

F

Appendix F

STANDARD OPERATING PROCEDURES

APPENDIX F

INDEX OF APPLICABLE STANDARD OPERATING PROCEDURES

<u>SOP No.</u>	<u>Title/Description</u>
1.0	Field Logbook. Delineates protocols for recording field and sampling information in the field logbook.
2.0	Boring Log Development. Provides project team with the proper method for the generation of boring logs and well completion diagrams approved by registered geologists for report submittal.
3.0	Field Classification and Description of Soils. Provides guidance for field evaluation and classification of soils.
4.0	Sample Management. Outlines procedures to assure representative environmental sample data by documenting the management of samples from time of collection through analysis and final disposition.
5.0	Field Measurement of Organic Vapors. Procedures and guidance to conduct soil gas field surveys or headspace measurements of organic vapors.
6.0	Utility Clearance. Describes procedures to reduce risk of contact with buried or above-ground utility service lines.
7.0	Collection of Soil Samples. General procedures for collecting soil samples and information to be included in Field Logbook.
8.0	XRF Soil Analysis. Outlines the procedure for sample preparation and XRF analysis of soil samples for elements using a field portable XRF.
9.0	Packing and Shipping of Environmental Samples. Provides guidance for packing and shipping environmental samples with the appropriate chain of custody records.
10.0	Sample Preservation and Analysis Methods. Outlines procedures to ensure chemical integrity of sample is maintained from time of collection until analysis.
11.0	Sampling Equipment Decontamination. Outlines procedures for field decontamination of sampling equipment and personnel to ensure that introduction or transfer of contamination is eliminated.
12.0	Immunoassay. Outlines the procedures for the sample preparation, assay and analysis of soil samples using immunoassay test kits.
13.0	<i>In Situ</i> Groundwater Sampling. Describes procedures for collecting <i>in situ</i> groundwater samples.

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<u>SOP No.</u>	<u>Title/Description</u>
14.0	Borehole Abandonment. Outlines proper abandonment procedures to ensure borehole structure is not a preferential migration pathway for possible pollutants.
15.0	Well Development. Describes procedures for developing groundwater monitoring wells.
16.0	Surface Water Sampling. Describes techniques and equipment to be used for collection surface water samples.
17.0	Groundwater Purging and Sampling. Provides detailed procedures for collection of groundwater samples in the field.
18.0	Geophysical Testing. Outlines techniques for collecting geophysical data by means of surface borehole measurements.
19.0	Soil Gas Sampling. Details methodologies for collection near-surface and downhole soil gas samples in canisters or Tedlar bags.
20.0	Sludges and Sediments. Delineates protocols for collecting representative samples of sludges and sediments from areas of deposition.
21.0	Well and Piezometer Installation. Provides procedures and requirements for proper installation of groundwater wells and piezometers after completion of the well boring.
22.0	Field Measurement of pH. Describes methods for measuring pH of aqueous and soil samples in the field.
23.0	Field Measurement of Temperature. Describes the procedures to measure temperature readings in environmental samples.
24.0	Field Measurement of Specific Conductance. Describes the procedures for measuring the specific conductance of any aqueous solution.
25.0	Field Measurement of Water Levels. Describes equipment and procedures used to determine static water levels and total depth in monitoring wells and piezometers.
26.0	Photographic/Video Documentation. Provides guidelines ensuring documentation of project activities and completed project work.

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<u>SOP No.</u>	<u>Title/Description</u>
27.0	Drilling. Establishes procedures and methods for drilling exploratory boreholes for the purpose of sample collection, well installation, and collection of HydroPunch® groundwater samples.
28.0	Cone Penetrometer Drilling and Sampling Procedures. Establishes protocols for cone penetrometer drilling and sampling.
29.0	Trenching. Sets procedures for trenching and determining the boundaries of landfills and burnsites.
30.0	Methanol Preservation for Volatile Organic Compounds in Soils. Describes preparation, sample collection, and handling procedures for methanol preservation of samples.
31.0	Field Classification and Description of Rocks. Provides proper method for field classification and description of rocks.
32.0	Field Sampling with EnCore™
33.0	Groundwater Sampling Using Passive Diffusion Bag Samplers. Provides the detailed procedures for collecting groundwater samples for Volatile Organic Compounds in the field using a Passive Diffusion Bag.

