is responsible for ensuring that field personnel conduct field activities in accordance with this SOP and the Field Sampling Plan (FSP) Addendum.

Field Team Members-Field team members are responsible for implementing this SOP and communicating any unusual or unplanned condition to the FTL's attention.

Site Health and Safety Technician–The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers. This person is a trained radiological technician who works under the guidance of Science Application International Corporation's (SAIC's) Certified Health Physicist (CHP).

4.0 Required Equipment and Handling

4.1 IDW Containment Devices

Currently, the anticipated IDW containment device is:

- Department of Transportation (DOT)-approved 55-gallon steel containers (drums)

4.2 IDW Container Labeling

An "IDW Container" label shall be applied to each drum using indelible marking. Labeling or marking requirements for IDW are as detailed below.

- The Site Health and Safety Technician will screen all containers for radioactivity using hand-held field instruments.
- Include the following information on labels and markings: project name, generation date, location of waste origin, container identification number, sample number (if applicable), and contents (i.e., decontamination water).
- Apply each label or marking to the upper one-third of the container at least twice, on opposite sides.
- Position labels or markings on a smooth part of the container. The label must not be affixed across container bungs, seams, ridges, or dents.
- Use weather-resistive material for labels and markings and permanent markers or paint pens capable of enduring the expected weather conditions. If markings are used, the color must be easily distinguishable from the container color.
- Secure labels in a manner to ensure that they remain affixed to the container.

Labeling or marking requirements for hazardous (or radioactive) IDW expected to be transported offsite must be in accordance with the requirements of 49 CFR 172 (not anticipated for this work). Wastes determined to be hazardous or radioactive will be staged onsite until disposal options are determined by Department of Energy (DOE) or The Boeing Company (Boeing). Boeing will notify the California Department of Toxic Substances Control of disposal in accordance with Boeing's RCRA permit. Contact information is provided in the health and safety plan.

4.3 IDW Container Movement

Predetermine staging areas for IDW containers in accordance with SSFL requirements. Determine the methods and personnel required to safely transport IDW containers to the staging area before field mobilization. Handling and transport equipment will be consistent with the associated weight for both lifting and transporting. Transportation of IDW containers offsite via a public roadway is prohibited unless 49 CFR 172 requirements are met.

Wastes determined to be hazardous or radioactive will be handled as directed by DOE or Boeing and segregated from standard IDW and solid wastes.

4.4 IDW Container Storage

Stage containerized IDW awaiting results of chemical analysis at a pre-determined location on the SSFL site. Store containers such that the labels can be easily read. Provide a secondary/spill container for liquid IDW storage (e.g., steel drums shall not be stored in direct contact with the ground).

5.0 Procedures

All liquid IDW generated at the site will be disposed offsite. The field screening and chemical analyses will determine the ultimate disposition of the waste. Formal plans for the management of IDW will be determined by CDM Smith and submitted to DOE, Boeing, and DTSC for approval. Interim management of IDW is discussed below.

5.1 Collection for Offsite Disposal

Radiological screening and laboratory analysis are required before sending any IDW to an offsite TSDF or to a publicly owned treatment works (POTW). Manifests are required to accompany any IDW determined to be hazardous, and DOE will direct the handling of this material. Arrange with DOE and/or Boeing who are responsible for the site and signing as generator on any waste profile and all manifests or bill of ladings; it is CDM Smith's policy not to take ownership of the waste, but may sign waste profiles or manifests on behalf of DOE or Boeing, as an authorized contractor. Use permitted TSDFs and transporters for the respective wastes. Non-bulk containers (e.g., drums) must have a DOT-approved label affixed to the container and all required associated placard stickers before leaving SSFL for an offsite TSDF. Include information as required in 49 CFR 172.

5.1.1 Aqueous Liquids

Store used decontamination fluids in appropriate containers (e.g., 55-gallon drums) at a pre-designated staging area at SSFL. Prior to being disposed offsite by a disposal vendor, ship a sample of the fluids for laboratory analysis.

5.2.2 Disposable PPE and Other Solid Waste

Dispose of personal protective equipment and other solid waste (paper towels, plastic, etc.) offsite as solid waste. After screening for radioactivity, these wastes may be contained in standard plastic trash bags and placed in trash cans.

6.0 Restrictions/Limitations

The project managers will determine the most appropriate disposal option for solid waste and used decontamination fluids. Parameters to consider, especially when determining the level of protection, include the volume of IDW and the level of contaminants present in the surface and subsurface soils. Under no circumstances will IDW materials be stored in a site office or warehouse.

7.0 References

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Hazardous Materials Table, Special Provisions, Hazardous, Materials Communications, Emergency Response Information, and Training Requirements*, 49 CFR 172.

U. S. Environmental Protection Agency (EPA).1990. *Low-Level Mixed Waste: A RCRA Perspective for NRC Licensees*, EPA/530-SW-90-057. August

__________. January 1992. *Guide to Management of Investigation-Derived Wastes*, 9345.3-03FS.

Standard Operating Procedure No. 14
Geophysical Survey
Revision 1

Santa Susana Field Laboratory
Ventura County, California

Contract DE-AM09-05SR22404
CDM Smith Task Order DE-AT30-08CC60021/ET17

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete."

Prepared by: ______________________ 9/19/12
Date
Margaret Bloisa, P.G.
CDM Smith Geologist

PROFESSIONAL GEOLOGIST MARGARET BLOISA No. 8360 Exp. STATE OF CALIFORNIA

Approved by: ______________________ 9/19/12
Date
John Wondolleck
CDM Smith Project Manager

Geophysical Survey	SSFL SOP 14 Revision: 1 Date: September 2012

Prepared:	C. Werden/M. Bloisa	**Technical Review:**	J. Plevniak
QA Review:	Cheryl Sayler	**Approved and Issued:**	09/19/2012 *Signature/Date*

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to present the procedures for non-invasive geophysical surveys to be used to identify subsurface features within Area IV at Santa Susana Field Laboratory (SSFL), as needed to complete site characterization. The objective is to locate historic subsurface features (bedrock excavations), buried utilities, and to identify buried material within areas suspected of disposal of building demolition debris, including where landfill operations may have been conducted. All geophysical survey work will be performed by a subcontractor to CDM Smith. CDM Smith will provide field oversight of the geophysical contractor.

Table 1 identifies the areas where geophysical surveys are to be done in Subareas 5A, 5B, and 5C within Area IV, features of interest, historical use information, nearest boring locations and landmarks, and the recommended geophysical method(s). The FTL, or their designee, will refer to Table 1 to identify and delineate the areas/locations to be geophysically surveyed.

Geophysical methods proposed to locate and record buried geophysical features include:

- Total Field Magnetometry (TFM)
- Frequency Domain Electromagnetic Method (FDEM)
- Ground Penetrating Radar (GPR)
- Direct Current Electrical Resistivity (ER)
- Induced Polarization with SuperSting resistivity meter (IP)

TFM and FDEM will be applied to all areas of interest while GPR will be applied only to areas of interest that require further and/or higher resolution of a geophysical anomaly. ER and/or ER/IP methods will be used to assist in the delineation of certain features because these methods can penetrate to greater depths and are highly sensitive to electrical and chemical changes in soil that occur in contaminant plumes and landfills. The geophysical surveys will be conducted by geophysical subcontractor personnel trained, experienced, and qualified in shallow subsurface geophysics necessary to successfully perform all of the above geophysical methods.

2.0 Background

2.1 Discussion

This SOP is based on geophysical methods employed by the US Environmental Protection Agency's (EPA) subcontractor Hydrogeologic, Inc. (HGL) for the geophysical surveys they conducted in Area IV during 2010 and 2011. The Data Gap Investigation conducted as part of Phase 3 identified additional locations of suspected buried materials not surveyed by HGL and subsurface features such as sumps that were not located during prior sampling. To be consistent with the recently collected subsurface information, HGL's procedures were reviewed for applicability for the subsurface surveys described in this SOP.

The areas of interest and survey limits will be determined prior to field mobilization. The requirements for surveys and areas of interest are introduced in the Field Sampling Plan (FSP) Addendum for each subarea of Area IV. Additional areas of interest will be identified during implementation of soil sampling, subsurface drilling, and any anomalies identified by the utility locator subcontractor.

