110

U.S. Department of Energy

Oakland Operations Office, Oakland, California

FINAL
WORK PLAN FOR EASTERN DOG PENS INVESTIGATION

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH (LEHR)
UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612-5208

Prepared by:

Weiss Associates
5500 Shellmound Street
Emeryville, CA 94608-2411

February 26, 1999
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental Science, Engineering and Management

FINAL
WORK PLAN FOR EASTERN DOG PENS INVESTIGATION

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH (LEHR)
UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612-5208

Prepared by:

Weiss Associates
5500 Shellmound Street
Emeryville, CA 94608-2411

February 26, 1999
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Issued To: _____ Date: _____

Copy No.: _____ ☐ Controlled ■ Uncontrolled

Approvals Page

FINAL
WORK PLAN FOR EASTERN DOG PENS INVESTIGATION

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH (LEHR)
UNIVERSITY OF CALIFORNIA AT DAVIS, CALIFORNIA

Prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612-5208

Prepared by:

Weiss Associates
5500 Shellmound Street
Emeryville, CA 94608-2411

February 26, 1999
Rev. 0

Approved by: Mary Stallard Date: 2/26/99
Mary Stallard, C.E.G.
Project Quality Assurance Manager
Weiss Associates

Approved by: Robert O. Devany Date: 2/26/99
Robert O. Devany, C.E.G., C.H.G.
Project Manager
Weiss Associates

Approved by: Michael D. Dresen Date: 2/26/99
Michael D. Dresen, C.E.G., C.H.G.
Program Manager
Weiss Associates

CONTENTS

1. INTRODUCTION 1-1
- 1.1 Previous Eastern Dog Pens Investigations 1-2
  - 1.1.1 Operational History 1-2
  - 1.1.2 Existing Data 1-2
- 1.2 Work Plan Organization 1-3

2. INVESTIGATION DESIGN 2-1
- 2.1 Problem Statement 2-1
- 2.2 Decision Identification 2-1
- 2.3 Decision Input Identification 2-2
- 2.4 Study Area Boundary Definition 2-2
- 2.5 Design Optimization 2-3
  - 2.5.1 Detailed Gamma/Beta Radiation Survey and Soil Sampling 2-3
  - 2.5.2 Soil Sampling 2-4
  - 2.5.3 Gravel and Curb Sampling 2-4

3. INVESTIGATION PROCEDURES 3-1
- 3.1 Clearing and Grubbing 3-1
- 3.2 Surface Radiation Survey 3-1
- 3.3 Utility Clearance 3-1
- 3.4 Soil Sample Collection 3-2
- 3.5 Sample Documentation 3-2
  - 3.5.1 Chain-of-Custody 3-3
  - 3.5.2 Field Logbook 3-3
  - 3.5.3 Sample Numbers 3-4
  - 3.5.4 Sample Labels 3-4
  - 3.5.5 Custody Seals 3-4
- 3.6 Chemical and Radiological Analysis 3-4

4. LAND SURVEY 4-1

5. QUALITY ASSURANCE AND DATA MANAGEMENT 5-1

6. INVESTIGATION-DERIVED WASTE MANAGEMENT 6-1
- 6.1 Shallow Subsurface Soil Sampling 6-1
- 6.2 Decontamination Solutions 6-1

7. HEALTH AND SAFETY CONSIDERATIONS 7-1
- 7.1 Hazard Analysis 7-1
  - 7.1.1 Underground Utilities 7-1
  - 7.1.2 Confined Space Entry 7-2
  - 7.1.3 Radiological Exposure 7-2
  - 7.1.4 Chemical Exposure 7-2
  - 7.1.5 Heat Stress 7-2
- 7.2 Hazard Controls 7-2
  - 7.2.1 Hazardous Work Permit 7-2
  - 7.2.2 Site Control and Work Zones 7-3
  - 7.2.3 Personal Protective Equipment 7-3
  - 7.2.4 Decontamination Procedures 7-3
  - 7.2.5 Training 7-4
  - 7.2.6 Buddy System 7-4
  - 7.2.7 Safety Equipment 7-5
  - 7.2.8 Air Monitoring 7-5

8. REFERENCES 8-1

FIGURES

Figure 1. LEHR Site Map Showing Former Eastern Dog Pens

Figure 2. Analytical Results above Background from Previous Investigations in the Former Eastern Dog Pens

Figure 3. Proposed Shallow Soil Sample Locations in the Former Eastern Dog Pens

TABLES

Table 1. Laboratory Analytical Methods Proposed for the Former Eastern Dog Pen Investigation

Table 2. Sampling Plan for the Former Eastern Dog Pens Investigation

Table 3. Estimated Number of Samples Required from the Former Eastern Dog Pens for Statistical Comparisons

APPENDICES

Appendix A. Standard Operating Procedures

1.1 Chain-of-Custody

2.1 Sample Handling, Packaging and Shipping

3.1 Surface and Shallow Subsurface Soil Sampling

6.1 Sampling Equipment and Well Material Decontamination

15.1 Lithologic Logging

ACRONYMS

µCi	MicroCuries
µR	MicroRem
AHAs	Activity Hazard Analyses
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
bgs	Below ground surface
CA	Contamination Area
COC	Contaminant of Concern
CPGERP	Contingency Plan and General Emergency Response Procedures
cpm	Counts per minute
DAC	Derived Air Concentration
DOE	U.S. Department of Energy
DQO	Data Quality Objective
EPA	U.S. Environmental Protection Agency
EZ	Exclusion zone
GEL	General Engineering Laboratories, Inc.
GM	Geiger Müeller Detector
HSC	Health and Safety Coordinator
HSPs	Health and Safety Procedures
HWP	Hazardous Work Permit
ID	Identification
IDW	Investigation-Derived Waste
IRA	Interim Removal Action
K-40	Potassium-40
LEHR	Laboratory for Energy-Related Health Research
LFI	Limited Field Investigation
mCi	MilliCuries
MDA	Minimum detectable activity
mg/kg	Milligrams per kilogram

ACRONYMS

mg/kg	Milligrams per kilogram
MOA	Memorandum of Agreement
OSHA	Occupational Safety and Health Administration
pCi/g	PicoCurie(s) per gram
PHSP	Project Health and Safety Plan
PID	Photoionization Detector
PPE	Personal Protective Equipment
PVC	Poly vinyl chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
Ra-226	Radium-226
RBAS	Risk-Based Action Standard
RCT	Radiological Control Technician
RI/FS	Remedial Investigation/Feasibility Study
RNG	Random number generator
RPM	Remedial Project Manager
RPP	Radiation Protection Program
SC	Site Coordinator
SHSO	Site Health and Safety Officer
SOP	Standard Operating Procedure
SOPs	Standard Operating Procedures
SQP	Standard Quality Procedure
Sr-90	Strontium-90
Th-232	Thorium-232
TSM	Tailgate Safety Meeting
UC Davis	University of California at Davis
USA	Underground Services Alert
USCS	Unified Soil Classification System
VOC	Volatile Organic Compound

ACRONYMS

WA	Weiss Associates
WBH	Waste Burial Hole
WRS	Wilcoxon Rank Sum

1. INTRODUCTION

This work plan presents the approach and procedures for investigating contaminants in shallow soil in the former Eastern Dog Pens at the Laboratory for Energy-Related Health Research (LEHR), University of California at Davis (UC Davis) (Figure 1). This work plan includes descriptions and rationale for the planned investigation activities, detailed procedures for all fieldwork, quality assurance/quality control (QA/QC), health and safety, data management, waste management, and data quality objectives (DQOs). This plan conforms to the sampling and analytic methods approved by the Remedial Project Managers (RPMs) for use in previous investigations, including the 1996 Limited Field Investigation (LFI), and 1997 and 1998 Data Gaps Investigations conducted at LEHR.

Although the Memorandum of Agreement (MOA) between the U.S. Department of Energy (DOE) and University of California specifies the Eastern Dog Pens as an area of DOE responsibility, these dog pens directly overlie UC Davis' Landfill No. 2. Provided DOE and UC Davis agree to a resolution of the long-term management for this area, the remedial action selected for Landfill No. 2 may also address the Eastern Dog Pens. Since UC Davis has requested use of the Eastern Dog Pens area for waste staging and handling during their Waste Burial Hole (WBH) area Interim Removal Action (IRA) scheduled for the summer of 1999, these Eastern Dog Pen investigations must be completed before that time. This initial phase of Eastern Dog Pen investigation is also necessary now in order for characterization of this area to be complete prior to preparation of the RI/FS for UC Davis soil areas planned for 2000/2001.

The objectives of this Eastern Dog Pens Investigation are to provide additional characterization data that will:

- Serve as a baseline data set prior to the area's possible use by UC Davis for waste handling;
- Support negotiations between DOE and UC Davis on the long-term management/environmental cleanup of the Eastern Dog Pens;
- Support future baseline risk assessment; and,
- Provide UC Davis with information to guide remedial decisions for Landfill No. 2.

1.1 Previous Eastern Dog Pens Investigations

1.1.1 Operational History

Between 1958 and the mid-1980's, the Western and Eastern Dog Pens were used to house dogs involved in radium-226 (Ra-226) and strontium-90 (Sr-90) research activities at the LEHR site. The dog pens were constructed in phases; the Eastern Dog Pens, built between 1968 and 1970, are the most recently constructed set. The Eastern Dog Pens contained 96 pens in three rows (K, L, and M), with each row containing 32 pens (Figure 2).

The radionuclide-dosed dogs were kept indoors for a 30-day holding period, prior to moving them outside to the Western and Eastern pens (Goldman, 1997; DOE archived records), regardless of the dose level. Calculations by Rosa, Gielow and Peterson in the 1963 LEHR Annual Report (DOE archived records) indicate that dogs were eliminating up to 0.23 microCuries (μCi) per 48 hrs in feces and urine 28 days after Sr-90 exposure. Calculations by Goldman in a 1963 memorandum (DOE archived records) estimated that about 500 μCi/yr Sr-90 and about 50 μCi/yr Ra-226 were eliminated as urine by the outdoor dogs at that time.

The dogs placed in the outside pens were paired by sex; two male or two female dogs were placed in each pen (Ballard, 1997; Goldman, 1997; Hinz, 1997). Dogs which had received high radionuclide doses were not placed next to control dogs (Goldman, 1997), but the dogs were not otherwise segregated by dose level (Ballard, 1997; Goldman, 1997; Hinz, 1997). In general, dogs remained in the same pen for the duration of their lifespan, typically 10 to 12 years (Ballard, 1997; Goldman, 1997; Hinz, 1997). Feces were removed from the pens daily, and urine percolated into the gravel (Ballard, 1997; Goldman, 1997; Hinz, 1997; DOE archived records).

Dogs were dipped in chlordane to control fleas from 1960 until 1968, when excess exposure to chlordane apparently impacted the health of the dogs (DOE archived records). The dipping was apparently performed near the western boundary of the Western pens (Goldman, 1997; Hinz, 1997). It is not clear where the pesticide was stored, whether it was kept in a liquid or powder form, or where the dipping fluid was disposed after use. Chlordane was also sprayed in and around the pens, particularly near the southern edge of the pens because flea-bearing rodents were believed to be more plentiful south of the dog pens than elsewhere due to the proximity of Putah Creek (Ballard, 1997). Annual usage of chlordane is estimated to be between 25 and 50 gallons (Dames & Moore, 1993).

1.1.2 Existing Data

Shallow soil samples were collected and analyzed from the Eastern Dog Pens in 1990 (Dames & Moore, 1993) and 1996 (Figure 2); however, these data are not sufficient to meet the objectives listed above. Additionally, these samples were not collected as part of the CERCLA investigation and the QA/QC procedures fall short of those required under CERCLA. Therefore, these previous data were considered qualitatively in planning this investigation. Field radiation survey data from the dog pen pedestals removed in 1996, anecdotal information about the dog pen

operations (see Section 1.1.1), and results of the extensive Western Dog Pens investigations conducted in 1998 (Weiss Associates, 1998a) were also considered in planning this investigation.

In summary, previous data from the Eastern Dog Pens (Figure 2) indicate:

- Chlordane was present in most surface and in one 1.5-ft below ground surface (bgs) samples at concentrations up to 0.48 milligrams per kilogram (mg/kg);
- Several radionuclides, including Ra-226, cesium-137 (Cs-137), thorium-232 (Th-232), and potassium-40 (K-40), were detected in one or more samples at levels slightly above background; and,
- Several other radionuclides may be present above background, but data quality is questionable (Sr-90 and uranium-235 [U-235]) or data are in units different from the background level (tritium).

Based on similar operational histories and existing data, the contaminant nature and extent in the Eastern Dog Pens is expected to be very similar to that in the Western Dog Pens. If anything, contamination in the Eastern Dog Pens may be less because of the shorter operational history. Therefore, based on the Western Dog Pens data (Weiss Associates, 1998a), contamination in the Eastern Dog Pens most likely:

- Attenuates fairly sharply with depth in soil beneath the pen gravel;
- Includes mercury, chlordane, Ra-226, Cs-137, and other radionuclides at levels slightly above background; and,
- Shows no predictable lateral distribution pattern.

1.2 Work Plan Organization

Section 2 of this work plan presents the rationale and design for the Eastern Dog Pen Investigations. Sections 3 and 4 provide detailed procedures for conducting these investigations. Sections 5, 6, and 7 describe QA/QC and data management, waste management, and health and safety procedures, respectively. Cited references are listed in Section 8.