BENICIA SOP #1

FIELD LOGBOOK

1.0 PURPOSE

- 1.1 The purpose of this standard operating procedure (SOP) is to delineate protocols for recording field and sampling information in the Field Logbook that will provide a complete record of procedures as performed in the field.

2.0 SCOPE AND APPLICABILITY

- 2.1 This procedure applies to all project team personnel and subcontractors who conduct field investigations and collect and/or handle environmental samples.

3.0 REFERENCES

- 3.1 U.S. Environmental Protection Agency (EPA), *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods*, Second Edition, EPA-600/4-84-076, December 1984, p. D1-D11.
- 3.2 U.S. EPA/NEIC, *User's Guide to the EPA Contract Laboratory Program*.
- 3.3 U.S. EPA/NEIC, *Policies and Procedures*, 330/9/78/011-R, 1982.
- 3.4 Brown and Caldwell. 1991. *Hazardous Materials Field Procedures Manual*, September.

4.0 DEFINITIONS

Not applicable

5.0 GENERAL

- 5.1 An essential part of any environmental project is assuring the proper documentation of all field activities. Projects where analytical data or conclusions based upon analytical data may be used in litigation demand that accountability of the history of a sample be available to demonstrate that the data are a true representation of the environment. Therefore, it is extremely important that field documentation be complete, accurate and consistent. In general, any type of useful field material that is not recorded by or added to other documentation should be entered in the field logbook.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager** shall ensure that the field documentation procedures used will adhere to this SOP.
- 6.2 The **Field Supervisor** shall ensure field logbooks are properly completed at the end of each field day, and is responsible for tracking the location of each field logbook.

7.0 PROCEDURES

- 7.1 All field activities shall be documented in bound field logbooks. All information pertinent to a field survey or sampling effort will be recorded in a bound logbook.
- 7.2 Each page will be consecutively numbered, dated, and signed. All entries will be made in dark indelible ink and all corrections will consist of line-out deletions that are initialed and dated. The person making the correction will provide a brief explanation for the change. Pages should not be removed for any reason.
- 7.3 There should be no blank lines on a page. A single blank line or a partial blank line (such as at the end of a paragraph) should be lined to the end of the page. If only part of a page is used, the remainder of the page should have an "X" drawn across it. At a minimum, entries in the logbook will include but not be limited to the following:
 - 7.3.1 Date and onsite arrival time;
 - 7.3.2 Purpose for site visit;
 - 7.3.3 Site and weather conditions;
 - 7.3.4 Health and safety monitoring equipment readings;
 - 7.3.5 Sample team members and level of health and safety protection;
 - 7.3.6 Other personnel present and any visitors (including site arrival and departure times);
 - 7.3.7 Site location;
 - 7.3.8 Observations or events that may impact the investigation;

- 7.3.9 Sample location (sketches are helpful), type, depth, methodology, number, preservation method (if any), collection time, sample collector, and any sampling difficulties;
 - 7.3.10 Sample conditions that could potentially affect the sample results;
 - 7.3.11 QC sample(s) collected;
 - 7.3.12 Site conditions at the time of sampling round completion and site departure time;
 - 7.3.13 If deviating from FSIP, clearly state the reason(s) for deviation;
 - 7.3.14 Signature of the logger; and
 - 7.3.15 Persons contacted and topics discussed.
- 7.4 Field situations vary widely. No general rules can specify the extent of information that must be entered in a logbook. However, records should contain sufficient information so that someone can reconstruct the field activity without relying on the collector's memory. Language used shall be objective, factual, and free of personal opinions. Hypothesis for observed phenomena may be recorded, however, they must be clearly indicated as such and only relate to the subject observation.
- 7.5 Logbooks will be assigned to a specific sampling team. If it is necessary to transfer the logbook to alternative team member during the course of field work, the person relinquishing the logbook will sign and date the logbook at the time of transfer.
- 7.6 Photographs provide the most accurate demonstration of the field worker's observations. They can be significant to the field team during future inspections, informal meetings, and hearings. Photographs should be taken with a camera-lens system having a perspective similar to that afforded by the naked eye. Telephoto or wide-angle shots cannot be used in enforcement proceedings.
- 7.7 A photograph must be documented if it is to be a valid representation of an existing situation. Therefore, for each photograph taken, several items shall be recorded in the field logbooks:
- 7.7.1 Date and time photograph taken;