2.2 Associated Procedures

- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*
- SSFL SOP 6, *Field Measurement of Total Organic Vapor*
- SSFL SOP 7, *Field Measurement of Residual Radiation*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*

3.0 General Responsibilities

Field Team Leader-The field team leader (FTL) is responsible for ensuring that the geophysical subcontractor conducts the survey work in accordance with this SOP.

4.0 Required Equipment

- Appropriate project documents (including FSP Addendum and health and safety plan)
- Global Positioning System (GPS) unit for recording coordinates
- Field logbook
- Pin flags and/or wooden stakes
- Geometrics G858 cesium vapor magnetometer
- Trimble Pro XR
- Noggin Plus 500 Smart Cart
- Geonics EM-31 Standard
- Personal protective clothing and equipment (there may be limitations for steel-toed boots and geophysical equipment)
- 300 foot tape measure
- Fluorescent spray paint
- Equipment operation manuals
- NavCom SF 2050-G GPS
- Allegro hand held computer
- SuperSting R8/IP
- Geonics EM-31 Short

5.0 Procedures

5.1 Site Reconnaissance

The FTL, or their designate, will perform a site reconnaissance of the area of interest to identify features that would suggest ground disturbance and further define the geophysical survey boundaries. Mounding or hummocky ground surface, the presence of surface debris and/or ferrous material will be noted. These features will be marked with a wooden stake, surveyor’s flag, or nail and whisker, and their location recorded with a GPS unit. All surface metal such as scrap metal, fences, above ground pipes and tanks, manholes, and signposts, will be mapped and recorded using a GPS unit. Radiological screening will occur at each area of interest scheduled for a geophysical survey.

5.2 Grid Layout

Areas of interest will be divided into 100-foot by 100-foot grids. A wooden stake placed at the southwest corner of each grid will be used to uniquely identify each grid. A 300-foot measuring tape will be used to measure the north and south sides of each grid. North to south oriented traverse lines will be marked starting from the southwest corner of each grid. A survey transit or equivalent will be used to ensure the sides of each grid are perpendicular, or documented with the FTL that this was not completed. Geophysical data will be collected along these traverse lines.

5.3 Data Acquisition

5.3.1 Total Field Magnetometry

TFM will consist of the Geometrics G858 cesium vapor magnetometer (CVM) used for area of interest measurements. TFM is useful for identifying ferrous metal objects at shallow to moderately deep depths as well as mapping subtle changes in magnetic properties of soil.

Variation of the Earth’s total magnetic field will be measured at the anomalous location (as appropriate) using the CVM. Because the size of the area of interest will vary by location, the spacing of transects and grids may vary as discussed below. . Nominally selected areas may be surveyed using 100-foot by 100-foot grids divided into 10-foot spaced transects (however size of the area may dictate changes in the transect spacing) and marked in the field using traffic cones. Each transect will be traversed until the grid is completely surveyed. A common point on each grid will be reoccupied several times during the survey to monitor and record the variations in the earth's magnetic field over time.

The CVM will be set to record 10 cycles per second and a NavCom SF2050-G GPS unit will be attached to the CVM. Data will be stored in the G858 internal data logger. The CVM will carry one sensor mounted on an aluminum boom and perpendicular to the ground at a height of about 3 feet. The operator will remove all metal from his persons prior to performing the survey and will ensure the proper orientation of the sensors. The operator will check battery level and the GPS and the sensor signal strength. The operator will monitor the GPS and signal data stream during the survey using the G858 liquid crystal display. Data will be downloaded from the data logger to a field laptop computer at the end of each day and backed up on the Subcontractor's office computer.

The need for additional filtering of the TFM data will be determined by the geophysicist interpreting the data and cannot be specified at this time. The data processing and assumptions will be provided by the CDM subcontractor performing the geophysical surveys.

5.3.2 Frequency Domain Electromagnetic Method

Mapping of shallow disposal pits, septic tank fill areas, utility lines, and larger metallic objects using conductivity measurements will be accomplished using the FDEM system, the Geonics EM-31 Standard and EM-31 Short. The EM-31 Short will be used for septic tank fill areas, sewer holdup tanks, and former excavations as it is more sensitive to these features than the EM-31 Standard. The EM-31 will be set to record terrain conductivity at an interval of five cycles per second. Location information will be obtained using a NavCom SF2050-G GPS unit; conductivity and GPS data will be recorded on an Allegro handheld personal computer. Data will be downloaded at the end of each day.

As appropriate, terrain conductivity at the survey location will be measured using the EM-31. Nominally, 100-foot by 100-foot grid will be divided into 5-foot spaced transects and marked in the field using traffic cones. However, spacing may vary based on the size of the area and objectives stated in the applicable Field Sampling Plan Addendum developed for each Area IV subarea. Each transect will be traversed until the grid is completely surveyed.

The operator will remove all metal from his/her body prior to conducting the survey. The Operator will check the GPS data stream and perform an EM-31 function test, and ensure that the coils are approximately 3 feet above the ground (or properly suspended in a nonmetallic cart-type configuration) and oriented parallel with the ground. The operator will ensure proper function of the EM-31 and GPS by monitoring the liquid crystal display of the Allegro handheld personal computer.

5.3.3 Ground Penetrating Radar

GPR will be used to locate utilities, underground storage tanks, metallic and non-metallic containers, and boundaries of excavations to a higher resolution than that obtained using the TFM or FDEM systems. GPR uses pulsed, high frequency signals (i.e., radio waves) transmitted into the ground using an antenna. The sample antenna receives the electromagnetic waves reflected from materials with differing dielectric properties. The data are recorded by the Noggin Plus 500 Smart Cart instruments digital video logger (DVL).

An odometer will be attached to the Noggin Plus 500 Smart Cart and data will be recorded at a rate of 1 cycle per inch. Data will be recorded using the DVL and will be downloaded at the end of each day to a field laptop computer at the end of each day and backed up on the Subcontractor's office computer.

GPR will be collected along individual traverses at an appropriate spacing for the target and size of the area to be investigated. Generally for areas 25 feet by 25 feet or smaller, the transects will be 2 feet apart, but the transect spacing may vary depending on the objective of the survey. Each transect will be traversed until the grid is completely surveyed.

To ensure proper operation of the GPR system, the operation will monitor the line length and cross-section on the DVL.

5.3.4 Electrical Resistivity and Induced Polarization Methods

The electrical resistivity method is highly effective in the delineation of materials or interfaces that have a contrast in electrical resistivity across a vertical or horizontal boundary. Examples of types of materials with contrasting electrical resistivity are: overlying soils vs. bedrock, fresh-water sand vs. clay, and highly contaminated soils vs. background soils. The electrical resistivity method is expected to be useful at SSFL for the delineation of the overlying soils/bedrock interface in the area of landfills, as well as wherever there is an interest in imaging the overlying soils/bedrock interface or vertical excavation boundaries at depths greater than 5 feet below ground surface.

The IP method will be used to delineate materials or interfaces that have a contrast in chargeability, such as chemical plumes vs. background soils, and soils or groundwater undergoing complex ionic interactions vs. background soils, such as areas where redox reactions are taking place. As such, the identified landfill areas in Area IV are expected to exhibit a measurable difference in both resistivity and chargeability.

The induced polarization method will measure the chargeability of a material (ability of that material to polarize) by sending a known amount of current into a section of ground, and then records the voltage on the decay curve after the current is turned off during a specified integration time. The integrated voltage is then normalized by the primary voltage, and the result is called chargeability, with units of milliseconds (ms).

The IP method is also provides a measure of the frequency dependence of resistivity. IP is a surface phenomenon which takes place at the interface between an electrolyte and a mineral grain. The chargeability of a material depends on the salinity of the electrolyte, grain size distribution, ion exchange properties of the interface, thickness of the electrical double layer, current pulse duration and excitation frequency. Clays and disseminated mineral deposits tend to have higher chargeability than sands or granites because they tend to have more free ions available. In addition, because of the ionic exchanges and complex chemistry that occurs in landfills, it is anticipated that there will be an increased chargeability in these areas.