2. INVESTIGATION DESIGN

This section describes the rationale and design for the proposed investigations in the Eastern Dog Pens, based in part on the U.S. Environmental Protection Agency (EPA) Data Quality Objectives (DQO) process. The sections below follow the *Guidance for the Data Quality Objective Process* (EPA, 1994) and are consistent with *Data Quality Objectives for Superfund* (EPA, 1993).

2.1 Problem Statement

A conceptual model of contaminant type and distribution in the Eastern Dog Pens is required to support remedial decision making and risk assessment.

2.2 Decision Identification

Because the pens are underlain by UC Davis Landfill No. 2, the following must be considered in evaluating the Eastern Dog Pens results:

1) effects of disturbed fill overlying the landfill trenches;

2) potential impact of dog pen contaminants on the landfill; and,

3) potential impact of landfill contaminants on the dog pens.

2.3 Decision Input Identification

Soil samples will be analyzed for the potential COCs identified in the Western Dog Pens. These include the radionuclides, metals, pesticides, and nitrogen compounds shown on Table 1. In the unlikely event that gross alpha results indicate the presence of other alpha emitters, those samples will also be analyzed for plutonium-241 and americium-241. If the gross beta results are anomalous, beta emitters may be added to the analyte list. Although volatile organic compounds (VOCs) were reportedly never used in the dog pens and have not been detected in any previous dog pens samples, VOCs by CLP SOW OLM 03.1 will be added to the analyte list if the field PID indicates above-background readings. In addition to these chemical and radionuclide parameters, selected samples will be analyzed for bulk density and moisture content to provide information for evaluating remedial actions and performing risk assessment.

The chemical and radionuclide results for Eastern Dog Pens samples will be compared to the established background levels, lowest Risk-Based Action Standards (RBASs), and Western Dog Pens results. To ensure these comparisons are valid, the same analytic methods and detection limits that

were used for the recent Background and Western Dog Pens Investigations (Weiss Associates, 1998b) will also be used for these Eastern Dog Pens investigations.

2.4 Study Area Boundary Definition

Spatially, the study area is defined as the fenced area encompassing the three rows of 32 dog pens that make up the Eastern Dog Pens (Figures 1 through 3). The study area includes the concrete curbing, asphalt, and gravel within this area, and also includes all soil between 0 and 2 ft bgs under the gravel.

This phase of investigation must be completed by July 1999 to accommodate UC Davis' schedule for remedial work in the area. Because suspected contaminants in the Eastern Dog Pens are relatively stable and immobile, data collected during this investigation should be considered representative of conditions in this area at least through the period required to evaluate and implement remedial actions.

2.5 Design Optimization

Key considerations in the investigation design and their potential implications include:

- Limited time frame: sampling for laboratory analysis must be conducted in one phase for this investigation, because of the 30- to 45-day laboratory turnaround time and the need to have results by late spring.
- Presence of landfill: sample depths must be limited to the first two ft of soil to minimize the potential for intercepting waste.
- Constituents detected above background in all previous Western and Eastern Dog Pens investigations: constituents and levels detected are generally consistent from investigation to investigation; therefore the same suite of constituents will be analyzed during these investigations.
- Pattern of lateral contaminant distribution based on all previous Western and Eastern Dog Pen investigations: contaminants in surface soil show limited variability and no predictable pattern, either within pens or from pen to pen; therefore a random sampling scheme is appropriate.

Based on these considerations, the proposed Eastern Dog Pens investigations consist of two phases:

1) A detailed gamma survey of the entire area; and,
2) Soil sampling at 0 and 2 ft below ground surface at selected locations, with analysis for selected radionuclides, metals, nitrogen compounds, and pesticides.

The rationale and design for these steps are described in detail in the following sections. Limited gravel and curb sampling is also planned, and is described in Section 2.5.3. Detailed procedures, specifications, and equipment are described in Section 3.

2.5.1 Detailed Gamma/Beta Radiation Survey and Soil Sampling

Prior to any soil sampling, a gamma radiation survey of the entire gravel surface of the Eastern Dog Pens area will be conducted on a 2 ft by 2 ft grid. A similar survey was conducted over the Western Dog Pens prior to the extensive soil sampling conducted in 1997 and 1998. No significant gamma radiation anomalies were observed during this survey; and the minor anomalies that were observed did not correlate well with the laboratory analytic results for gamma emitters in the underlying soil samples.

Nevertheless, this technique is a quick and inexpensive means of gathering some information on the presence of gamma emitters near the dog pen surface. Based on previous data, the gamma emitters Ra-226 and Cs-137 are expected to be the primary radionuclides of concern in the Eastern Dog Pens. Therefore, an elevated gamma radiation reading may indicate the presence of these contaminants, and can be used to modify the random soil sampling strategy described in the next section.

2.5.2 Soil Sampling

Based on the relatively small variability and unpredictable spatial distribution of contaminants expected in the Eastern Dog Pens, sampling locations have been chosen using a Random Number Generator (RNG). First, 21 pens were chosen randomly (Figure 3). As shown on Figure 3, five of the 21 pens are designated as "contingency pens". Of the 21 randomly selected pens, these were the last five selected. These pens will be replaced by pens with elevated gamma survey readings, if any are identified.

Then, one of three areas (Figure 3) within the 21 chosen pens was randomly selected for sampling (Table 2). Area 1 is the asphalt area at the front of each pen. This area has not been sampled in previous dog pen investigations, and field radiation surveys of the gates and fence posts that were in this area have shown some locations with above-background radiation. Area 2 is the area within the inner curb where the housing pedestal was located. Previous investigations have suggested slightly elevated radiation levels on and under the pedestals. Area 3 is the remainder of the pen area; previous investigations in the Western Dog Pens showed no predictable pattern of radiation in this area. Within the particular area chosen, the actual sample location will be randomly selected.

This sampling density will provide soil data from 21 of the 96 Eastern Pens, or about 22% of the pens. The total area of the Eastern Dog Pens is about 35,000 square ft, resulting in one sample per 40 ft by 40 ft area. Assuming the Eastern Dog Pens contaminant distribution is similar to the Western Dog Pens, the data collected in this investigation should be adequate to allow valid statistical comparisons with background levels (using the Wilcoxon Rank Sum Test) and/or RBASs

(using the Sign Test). The required number of samples for these tests for key COCs identified in the Western Dog Pens are shown in Table 3.

As discussed above, the Eastern Dog Pens sampling must be limited to shallow soil to minimize the risk of intercepting any landfill wastes. The actual depth to the top of the waste in the landfill is unknown. Furthermore, extensive sampling in the Western Dog Pens suggests that contamination attenuates sharply with depth. Therefore, soil sampling will be limited to the upper 2 ft. Surface samples and samples 2 ft bgs will be collected at all 21 locations described above. Duplicate samples will be collected from four of the 42 sample locations (approximately 10%) for QA/QC purposes.

The proposed list of analytes is discussed in Section 2.3 above. As shown on Tables 1 and 2, all soil samples will be analyzed for selected radionuclides, metals, pesticides and nitrogen compounds. Four samples from the surface and four samples from 2 ft bgs will also be analyzed for bulk density and moisture content. Surface soil samples from six other pens in the southernmost row (Figure 3) will also be collected and analyzed for tritium only, to provide additional baseline data for this area prior to its use by UC Davis. Analytic methods and detection limits are shown on Table 1.

2.5.3 Gravel and Curb Sampling

In addition to the gamma survey and soil sampling, 16 gravel and six curbing samples from the Eastern Dog Pens will be analyzed. Gravel samples will be collected from the 15 soil sampling locations where gravel is present, and a duplicate gravel sample will be collected from one of these locations (Table 2). Three curbing locations with elevated gamma survey readings and three locations with background readings will also be sampled. These gravel and curbing samples will be submitted to the laboratory for Ra-226 and Sr-90 analysis. The selected gravel sample analytes are based on previous results from the Western Dog Pens that indicate possible impact to some gravel by Sr-90 and/or Ra-226. The purposes of the curbing sampling are to determine if: 1) the two radionuclides known to have been used in the dog pens have impacted the curbing; and, 2) field gamma readings can be used as an indicator of elevated gamma/beta emitters in the curbing.

3. INVESTIGATION PROCEDURES

This section describes the field and analytic procedures to be used during the Eastern Dog Pens investigation. The fieldwork is scheduled to begin in February 1999. All work will be conducted in accordance with this work plan, the Quality Assurance Project Plan (QAPP; Weiss Associates, 1998b), and the appropriate Standard Operating Procedures (SOPs; Weiss Associates, 1998c), which are included as Appendix A to this work plan.

Soil sample collection will be conducted in accordance with SOP 3.1, Surface and Shallow Subsurface Soil Sampling, and SOP 15.1, Lithologic Logging (Appendix A). Sample chain-of-custody records will be prepared in accordance with SOP 1.1, Chain of Custody (Appendix A). Sample handling, packaging, and shipping will be conducted in accordance with SOP 2.1, Sample Handling, Packaging and Shipping (Appendix A). Samples will be collected from appropriate locations as described in Section 2.0.

3.1 Clearing and Grubbing

Prior to any other fieldwork, the Eastern Dog Pens area will be cleared of debris and vegetation will be removed to the extent necessary to allow the surface radiation survey and soil sampling to be efficiently performed. All Elderberry shrubs will be preserved.

3.2 Surface Radiation Survey

A surface gamma/beta radiation survey will be conducted over the entire Eastern Dog Pens area using a Ludlum Model 2221 instrument with a Model 44-10 (2 inch by 2 inch) sodium-iodide scintillator. The instrument will be held at a height and moved at a rate to provide reconnaissance readings representative of approximately 2 ft by 2 ft grid areas. The detection limit for this instrument is approximately 900 counts per minute per microRem per hour (cpm/μR/hr). This translates to a few μCi/g for gamma emitters in surface soil.

Prior to conducting the survey, a background level will be established. Ten one-minute integrated counts will be taken at each of three on-site background locations. The background value will be established as the 98% upper confidence level, defined as the average of the thirty readings plus three standard deviations. For pens where above-background readings are recorded, the highest reading(s) will be recorded on a detailed Eastern Dog Pens map. At all locations with readings exceeding two times background, a one-minute integrated count will be taken and recorded on the map.

3.3 Utility Clearance

Underground utility clearance will be performed prior to the hand-augered soil sampling in the Eastern Dog Pens. Underground Services Alert (USA) will be contacted at least 48 hours prior to the start of fieldwork and UC Davis Facilities Services will also be alerted to the proposed fieldwork. The UC Davis Facilities Services Department will visit the proposed sampling locations and clear each location of UC Davis utilities. In addition, a certified underground utility locator will clear each location.

3.4 Sample Collection

The curbing samples will be collected using a concrete coring machine. The gravel samples will be collected using a hand trowel. The surface soil samples will be collected from the first soil encountered immediately below the approximately one-foot thick layer of gravel, also using a hand trowel. Curbing, gravel and surface soil samples will be collected in glass or plastic jars. The deeper soil samples will be collected in brass sleeves using a hand auger and split barrel sampler, starting at 1.5 ft below the gravel/soil interface and extending to 3 ft. For these deeper samples, the first three inches of sample will be for pesticide analysis, the second three inches will be for metals and nitrogen analyses, and the remaining foot of sample will be for radionuclide analyses. Soil sample collection will be in accordance with SOP 3.1, Surface and Shallow Subsurface Soil Sampling (Appendix A). The analytic suite, detection limits, sample volumes, and holding times are shown on Table 1.

Figure 3 shows the proposed locations for soil and gravel sampling. Table 2 summarizes the confirmed sample locations, the contingency sample locations (that may be changed depending on gamma survey readings), sample locations for tritium analysis only, sample locations for physical parameter analysis, and QA/QC sample locations. The six curbing samples will be selected based on the gamma survey results, with three samples collected from areas with elevated gamma readings (if any) and three collected from areas with background readings.

A sample preparation area will be established adjacent to the sampling site. The sample preparation area will be set up on an elevated work surface such as a table. This work surface will be covered with poly sheeting to minimize the spread of any contamination. The following equipment will then be staged in the vicinity of the work area:

- Spill kit;
- Sample containers;
- Demineralized water;
- Sampling tools;
- Custody seals and Chain-of-Custody forms; and,
- Preservatives, as required.

At the conclusion of each day's sampling, boreholes will be backfilled with native soil and tamped to form small mounds. Rinseate Sample/Equipment Blank consisting of reagent water

collected from a final rinse of sampling equipment (including core liners) will be collected once during the sampling activities, after decontamination procedures of the equipment have been performed. The purpose of rinseate samples is to determine whether the sampling equipment is causing cross contamination of samples. Following equipment decontamination, deionized/organic-free water will be used as a final rinse and collected in appropriate bottles.

3.5 Sample Documentation

The usability of the data obtained during this investigation will depend on its quality. A number of factors relate to data quality. Sample collection methods are as important to consider as the methods used for sample analysis. Following proper procedures for both sample collection and analysis reduces sampling and analytical error. To ensure sample integrity, samples will be handled using complete Chain-of-Custody documentation and preserved using proper sample preservation techniques, holding times, and proper shipment methods. Obtaining valid and comparable data also requires adequate QA/QC procedures and documentation.