7.7.2 Name of photographer;

7.7.3 Site name, location, and field task;

7.7.4 Brief description of the subject and the direction taken; and

7.7.5 Sequential number of the photograph and the roll number.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

8.1 A field logbook will be assigned to each sampling team for each project. In addition, a copy of the pages should be placed in the project file in case the logbook is lost or destroyed. Upon completion of the project, the field logbook will remain in the project files.

9.0 ATTACHMENTS

Not applicable

Standard Operating Procedure (SOP)
Addendum

SOP Section Number 1.0, for Field Logbook/Photographs has been adopted from other sources and amended as follows:

- Disregard "Photographs" portion of SOP.
- The first page of each logbook will list the logbook type, field team ID, Field Team Leader, type and number of log forms assigned, and other pertinent information. The Quality Control Coordinator (QCC) will fill out all relevant information before daily assignment of each logbook to the Field Team Leader (FTL). The FTL will sign the "check out/in" section, as applicable, and complete the "number of log forms completed" section before daily return to the QCC.
- The QCC will maintain a check out/in log to ensure the location and custody of all logbooks is known at all times.
- "Field Task Leader" shall be understood to mean Site Supervisory Geologist.
- All unused space on each log form shall be marked N/A or single lined out and initialed. All unused forms shall be single lined out and initialed. Each log form with entries shall be signed and dated by the FTL, or originator of entries, if different. All additions to log form entries shall be initialed. All corrections shall be single lined out and initialed.
- Document names and positions of all subcontractor personnel and visitors on a daily basis.
- Specific details for each sample shall be recorded as indicated on the log forms provided or, if specific space is not provided, on the Daily Field Activity Report log form. At a minimum, the following information shall be recorded for each sample collected:
 - sample type
 - sample collection method
 - time of collection
 - sample ID number
 - location/depth of sample
 - sample container and volume
- The manufacturer, model and serial number of field instruments (e.g., OVM, water quality, etc.) shall be recorded. Also, source lot # and expiration date of standard shall be recorded if calibrated in the field.

Approved by:

Project Geologist

Project Manager

Quality Assurance Manager

BENICIA SOP #2

BORING LOG DEVELOPMENT

1.0 PURPOSE

- 1.1 The purpose of this standard operating procedure (SOP) is to provide project team employees with the proper method for the generation of boring logs and well completion diagrams using field boring logs and electronic boring log software.

2.0 SCOPE AND APPLICABILITY

- 2.1 Procedures defined herein are followed by project team employees for the completion of final boring logs and well completion diagrams.

3.0 REFERENCES

- 3.1 *Classification of Soil for Engineering Purposes*, ASTM D2487-92 and D2488-90.
- 3.2 *Compendium of Superfund Field Operations Method*, Section 8.3, EPA/540 (pages 87-1001). U.S. Environmental Protection Agency, Washington, DC, 1987.

4.0 DEFINITION OF TERMS

Not applicable

5.0 GENERAL

Not applicable

6.0 RESPONSIBILITIES

- 6.1 The **Rig Geologist** shall be responsible for conducting and documenting field activities. The rig geologist logs lithology on the Boring Log Entry form, enters the well construction details on the well completion diagram (if applicable), and records the control sample number with its pertinent information on the chain of custody (COC) record. When completed, the documents are forwarded to the data entry operator.
- 6.2 The **Data Entry Operator** shall be responsible for entering and formatting the data specified on the boring log, the COC and the well completion diagram into

the appropriate electronic borehole log. If the content of the data is questionable, the data processor refers to the reviewing geologist for clarification. When completed, the original and processed versions of the boring logs and well completion diagrams are forwarded to site supervising geologist.