The apparent resistivity and the apparent chargeability for each pair of surface or borehole current/potential electrodes will be recorded using the “SuperSting.” The SuperSting is a multi-channel portable memory earth resistivity meter with memory storage of readings and user defined measure cycles. By varying the spacing between both individual and pairs of electrodes within certain types of geometrical arrays, two 2D grids (X versus Z) of data are obtained for any given deployment - one of apparent resistivity and one of apparent chargeability. Increasing the distance between current and potential electrode pairs allows the current to travel deeper into the ground and "sample" to greater depths. These grids of data points are then interpreted for the optimal resistivity/chargeability earth model that would generate the apparent measurements obtained along a given established transect.

The SuperSting has a fully automated measuring system, which allows a full suite of measurements to be taken once the electrode array has been placed in the ground. The ability to collect 2D data (i.e., at several different fixed depths and several different lateral locations) allows an interpretation of vertical changes in resistivity and chargeability with depth and thus will provided an image of these changes (and ideally the lateral and vertical boundaries of landfill materials).

Landfill Investigations

Prior to any data acquisition, available SSFL geophysical anomaly and site maps will be reviewed to identify the locations of all utilities and subsurface features that may affect the resistivity readings. It is anticipated that at least two linear resistivity/IP transects at least 300 feet in length (one across the length and one across the width of the landfill) and centered on the location of landfill of interest will be established. Once established, each transect will be marked at 2-meter intervals along its entire length. Any utilities within 30 feet of these transects will be marked on the ground so that resistivity and IP anomalies from utilities can be identified in the data collected.

Electrode stakes will then be placed in the ground at each 2-meter interval, the electrodes will be attached and the circuit completed. It will be necessary to drill ¾-inch holes (2 feet deep) to allow soil contact where electrode locations fall within paved areas. Once this is done, manufacturer-recommended tests will be performed, including a contact resistance test. DC resistivity and IP data will then be acquired along each transect across the landfill at the Property using a dipole-dipole array of multiple electrodes spaced at 2-meter intervals. This array will maximize the depth of penetration of the current sent by the transmitter and provide a high quality image of the subsurface to a depth of at least 60 feet below ground surface. Once the data are collected, they will be downloaded to a laptop computer and saved for further processing. Relative elevations along each resistivity transect will be obtained by the geophysics crew using a stadia rod and eye level.

Historic Excavation and Optimal Sampling Location Delineation

In areas where the vertical boundary of a former excavation or the optimal location to sample in order to reach targeted depth is desired, individual electrical resistivity transects to provide a 2D image of the fill/native or soils/bedrock interface will be installed across the area of interest. In general, for each of these anomalous areas, one linear DC resistivity transect, with the general rule that the length of the transect will be at least four but preferably five times as long as the required depth of investigation, will be established across the boundaries of the area. Once established, each transect will be marked at 2-meter intervals along its entire length. Any utilities within 10 feet of these transects will be marked on the ground so that resistivity anomalies from utilities can be identified in the data collected.

Electrode stakes will then be placed in the ground at each 2-meter interval, the electrodes will be attached and the circuit completed. It will be necessary to drill ¾-inch holes (2 feet deep) to allow soil contact where electrode locations fall within paved areas. Once this is done, manufacturer-recommended tests will be performed, including a contact resistance test. DC resistivity data will then be acquired along each transect across the designated area using a dipole-dipole array of multiple electrodes (up to 28 assumed) spaced at 2-meter intervals. This array will maximize the depth of penetration of the current sent by the transmitter and provide a high quality image of the subsurface to a maximum depth for the established length. Once the data are collected, they will be downloaded to a laptop computer and saved for further processing. If necessary, relative elevations along each resistivity transect will be obtained by the geophysics crew using a stadia rod and eye level.

Data Interpretation

For both applications the EarthImager 2D software package will be used to interpret the surface data acquired. Apparent resistivity and/or chargeability data will be downloaded from the instrument to a computer and these data sets will then be appropriately edited using this two-dimensional inversion modeling program. An interactive graphic display of the data readings will be used to remove invalid data points or groups of readings, as necessary. Appropriate inversion parameters (there are a few different options for obtaining a best fit to the data) will be chosen for each transect acquired, the inversion will be performed, and a resultant model section of resistivity or percent chargeability will be produced. One master color scheme will be chosen for all transects acquired that represents the full range of data values interpreted, such that a 2-D section acquired along one transect can be compared to a section acquired along another transect. It is from these model sections that interpretations of the lateral and vertical boundaries of the landfill, or the depth to bedrock or excavation will be made.

5.4 Navigation and Global Positioning System (GPS)

To properly locate and record geophysical investigations positions and anomalies, two GPS devices will be used:

- NavCom SF2050G, used with EM-31 and CVM
- Trimble ProXR, used for grid setup, surface material identification, and ground truthing.

The geodetic datum will be the California State Plane Coordinate System, North American Datum 1983 Zone 5, converted from the World Geodetic System 84 geographic (north latitude, west longitude) datum.

5.5 Quality Assurance/Quality Control

5.5.1 Control Evaluation Area

The effectiveness of the use of the CVM, EM-31, and GPR to detect buried metallic objects under actual site conditions will be demonstrated using a performance test plot established by CDM Smith in Subarea 5D-North. The test plot includes specific locations of buried debris. Instruments used to conduct the Phase 3 geophysical surveys will be used over the test plot to check instrument responses.

In addition, a QA/QC control evaluation area to be constructed by CDM Smith in Subarea 5D-North in an undisturbed area free of buried metal and cultural interferences, will be used to obtain background readings. The area will consist of an instrument check base station and two evaluation test strips (a baseline and seeded line).

The EM-31 and CVM will be evaluated each morning in the QA/QC control evaluation area as follows:

- Static Test – three minute stationary test conducted in the instrument check base station with EM-31 or CVM recording data. The operator will shake and pull the cables to simulate field conditions.
- Baseline Test – motion test conducted over the baseline evaluation test strip using EM-31 or CVM recording data.
- Seeded Line Test – motion test conducted over the seeded line evaluation test strip using EM-31 or CVM recording data.

The test data will be reviewed during data collection and following data collection. CDM Smith and the subcontractor will evaluate the test data to determine if the equipment was functioning properly and that the target detection capabilities of the instruments were consistent with the objectives/standards of the investigation.

5.5.2 Daily Instrument Checks

All geophysical instruments are calibrated at the factory and no field calibration will be necessary. Daily instrument field checks will be performed as recommended by the manufacturer. The functional and quality checks for each instrument are described below. Refer to the manufacturer's operation manual for specific procedures for each instrument.

<u>CVM</u> – Following setup of the instrument and before operating the CVM the following functions will be checked to ensure proper operation:

- Battery – batteries will be checked to ensure that they are fully charged.
- Signal Strength – Prior to operating the CVM, the sensors signal strength will be operating at 25 percent or greater full signal strength.
- GPS Acquisition – Prior to operating the CVM, the GPS chat mode will be checked to ensure that unit is functioning properly and receiving a signal.

<u>EM-31 Standard and EM-31 Short</u> – Prior to each day of testing and at the completion of each day's geophysical activities, several functional tests and nulling of the in-phase component ("I" component) will be conducted at the instrument check base station. The "I" component is the ratio of the two electromagnetic waves measured by the instruments used in these methods and generally indicates the presence of good electrical conductors. The following information will be recorded daily:

- Battery Check – record at beginning of day and prior to connecting to receiver. Batteries should read above 4.7 volts.
- Zero in Test – record at beginning of day and prior to connecting to receiver. The Q interval (measure of the average bulk terrain conductivity sampled over a volume of earth to a maximum depth proportional to the coil spacing and transmission frequency of the instrument) is required to be between -1.000 and 1.000. Adjust instrument as necessary.