The components of the sample documentation and custody system will include the following:

- Chain-of-Custody Form,
- Field Logbook/Field Activity Daily Log,
- Sample Numbers,
- Sample Labels; and,
- Custody Seals.

3.5.1 Chain-of-Custody

Chain-of-Custody forms will be completed by the sample team members to track sample custody as well as to specify the requested analyses. Chain-of-Custody forms will be completed in accordance with the requirements of SOP 1.1, Chain of Custody, provided in Appendix A.

3.5.2 Field Logbook/Field Activity Daily Log

Descriptions and observations made during field and sampling activities will be documented in the field logbook and field activity daily log. In addition, boring logs with detailed lithologic descriptions will be prepared in accordance with SOP 15.1 for the Eastern Dog Pens. The following will be recorded in the field logbook and field activity daily log:

- Project name and number;
- Location of site;
- Purpose of sampling;

- Description of field activities;
- Names of sampling personnel;
- Date and time of entries;
- Sample medium description using the USCS classification method;
- Date and time of sample collection;
- Sample locations, Identification (ID) number and methodology;
- Field observations;
- Results of field measurements; and,
- Results of field calibrations for instruments used.

3.5.3 Sample Numbers

The sample matrix will be identified by "SS" for soil sample, "GS" for gravel sample and "CS" for concrete sample. Following the matrix identifier will be "DP" to designate dog pens investigation data. Samples will be numbered sequentially, starting where the last dog pens sampling (in the Western Dog Pens) left off. Therefore, the first soil sample collected will be identified as **SSDP0302.** The first gravel sample will be identified as **GSDP0001,** and the first concrete sample from the curbing will be identified as **CSDP0001.**

3.5.4 Sample Labels

Sample labels will be attached to individual sample containers and will contain the following information:

- Project number;
- Sample ID number;
- Date and time collected;
- Initials of sampler; and,
- Requested analyses.

3.5.5 Custody Seals

Custody seals will be used to detect tampering and will be placed over the lid of the shipping container and annotated with the following information:

- Date and time; and,
- Initials of sampler.

3.6 Chemical and Radiological Analysis

Table 1 specifies the analytes, analytic methods, sample containers, holding times, and detection limits required for the Eastern Dog Pens samples.

4. LAND SURVEY

Following the completion of the Eastern Dog Pens field activities, a land survey will be performed to establish coordinates for each sample collection point. This survey will locate each point both horizontally and vertically and to the nearest 1.0 ft and 0.1 ft, respectively. A State of California-licensed land surveyor will do all surveying.

5. QUALITY ASSURANCE AND DATA MANAGEMENT

The quality assurance requirements applicable to the Eastern Dog Pens investigations are detailed in the QAPP for the environmental restoration activities at the LEHR site (Weiss, 1998b). This plan is based upon the requirements of DOE Order 5700.6c *Quality Assurance* and EPA QAMS-005/80 *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* as they are applicable to the scope of work. Additional task-specific quality assurance requirements are detailed in the SOPs provided in Appendix A.

The samples collected for this investigation will be analyzed by General Engineering Laboratories, Inc. (GEL) in Charleston, South Carolina. Laboratory reports (hard copies and electronic files) will be forwarded from the laboratories to the Weiss Associates Data Validation Chemist. These results will be validated and transferred to the project database by the Weiss Associates Database Manager in accordance with procedures described in the QAPP (Weiss Associates, 1998b). Data receipt, sample tracking, data entry, data storage, and data reporting will be managed by WA according to the procedures defined for these activities in the LFI Work Plan (IT Corporation, 1996).

6. INVESTIGATION-DERIVED WASTE MANAGEMENT

The management of IDW proposed for the Eastern Dog Pens investigations is in accordance with the EPA document *Management of Investigation Derived Waste During Site Inspections* (EPA, 1991), and DOE Order 5820.2a, *Radioactive Waste Management*. The approach to IDW management in the work plan focuses on protecting human health and environment while applying the Area of Containment unit concept (EPA, 1991) for each of the investigation areas. This concept or approach involves leaving a site in a condition no worse than that which existed prior to the investigation, minimizing the quantity of generated wastes, and leaving wastes on-site that do not require off-site disposal or extended above ground containerization.

6.1 Shallow Subsurface Soil Sampling

Shallow soil sampling by hand augering creates low waste volumes. Upon completion of the hand augered boreholes in the Eastern Dog Pens and review of the field screening results, the boreholes will be backfilled with the material removed from it.

6.2 Decontamination Solutions

Decontamination solutions will consist of water used to clean the sample collection tools and personnel wash water. Rinseate water will be discharged into a shallow depression in the area where it was generated.

7. HEALTH AND SAFETY CONSIDERATIONS

Health and safety considerations for the activities detailed within this Work Plan are covered by the following documents: the Project Health and Safety Plan (PHSP) (WA, 1998d); Health and Safety Procedures (HSPs) (WA, 1998e) and Standard Operating Procedures (SOPs)(WA, 1998c), as referenced in this Work Plan; the Contingency Plan and General Emergency Response Procedures (CPGERP) (WA, 1998f); the As Low As Reasonably Achievable (ALARA) Program (WA, 1997), and the Radiation Protection Program (RPP)(WA, 1998g). The health and safety considerations presented in this section of the Work Plan coupled with the above-listed documents represent the safety and health program required by 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response and 10 CFR 835, Occupational Radiation Protection, for these work activities.

7.1 Hazard Analysis

A job hazard analysis identifies potential safety, health and environmental hazards and provides for the protection of personnel. Hazard analysis helps to ensure that all waste safety concerns are met. The Activity Hazard Analyses (AHAs) to be followed for this project entitled "Soil Sampling" is included in the Appendix of the PHSP. A hazard analysis for these activities, as well as specific additional control measures to be followed, are described in Section 5 of the PHSP. Specific sections describing hazard analysis and control have been included from the PHSP, where applicable.

During these activities, the Site Coordinator (SC), Site Health and Safety Officer (SHSO), Radiological Control Manager (RCM), Radiological Safety Officer (RSO), Radiological Control Technician (RCT), or Health and Safety Coordinator (HSC) will monitor the site for any changes in conditions that would require modification of work conditions (i.e., personal protective equipment [PPE]). In the event that changes arise in radiological or industrial health and safety conditions that are not covered by this Work Plan or referenced documents, this Work Plan will be modified in accordance with the procedures contained in Standard Quality Procedure 11.1 (SQP), "Fieldwork Variances/Request For Information" (WA, 1998h).

7.1.1 Underground Utilities

UC Davis personnel and a private subcontractor will clear utilities prior to hand augering as described in Section 3.3. It should be noted, however, that the potential of accidentally encountering unmarked or mislocated underground utilities during the proposed field sampling activities still exists. However, hand augering is one of the least intrusive and safest sampling methods that can be employed to sample soils in areas containing utilities. In the event a utility is encountered with a hand auger, no damage to the utility would be expected.

7.1.2 Confined Space Entry

Confined space entry will not be required during the performance of any field sampling activities. All activities have been planned such that confined space entry will not be required.

7.1.3 Radiological Exposure

The waste materials to be encountered may contain low-level radioactive material from prior animal research activities. The predominant nuclides used during these activities were Ra-226 and Sr-90. Sampling activities may present a risk of radiological exposure to personnel through direct exposure to radioactive materials as well as through ingestion and inhalation. Personnel in the vicinity of the sampling activity shall wear modified Level D PPE as described in Section 7.2.3.

7.1.4 Chemical Exposure

During sampling activities direct instrumentation (PID, GM) will be used to detect the presence of hazardous chemicals and radioactivity.

7.1.5 Heat Stress

This work activity is scheduled to be performed at a time when workers are unlikely to be affected by heat related injuries. Heat stress is only likely to be a concern if work is postponed by four to eight months. In this unlikely event, a work plan addendum addressing heat stress will be prepared.

7.2 Hazard Controls

The following control measures will be implemented during these activities. These control measures are intended to supplement the PHSP.

7.2.1 Hazardous Work Permit

Hazardous Work Permits (HWPs) will be used to control work in the exclusion zone and other areas where hazardous conditions may exist. An HWP will be issued in accordance with the procedures specified in the PHSP (WA, 1998d) and in accordance with HSP 17.1, Hazardous Work Permits. The following information will be described or referenced in the HWP:

- Scope of work to be performed;
- Anticipated radiological, safety, and industrial hygiene conditions;

- PPE and respiratory protection requirements;
- Radiological and industrial hygiene monitoring requirements;
- Dosimetry requirements;
- Work Plan and/Activity Hazard Analysis;
- Period for which the HWP is valid; and,
- Additional requirements for entry.

7.2.2 Site Control and Work Zones

The site control and work zones will be enclosed by boundary ropes or ribbons supported with stanchions. The placement of the stanchions and boundaries will be controlled by the RSO and/or the SHSO to facilitate access to the work area for equipment. The boundaries for site control and work zones will be set up and signs posted in accordance with the PHSP and the RPP.

7.2.3 Personal Protective Equipment

Workers in the exclusion zone will wear modified Level D PPE in accordance with the PPE selection matrix in the PHSP unless otherwise specified in the HWP for the task.

Modified Level D PPE will consist of the following when specified in the HWP:

- Hard hat, American National Standards Institute (ANSI) approved;
- Steel-toed chemical resistant boot or boot covers;
- Chemical resistant coveralls;
- Safety glasses with side shields;
- Chemical resistant gloves inner and outer gloves;
- Full tape of wrists and ankles; and,
- Leather work gloves.

7.2.4 Decontamination Procedures

The decontamination area will be set up adjacent to the exclusion zone (EZ) for equipment and personnel. The area will be delineated with traffic cones and/or radiological barrier tape. The decontamination zone will be posted with the appropriate warning sign.

Decontamination procedures will be conducted in accordance with Section 10 of the PHSP for personnel decontamination, equipment decontamination and PPE decontamination. For radiological hazard work decontamination the radiological workers will perform whole-body frisks

and, if contamination is found, the RCT will be notified to determine the extent of contamination and direct/supervise decontamination.

Equipment and respirators (if used) will be cleaned and, prior to removal from the decontamination area, will be surveyed by the RCT in accordance with Section 10 of the PHSP.

7.2.5 Training

Personnel performing activities associated with the Eastern Dog Pens investigation will receive training covering this work plan. All on-site project personnel shall have completed at least 40 hours of hazardous waste operations-related training, as required by Occupational Safety and Health Administration (OSHA) Regulation 29 CFR 1910.120. All field employees receive a minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor. Those personnel who completed the 40-hour training more than 12 months prior to the start of the field activities shall have completed an 8-hour refresher course within the past 12 months. The SC shall have completed an additional 8 hours of relevant supervisory health and safety training. In addition, any workers who will enter radiological control zones shall have successfully completed Radiological Worker II training and site-specific Radworker training. All site workers shall receive training covering the Contingency Plan and General Emergency Response Procedures (Weiss Associates, 1998f). Personnel performing activities within the contamination area will receive the training in accordance with the requirements specified in SQP 3.2, *Indoctrination and Training* (WA, 1998h), for the specific job assignments.

7.2.6 Buddy System

The buddy system will be utilized to protect personnel in the work area. At least two persons will be required to be in the work area when work is conducted in the exclusion zone, which might result in worker contamination or injury.

The buddy system is a method of organizing employees into work groups and is designed to provide those employees with assistance when needed. Each employee in a work group is designated to be observed by at least one other person. Assignment of designated partners should take place during the TSM.

The responsibility of the buddy is to:

- Provide assistance, if needed;
- Maintain line of sight contact or verbal contact with workers in the CA;
- Observe for signs of chemical or physical trauma or heat stress such as:
  - changes in complexion and skin discoloration;
  - changes in coordination or demeanor;
  - excessive saliva and pupillary response; or,
  - changes in speech pattern;

- Periodically verify the integrity of all protective clothing; and,
- Notify the Project SC if emergency help is needed.

Entry to or exit from the CA under the conditions described earlier without a designated partner is prohibited.

7.2.7 Safety Equipment

In addition to other equipment specified in this work plan, the following safety equipment will be staged at the boundary of the CA:

- First aid kit;
- Portable eyewash station and hand shower;
- Spill kit;
- Air horn;
- Portable radio for emergency communications; and,
- Fire extinguisher.

7.2.8 Air Monitoring

Air monitoring is essential to ensure that all field personnel will be adequately protected from airborne contaminants. Air monitoring will be conducted in accordance with HSP 6.1-Air Monitoring, HSP 14.1-Airborne Radioactivity Monitoring and Section 11 of the PHSP and the RPP.

General area radiological air monitoring locations will be near/in the work area having the highest potential for generating airborne radioactive contaminants. This monitoring will be conducted daily as may be required by the RSO.

If the general area air samples indicate that workers may be exposed to airborne radioactive contaminants that are >10% of the derived air concentration (DAC), listed in 10 CFR 835, Appendix A, then personal air samples (8-hr TWA) may additionally be used to monitor worker exposure and the RSO will take steps to reduce exposure through engineering controls.

All personal, integrated air monitoring samples and direct reading instrumentation readings taken for the purpose of determining appropriate H&S precautions shall be collected/taken in the approximate "breathing zone" of site personnel and integrated over an appropriate time interval. As appropriate, selective monitoring of high-risk workers (i.e. those who are closest to the source of contamination generation) will be conducted.

Real-time continuous monitoring during investigation activities to assist in identification of hazards will consist of: visual inspection; radiological survey instrument readings and PID

measurements. Use of Level C (or higher) protection will be utilized whenever justified by site conditions as presented in this Work Plan and the PHSP.