- 6.3 The **Site Supervising Geologist** shall be responsible for collecting and reviewing the written and electronic boring logs. Prior to the registered geologist review, the site supervising geologist examines the documents for any erroneous data and ensures the overall integrity of the document, such as correct representation of geologic data, etc. Once completed the documents are forwarded to the registered geologist for final approval and signature.
- 6.4 The **Registered Geologist** shall be responsible for making certain the final processed log and signed field log are consistent. This is the last time corrections should be made. The final reviewed hard copy of boring logs and well completion diagrams are then forwarded to the data processor for final corrections and then back to the registered geologist for signature.
- 6.5 The **Project Secretary** shall be responsible for archiving the boring logs. The project secretary files the original and signed paperwork in the project file.

7.0 PROCEDURES

7.1 Prior to field work, procedures to be used to develop the field boring log will be discussed between the rig geologist and the site supervising geologist. The lithological descriptions for soil should generally be written in the following order:

- Lithology;
- Color;
- Description of Lithology;
- Moisture;
- Plasticity;
- Density/consistency; and
- Additional observations.

7.1.1 Examples of Lithologic Descriptions:

- CL SANDY CLAY: 5Y5/2 olive gray, clay with approximately 30% fine to medium sand, moist, medium plasticity, hard, strong HC odor and stain, trace rootlets.*
- GPGM SANDY SILTY GRAVEL: 10YR4/3 dark brown, sub-angular gravel to 10mm with approximately 30% medium sand and approximately 30% silt, moist, non-plastic, loose.*
- ML CLAYEY SILT: 2.5Y5/4 lt olive brown, silt with approximately 30% clay, dry, low plasticity, very stiff, blocky structure..*
- SP SAND: 5Y5/3 olive, fine sand with 15% silt, non-plastic, dense, FeOx stain.*

7.2 Additional information that should appear on the borehole log includes:

- Project name/number;
- Boring or well number;
- Boring location (approximate in relation to an identifiable landmark);
- Elevation (from survey);
- Name of drilling contractor, drilling/sampling method, equipment used;
- Water level (initial and static);
- Start/finish time (time and date); and
- Name of logger.

7.3 Upon receipt of the reviewed copy of the original boring log, the data entry operator enters the boring log data with any revisions indicated by the registered geologist. Minor or major revisions can be made by the geologist on a boring log. Most notable editions are the following:

7.3.1 Changes in lithology and sample depths;

7.3.2 Changes to type of density (i.e., dense.....(to).....very dense);

7.3.3 Insertions of groundwater depths; and

7.3.4 Words requiring abbreviation/spelling out.

7.4 Upon final entry of the revised data, a copy of the final boring log is printed. The final borings are signed by the appropriate registered geologist.

BENICIA SOP #3

FIELD CLASSIFICATION AND DESCRIPTION OF SOILS

1.0 PURPOSE

- 1.1 The purpose of the standard operating procedure (SOP) is to provide project team employees with the proper method for field classification and description of soils for entry into borehole logs.

2.0 SCOPE

- 2.1 Procedures defined herein are followed by project team employees for entry of classification and description of soil into borehole logs.

3.0 REFERENCES

- 3.1 Dunn, I.S., Anderson, L.R. and Kiefer, F.W., *Fundamentals for Geotechnical Analysis*, John-Wiley, New York, 1980.
- 3.2 Geotechnical Branch, U.S. Bureau of Reclamation, *Soil Classification Handbook*, Denver, Colorado, 1986.