- Nulling – record at beginning and end of each day. The I component should be adjusted to 0.000 and within -0.003 and 0.003. Check and adjust frequently throughout the day.
- Phase Test – record at the beginning of the day and during the midday function test. The Q value is required to be 0.100 between two course adjustment settings.
- Sensitivity Test – record at the beginning of the day and during midday function test.
- Q and I Values – record at the beginning of the day and end of the day. The Q and I values will be recorded while EM-31 is in North-South orientation and in East-West orientation.
- GPS Acquisition – before performing geophysical operations, check GPS signal and data acquisition system.

Geophysical and GPS data will be downloaded from the recording unit to an external computer at the end of each day. The data will be reviewed for quality and accuracy. Issues with geophysical or GPS data will be noted and corrective actions will be developed if necessary.

SuperSting R8/IP – instrument calibration is generally done by the manufacturer. During this procedure, instrument firmware is loaded into the instrument memory, and all system functions are checked to make sure they are working correctly. SuperSting cables will also be checked at the manufacturer to ensure that they are working properly prior to their deployment to the site.

Contact Resistance Test – There are a few field procedures recommended by the manufacturer to ensure high quality resistivity/IP data are obtained. Steel resistivity stakes will be planted in the ground at each two-meter electrode station for the length of each resistivity/IP transect; once the stakes are established the resistivity cable with stainless steel electrodes will be attached to each stake with a rubber band to form the electrical circuit. Prior to data acquisition, all recommended manufacturer system tests will be conducted, and contact resistance tests will be conducted on the electrodes to ensure that enough current is traveling through the ground to obtain accurate results; this test will be conducted between pairs of electrodes. No pair of electrodes shall be accepted unless the resistance between them is 1.5kOhm or lower. If this test fails, soil at the base of the stakes in question will be watered with a saltwater solution, and, (only if necessary) small pits may be dug where the saltwater solution will be left to sit and slowly absorb into the sand in order to decrease the contact resistance. Once the contact resistance between all electrodes has reached an acceptable level the dipole-dipole data will be collected along each line using a linear array of multiple electrodes. As another quality check, for each measurement on each line, two readings will be taken in order to allow a determination of data repeatability.

Quality Checks in EarthImager – As a final check on data quality, the interactive data display features in EarthImager will be used in order to eliminate noisy data points from the 2D inversion. EarthImager has several different parameter display options, such as negative readings, raw measured electrical resistivity, measured voltage, measured error between duplicate readings, and injected current. No data points will be allowed to stay in the edited resistivity/IP file unless these data meet the acceptable criteria (i.e., no negative readings or voltages below 0.2 mV) for quality data. Criteria for site dependant parameters cannot be stated prior to data acquisition.

5.5.3 Ground Truthing

Grounding truthing will be performed to verify or eliminate an instrument response anomaly. Ground truthing may include additional site reconnaissance, additional magnetic locator(s), and other line of evidence observations used to support or eliminate the anomaly and further investigation action(s). If an anomaly is verified, its boundaries, type, and location will be incorporated into the SSFL geographic information system.

5.6 Reporting

Geophysical survey reporting will include:

- Record of instrument calibration in accordance with manufacturer's instructions.
- Conduct and document replicate measurements so that measurement precision can be established.

- Review of graphical data during field activities to determine that the quality is adequate, and whether the survey results appear to be consistent with geological concepts of the area of interest.
- Conduct interim, real-time scrutiny of the data to identify any technical difficulties, and notify CDM Smith of any quality problems and corrective actions taken.
- Identification of utilities and subsurface features will be marked by the subcontractor at the surface using field markings (paint, flags, or wooden stakes). A copy of the field-marked map will be provided to CDM Smith at the end of the day that the surveys are completed.
- Site sketches will reference permanent landmarks so that locations can be determined at a later date in the event that field markings, flags, or stakes have been obliterated or removed.
- Iso-intensity contour maps of the TFM and FDEM data will be prepared and included in the report.
- Field notes and maps will be provided to CDM Smith at the end of the day that the surveys are completed (operator, line and trace designation, equipment reference, antenna frequency, and profile image in hardcopy format).
- Electronic record of all geophysical survey and GPS data.
- Letter format report(s) providing a project narrative and summarizing the area(s) surveyed, technology used, and the findings. Attachments to the letter report will include copies of the field logbook notes, hand-drawn site sketches, electronic survey records, and quality control data and level of quality of the data.

6.0 Restrictions/Limitations

All geophysical methods have limitations. The FTL and technical staff must work with the subcontractor to understand the limitations of various data collection techniques. Limitations typically are associated with interferences (both surface and underground) that result in anomalous reading/results.

7.0 References

U.S. Environmental Protection Agency. 1997. *Expedited Site Assessment Tools For Underground Storage Tank Sites: A Guide For Regulators.* EPA 510-B-97-001. March.

_______. 1993b. *Use of Airborne, Surface, and Borehole Geophysical Techniques at Contaminated Sites: A Reference Guide.* EPA/625/R-92/007. Office of Research and Development, Washington, DC

Table 1. Locations for Geophysical Survey

Location	Description	Sampling Rationale	Geophysical Survey Needs	Recommended Geophysical Methods
Subarea 5C				
NW Area	Bldg 4056 Landfill Area	To delineate and characterize the area of fill	Conduct geophysical survey of former Building 4056 Landfill Annex area (roughly 200 ft x 200 ft) in effort to demarcate areal extent of fill. Test pits and trenches will subsequently be located based on results of the survey to delineate and characterize the area of fill.	EM31-SH, EM-61, Cesium vapor magnetometer, Electrical resistivity, possibly induced polarization, Electrical resistivity/IP will be established as individual transects approximately 300 feet in length, with 2-meter electrode spacing and centered on the expected location of the landfill.
SW Area	Near SL-695	Confirm location of former sanitary sewer line	Conduct Geophysics along southern wall of Bldg 4065 to confirm location of former sanitary sewer line connection to the	Utility locating methods
NE Area	Bldg 4062	To determine existence/location of fuel lines connected to former fuel UST	Conduct geophysical survey of area (roughly 25 ft x 50 ft) north of Building 4062 to determine existence/location of fuel lines that connected a former fuel UST with equipment in the building.	Utility locating methods
Center Area	Bldg 4100	Confirm sanitary sewer line.	Conduct geophysical survey of area (roughly 20 ft x 30 ft) to locate sanitary sewer line exiting west side of Building 4100 and confirm sewer line terminates at the lined drainage	Utility locating methods
5C_DG-628	Building 4100 Liquid Waste Hold up Tank Vault	Location targets soil beneath former liquid waste hold up tank vault. Based on demolition/removal photos, the vault excavation bottom is estimated at approx 28 feet bgs. Collect soil from 28 feet to bedrock, sampling from native soil if observed; otherwise collect sample immediately above bedrock. Two samples assumed; sample depths may vary based on field conditions.	These borings only reached depths of 13.5 (DG-628) and 10.0 ft (DG-630). Survey area of former excavation, approximately 10 ft x 15 ft to determine lateral and vertical extent of excavation. This area is partially included in the SW area (see above) to be geophysically surveyed on west side of Building 4100 as shown on Figure 4 for Subarea 5C, Proposed locations of Geophysical Surveys. Based on results of survey, new locations will be selected where it looks like it may be possible to get to the targeted depths.	Ground penetrating radar and possibly electrical resistivity, data will be collected along individual transects. Electrical resistivity transects will be centered over the expected location, use 2-meter spacing and may be as long as 150 feet as space allows.
5C_DG-630	Building 4100 Liquid Waste Hold up Tank Vault	Location targets former discharge pipe entrance to liquid waste hold up tank vault. Sample depths selected based on hold up tank vault removal to target native soil beneath e1cavation backfill. Note: All soil immediately adjacent to the inlet (i.e., at inlet depth) was excavated during removal of the hold up tank and backfilled.		
Subarea 5B				
Northern Area	SL-502 near Bldg 4019	Targets waste holdup tank associated with B4019 sanitary sewer line (identified in EPA HSA). Analyze all samples due to potential release at depth; collect deepest sample just above bedrock and analyze for full suite plus VOCs (SM) to evaluate potential migration to groundwater.	Conduct geophysical survey of area approx. 15 ft x 30 ft to identify location of sanitary sewer waste holdup tank	EM31-SH, ground penetrating radar
Center Area	Surrounds SL-693	Conduct geophysical survey and excavate trench targeting leach line, linear geophysical anomaly, and northern terminus of above ground fuel line. Extend trench approximately 20 feet eastward to investigate the northern terminus of the fuel line (i.e., determine if the pipeline goes underground at this location and has been removed). Collect an additional sample if the terminus of the pipeline is identified or soil staining observed. Adjust 5 foot boring sample to target beneath piping or below fill in top of native if observed. Analyze for PAHs and TPH.	Conduct geophysical survey of area approx. 35 ft x 30 ft targeting leach line, linear geophysical anomaly, and northern terminus of aboveground fuel line to determine if pipe went below grade and if it has been removed.	EM31-SH, ground penetrating radar, utility locating methods
Southern Area	Bldg 4011	To determine location of septic tank associated with Bldg 4011	Conduct geophysical survey of area approx. 40 ft x 40 ft to determine the location of septic tank associated with Building 4011.	EM31-SH, ground penetrating radar
5B_DG-550	Waste Holdup Tank East of B4010	Stepdown to delineate depth of identified contamination area. Specifically targets former Waste Holdup Tank; however, representative of deep impacts in excavation/fill area. 10 and 15 foot samples target native soil beneath fill and fill/native soil above bedrock, to evaluate depth penetration and maximum impacts above bedrock.	Borehole terminated at 5.2 ft. Survey area approximately 25 ft around sample location in effort to determine optimal location to get to target depth.	Ground penetrating radar, possibly electrical resistivity. Data will be collected along individual transects. Electrical resistivity transects will be centered over sample location, use 2-meter spacing and may be as long as 150 feet as space allows.