Direct read instruments (PID) will be used to monitor VOCs. VOCs are not likely to be encountered, however, if the PID has a reading above the action levels presented in the PHSP then the level of PPE in use will be assessed immediately and modified as necessary. A grab air sample may be collected and analyzed to better define airborne constituents. All available data will be evaluated for selection of the PPE level and the HWP will be modified if necessary.

The appropriate air monitoring equipment will be acquired and assessed for suitability prior to the pre-phase inspection. All equipment will be maintained and calibrated in accordance with manufacturer's recommendations, SOP 25.1-Radiological Surveys and Instrumentation, and HSP 14-Airborne Radioactivity Monitoring.

Air monitoring will be conducted daily or until collected data is sufficient to predict exposures to airborne contaminants.

The radionuclides of concern and their respective DACs are provided below:

- Sr-90; 2E-9; and,
- Ra-226; 3E-10.

8. REFERENCES

Ballard, Don, University of California at Davis (UC Davis), 1997, personal conversation with Alison Watts of Weiss Associates, October 8.

Dames and Moore, 1994, Final Draft RI/FS EA Work Plan, LEHR Environmental Restoration, University of California, September.

Dames and Moore, 1993, Phase II Site Characterization Report for the LEHR Environmental Restoration, UC Davis, February.

Goldman, Marvin, LEHR Director, UC Davis, 1997, phone conversation with Alison Watts, October 15.

Hinz, Ed, 1997, Electrical Engineer, UC Davis, personal conversation with Alison Watts of Weiss Associates, October 8.

IT Corporation, 1996, LFI Work Plan, LEHR, UC Davis, July.

United States Department of Energy (DOE), Various DOE Records Archived at the Federal Records Center, 1000 Commodore Drive, San Bruno, California.

United States Environmental Protection Agency (EPA), 1994, Guidance for the Data Quality Objectives Process, EPA QA/G-4 EPA/600/R-96/055, September.

EPA, 1993, Data Quality Objectives for Superfund, EPA/540/R-98/071.

EPA, 1991, Management of Investigation Derived Wastes During Site Inspections, OSWER Directive 9345.3-02, Washington, D.C.

UC Davis, 1998, Letter regarding Eastern Dog Pens Characterization from Brian Oatman, LEHR/SCDS Project Manager, to Susan Fields, DOE, December 15.

Weiss Associates, 1998a, Technical Report: Results of Western Dog Pens, Background, and Off-Site Investigations, LEHR, U.C. Davis, California, June.

Weiss Associates, 1998b, Quality Assurance Project Plan for Environmental Restoration/Waste Management, LEHR, UC Davis, California, February.

Weiss Associates, 1998c, Final Standard Operating Procedures, LEHR, University of California at Davis, California, Weiss Associates, March.

Weiss Associates, 1998d, Project Health and Safety Plan for Environmental Restoration/Waste Management, LEHR, UC Davis, California, November.

Weiss Associates, 1998e, Final Health and Safety Procedures, LEHR, University of California at Davis, California, Weiss Associates, January.

Weiss Associates, 1998f, Contingency Plan and General Emergency Response Procedures for Energy-Related Health Research (LEHR), UC Davis, California, November.

Weiss Associates, 1998g, Final Radiological Protection Program, Rev. 2, LEHR, University of California at Davis, California, Weiss Associates, January.

Weiss Associates, 1998h, Standard Quality Procedures for Environmental Restoration/Waste Management, LEHR, UC Davis, California, February.

Weiss Associates, 1997, Final As Low As Reasonably Achievable (ALARA) Program Management, Rev. 2, LEHR, University of California at Davis, California, June.

FIGURES

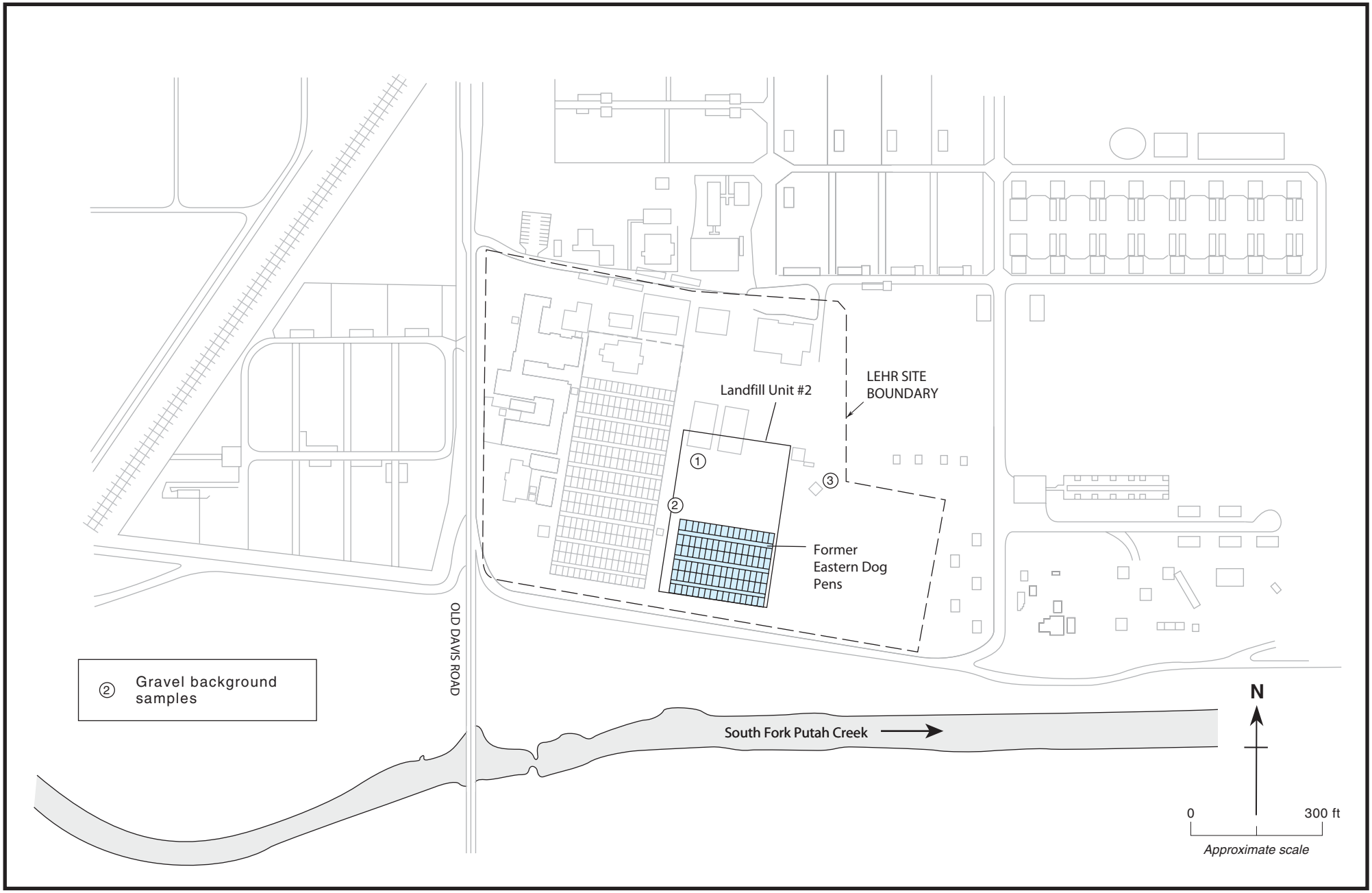

Figure 1. LEHR Site Map Showing Former Eastern Dog Pens and Background Gravel Sample Locations

Weiss Associates

4001-110-01.ai

06/29/99

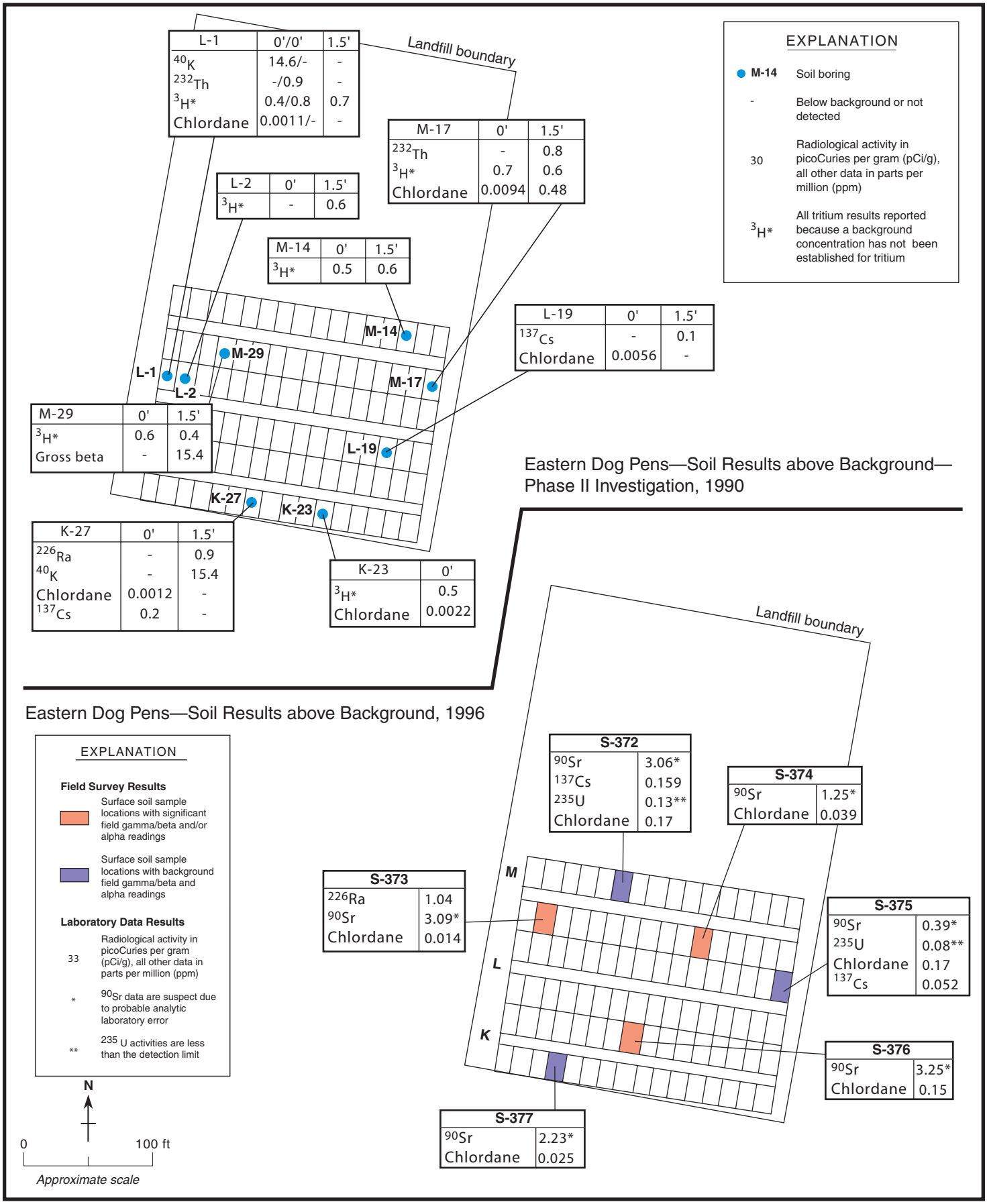

Figure 2. Analytical Results above Background from Previous Investigations in the Former Eastern Dog Pens