4.0 DEFINITIONS

- 4.1 USCS. Unified Soil Classification System

5.0 GENERAL

- 5.1 The most popular soil classification method that is based on grain size and other properties, is the Unified Soil Classification System (USCS). This system was initially developed by A. Casagrande in 1948 and was then called the Airfield Classification System. It was adopted with minor modifications by the U.S. Bureau of Reclamation and the U.S. Corps of Engineers in 1952. In 1969, the American Society for Testing and Materials (ASTM) adopted the system. This system is designated by ASTM as D-2487-85 and will be used as a guideline for classifying and describing lithology. It requires certain information (e.g., liquid limit, plastic limit moisture content and plasticity index) about the soil which can only be obtained in a laboratory.
- 5.2 The USCS is based on grain size and response to physical manipulation at various water contents. This system is often used for classifying soils

encountered in boreholes, test pits, and surface sampling. The following properties form the basis of USCS soil classification:

5.2.1 Percentage of gravel, sand, and fines;

5.2.2 Shape of the grain size distribution curve; and

5.2.3 Plasticity and compressibility characteristics.

5.3 Four soil fractions are recognized. They are cobbles, gravel, sand, and fines (silt or clay). The soils are divided as coarse grained soils, fine grained soils, and highly organic soils. The coarse grained soils contain 50 percent of grains coarser than a number 200 sieve (approximately 0.08 mm). Fine grained soils contain more than 50 percent of material smaller than the number 200 sieve. Organic soils contain particles of leaves, roots, peat, etc.

6.0 RESPONSIBILITIES

6.1 Each **Project Manager** shall ensure that the soil classification and description procedures used conform to the guidelines in this SOP.

6.2 The **Field Supervisor** is responsible for reviewing lithologic logs for accuracy and completeness prior to releasing them to the project manager for review.

6.3 The **Rig Geologist** is responsible for following the soil classification and description procedures in this SOP, and for accurately and completely representing the lithology encountered in the field.

7.0 PROCEDURES

The following will be used as a guideline for logging lithology from subsurface activities (i.e. borehole drilling, trenching, etc.).

7.1 The USCS recognizes 15 soil groups and uses names and letter symbols to distinguish between these groups. The coarse grained soils are subdivided into gravels (G) and sands (S). Both the gravel and sand groups are divided into four secondary groups. Fine grained soils are subdivided into silts (M) and clays (C).

7.2 Soils are also classified according to their plasticity and grading. Plastic soils are able to change shape under the influence of applied stress and to retain the shape once the stress is removed. Soils are referred to either low (L) or high (H) plasticity. The grading of a soil sample refers to the particle size distribution of

the sample. A well graded (W) sand or gravel has a wide range of particle sizes and substantial amounts of particles sized between the coarsest and finest grains. A poorly graded (P) sand or gravel consists predominately of one size or has a wide range of sizes with some intermediate sizes missing.

7.3 Soils which have characteristics of two groups are given boundary classifications using the names that most nearly describe the soil. The two groups are separated by a slash. The same is true when a soil could be well or poorly graded. Again the two groups are separated by a slash.

7.4 Soil description should be concise and stress major constituents and characteristics for fine-grained, organic, or coarse-grained soils. Tables 1 and 2 are checklists for descriptions of fine-grained, organic soils, and coarse-grained soils, respectively. Field descriptions should include as a minimum:

7.4.1 Soil name. The basic name of the predominant constituent and a single-word modifier indicating the major subordinate constituent;

7.4.2 Particle Size Distribution. An estimate of the percentage and grain-size range of each of the soil's subordinate constituents with emphasis on clay-particle constituents. This description may also include a description of angularity. This parameter is critical for assessing hydrogeology of the site and should be carefully and fully documented;

7.4.3 Gradation or Plasticity. For granular soil (sands or gravels) that should be described as well-graded, poorly graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction. Cohesive soil (silts or clays) should be described as non-plastic, low plastic, medium plastic, or highly plastic.