Table 1. Locations for Geophysical Survey				
Location	**Description**	**Sampling Rationale**	**Geophysical Survey Needs**	**Recommended Geophysical Methods**
Subarea 5B continued				
5B_DG-551	Building 4710	Stepdown to delineate depth of identified contamination area. Specifically targets former UST; however, representative of deep impacts in excavation/fill area. 10 and 15 foot samples target native soil beneath fill and fill/native soil above bedrock, to evaluate depth penetration and maximum impacts above bedrock.	Borehole terminated at 3.9 ft. Survey area approximately 25 ft around sample location in effort to determine optimal location to get to target depth.	Ground penetrating radar, possibly electrical resistivity, data will be collected along individual transects. Electrical resistivity transects will use 2-meter spacing and may be as long as 150 feet as space allows.
5B_DG-636	North of Building 4226	Targets potential sump on north side of B4226. EPA HSA indicates sump on south side of B4226; however, facility drawing indicates sump on north side. Trenching proposed on south side to address uncertainty. Location also targets storage visible in 1980 aerial photo and serves as stepout for PCBs at SL-087-SA5B. Hold 10 foot sample pending shallow results.	Borehole terminated at 6.8 ft. Survey area approximately 25 ft around sample location in effort to determine optimal location to get to target depth.	Ground penetrating radar, possibly electrical resistivity, data will be collected along individual transects. Electrical resistivity transects will be centered over sample location, use 2-meter spacing and may be as long as 150 feet as space allows.
5B_DG-650	Building 4826	Stepdown for previous location targeting former sodium tank pit with fill observed to 10 feet and no refusal encountered. TPH > 10x ISL detected at depth. Depths indicated are estimated; target native soil below fill and just above bedrock.	Borehole terminated at 4.6 ft. Survey area approximately 25 ft around sample location in effort to determine optimal location to get to target depth.	Ground penetrating radar, possibly electrical resistivity, data will be collected along individual transects. Electrical resistivity transects will use 2-meter spacing and may be as long as 150 feet as space allows.
5B_DG-651	South of Building 4826	Representative location in operational area between B4026 and B4354. Also targets linear terrain conductivity anomaly. Include corrosion inhibitors since cooling tower operations at B4006. Hold 10 foot sample pending shallow results.	Borehole terminated at 1.7 ft. Survey area approximately 25 ft around sample location in effort to determine optimal location to get to target depth.	Ground penetrating radar, possibly electrical resistivity, data will be collected along individual transects. Electrical resistivity transects will use 2-meter spacing and may be as long as 150 feet as space allows.
5B_DG-670	Presumed Sump West of Building 4006	Stepout for TPH, dioxins and metals at presumed sump; also representative location in operation area. Analyze all samples for TPH and metals based on detections at depth in SL-081-SA5B, SL-082-SA5B, and PUBS1066, and remaining chemicals based on potential migration from sump along bedrock.	Borehole terminated at 8.2 ft. Survey area approximately 25 ft around sample location in effort to determine optimal location to get to target depth.	Ground penetrating radar, possibly electrical resistivity, data will be collected along individual transects. Electrical resistivity transects will be centered over sample location, use 2-meter spacing and may be as long as 150 feet as space allows.
5B_DG-671	Presumed Sump West of Building 4006	Stepdown for TPH and metals at depth in SL-082-SA5B based on previous detection at 8 feet. Collect and analyze sample at 10 feet; 15 foot sample targets just above bedrock.	Borehole terminated at 7.4 ft. Survey area approximately 25 ft around sample location in effort to determine optimal location to get to target depth.	Ground penetrating radar, possibly electrical resistivity, data will be collected along individual transects. Electrical resistivity transects will be centered over sample location, use 2-meter spacing and may be as long as 150 feet as space allows.
5B_DG-686	East of Building 4006	Location targets a 1,000-gallon diesel UST and provides representative characterization at surface. Collect samples to bedrock due to tank size; hold samples deeper than 10 feet pending shallow results or analyze if impacts noted above bedrock.	Borehole terminated at 6.8 ft. Survey area approximately 25 ft around sample location in effort to determine optimal location to get to target depth.	Ground penetrating radar, possibly electrical resistivity, data will be collected along individual transects. Electrical resistivity transects will be centered over sample location, use 2-meter spacing and may be as long as 150 feet as space allows.
Subarea 5A *				
NW Area	SL-522 & SL-535	**SL-522:** Location targets removed fuel oil UST (UT-18) located south of B4024. Tank bottom depth expected ~8' with bedrock anticipated at ~10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths to characterize fill of unknown origin and potential release from tank. Conduct geophysical survey prior to sampling to determine location of removed UST. **SL-535:** Location targets removed fuel oil UST (UT-19) located northeast of B4024. Tank depth anticipated ~8'. Location based on facility drawing; previous location targeting UST (U5BS1126) had bedrock refusal above the tank bottom depth. Bedrock at ~10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths to characterize fill of unknown origin and potential release from tank. Conduct geophysical survey prior to sampling to determine location of removed UST.	Conduct geophysical survey of 2 areas approx. 10-15 ft x 20 ft to identify location of removed fuel oil USTs to determine optimal location of borings 5A-DG-522 and 5A-DG-535.	Ground penetrating radar, possibly electrical resistivity in each area: data will be collected along individual transects. Electrical resistivity transects will be centered over sample location, use 2-meter spacing and may be as long as 150 feet as space allows.