Weiss Associates

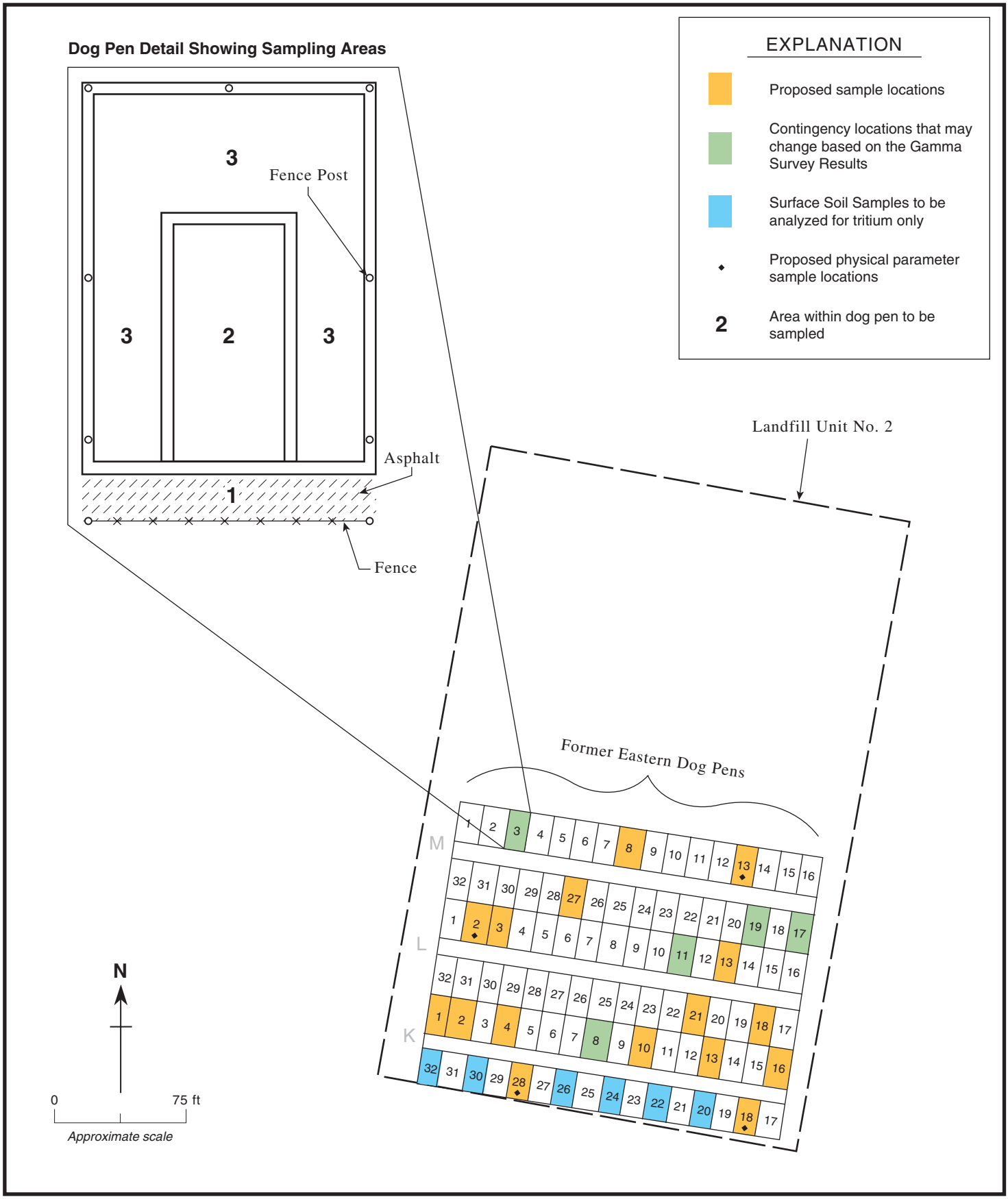

Figure 3. Proposed Shallow Soil Sample Locations in the Former Eastern Dog Pens

Weiss Associates

TABLES

Table 1. Laboratory Analytical Methods Proposed for Former Eastern Dog Pen Investigation

Parameter	Analytical Method	Contract Required Detection Limit (pCi/g for radionuclides, mg/kg for metals and organics)	Hold Times	Soil Sample Containers*
Radionuclides:				
Carbon-14	Lab SOP	0.1	6 months	2 16-oz jars or 2 2-in x 6-in brass tubes per sample
Gamma Emitters	EPA Method 901.1	0.005-2		
Gross Alpha	EPA Method 9310	1		
Gross Beta	EPA Method 9310	1		
Ra-226	EPA Method 901.1**	0.1		
Sr-90	EPA Method 905.0	0.05		
Thorium-228	Lab SOP	0.01		
Thorium-230,232	Lab SOP	0.05		
Tritium	EPA Method 906.0	1		
Uranium-233/234,238	Lab SOP	0.025		
Uranium-235	Lab SOP	0.01		
Metals/Other Inorganics:				
Chromium (total)	CLP SOW ILM 02.1	1	6 months	1 8-oz jar or 1 2-in x 3-in brass tube per sample
Chromium (+6)	EPA Method 7196	0.05	28 days	
Mercury	CLP SOW ILM 02.1	0.1	28 days	
Inorganic Nutrients:				
Nitrate	EPA Method 300.0	1	48 hrs	
Total Kjeldahl Nitrogen (TKN)	EPA Method 351.2	2	28 days	
Organics:				
Organochlorine Pesticides (and PCBs)	CLP SOW OLM 03.1	Exhibit C of SOW OLM 03.1	14 days to extraction, 40 days to analysis of extract	1 8-oz jar or 1 2-in x 3-in brass tube per sample
Volatile Organic Compounds***	CLP SOW OLM 03.1	Exhibit C of SOW OLM 03.1	14 days	
Physical Parameters:				
Moisture Content	ASTM D 2216-92/D and ASTM D 4643-93/D			1 4-oz jar or 1 2-in x 3-in brass tube per sample
Bulk Density	ASTM D 2937-94			

Abbreviations:
SOP = Standard Operating Procedure
CLP SOW = Contract Laboratory Program Statement of Work
OLM03.1 = Organic Laboratory Method 03.1 or more recent
ASTM = American Society of Testings and Material

Notes:
- Soil for tritium analysis only will be collected in 1 8-oz jar. Gravel and concrete samples for Ra-226/Sr-90 analysis will be collected in 2-L plastic jars.

** With 30-day in-growth and 1000-minute count time.

*** Volatile Organic Compounds will only be analyzed if PID field measurement is above 5 ppm

Table 2. Sampling Scheme for the Former Eastern Dog Pen Investigation

Dog Pen Number	Sampling Area within Dog Pen	Duplicate Sample	Contingency Locations	Physical Parameters	Gravel Samples
M3	3		X		X
M8	2				X
M13	2			X	X
M17	1	X (surface)	X		
M19	3		X		X
M27	2				X
L2	2			X	X
L3	2				X
L11	3	X (2 ft bgs)	X		X
L13	2				X
L18	3				X
L21	3				X
K1	2	X (surface)			X
K2	3				X
K4	1				
K8	1		X		
K10	3	X (gravel)			X
K13	1				
K16	1				
K18	2	X (2 ft bgs)		X	X
K28	1			X	

Notes:
At each sample location a surface soil sample and a 2 ft depth sample will be collected.
Area inside Dog Pen: 1 = Asphalt area in the front of the Dog Pen
2 = Pedestal Area
3 = Area outside Pedestal Area
Contingency Locations may be moved to locations of elevated activity identified from the Gamma Survey.
One rinseate sample will be collected.
Gravel samples will only be analyzed for Ra-226 and Sr-90.
A surface soil sample will also be collected for tritium analysis only from pens K-20, K-22, K-24, K-26, K-30 and K-32
Six curbing samples will be collected for Ra-226 and Sr-90 analysis based on the Gamma Survey results.

Table 3. Estimated Number of Samples Required from the Former Eastern Dog Pens for Statistical Comparisons[1]

Constituent	No. of Samples Required for Statistical Comparison[2]	Distribution/Value for Statistical Comparison[3]
Mercury	42	0 to 2 ft bgs background distribution
Radium-226	13	background distribution
Cesium-137	25	lowest RBAS
Alpha Chlordane	38	lowest RBAS
Gamma Chlordane	29	lowest RBAS

Notes:
[1] Assumes Eastern Dog Pen data distribution is identical to that in the Western Dog Pens.
[2] Wilcoxon Rank Sum (WRS) Test for comparison with background, Sign Test for comparison with lowest Risk-based Action Standard (RBAS).
[3] Lowest RBAS, or background distribution when RBAS is less than background, or subset of background distribution when background is stratified.

APPENDIX A

STANDARD OPERATING PROCEDURES

1.1 Chain-of-Custody

2.1 Sample Handling, Packaging and Shipping

3.1 Surface and Shallow Subsurface Soil Sampling

6.1 Sampling Equipment and Well Material Decontamination

15.1 Lithologic Logging

CHAIN OF CUSTODY

STANDARD OPERATING PROCEDURE

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the method and responsibilities associated with the maintenance and custody of samples which are to be used to provide data which form a basis for making project related decisions. It outlines the general procedures for maintaining and documenting sample chain of custody from the time of sample collection through sample disposition.

2.0 REFERENCES

2.1 Quality Assurance Project Plan

2.2 SQP 4.2 - Records Management

3.0 DEFINITIONS

3.1 Chain-of-Custody

The Chain-of-Custody (COC) document is the written record that traces the sample possession from the time each sample is collected until its final disposition, sometimes called the "cradle to grave" record. Chain-of-Custody is maintained by compliance with one of the following criteria:

- The sample is in the individual's physical possession;
- The sample is maintained in the individual's physical view after being in his/her possession;
- The sample is transferred to a designated secure area restricted to authorized personnel; and,
- The sample is sealed and maintained under lock and key to prevent tampering, after having been in physical possession.

3.2 Waybill

A document that contains a list of the goods and shipping instructions relative to a shipment.

4.0 PROCEDURE

4.1 Responsibilities

4.1.1 The Project Manager is responsible for assuring proper COC is initiated at the time the sample(s) are collected and maintained throughout the handling and subsequent transportation of the sample(s) to the designated laboratory. Additionally, the Project Manager is the project authority for determining the disposition and fate of sample(s) which have identified deficiencies (e.g., missed holding times, elevated temperature at receipt, etc.).

4.1.2 The sample team member(s) are responsible for properly documenting and maintaining the COC from the time of sample collection until the sample(s) are delivered to the lab.

4.1.3 Laboratory personnel are responsible for receipt and entry of samples into the laboratory which have been submitted under a COC document. Additionally, samples received will be entered into the laboratory COC procedures by properly documenting and maintaining COC from the moment that they take custody of the sample(s) at the laboratory until the sample(s) are disposed of or returned to the client.

4.2 General

4.2.1 An overriding consideration for data resulting from laboratory analyses is the ability to demonstrate that the samples were obtained from the locations stated and that they reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal must be documented to accomplish this. Documentation will be accomplished through a COC Record that lists each sample and the individuals performing the sample collection, shipment, and receipt.

4.2.2 The original COC document will accompany the samples while a copy will be retained in the project file.

4.3 Field Sample Custody

4.3.1 Sampling personnel, upon collection of samples for analysis, will properly complete a COC Record (Attachment 6.1). The COC document will be the controlling document to assure that sample handling and custody are maintained thereby assuring the sample(s) are representative of the environment from which they were collected. At a minimum, the following information will be recorded on the COC document:

- The unique identification number assigned to each sample;
- A physical description of the sample type (e.g., soil, water, etc.);
- The date and time of the sample collection;
- Container type (e.g., glass, poly, brass sleeve, etc.);

- Sample volume and number of containers (e.g., 2 x 40 ml, 3 x 1 liter);
- Sample preservation (e.g., HNO_3, H_2SO_4, 4°C);
- Requested analyses;
- Special instructions to the laboratory including handling requirements, quality assurance/quality control, health and safety, and sample disposition;
- The project name and number;
- The date the analytical report is due;
- The names of all sampling personnel;
- The name and phone number of the project contact;
- The name and phone number of the laboratory contact; and,
- The name of the courier and the waybill number (if applicable).

4.3.2 The COC document will be initiated in the field by the person collecting the samples and signed by each individual who has the samples in their possession. Each time that sample custody is transferred, the former custodian must sign over the COC as Relinquished By, and the new custodian must sign on to the COC as Received By. Each signature must be accompanied by the date, time, and the name of their project or company affiliation.

4.3.3 Transferring of COC from sampling personnel to the analytical laboratory will be performed in accordance with the requirements stated below.

4.3.4 If the sampling personnel deliver the samples to the laboratory, transfer of COC occurs as follows:

- The sample custodian delivers the samples to the laboratory and relinquishes the samples directly to a laboratory representative. Any person involved in the collection of the samples may act as the sample custodian.
- The custodian signs the COC listing his/her name, affiliation, the date, and time.
- The laboratory representative must receive the samples by signing his/her name, affiliation, the date, and time on the COC. The laboratory representative may decline to take receipt of the samples if the COC is not properly completed or if the samples are not properly packaged. Any designated laboratory personnel may act as the sample custodian.
- One copy of the COC is given to the sample collector to be returned to the project files and one copy is maintained with the samples at the laboratory.

4.3.5 If the sampling personnel transfer sample(s) to the laboratory utilizing a common carrier, sampling personnel will retain COC responsibility and the common carrier is not responsible for maintaining sample custody. The sample collectors are responsible for packaging the samples in a manner that meets the COC definition criteria, that is, the samples are sealed to prevent tampering. When transferring samples to the courier for transport, COC procedures are maintained as follows:

- The sample collector lists the courier affiliation and waybill number on the COC.
- The sample collector relinquishes custody by signing his name, affiliation, date, and time. The collector keeps a copy of the relinquished COC for the project file.
- The relinquished original COC is sealed in a watertight plastic bag and taped to the inside of the lid of the container used for transportation.
- The transportation container is sealed to prevent tampering and given to the courier for delivery to the laboratory.
- The sample collector obtains a copy of the waybill from the courier for the project file.
- The laboratory representative must receive the samples by signing his/her name, affiliation, the date, and time on the COC. This copy is maintained with the samples at the laboratory.
- The laboratory representative obtains a copy of the waybill from the courier for the project file.

4.3.6 Sampling personnel should record field events on a "Field Activity Daily Log" (see Attachment 6.2) and/or a "Sample Collection Log" (see SOP 3.1) as may be necessary to document the field work.

4.4 Analytical Laboratory Custody

4.4.1 Upon receipt at the analytical laboratory, the field generated COC document will be signed and dated; the time, temperature and condition of the samples will be noted; and laboratory identification will be provided in the appropriate spaces.

4.4.2 Laboratory receipt personnel will enter the samples into the laboratory by implementing the sample custody procedures addressed within their LEHR approved QA Program.

4.4.3 After completion of analytical testing, sample remnants not consumed during testing may be kept for six months beyond the completion of analysis, unless otherwise specified by a notation on the COC that samples are to be returned to the project site for disposal. Once this time period has elapsed, the samples will be disposed of and the disposal record number will be recorded on the laboratory record copy of the COC.