Criteria for Describing Plasticity

Descriptive item	Criteria
Nonplastic	A 1/8 inch (3 mm) thread cannot be rolled at any moisture content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times close to the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Table 1
Checklist for Description of Fine-grained and Organic Soils

Items of descriptive data	Typical information desired for silt and clay
Group name	SILT, LEAN CLAY, ETC., include cobbles and boulders in typical name when applicable.
Size distribution	Approximate percent of fines, sand, and gravel of fraction less than 3 inch in size; must add to 100 percent
Plasticity of fines	Nonplastic; low; medium; high
Dry strength	None; low; medium; high; very high
Dilatancy	None; slow; rapid
Toughness near plastic limit	Low; medium; high
Moisture condition	Dry; moist; wet
Color	Munsell color chart; if possible, note mottling or banding
Odor	Only mention of organic or related to contaminants
Structure	Stratified; laminated; fissured; slickensided; blocky; lensed; homogeneous
Consistency	Very soft; soft; firm; hard; very hard
Relative Permeability	Low; medium; high; fractures, open, iron-stained, calcite-filled, open but claylined
Local Geologic Name	If applicable
Group symbol	CL, CH, ML, MH, OL/OH, or appropriate borderline symbol when applicable; should be compatible with typical name used above

Table 2
Checklist for Description of Coarse-grained Soils

Items of descriptive data	Typical information desired for sand and gravel
Group name	WELL-GRADED GRAVEL WITH SAND, ETC., will include cobbles and boulders in typical name when applicable.
Gradation	Describe range of particle sizes, such as fine to medium sand or fine to coarse gravel, or the predominant size or sizes as coarse, medium. Fine sand or coarse or fine gravel.
Size distribution	Approximate percent of gravel, sand, and fines in the fraction finer than 3 inch; must add to 100 percent.
Plasticity of fines	Nonplastic; low; medium; high
Particle shape	Flat, elongated, or flat and elongated (if applicable)
Particle angularity	Angular; subangular; subrounded; rounded
Moisture condition	Dry; moist; wet
Color	Munsell color chart
Odor	Only mention of organic or related to contaminants
Structure	Stratified; lensed; homogeneous
Cementation	Weak; moderate; strong
Relative Permeability	Low; medium; high; fractures, open, iron-stained, calcite-filled, open but claylined
Local Geologic Name	If applicable
Group symbol	GP, GW, SP, SW, GM, GC, SM, SC, or the appropriate symbol when applicable; should be compatible with typical name used above
Mineralogy	Rock hardness for gravel and coarse sand. Note presence of mica flakes, shaly particles, or organic matter.

7.4.4 **Dry Strength.** Dry strength describes the crushing characteristics of a dry soil crumb about ¼ inch (5 mm) in diameter. If a crumb of dry soil is not available, after removing particles larger than No. 40 sieve size, mold at least three balls of soil about ¼ inch (5 mm) in diameter to the consistency of putty, adding water if necessary. Allow the balls to dry completely by oven, sun, or air drying, and then test their strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

Criteria for Describing Dry Strength

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

7.4.5 **Dilatancy.** Dilatancy describes the soils reaction to shaking. After removing particles larger than No. 40 sieve size, prepare a ball of moist soil about ½ inch (15 mm) in diameter. Add enough water, if necessary, to make the soil soft but not sticky.

Place the ball in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the ball which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the ball stiffens, and finally cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Criteria for Describing Dilatancy

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

7.4.6 **Toughness.** Toughness is the consistency of the soil near the plastic limit. After removing particles larger than the No. 40 sieve size, mold a ball of soil about ½ inch (15 mm) in diameter to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. The specimen is then rolled out by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. The thread is folded and rerolled repeatedly. During this manipulation, the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

Criteria for Describing Toughness

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

7.4.7 **Moisture Content.** The amount of soil moisture described as dry, moist, or wet;

Criteria for Describing Moisture

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

- 7.4.8 Color. The basic color of the soil. (Refer to Munsell soil color charts.);
- 7.4.9 Odor. Odor is described from a warm, moist sample. The odor should only be described if it is organic or unusual. An organic odor will have distinctive decaying vegetation smell. Unusual odors, petroleum product, chemical, and the like should be described.
- 7.4.10 Soil Texture and Structure. Description of particle size distribution, arrangement of particles into aggregates, and their structure. This description includes joints, fissures, slicked sides, bedding, veins, root holes, debris, organic content, and residual or relict structure, as well as other characteristics that may influence the movement or retention of water or contaminants;

Structure (for description of soils only)

Stratified	Alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness
Laminated	Alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small lenses of sand scattered through a mass of clay; note thickness.
Homogeneous	Same color and appearance throughout.