Table 1. Locations for Geophysical Survey				
Location	**Description**	**Sampling Rationale**	**Geophysical Survey Needs**	**Recommended Geophysical Methods**
Subarea 5A continued				
NE Area	SL-564	Location targets removed UST UT-22 (used for fuel oil); positioned within light toned mounded material identified in EPA tech memo. Bedrock is anticipated at ~10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths. Conduct geophysical survey prior to sampling to determine location of removed UST, shown in two different locations in separate documents.	Conduct geophysical survey of 2 areas approx. 13 ft x 55 ft and 10 ft x 15 ft at corner of former building to determine location of removed fuel oil UST for optimal placement of boring 5A_DG-564. Tank location has been shown in two different locations in separate documents.	Ground penetrating radar, EM31-SH
Southern Area	Area around Bldg 4005	Sample USTs area surrounding former Bldg 4005	Conduct geophysical survey to investigate presence or absence of USTs in the Sitewide Tank Tech Memo as having unknown locations.	EM-61, ground penetrating radar
5A_DG-511	West of Building 4024	Location targets fill from unknown origin west of B4024 observed at SL-245-SA5A to 30' (fill extent shown on 1961 B4024 facility drawing and likely placed during original construction activities); positioned near ramp into B4024 adjacent to the reactor vault complex. Bedrock anticipated ~30'. Collect samples at 5' intervals to 20', then every 10' to bedrock with the deepest sample just above bedrock; analyze all depths to characterize fill.	Conduct geophysical survey prior to sampling to determine location of reactor vault complex or location/extent of backfill if vault has been removed.	EM-61, EM31-SH
5A_DG-522	South of Building 4024	Location targets removed fuel oil UST (UT-18) located south of B4024. Tank bottom depth expected ~8' with bedrock anticipated at ~10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths to characterize fill of unknown origin and potential release from tank.	Conduct geophysical survey prior to sampling to determine location/extent of backfill emplaced after removal of UST.	EM31-SH, ground penetrating radar
5A_DG-525	East of Building 4024	Location targets fill from unknown origin in location of former underground radioactive gas hold-up tanks (samples of fill contain dioxins, PAHs, TPH, and/or metals above screening criteria). Bedrock anticipated ~15'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths to characterize fill.	Conduct geophysical survey prior to sampling to determine location/extent of backfill emplaced after removal of underground radioactive gas hold-up tanks.	EM31-SH, ground penetrating radar
5A_DG-527	Open Storage East of Building 4024	Stepup at SL-113-SA5A for 0' and 5' samples (Zinc and TPH detected above ISLs at depth) to characterize fill in location of former underground radioactive gas hold-up tanks (samples of fill contain dioxins, PAHs, TPH, and/or metals above screening criteria) and fenced open storage observed first in 1990 aerial photo. Bedrock anticipated at 15'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all	Conduct geophysical survey prior to sampling to determine location/extent of backfill emplaced after removal of underground radioactive gas hold-up tanks.	EM31-SH, ground penetrating radar
5A_DG-528	Southeast of Building 4024	Representative location characterizing operational area; positioned south of fill from unknown origin in location of former underground radioactive gas hold-up tanks (samples of fill contain dioxins, PAHs, TPH, and/or metals above screening criteria). Bedrock anticipated ~10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all	Conduct geophysical survey prior to sampling to determine location/extent of backfill emplaced after removal of underground radioactive gas hold-up tanks.	EM31-SH, ground penetrating radar
5A_DG-529	East of Building 4024	Location targets ground penetrating radar anomaly and fill from unknown origin in location of former underground radioactive gas hold-up tanks (samples of fill contain dioxins, PAHs, TPH, and/or metals above screening criteria); and characterizes fenced open storage. Bedrock anticipated at 15'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths to characterize fill.	Conduct geophysical survey prior to sampling to determine location/extent of backfill emplaced after removal of underground radioactive gas hold-up tanks.	EM31-SH, ground penetrating radar
5A_DG-532	East of the Building 4024	Location targets area east of the Hot Waste Storage vaults and stepout from SL-117-SA5A and SL-118-SA5A (TPH detected above ISL). Bedrock anticipated ~10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; hold deeper samples pending shallower results.	Conduct geophysical survey approximately 25 ft around sample location to determine optimal location to get to target depth.	Ground penetrating radar, possibly electrical resistivity, data will be collected along individual transects. Electrical resistivity transects will be centered over sample location, use 2-meter spacing and may be as long as 150 feet as space
5A_DG-535	Northeast of Building 4024	Location targets removed fuel oil UST (UT-19) located northeast of B4024. Tank depth anticipated ~8'. Location based on facility drawing; previous location targeting UST (U5BS1126) had bedrock refusal above the tank bottom depth. Bedrock at ~10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths to characterize fill of unknown origin and potential release from tank.	Conduct geophysical survey prior to sampling to determine location/extent of backfill emplaced after removal of UST.	EM31-SH, ground penetrating radar
Subarea 5A continued				

Table 1. Locations for Geophysical Survey

Location	Description	Sampling Rationale	Geophysical Survey Needs	Recommended Geophysical Methods
5A_DG-545	Between Buildings 4024 and 4027	Stepout from SL-118-SA5A that targeted the Hot Waste Storage vaults (TPH detected above ISLs); positioned near entrance to B4027. Bedrock anticipated ~5'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; hold deeper samples pending shallower results, if	Conduct geophysical survey approximately 25 ft around sample location to determine optimal location to get to target depth.	Ground penetrating radar, electrical resistivity, Electrical resistivity transects will be centered over sample location, use 2-meter spacing and may be as long as 150 feet as space allows.
5A_DG-564	East of Building 4032	Location targets removed UST UT-22 (used for fuel oil); positioned within light toned mounded material identified in EPA tech memo. Bedrock is anticipated at ~10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths. Conduct geophysical survey prior to sampling to determine location of removed UST, shown in two different locations in separate documents.	Conduct geophysical survey prior to sampling to determine location/extent of backfill emplaced after removal of UST.	EM31-SH, ground penetrating radar
5A_DG-600	West of Building 4005	Location targets B4005 floor trench conveyance pipe (dioxins, metals, PAHs, and PCBs detected above ISLs in previous lined trench sediment samples); also stepout from septic tank (dioxins detected above ISLs) and characterizes operational area; positioned between underground stormwater and floor trench conveyance pipes. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths to assess potential subsurface release and migration along bedrock.	Conduct geophysical survey prior to sampling to determine locations of floor trench conveyance pipe and septic tank.	EM31-SH, ground penetrating radar
5A_DG-602	West of Building 4005	Stepout from septic tank (dioxins); also characterizes operational area. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths to assess potential subsurface release and migration along bedrock.	Conduct geophysical survey prior to sampling to determine location of septic tank.	EM31-SH, ground penetrating radar
5A_DG-611	Northeast of Building 4005	Location targets two liquid hold-up tanks and undefined feature area (possible staining); also stepout for Clearly Contaminated Area. Bedrock anticipated between 5' and 10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths to assess potential depth of impacts (previous samples were shallow and for metals only).	Conduct geophysical survey prior to sampling to determine location of former underground liquid hold-up tanks.	EM-61, EM31-SH, ground penetrating radar
5A_DG-694	Southeast of Building 4073	Location targets discharge from cooling water hold-up tank drain line. Bedrock anticipated between 5' and 10'. Collect samples at 5' intervals to bedrock with deepest sample just above bedrock; analyze all depths.	Conduct geophysical survey prior to sampling to determine location of cooling water hold-up tank drain line.	Utility locating methods

* None of the boring locations 5A_DG-511 through 694 in Subarea 5A have been drilled. Geophysical surveys will be done prior to drilling/sampling with the goal of selecting optimal locations for the borings so that the target depths will be reached. Surveys will be conducted within 25 ft of targeted structure.

Photographic Documentation of Field Activities	SSFL SOP 15 Revision: 0 Date: April 2012

Prepared:	A. Herrington	**Technical Review:**	C. Werden
QA Review:	J. Oxford	**Approved and Issued:**	John T Wondolleck 4/6/2012 *Signature/Date*

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to provide standard guidelines and methods for photographic documentation. All photography should be digital – camera and/or video – and document field activities and site features (geologic formations, core sections, lithologic samples, general site layout, etc.). This SOP is intended for circumstances when formal photographic documentation is required.

All photography at SSFL is highly restricted. The use of cameras or video equipment at the SSFL site requires a permit secured through the primary site manager – The Boeing Company (Boeing). Unpermitted photography is strictly prohibited.

2.0 Background

2.1 Definitions

Standard Reference Marker - A standard reference marker is a reference marker that is used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

2.2 Associated Procedures

- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*
- SSFL SOP 14, *Geophysical Survey*

2.3 Discussion

Photographs taken during field investigations are used as an aid in documenting and describing site features, sample collection activities, equipment used, and possible lithologic interpretation. This SOP provides basic details for taking photographs during fieldwork. The use of a photographic logbook or log form and standardized entry procedures are also outlined. In addition, all SOPS will be on hand with the field sampling team.

3.0 General Responsibilities

Field Team Leader-The field team leader (FTL) is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The FTL is also responsible for supporting decisions of items to be photographed - specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographer-The photographer is one of the field crew. The photographer is responsible for maintaining a logbook or photographic log form per Sections 5.1 and 5.2 of this SOP.