5.0 RECORDS

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2.

6.0 ATTACHMENTS

6.1 Chain-of-Custody Record

6.2 Field Activity Daily Log

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the PQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

CHAIN OF CUSTODY RECORD

Chain-of-Custody Record

L001

Please send analytical results and a copy of the signed chain of custody form to:

_____

Project ID:_____

Lab Personnel: **PLEASE INCLUDE QA/QC DATA**

1) Specify analytical method and detection limit in report.
2) Notify us if there are any anomalous peaks in GC or other scans.
3) ANY QUESTIONS/CLARIFICATIONS: CALL US.

Sampled by:_____

Laboratory Name:_____

No. of Containers	Sample ID	Container Type[1]	Sample Date	Sample Time	Vol[2]	Fil[3]	Ref[4]	Preservative (specify)	Analyze for	Analytical Method	Turn[5]	COMMENTS

1._____ Released by (Signature), Date, Time

1._____ Affiliation

2._____ Received by (Signature), Date, Time

2._____ Affiliation

3._____ Released by (Signature), Date, Time

3._____ Affiliation

4._____ Shipping Carrier, Method, Date, Time

4._____ Affiliation

5._____ Released by (Signature), Date, Time

5._____ Affiliation

6._____ Received by Lab Personnel, Date, Time

6._____ Affiliation, Telephone

x._____ Seal Intact?

1 = Sample Type Codes: W=Water, S=Soil, Describe Other; Container Type Codes: V=VOA/Teflon Septa, P = Plastic, C or B = Clear/Brown Glass, Describe Other;
2 = Volume per container; 3 = Filtered (Y/N); 4=Refrigerated (Y/N)
5 = Turnaround [N=Normal, W=1 Week, R=24 Hour, HOLD (write out)]

ATTACHMENT 6.2

FIELD ACTIVITY DAILY LOG

Field Activity Daily Log

Page__of__

Project Name_____

Project # _____ Project Manager _____ Vehicle(Field Use): WA _____ Odometer in _____

Name _____ Personal ____ Odometer out _____

Billing Period _____ Total Hrs. Billed _____ Rental _____ Mileage _____

Requested Work Summary

Activity Code	Hours Billed	Activity Code	Hours Billed
[_____]	[_____]	[_____]	[_____]
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Extra Scope of Work (ESOW) Summary

Activity Code	Hours Billed
[_____]	[_____]
_____	_____
_____	_____
_____	_____
_____	_____

Date/ Time	Activity Description	Activity Code	Hours	ESOW

SAMPLE HANDLING, PACKAGING AND SHIPPING

STANDARD OPERATING PROCEDURE

1.0 PURPOSE

This Standard Operating Procedure (SOP) outlines the methods and responsibilities for field personnel to use in the packaging and shipping of environmental samples, including hazardous, low-level radioactive, and mixed waste samples, for chemical and physical analysis. This SOP only applies to the packaging and shipping of limited quantity, environmental samples. The details in this SOP are only applicable to the general requirements for sample packaging and shipping and should only be used as a guide for developing more job-specific work plans.

2.0 REFERENCES

2.1 *EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14*

2.2 *EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, Interim Final OSWER Directive 9355.3-01*

2.3 *Code of Federal Regulations, DOT 49 CFR Parts 100 to 177*

2.4 *Dangerous Goods Regulations, IATA, January 1, 1994*

2.5 *SQP 4.2 - Records Management*

3.0 DEFINITIONS

3.1 *Environmental Sample*

A limited quantity sample of soil, water, air, or other substance found in the environment collected specifically for chemical or physical analysis.

3.2 Hazardous Material

Hazardous material means a substance or material, which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. For the LEHR site, the term includes hazardous substances and hazardous wastes, materials designated as hazardous under the provisions of 49 CFR Sec. 172.101, and materials that meet the defining criteria for hazard classes and divisions in 49 CFR part 173.

3.3 Hazardous Substance

Hazardous substance for the purposes of this SOP, means a material, including its mixtures and solutions, that:

- Is listed in Appendix A to 49 CFR Sec. 172.101;
- Is in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) listed in Appendix A to 49 CFR Sec. 172.101; and
- When in a mixture or solution:
  - For radionuclides, conforms to paragraph 6 of Appendix A to Sec. 172.101.
  - For other than radionuclides, is in a concentration by weight which equals or exceeds the concentration corresponding to the RQ of the material, as described in 49 CFR Sec. 173.133.

3.4 Hazardous Waste

Any substance listed in 40 CFR Subpart D (260.30 et seq.) or otherwise characterized as ignitable, corrosive, reactive, or toxic as specified in Subpart C (261.20 et seq.) that would be subject to manifest and packaging requirements specified in 40 CFR 262. Hazardous waste is defined and regulated by the U.S. Environmental Protection Agency (EPA).

3.5 Sample

Physical evidence collected from a facility or the environment which is representative of conditions at the point and time at which the sample is collected.

4.0 PROCEDURE

4.1 Responsibilities

4.1.1 Compliance with this procedure is the responsibility of project management, site management, health and safety, and field personnel.

4.1.2 The Project Manager (PM) is responsible for the development and review of site-specific work plans which address the specific sample handling, packaging, and shipping requirements for the project. The PM should review the project-specific documentation forms to ensure they are appropriate for the field activities. The PM is also responsible for seeing that field personnel receive proper training and maintain quality assurance/quality control (QA/QC).

4.1.3 The Project Quality Assurance Specialist (PQAS) is responsible for the periodic review of documentation generated during sample handling, packaging, and shipping and the periodic review and audit of field personnel as they perform the work. If problems arise, the PQAS is also responsible for swift implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to requirements, issuing nonconformances).

4.1.4 Site Health and Safety Officer (SHSO) is responsible for ensuring complete compliance with the Health and Safety Plan by all personnel on site. He/She is responsible for ensuring that all protective measures are identified and implemented to adequately protect site workers.

4.1.5 Radiological Control Technician (RCT) is responsible for assisting the SHSO in the performance of monitoring, posting and evaluation of work-site safety and radiological controls conditions.

4.2 Sample Handling

4.2.1 Inspect the sampling containers to ensure that they are appropriate for the samples being collected, correctly preserved, and undamaged.

4.2.2 When collecting a sample, always use approved/site specific personal protective equipment (e.g., gloves, etc.) to prevent cross-contamination from sample to sample but also as a health and safety requirement.

4.3 Field Packaging

4.3.1 Collect the samples in accordance with the site-specific sampling plans and applicable SOPs.

4.3.2 As soon as possible after sample collection, tightly seal the container. Custody seals may be used for additional sample security. The custody seal should be placed over the cap so that any attempt to remove the cap will cause the seal to be broken. Do not place custody seal over a volatile organic analysis (VOA) vial septum.

4.3.3 Place all containers in separate, appropriately sized, airtight, seam sealing polyethylene bags (e.g., Ziploc™). Seal the bag, removing any excess air.

4.3.4 Place the bagged container inside an insulating shipping container, "cooler." This cooler should have frozen blue ice inside to assure samples remain cool, "4°C," during transit from field to the packaging location.

4.3.5 Maintain the samples under chain-of-custody (COC) (SOP 1.1) in accordance with the site-specific work plans and appropriate SOPs.

4.4 Sample Packaging

4.4.1 Ensure that packages meet applicable requirements of Reference 2.3.

4.4.2 Inspect the integrity of the shipping container. The container is generally a "cooler" constructed of heavy plastic or metal with appropriate insulating properties so that variations in temperature during shipping are minimized. Also, make sure that the drain plug has been sealed.

4.4.3 Place two or more inches of absorbent packaging material (e.g., Vermiculite™) in the bottom of the shipping container. There should be sufficient absorbent material to absorb two times the volume of liquid, if liquid is present.

4.4.4 Carefully check the COC record against the collected sample labels and containers to ensure that the sample numbers, sample description, date and time of collection, container type and volume, preservative, and the required analytical methods are correct and in agreement.

4.4.5 Place the samples in the shipping container, allowing sufficient room between the samples to place ice and/or packing material.

4.4.6 Double bag and seal crushed or cubed ice in heavy-duty polyethylene bags. Place these bags of ice on top of and between samples. Blue ice should only be used, along with crushed/cubed ice; it does not maintain the 4°C temperature necessary for regulatory compliance. The remaining space will be filled with packing material.

4.4.7 All samples requiring 4°C temperature preservation will be acceptable "as in" within the range of 4°C ± 2°C. The laboratory should record the temperature of receipt on the COC. For all samples received from 6°C to 10°C, the sample(s) and temperature (in 1°C increments) will be noted on the COC and then analyzed. Samples with temperatures greater than 10°C and VOA samples below 0°C will be reported immediately to the Project Manager.

4.5 Sample Shipping

4.5.1 Shipping shall meet all applicable requirements of References 2.3 and 2.4.

4.5.2 All materials being offered for transportation shall be properly classified based on existing data, site history, chemical characteristics, and radiological characteristics, etc. This is necessary in order to ensure that all appropriate packaging, marking, labeling, handling, placarding, shipping papers, and mode of transportation are utilized as applicable/required.

4.5.3 Samples that contain or could potentially contain radioactive material shall only be sent to laboratories with an appropriate NRC or Agreement State Radioactive Materials License. Prior to

shipment of radioactive material, it should be verified that the laboratory/facility is able to receive/possess the nuclides and total activity present in the shipment.

4.5.4 As applicable, all radiological surveys mandated by Reference 2.3 shall be performed for packages and conveyances for shipping and receipt of radioactive material.

4.5.5 The person in charge of sample custody will time, date, and sign over relinquishment of custody on the COC. When a common carrier is to be used for sample shipment, also record the air/waybill number (tracking number) and the name of the carrier on the COC record. Place the original copy of the COC record in a sealed, clear plastic envelope or bag and tape the COC record envelope to the inside lid of the shipping container. Retain a copy of the COC record for tracking purposes.

4.5.6 Using nylon reinforced strapping tape or mailing tape, seal the shipping container.

4.5.7 Place custody tape over opposite ends of the lid.

4.5.8 Mark the container "THIS END UP," or apply arrow labels that indicate the proper position to be maintained during shipping.

4.5.9 Apply a label stating the name and address of the shipper and the receiving laboratory on the outside of the cooler.

4.5.10 Turn the sample(s) over to the courier or carrier for delivery to the laboratory. All samples should be shipped by the fastest available method to the laboratory as soon as possible after sample collection.

NOTE: The courier or carrier is not responsible for sample custody and is not required to sign the COC.

4.5.11 Contact the appropriate laboratory personnel to advise them of the sample shipment.

4.5.12 Review the COC and sample collection forms for completeness and turn them over to site or project management personnel.

5.0 RECORDS

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2.

6.0 ATTACHMENTS

None.

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the PQAM, if the substitute form contains equivalent information as the referenced form.

SURFACE AND SHALLOW SUBSURFACE SOIL SAMPLING

STANDARD OPERATING PROCEDURE

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of surface (0 to 6-inch in depth) and shallow subsurface (6-inch to 6-feet in depth) soil samples for physical and chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all surface and shallow subsurface soil samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

2.0 REFERENCES

2.1 *EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14*

2.2 *EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, Interim Final OSWER Directive 9355.3-01*

2.3 *SOP 1.1 - Chain-of-Custody*

2.4 *SOP 2.1 - Sample Handling, Packaging and Shipping*

2.5 *SOP 6.1 - Sampling Equipment and Well Material Decontamination*

2.6 *SOP 17.1 - Sample Labeling*

2.7 *SOP 17.2 - Sample Numbering*

2.8 *SQP 4.2 - Records Management*

3.0 DEFINITIONS

3.1 Surface Soil Sample

Soil collected from the surface to a depth of no more than 6 inches.

3.2 Shallow Subsurface Soil Sample

Soil collected from a depth of 6 inches to 6 feet.

3.3 Subsurface Soil Sample

Soil collected at any depth interval greater than 6 inches.

3.4 Disturbed Soil Sample

A soil sample whose in situ physical structure and fabric has been disturbed as the direct result of sample collection.

3.5 Undisturbed Soil Sample

A soil sample whose in situ physical structure and fabric has not been disturbed as the result of sample collection.

3.6 Grab Samples

Representative disturbed soil sample that is collected by using such devices as a shovel, stainless steel spoon, etc.

4.0 PROCEDURE

This section contains both the responsibilities and procedures involved with surface and shallow subsurface soil sampling. Proper surface and shallow subsurface soil sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives;
- Locations and depths of soil samples to be collected;
- Numbers and volumes of soil samples to be collected;
- Types of analyses to be conducted for the samples;

- Specific quality control (QC) procedures and sampling required; and,
- Any additional surface or shallow subsurface soil sampling requirements or procedures beyond those covered in this SOP, as necessary.

At a minimum, the procedures outlined below for surface and shallow subsurface soil sampling will be followed.

4.1 Responsibilities

4.1.1 The Project Manager is responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

4.1.2 The Project QA Specialist (PQAS) is responsible for periodic review of field generated documentation associated with this SOP. The PQAS is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

4.1.3 Field personnel assigned to surface and shallow subsurface soil sampling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Field Coordinator or the PQAS.