- 7.4.11 Relative Density or Consistency. An estimate of density of a fine-grained soil or consistency of a cohesive soil, usually based on standard penetration tests;

Criteria for Describing Consistency

Descriptive item	Criteria
Very soft	Thumb penetrates soil more than 1 inch
Soft	Thumb penetrates about 1 inch
Firm	Thumb indentation up to ¼ inch
Hard	No indentation with thumb, readily indented with thumbnail
Very Hard	Not indented with thumbnail

7.4.12 Cementation. An estimate of cementation of a coarse-grained soil.

Criteria for Describing Cementation

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

7.4.13 Relative Permeability. An estimate of the permeability based on visual examination of materials (e.g., high permeability for coarse sand and gravel verses low permeability for silty clay). The estimate should address presence and condition of fractures (open, iron-stand, calcite-filled, open but claylined, etc.), as well as fracture density and orientation;

7.4.14 Local Geologic Name. Any specific local name or generic name (i.e., alluvium, loess); and

7.4.15 Group Symbol. USCS of symbols.

7.5 The soil logs should also include a complete description of any tests run in the borehole; placement and construction details of piezometers, wells, and other monitoring equipment; abandonment records; geophysical logging techniques used; and notes on readings obtained by air monitoring instruments.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

All completed lithologic logs shall be placed in the project file at project completion.

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #4

SAMPLE MANAGEMENT

1.0 PURPOSE

- 1.1 The purpose of this standard operating procedure (SOP) is to assure representative environmental sample data by documenting the management of samples from time of collection through analysis and final disposition.

2.0 SCOPE AND APPLICABILITY

- 2.1 This procedure applies to all project team personnel and subcontractors who collect or handle environmental samples.

3.0 REFERENCES

- 3.1 U.S. Environmental Protection Agency (EPA). 1984. *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition.* EPA-600/4-84-076, p. D1-D11, December.
- 3.2 U.S. EPA/National Enforcement Investigations Center (NEIC), *User's Guide to the EPA Contract Laboratory Program.*
- 3.3 U.S. EPA/NEIC, 1982. *Policies and Procedures*, 330/9/78/001-R.

4.0 DEFINITIONS

- 4.1 Representativeness. The degree to which data are a true representation of the conditions at a specific location and time.
- 4.2 Sample Management. A set of procedures used to ensure that the integrity of a sample is maintained. Stringent documentation of the implementation of these procedures is required to satisfy legal requirements if sample data are used in litigation.
- 4.3 Custody. The physical control of an object, in this case of an environmental sample.
- 4.4 Chain of Custody (COC). The process identifying those individuals who sequentially maintain physical custody of the sample.

- 4.5 COC Record. The documentation of the COC showing times, dates and names of the individuals relinquishing and receiving the samples identified on the record.
- 4.6 Custody seals. Narrow strips of adhesive paper used to document that tampering with the sample cooler has not occurred from the time of collection to laboratory receipt.

5.0 GENERAL

- 5.1 An essential part of the sampling/analytical portion of any environmental project is assuring the integrity of the sample from collection to data reporting. Projects where analytical data or conclusions based upon analytical data may be used in litigation demand that accountability of the history of a sample be available to demonstrate that the data are a true representation of the environment. The COC is used as evidence in legal proceedings to demonstrate that a sample was not tampered with or altered in any way that may skew the analytical accuracy of the laboratory results. Therefore, it is extremely important that COCs be complete, accurate, and consistent.
- 5.2 Assuring sample integrity and accountability requires strict adherence to the proper use of the following five essential sampling components:
 - 5.2.1 Sampling Plan (Field Site Investigation Plan [FSIP])
 - 5.2.2 COC
 - 5.2.3 Sample Labels and custody seals
 - 5.2.4 Field Logbooks
- 5.3 Successful implementation of these components requires a thorough understanding of sample custody requirements. A sample is under custody under the following conditions:
 - 5.3.1 When it is in an individual's physical possession;
 - 5.3.2 When it is in view of an individual, after being in their physical possession;
 - 5.3.3 When it was in an individual's physical possession and then locked up so no one could tamper with it; and

5.3.4 When it is in a designated and identified secure area, controlled and restricted to authorized personnel only.

5.4 A sample remains in an individual's custody until relinquished in writing to another person who is authorized to take custody of the sample.