4.0 Required Equipment

A general list of equipment that may be used:

- 35mm digital camera
- Standard reference markers

- Logbook
- Indelible black or blue ink pen
- Extra batteries for 35mm camera
- Storage medium (disks or cards) for digital camera

5.0 Procedures

5.1 Documentation

Use a photographic log form and/or project specific logbook to log and document photographic activities. Review SSFL SOP 8.

5.2 Operation

5.2.1 General Photographic Activities in the Field

The following sections provide general guidelines that should be followed to visually document field activities and site features using digital cameras and video equipment. Listed below are general suggestions that the photographer should consider when performing activities under this SOP:

- The photographer should be prepared to make a variety of shots, from close-up to wide-angle. Many shots will be repetitive in nature or format, especially close-up site feature photographs.
- The lighting for sample and feature photography should be oriented toward a flat condition with little or no shadow. Or, a flash may be used.
- Digital cameras have multiple photographic quality settings. A camera that obtains a higher resolution (quality) has a higher number of pixels and will store less photographs per digital storage medium.

5.2.2 General Guidelines for Still Photography

Caption Information

All photographs will have a full caption on a photo log sheet. The caption should contain the following information (digital photographs should have a caption added after the photographs are downloaded):

- Date and time
- Direction (if applicable)
- Photographer
- Description of activity/item shown (e.g., name of facility/site, specific project name, project number)
- Any other relevant information

When possible, a standard reference marker should be used in all documentary visual media. While the standard reference marker will be predominantly used in close-up feature documentation, inclusion in all scenes should be considered.

Digital media should be downloaded at least once each day to a personal computer; the files should be in either “JPEG” or “TIFF” format. Files should be renamed at the time of download to correspond to the logbook. It is recommended the electronic files be copied to a compact disc for backup.

Close-Up and Feature Photography

Any close-up photographs should include a standard reference marker of appropriate size as an indication of the feature size. Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their *in situ* locations. This enables a more accurate record of their initial condition and color.

Site Area Photography

Site area and background photography is not allowed without prior permission of Boeing.

Panoramic

Panoramic photography is not allowed without prior permission of Boeing.

5.2.3 Photographic Documentation

Photographic activities must be documented in a photographic log or in a section of the field logbook. The photographer will be responsible for making proper entries.

In addition to following the technical standards for logbook entry as referenced in SSFL SOP 8, the following information should be maintained in the appropriate logbook:

- Photographer name
- If required, an entry shall be made for each new roll control number assigned
- Sequential tracking number for each photograph taken (the camera-generated number may be used)
- Date and time (military time)
- Location
- A description of the activity/item photographed
- Record as much other information as possible to assist in the identification of the photographic document

5.3 Post Operation

5.3.1 Documentation

At the end of each day's photographic session, the photographer(s) will ensure that the field logbook (in accordance with SSFL SOP 8) and/or photographic log is complete.

5.3.2 Archive Procedures

- Photographs and the associated digital media will be submitted to the project files and handled according to contract records requirements. The project manager will ensure their proper distribution.
- Completed pages of the appropriate logbook will be copied weekly and submitted to the project files.

6.0 Restrictions/Limitations

This document is designed to provide a set of guidelines for the field amateur photographer to ensure that an effective and standardized program of visual documentation is maintained.

Note: Photography is restricted at SSFL; a camera permit from Boeing is required.

7.0 References

No references were used to develop this SOP.

Control of Measurement and Test Equipment	SSFL SOP 16 Revision: 0 Date: April 2012

Prepared: R. Kaspzyk

Technical Review: C. Zakowski

QA Review: J. Oxford

Approved and Issued: [signature] 4/6/2012
Signature/Date

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to establish the baseline requirements, procedures, and responsibilities inherent to the control and use of all measurement and test equipment (M&TE; e.g., hand-held field monitoring equipment, global positioning system (GPS) unit) for the Santa Susana Field Laboratory (SSFL) site.

2.0 Background

2.1 Definitions

Requisitioner – The person responsible for ordering the leased or purchased equipment.

Traceability – The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

2.2 Associated Procedures

- SSFL SOP 6, *Field Measurement of Total Organic Vapors*
- SSFL SOP 7, *Field Measurement of Residual Radiation*
- SSFL SOP 8, *Field Data Collection Documents, Content, and Control*
- Manufacturer's operating and maintenance and calibration procedures

2.3 Discussion

All M&TE used will be rented or leased from an outside vendor, or purchased. It is essential that measurements and tests resulting from the use of equipment be of the highest accountability and integrity. The equipment user should completely understand the operational instructions and comply with the specifications in the manufacturer's operations and maintenance manual and follow calibration procedures and in accordance with the Field Sampling Plan (FSP) Addendum.

3.0 Responsibilities

All staff with direct control and/or use of M&TE are responsible for being knowledgeable of and understanding and implementing the requirements contained herein. In addition, all field staff will be required to review the FSP Addendum, particularly as where the Addendum affects this SOP. It is possible that a variance from this SOP be identified as part of the Data Gap Investigation which would be described in the FSP Addendum.

The field team leader (FTL) or designee (equipment coordinator, quality assurance coordinator, etc.) is responsible for initiating and tracking the requirements contained herein.

4.0 Requirements for M&TE

- Determine and implement M&TE-related project-specific requirements.
- Follow the maintenance and calibration procedures when using M&TE.
- Obtain the maintenance and calibration procedures if they are missing or incomplete.
- Attach or include the maintenance and calibration procedures with the M&TE.
- Prepare and record maintenance and calibration in an equipment log or a field log as appropriate (Attachment A).
- Maintain M&TE records.
- Label M&TE requiring routine or scheduled calibration (when required).
- Perform calibration using the appropriate procedure and calibration standards; maintenance will be discussed with the supplier before conduct.

- Identify and take action on nonconforming M&TE.

5.0 Procedures

5.1 Obtain the Operating and Maintenance and Calibration Documents

For leased equipment, the requisitioner will request the maintenance and calibration procedures, the latest calibration record, and the calibration standards certification be provided to CDM Smith. If this information is not delivered with the M&TE, ask the procurement division to request it from the vendor.

5.2 Prepare and Record Maintenance and Calibration Records

The FTL or designee will record the initial daily maintenance and calibration events in a field logbook. Subsequent maintenance and calibration events will be reported to the FTL and recorded at the end of the each day.

5.3 Operating, Maintaining, or Calibrating an M&TE Item

The FTL or designee and user must operate, maintain, and calibrate M&TE in accordance with the maintenance and calibration procedures. Record maintenance and calibration actions in the equipment log or field log.

5.4 Shipment

The rental equipment supplier must inspect the item to ensure that the maintenance and calibration procedures and latest calibration and standards certification records are included before shipment. If any documentation is missing or incomplete, the item should not be shipped.

The receiver (FTL or field requisitioner) will communicate all documentation requirements to the shipper. They must also inspect and confirm the requested equipment and records were provided upon receipt. If documentation is missing, immediately contact the procurement division and request that they obtain the documentation from the vendor.

5.5 Records Maintenance

The receiver must also forward the packing slip to the procurement division.

The user must:

- Forward the completed field log to the FTL and SSFL project manager for inclusion in the project files.
- Retain the most current maintenance and calibration record and calibration standards certifications with the M&TE item and forward previous versions to the FTL and project manager for inclusion in the project files.

5.6 Traceability of Calibration Standards

The FTL or designee and user must:

- Order calibration standards designated by the supplier.
- Request and obtain certifications for standards that clearly state the traceability.
- Request and obtain material safety data sheets for the standards.
- Monitor standards that are perishable and consume or dispose of them on or before the expiration date.

5.7 M&TE That Fails Calibration

The FTL or designee must:

- Immediately discontinue use of the equipment and segregate the item from other equipment. Notify the FTL and take immediate action to replace the item.
- Review the current and previous maintenance and calibration records to determine if the validity of current or previous measurement and test results could have been affected and notify the FTL of the results of the review.