4.2 Surface Soil Sampling Equipment

4.2.1 A number of devices are available for the collection of surface soil samples. These include, but are not limited to: core samplers, hand augers, spoons, scoops, trowels, shovels, triers, etc. These devices are constructed of a number of materials including, but not limited to, stainless steel, brass, glass, teflon, etc.

4.2.2 The sampling and analytical requirements, as well as site characteristics, must be taken into account when determining the proper surface soil sampling equipment to use.

4.2.3 At present, the method commonly used for the collection of surface samples and shallow subsurface samples, both disturbed and undisturbed, is with a core sampler. The core sampler is usually a hollow, stainless steel cylinder, tapered at the leading end. A sample sleeve (brass, stainless steel, lexan, etc.) is inserted into the trailing end. The trailing end is then connected to a piston-type drive hammer. The core is driven into the soil by the hammer so that a relatively undisturbed sample is collected in the sleeve. The sample is then handled and shipped in the sample sleeve.

4.2.4 When a core sample is not feasible or planned, a sample can be collected by using such devices as a shovel, hand auger, trowel, or stainless steel spoon, etc. The soil is transferred from the collection device into decontaminated sample containers (commonly glass jars). The project work

plans will specify the type of sampling equipment to be used. The sample containers to be used will also be specified in the project work plans.

4.3 Surface Soil Sample Collection

4.3.1 Prior to sampling and between sampling locations, decontaminate the sample equipment according to SOP 6.1 and procedures outlined in the project work plans.

4.3.2 Ensure that all surface and shallow subsurface soil sampling locations have been appropriately cleared of all underground utilities and buried objects per the project work plans. Review all forms and diagrams documenting the location of the cleared sampling locations, as well as that of any underground utilities or lines, or other buried objects.

4.3.3 As required, calibrate any health and safety monitoring equipment according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s), as specified in the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

4.3.4 Don appropriate personal protection equipment as specified in the project work plans.

4.3.5 Clear the area to be sampled of surface debris and vegetation using equipment that will not be used for sample collection.

4.3.6 If using the coring device, place the sleeve into the device and drive the assembly into the soil using the drive hammer. Drive the device into the soil until the trailing end of the sleeve is at the soil surface.

4.3.7 Retrieve the device; check to see that soil recovery is adequate in the sample sleeve. If there is sufficient recovery, mark or note the leading end of the sample sleeve.

4.3.8 If using a different sample collection device (other than the coring device), use the other device to scoop or collect soil and directly transfer the soil into the sample container (e.g., glass jar, brass sample sleeve, etc.). Fill the sample container such that little to no head-space exists.

4.3.9 If using sample sleeves, place teflon tape over each end of the sleeve and seal each end with plastic end caps. Custody seal may be used for additional sample security.

4.3.10 If using glass jars, cap or seal the jars appropriately. Custody seals may be used for additional sample security.

4.3.11 Appropriately label and number the sample containers per SOPs 17.1 and 17.2, respectively, and the project work plans. The label will be filled out with waterproof ink and will contain, at a minimum, the following information:

- Project number;
- Sample number;

- Sample location;
- Sample depth;
- Sample type;
- Date and time of collection;
- Parameters for analysis; and,
- Sampler's initials.

4.3.12 Document the sampling event on the Sample Collection Log (Attachment 6.1) or an equivalent form as specified in the project work plans. Note any pertinent field observations, conditions or problems on the Field Activity Daily Log (SOP 1.1). Any encountered problems or unusual conditions should also be immediately brought to the attention of the Site Coordinator.

4.3.13 Appropriately preserve, handle, package, and ship the samples per SOP 2.1 and the project work plans. The samples shall also be maintained under custody per SOP 1.1.

4.3.14 Fill and abandon the sample hole as required by the project work plans.

4.4 Shallow Subsurface Soil Sampling

4.4.1 The common method to collect shallow subsurface soil samples is to use a hand auger to bore to the desired sampling depth and then retrieve the sample with a core sampler. The hand auger might also be used to recover the sample for direct transfer into glass jars. The exact methodology to be used will be specified in the project work plans.

4.4.2 For subsurface soil samples of less than 18 inches in depth, successive drives of the core sampler may potentially be used to recover shallow subsurface soil samples. In all methods cited above, borehole stability should be maintained to prevent the recovery of slough in the samples. If sloughing cannot be controlled, then another sampling methodology may have to be considered.

4.4.3 As with surface soil samples, shallow subsurface soil sampling follows the same sample collection procedures specified in Sections 4.3.1 through 4.3.13.

5.0 RECORDS

Records generated as a result of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2.

6.0 ATTACHMENTS

6.1 Sample Collection Log

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the PQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

SAMPLE COLLECTION LOG

SAMPLE COLLECTION LOG

DATE	
TIME	
PAGE	OF
PROJECT NO.	

PROJECT NAME _____

SAMPLE NO. _____

SAMPLE LOCATION _____

SAMPLE TYPE _____

COMPOSITE _____ YES _____ NO

COMPOSITE TYPE _____

DEPTH OF SAMPLE _____

WEATHER _____

CONTAINERS USED	VOLUME COLLECTED

COMMENTS:

PREPARED BY: _____

SAMPLING EQUIPMENT AND WELL MATERIAL DECONTAMINATION

STANDARD OPERATING PROCEDURE

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the decontamination of sampling equipment and well construction materials. Proper equipment decontamination is essential in ensuring the quality and integrity of samples collected during a given sampling event. Additional specific sampling equipment and well material decontamination procedures and requirements will be provided in the project work plans.

2.0 REFERENCES

2.1 *EPA, September 1987, EPA Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14*

2.2 *EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01*

2.3 *SOP 6.2 - Drilling and Heavy Equipment Decontamination*

2.4 *SQP 4.2 - Records Management*

3.0 DEFINITIONS

3.1 Deionized Analyte-Free Water

Ion-free, analyte-free water produced on site or purchased from a supplier with a deionization chamber equipped with a carbon filter.

3.2 Potable Water

Treated municipal water, or other drinking-grade water.

3.3 Laboratory Grade Detergent

A standard brand of laboratory-grade detergent, such as "Alconox" or "Liquinox."

3.4 Methanol

Laboratory-grade methanol alcohol, CAS #67-56-1.

3.5 Hexane

Laboratory-grade hexane, CAS #110-54-3.

3.6 HPLC Water

High performance liquid chemotrgraphy-grade water.

4.0 PROCEDURE

This section contains responsibilities, requirements, and procedures for sampling equipment and well material decontamination. The decontamination is required to maintain proper quality and integrity of collected samples.

The details within this SOP should be used in conjunction with the project work plans. The project work plans will provide the following information:

- Types of equipment requiring decontamination under this SOP;
- Specific materials to be used for the decontamination; and
- Additional decontamination requirements and procedures beyond those covered in this SOP, as necessary.

All field personnel associated with decontamination of sampling equipment or well materials must read both this SOP and the project work plans prior to implementation of related decontamination activities. Information and requirements for the decontamination of any and all drilling and heavy equipment is provided in SOP No. 6.2.

4.1 Responsibilities

4.1.1 The Project Manager is responsible for ensuring that all sampling equipment and well material decontamination activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

4.1.2 The Project QA Specialist (PQAS) is responsible for periodic review of field generated documentation associated with this SOP. The PQAS is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to decontamination requirements, issuing nonconformances, etc.) if problems occur.

4.1.3 Field personnel assigned to sampling equipment and well material decontamination activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the Field Coordinator or the PQAS.

4.2 Decontamination Facility

If possible, sampling equipment decontamination will take place in an area designed exclusively for decontamination. This area will ideally be located within the contamination reduction zone on the project site. Well materials may be decontaminated at the facility set up for decontamination of drilling and heavy equipment (see SOP No. 6.2).

Each decontamination facility will be constructed so that the equipment, as well as all wastes generated during decontamination (e.g., soil, rinsate, liquid spray, debris, etc.), are contained to the extent appropriate. In addition, chemical products used in the decontamination process must be properly containerized and labeled.

4.3 Decontamination of Non-Dedicated Sampling Equipment

Each piece of reusable, non-dedicated sampling equipment will be decontaminated before each sampling event. The standard procedure will be performed as described below.

4.3.1 Suitable personal protective equipment (specified by the project work plans) must be worn by all personnel involved with the task to reduce personal exposure.

4.3.2 Heavily caked soil and/or other material will be scraped or brushed from equipment. Steam cleaning of equipment may be required to remove material from samplers.

4.3.3 Equipment that will not be damaged by water should be placed into a wash tub containing a laboratory-grade detergent solution and scrubbed with a brush or clean cloth. Rinsing will then be conducted with fresh, potable water, followed by deionized water.

4.3.4 Methanol, hexane, and HPLC water rinses may then follow for some sampler components when specified by the project work plans.

4.3.5 Any equipment that may be damaged by submersion into water will be wiped clean using a sponge and detergent solution. Cleaning will be followed by wiping the equipment with deionized water.

4.3.6 Air dry the rinsed equipment. Soil organic vapor (SOV) sampling equipment should be flushed dry with bottled air of known quality and/or as per the project work plans.

4.3.7 Place decontaminated equipment on clean plastic sheeting to prevent contact with contaminated soil. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

4.3.8 Decontamination activities will be documented on the Field Activity Daily Log (FADL) (SOP 1.1) or other appropriate form(s), as specified by the project work plans.

4.4 Decontamination of Dedicated Sampling Equipment

Dedicated sampling equipment, such as submersible pumps, will be decontaminated prior to installation inside monitoring wells. At a minimum, the procedure outlined below must be performed. If factory-cleaned, hermetically sealed materials are used, no decontamination will be necessary, provided that laboratory decontamination certification is submitted with the equipment.

4.4.1 Suitable personal protective equipment will be worn by all personnel involved in the task, in accordance with the project work plans.

4.4.2 Pumping lines will be washed with a laboratory-grade detergent solution.

4.4.3 The equipment will then be rinsed twice with tap water, followed by a rinse with deionized water.

4.4.4 Air dry.

4.4.5 Place decontaminated equipment on clean plastic sheeting to prevent contact with contaminated soil. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

4.4.6 Decontamination activities will be documented on the FADL or the appropriate form(s), as specified by the project work plans.

4.5 Decontamination of Well Materials

Well materials including well casing, well screens, centralizers, and end caps will be decontaminated prior to use in constructing monitoring wells. (If factory-cleaned, hermetically sealed material are used, no decontamination will be necessary, provided that laboratory decontamination certification is submitted with the equipment.) The standard procedure outlined below must be performed when decontaminating well materials.

4.5.1 Appropriate personal protective equipment will be worn by all personnel involved in the task, in accordance with the project work plans.

4.5.2 Materials will be thoroughly sprayed and washed with water using a high pressure steam cleaner.

4.5.3 Air dry.

4.5.4 Decontaminated materials will be placed on clean metal racks or clean plastic sheeting. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

4.5.5 Decontamination activities will be documented on the FADL or other appropriate form(s), as specified by the project work plans.

5.0 RECORDS

Records generated as a result of this SOP will be maintained in the Project Records file in accordance with SQP No. 4.2.

6.0 ATTACHMENTS

None.

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the PQAM, if the substitute form contains equivalent information as the referenced form

LITHOLOGIC LOGGING

STANDARD OPERATING PROCEDURE

1.0 PURPOSE

This procedure describes the basic methods for logging soil using the USCS visual method. Use of visual examination and simple manual tests associated with the USCS procedure gives standardized criteria and processes for describing and identifying soils. Logging soil assures that data, information, and descriptions generated from each borehole or excavation are properly collected and documented. Furthermore, proper documentation and logging of soil allows direct comparison of lithology between different boreholes. This document describes:

- the methods for describing soil samples;
- what information is necessary to complete the lithologic log;
- the required forms on which field observations are logged; and,
- the equipment necessary for logging and visual classification of soil samples.

2.0 REFERENCES

2.1 *U.S. Department of the Interior, Bureau of Reclamation (USBR), 1986, Procedures for Determining Unified Soil Classification (Visual Method), USBR 5005-86*

2.2 *SOP 2.1 - Sample Handling, Packaging, and Shipping (Appendix A)*

3.0 DEFINITIONS

This section presents definitions of some of the common basic terminology utilized in soil classification. These definitions do not substitute for the training and experience required in learning the multitude of definitions used in soil classification.

3.1 Gravel

Particles of rock that will pass a 3-inch sieve and be retained on a No. 4 sieve. Criteria to distinguish coarse and fine is provided in Section 5.2.1 of Reference 2.1.

3.2 Sand

Particles of rock that will pass a No. 4 sieve and be retained on a No. 200 sieve. Criteria to distinguish coarse, medium, and fine is provided in Section 5.2.2 of Reference 2.1.

3.3 Clay

Soil passing the No. 200 sieves that exhibits plasticity (putty-like properties) within a range of moisture contents, and which exhibits considerable dry strength when air-dry. Criteria to distinguish inorganic and organic clay are provided in Section 5.2.5 and 13.6 through 13.7.2 of Reference 2.1.

3.4 Silt

Material passing the No. 200 sieve that is non-plastic or very slightly plastic and exhibits little or no strength when air-dry. Criteria to distinguish inorganic and organic silt are provided in Sections 5.2.6, 13.7.3, and 13.7.4 of Reference 2.1.

3.5 Dry Strength

This is the resistance of a 1/4-inch air-dry ball made from the test material to crushing between the fingers. Dry strength is described with the terms None, Low, Medium, High, and Very High. Dry strength testing procedures are presented in Sections 13.2 of Reference 2.1.