5.8 Determine if Other Related Project Requirements Apply

In the event a different or unique piece of equipment is needed on short notice for site-specific activity, the FTL or designee will determine if other M&TE project-related requirements could apply. If M&TE-related requirements apply, obtain a copy of them and review and implement as appropriate.

6.0 Restrictions/Limitations

Calibration and maintenance for field instruments are critical to collecting reputable data. If field monitoring equipment is not working properly, it should not be used. Work will be suspended until functional monitoring equipment is available.

7.0 References

No references used to develop this SOP.

8.0 Attachments

Attachment A – Maintenance and Calibration Form

Attachment A

CDM Smith A subsidiary of Camp Dresser & McKee Inc.

Maintenance and Calibration

Date: Time: (a.m./p.m.)		
Employee Name:		Equipment Description:
Contract/Project:		Equipment ID No.:
Activity: ___________________________		Equipment Serial No.: ______________________
Maintenance		
Maintenance Performed:		
Comments:		
Signature: ___________________________		Date: ______________________
Calibration/Field Check		
Calibration Standard:		Concentration of Standard:
Lot No. of Calibration Standard:		Expiration Date of Calibration Standard:
Pre-Calibration Reading:		Post-Calibration Reading:
Additional Readings:		Additional Readings:
Additional Readings:		Additional Readings:
Pre-Field Check Reading:		Post-Field Check Reading:
Adjustment(s):		
Calibration: ☐ Passed ☐ Failed		
Comments:		
Signature: ___________________________		Date: ______________________

Laboratory Homogenization For Phase 3 Soil Samples

SSFL SOP 17
Revision: 1
Date: June 2012

Prepared: T. Burgesser **Technical Review:** C. Werden

QA Review: K. Zilis **Approved and Issued:** John T Wondolleck 6/06/12
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to define the requirements and responsibilities for homogenizing multiple sample containers into one discrete surface or subsurface soil for all non-volatile/semi-volatile analyses (and select other) analyses for samples collected from the Santa Susana Field Laboratory (SSFL) site. Physical homogenization of soil material will be performed by subcontract laboratories. Homogenization of the depth-discrete samples by CDM Smith will not be performed in the field or in the field trailer. This SOP is intended to identify the minimum requirements required of the subcontract laboratories and is not intended to replace or supersede existing laboratory specific SOP.

2.0 Background

Soil sample homogenization prior to laboratory analysis has been requested by the California Department of Toxic Substances Control (DTSC) for the SSFL Phase 3 non-volatile chemical analyses. Homogenization was previously performed for selected SSFL Chemical Soil Background Study samples collected in the summer and fall 2011. During the background study, DTSC homogenized soil samples for chemical analyses for dioxins/furans, pesticides/herbicides, and metals, not including hexavalent chromium. The DTSC has determined that homogenizing future soil samples for all inorganic and non-volatile analyses (refer to the Field Sampling Plan [FSP] Addendum) will provide greater consistency and comparability of the analytical results from future studies throughout SSFL sampling programs.

During Phase 3 sampling, surface and subsurface soil samples will be collected following SSFL SOPs 2, 3, 4, and 5 through the use of stainless steel sleeves or placement in glass sample jars. Because of the volume needed for multiple chemical analyses, multiple sleeves or glass jars may be required from each sampling location. Soil samples to be analyzed for metals (not including hexavalent chromium), PCBs, dioxins/furans, pesticides, herbicides, and perchlorate will be subject to homogenization. Soil samples for VOC, SVOCs, TPH, alcohols, glycols, and similar volatiles analyses will not be homogenized.

Homogenization of soil samples will be requested to be performed by each laboratory before analytical testing begins.

2.1 Definitions

Grab Sample - A discrete portion of sample material or an aliquot taken from a specific sample location at a given point in time.

Spoon/Scoop/Trowel - A small stainless steel, Teflon®, Teflon® -lined, or plastic utensil measuring approximately 6 inches in length with a stem-like handle (for manual operation). Samples are handled and combined collected using a scooping action.

Stainless Steel or Glass Trays, Bowls or Pans – Appropriately-sized mixing containers used in the homogenization process.
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2.2 Associated Procedures

- SSFL SOP 2, *Surface Soil Sampling*
- SSFL SOP 3, *Subsurface Soil Sampling with Hand Auger*
- SSFL SOP 4, *Direct Push Technology Sampling*
- SSFL SOP 5, *Backhoe Trenching/Test Pits for Sample Collection*
- SSFL SOP 10, *Sample Custody*

- SSFL SOP 11, *Packaging and Shipping Environmental Samples*
- SSFL SOP 12, *Field Equipment Decontamination*

3.0 General Responsibilities

Field Team Leader-The field team leader (FTL) is responsible for ensuring that the Field Sample Coordinator is properly trained to manage the Phase 3 samples – identifying those sample sleeves and jars that do not require homogenization and those sample sleeves and jars that do require homogenization by the subcontract laboratory. The FTL also need to confirm that the sampling team is collecting sufficient sample volume for the homogenization measures.

Field Sample Coordinator–The sample coordinator is responsible for ensuring that all contracted laboratories follow this guidance in accordance with this procedure. In addition, all subcontract laboratories are required to have an SOP in place that describes in detail the specific laboratory procedures utilized to comply with this SOP.

Field Sampling Team-The field sampling team is responsible for collecting the proper volume of sample (refer to Table 1 in the FSP Addendum).

Laboratory Project Manager (PM)–The laboratory project manager is responsible for ensuring that all instructions regarding soil sample homogenization are followed by laboratory staff.

4.0 Required Equipment

Because homogenization of samples will occur a the subcontract laboratory, the laboratory supplies at a minimum should include:

- Laboratory logbook, bench sheet forms, other forms for documenting sample homogenization
- Indelible black or blue ink pens and markers
- Appropriate size sample containers (glass and plastic) with labels
- Stainless steel or glass trays, bowls, or pans
- Stainless steel or Teflon lined scoops/spoons/trowels
- Decontamination supplies
- Nitrile or appropriate gloves

5.0 Procedures

5.1 Laboratory Soil Homogenization/Compositing (Cone and Quarter Method)

The following steps will be performed by the analytical laboratory to create a composite soil sample for the non-volatile analyses. The laboratory will use sample quantities submitted in stainless steel sleeves or glass jars to perform this procedure.

1. Decontaminate all laboratory compositing equipment according to appropriate Laboratory SOPs.

2. Don appropriate PPE and gloves. Clean gloves must be worn for each sample composited.

3. With the top 1/3 and bottom 1/3 of sample material in the homogenization tray/bowl/pan, chop-up the sample into small chunks using a clean, stainless steel wallboard knife or other suitable implement.

4. Remove non-soil debris, including sticks and vegetation, as much as possible.

5. Scooping from the edge, form a mound in the center of the tray/bowl/pan.

6. Divide the mound into two equal piles and form each pile into a mound.

7. Divide each into two piles. (At this point there should be four piles in the tray/bowl/pan).

8. Mix the piles together that are opposite from each other into a single mound.

9. Repeat steps 7, 8 and 9 until the sample is thoroughly homogenized (a minimum of 3 times).

10. Transfer the thoroughly mixed sample to appropriately labeled sample containers for the required analyses.

11. Analyze the samples.

5.2 Contracted Laboratory Compositing Equipment Decontamination

To clean laboratory equipment used in homogenization, remove all gross materials/stains/hardened material using a scrubbing pad or brush and rinsing the equipment with water. After scrubbing and rinsing, the laboratory should implement internal laboratory procedures/SOPs to complete cleaning and decontamination process to ensure the compositing equipment is free of potential cross contamination. At a minimum, the laboratory decontamination process must comply with the requirements of SSFL SOP 12.

6.0 Documentation

Document all compositing activities including decontamination in an appropriate logbook and/or bench sheet.

7.0 References

Lancaster Laboratories Inc. 2011*SOP-SS-009 Homogenization and Subsampling of Solid Waste Samples from Environmental Sources.* July.

State of California Department of Toxic Substances Control (DTSC), 2012. *Homogenization of Soil Samples for Chemical Characterization, Santa Susana Field Laboratory, Ventura County, California*. February 29, 2012.