3.6 Penetration Resistance

Penetration resistance is based on blow counts recorded per foot while driving a Standard Penetration Sampler with a 140-pound hammer. A larger diameter sampler will have higher blow counts.

3.7 Dilatancy

This is a measure of the ability of a 1/2- to 1-inch-long pat made from the test material to yield water when shaken horizontally. Dilatancy is described with the terms None, Slow, and Rapid. Dilatancy testing procedures are presented in Section 13.3 of Reference 2.1.

3.8 Toughness

This is a measure of the test material's ability to be rolled into a 1/8-inch-diameter thread. Toughness is described with the terms Low, Medium, and High. Toughness testing procedures are presented in Section 13.4 of Reference 2.1.

3.9 Plasticity

This is a description of the test sample behavior derived during the performance of the toughness test. Plasticity is described with the terms Nonplastic, Low, Medium, and High. Plasticity testing procedures are presented in Section 13.5 of Reference 2.1.

3.10 Color

3.6.1 There are two approaches to identifying the color of samples. Either the Rock Color Chart can be used. Or the logger can subjectively judge the color using a set of standard colors. For this Work Plan the logger should subjectively judge the color using the following colors in combination:

- Brown;
- Yellow;
- Blue;
- Orange;
- Red;
- Grey; and,
- Olive.

No more than two colors should be combined, with the more dominant color being preceded by the secondary color and separated by a hyphen, e.g. "brown-gray". The color description may be additionally modified by the terms "light" and "dark" as appropriate. For brevity, and to also distinguish subjective color descriptions from those of the Rock Color Chart, the "ish" suffix should be avoided.

Frequently, a sample has spots or patches which are colored differently from the bulk of the sample. This is called mottling. Where it occurs, the proper description includes the color of the bulk sample followed by the word "mottled," followed by one or more of the color descriptions, e.g., "dark brown mottled tan."

This is a description of the test sample behavior derived during the performance of the toughness test. Plasticity is described with the terms Nonplastic, Low, Medium, and High. Plasticity testing procedures are presented in Section 13.5 of Reference 2.1.

3.11 Moisture Content

The terms used to describe moisture content are dry, damp, moist, and wet, The moisture content is determined by feel. Dry is an unusual condition where the sample is completely desiccated as if it were baked in an oven. A damp sample will have enough moisture to keep the sample from being brittle, dusty or cohesionless and is darker in color that the same material in the dry state. A moist sample will leave moisture on your hand but displays no free water. A wet sample is one which is saturated and displays free water.

3.12 Estimated Grain Size Percents

The method of determining the percent composition of various grain sizes is largely visual except in distinguishing between silt and clay. When noting percentages, if all the fractions of all sizes in the sample are listed, they should total 100%.

When estimating percent of fines, because of the difficulties in distinguishing silt from clay, only the percent total fines should be estimated.

When describing gravel, the size of the clasts should be noted in inches, using "in." to symbolize inches. If the range of clasts begins just above coarse sand, then specify the largest size in a range of clasts, e.g. 20% gravel and cobbles to 5 inches.

When describing sand sizes, the terms fine, medium, and coarse are to be used.

3.13 Estimated Relative Permeability

Relative permeabilities are given as very low, low, low to moderate, moderate, moderate to high, high, and very high. It is extremely difficult to estimate the hydraulic permeability visually. Very high permeability materials are rare and usually occur as very well sorted gravels and sands with very little fine sediment. Generally, permeability decreases with degree of consolidation and amount of clay.

3.14 Odor

Odor is not usually mentioned unless a particular odor is detected. The absence of odor is only reported where the lack of it is diagnostic.

IMPORTANT: When contamination is severe enough to produce an odor without having to directly sniff the sample, i.e., free floating odors from around the borehole or an unbroken sample, all workers should put on respirators and halt work until the office has been contacted.

4.0 PROCEDURE

This section provides both the responsibilities and procedures involved with soil logging. The details within this SOP will be used in conjunction with the Final Work Plan for Western Dog Pens, Background, and Off-site Investigations.

4.1 Responsibilities

4.1.1 The Field Coordinator (FC) will be responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

4.1.2 The Project Quality Assurance Specialist (PQAS) will be responsible for periodic review of field generated documentation associated with this SOP. The PQAS will also be responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and procedures, variances to QC sampling requirements, issuing non-conformances, etc.) if problems occur.

4.1.3 Field personnel assigned to sampling activities will be responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff will be responsible for reporting deviations from procedures to the FC, Weiss Associates Project Manager, or the PQAS.

4.2 Soil Boring Logs

The Borehole/Well Construction Log Form is included as Attachment 1 to this SOP. Field personnel recording lithologic information during drilling will use this form. The procedures which will be followed in completing the Borehole/Well Construction Log Form, are outlined below.

As applicable, the following information will be filled in completely at the top of the first page of each boring log:

- Project Number;
- Project Name;
- Project Location;
- Rough Sketch with scale and north arrow depicting the approximate location of boring to structures, or other field landmarks;
- Boring Number;
- Name of Drilling Contractor;
- Name of Driller(s);
- Name of Field Geologist completing the form;
- Date and time drilling is started and completed;
- Drilling/Sampling Method;
- Type of Drill Rig used in collecting the samples;
- Driller's C57 License Number; and,
- Borehole Diameter.

Each subsequent page of the Borehole/Well Construction Log should include:

- Photoionization (PID) or flame ionization detector (FID) readings recorded at the appropriate sample depth in units of parts per million (ppm);
- The instrument number of the PID used in the field;
- Borehole Completion and Sample Information (total borehole depth in feet, sample depth, sample description, blow counts, inches driven, inches recovered, sample condition);

- Borehole abandonment/completion information such as conductor casing(s) (interval and diameter), depth of sand pack and grout, well casing and screen depth; and,
- All depth or particle size numbers recorded as a decimal integer.

A daily field activity log will record the start of fieldwork and will be updated throughout the day by the field geologist/engineer. The daily field activity log will include:

- Date/Time and field activity description;
- Hours spent on field activity; and,
- A diary of daily activities, inspections, problems, conversations, visitors, weather conditions, and any other information relevant to the field activity.
- Samples collected for purposes other than soil classification are subject to handling, packaging, and shipping procedures described in SOP 2.1, Sample Handling , Packaging and Shipping.

4.3 Borehole Logging Procedures

The Borehole/Well Construction Log Form will be filled out accurately for each soil boring drilled and/or each soil boring attempted. Sample depths, locations and types will be recorded on the form. Boreholes that are logged entirely from cuttings and are not sampled must be indicated as such.

The log will contain a detailed description of the soil strata encountered and all pertinent information regarding drilling operations and estimated soil and ground water properties.

- Soil will be classified according to the Unified Soil Classification System (USCS) (Reference 2.1). The textural name for the soil will be written in the appropriate column using the USCS symbol.
- The format description for fine-grained sediments will include: textural classification (Silt, Sandy Silt, Clayey Silt, Sandy Clay, Silty Clay, Clay, Organic Silt, or Organic Clay); color, penetration resistance, moisture content, particle size distribution, estimated permeability, odor, miscellaneous (cementation, geologic origin, formation name, etc.).
- The format description of coarse-grained sediments will include: textural classification (Sand, Clayey Sand, Silty Sand , Gravelly Sand, Gravel, Clayey Gravel, Sandy Gravel); color, penetration resistance, moisture content, particle size distribution, grain shape, grain size, estimated permeability, odor, miscellaneous.
- A solid horizontal line and the appropriate depth in the USCS symbol column will mark abrupt soil changes. A dashed line will mark an apparent soil change. Diagonal lines will mark gradational changes. (Field personnel are best qualified to estimate the depth of changes. This task will not be delegated to office personnel, who have not observed the drilling operation.)

- Abbreviations will be used on the logs to save space for editing purposes.

Comments on the field log are extremely important. Some important aspects of the drilling operation that will be recorded are:

- The organic content of the soil and the depth of topsoil and roots;
- Any sudden change in the speed, sound, or penetration rate of the drill rig;
- If sampling is not continuous, drill cuttings will be used to complete the log; and,
- Any sample that is suspected of being disturbed, contaminated, or chemically or physically altered during the drilling process.

4.4 Surface Soil Lithologic Logs

Surface soil lithologic logs will be recorded on the daily field activity log and on the Sample Collection Log contained in SOP 3.1, Surface and Shallow Subsurface Soil Sampling, Attachment 1. This requires the FC/Field Geologist to make an illustration of the shallow sample location and record the:

- Project Number;
- Project Name;
- Project Location;
- Trench Number or Description; and,
- FC/Geologist Identity.

The following information will be recorded on the Sample Collection Log:

- Complete an accurate location sketch with dimensions to landmarks. Important features such as road intersections, corners of large buildings, or other man-made structures are best used. A north arrow will be included.

Samples collected for purposes other than soil classification are subject to handling, packaging, and shipping procedures as described in SOP 2.1.

Upon completion of shallow sample location, a completion note will be placed at the bottom of the last page of the Sample Collection Log, which will include:

- Sampling Completion at (Depth) Feet on (Date);
- Sampling Area Backfilled to Ground Surface on (Date); and,
- All depth numbers will be recorded in decimals.

4.5 Surface Soil Lithologic Logging Procedures

On the daily field activity log and Sample Collection Log in which the shallow boreholes or trenching are recorded, the following information will be included if appropriate:

- The sampler type. The abbreviations for sampler types are TW for thin-wall, P for piston, ST for Shelby Tube, and SS for standard split spoon. These abbreviations, or notations as to other sampler types, will be used in the "sampler type" column.
- Origin of sample. Specify if it is collected directly from the boring, a trench wall, or from an excavator bucket or shovel.
- The depth and location from which the sample originated. The sample depth is always measured to the top of the sample. A sample attempt where no sample is recovered will not be numbered, but the fact that a sampling attempt was made must be noted.
- The sample number.

The log will contain a detailed description of the soil strata encountered and all pertinent information regarding trenching operations and estimated soil and ground water properties.

- Soil will be classified according to the Unified Soil Classification System (USCS) (Reference 2.1). The textural name for the soil will be written on the excavation illustration at the appropriate depth interval.
- The format description for fine-grained sediments will include: textural classification (Silt, Sandy Silt, Clayey Silt, Sandy Clay, Silty Clay, Clay, Organic Silt, or Organic Clay); color, penetration resistance, moisture content, plasticity, particle size distribution, estimated permeability, odor, miscellaneous (cementation, geologic origin, formation name, etc.).
- The format description of coarse-grained sediments will include: textural classification (Sand, Clayey Sand, Silty Sand, Gravelly Sand, Gravel, Clayey Gravel, Sandy Gravel); color, penetration resistance, moisture content, particle size distribution, grain shape, grain size, estimated permeability, odor, miscellaneous.
- If abrupt soil changes are present, a solid horizontal line and the appropriate depth in the USCS symbol column will mark them. A dashed line will mark gradational soil changes. Diagonal lines should not be used. (Field personnel are best qualified to estimate the depth of changes. This task will not be delegated to office personnel, who have not observed the excavation operation.)
- Abbreviations will be used on the logs to save space for editing purposes.

Comments on the field log are extremely important. Some important aspects of the excavation operation that will be recorded follow:

- The organic content of the soil and the depth of topsoil and roots;
- Any sudden change in the speed, sound, or penetration rate of the excavation; and,

- Any sample that is suspected of being disturbed, contaminated, or chemically or physically altered during the excavation process.

5.0 RECORDS

Records generated as a result of this SOP will be controlled and maintained in the project record files.

6.0 ATTACHMENTS

6.1 Borehole/Well Construction Log

A form referenced or attached to this SOP may be replaced with a substitute form, with the approval of the PQAM, if the substitute form contains equivalent information as the referenced form.

ATTACHMENT 6.1

BOREHOLE/WELL CONSTRUCTION LOG

WEISS ASSOCIATES

BOREHOLE / WELL CONSTRUCTION LOG

Page ____ of ____

BOREHOLE LOCATION	Project: (facility, address, city, state)	Borehole/Well No:
		Job No:
	Logged By:	Edited By:
	Project Manager:	Drill Rig:
	Drilling Contractor: (name, city, state)	
	Driller:	License # : C57-
	Drilling Method:	Sample Method:
	Well Head Completion:	Ground Surface Elevation:
	Hammer Weight/Drop:	Borehole Diameter:
	Started, Time:	Date:
	Completed, Time:	Date:
Approximate Scale:	Water Depth	
	Boring/Casing Depth	
Notes:	Time	
	Date	

Total Boring Depth:	Total Well Depth:
Screened Interval:	Well Diameter:
Sand Pack (Type and Interval):	
Well Development Method:	
Time: Date:	Flow Rate:
Geophysical Logs, Type:	
By:	Date:

Sample ID	PID / FID (ppm)	Sampler Type / depth	Blows per 6 Inches	Inches Driven	Inches Recovered	Sample Condition	Boring Diameter	Diagram: Conductor Casing(s) Interval and Diameter	Diagram: Sand / Grout	Diagram: Well Casing / Screen	Depth in Feet	Recovery / Sample Loc.	Contact / Hyd. Conduct.	LITHOLOGIC DESCRIPTIONS
											1			
											2			
											3			
											4			
											5			
											6			
											7			
											8			
											9			
											10			

L:/data/graphics/general/forms/logform.ai

©Weiss Associates 6/96