6.0 RESPONSIBILITIES

6.1 The **Project Manager** (PjM) shall: develop or direct the preparation of a detailed sampling plan for air, water, biota, sediments, soils, or wastes which shall describe the sampling procedures to be used. The PjM is also responsible for ensuring that the chosen sampling procedures obtain samples representative of the environment being investigated and do not introduce trace levels of contaminants from external sources.

6.2 The **Field Supervisor** shall ensure that specified sampling procedures are followed; samples are labeled, handled and controlled correctly; and strict COC documentation is initiated, maintained, and documented.

6.3 The **Sample Collector** shall affix the sample label to the proper sample container at the time of the sampling event, and fill in appropriate sampling information on the label and COC.

7.0 PROCEDURES

7.1 All samples shall be collected according to the FSIP, and the Quality Assurance Project Plan (QAPP). The FSIP, and the QAPP shall be in the possession of the Field Supervisor at the time of sample collection.

7.2 Sample labels are required to prevent misidentification of samples. Sample identification methodology is presented in the QAPP.

7.2.1 The sample label shall be affixed to the proper sample container at the time of the sampling event by the sample collector.

7.2.2 During the actual sampling event, the following information shall be written on the label by the sample collector:

7.2.2.1 Initials of the sample collector;

7.2.2.2 Time/rate of sample collection (military format, i.e., using 24-hour clock notation);

7.2.2.2 Location where sample was collected;

7.2.2.3 Preservatives (if applicable); and

7.2.2.4 Required laboratory analysis.

7.2.3 All sample labels shall be accounted for in a bound sample control logbook which documents their unaltered use, modification, or destruction.

7.3 A custody seal for each individual sample cooler shall be signed and dated by the sample collector and placed on the cooler prior to shipment to the laboratory. The seal is placed on both ends of the cooler such that the cooler cannot be opened without breaking the seal. Care must be taken to use only custody seals that are serrated (tear easily when tampered with) and are of sufficient length that a major portion of the seal will adhere to the main body of the cooler.

7.4 All samples collected shall be documented in field logbooks issued and controlled by the Field Supervisor. The logbooks shall be serialized and checked out to the sampling team leader at the onset of field sampling efforts.

7.5 All personnel involved with sample collection and handling shall know and understand the COC procedures, which are described below. These procedures are included in the QAPP and shall be available to all personnel.

7.5.1 The COC should be initiated prior to the beginning of each sampling event by the sample collector. If a sample is split with a second party, follow the additional instructions in Section 7.5.8;

7.5.2 The sample collector shall verify that the COC record is complete, accurate in all aspects, and consistent with all other sample documentation (i.e., number of samples, sample labels, field logs);

7.5.3 After sample collection, the sample collector will sign the "Relinquished by" box on the COC, marking the date and time custody is transferred to the sample control manager or other authorized person;

7.5.4 The sample control manager or other authorized person will sign the "Received By" box, marking the date and time of receipt of the samples from the sample collector or other authorized person. Every transfer of physical custody shall be documented on the COC; and

- 7.5.5 The sample control manager or other authorized person will sign the "Relinquished By" box and enter the shipper's name and shipping number in the "Shipping Number" box immediately prior to sealing a sample shipping container for courier pickup after ensuring that samples and COCs match (i.e., only samples identified on the enclosed COCs are in the container and all samples enclosed are listed on the COCs enclosed). Note: as long as COCs are sealed inside the sample shipping container, commercial carriers are not required to sign the COC.
- 7.5.6 The "Received By" box will be signed by the laboratory sample receipt staff.
- 7.5.6 Distribution of the COC copies are as follows:
- 7.5.6.1 *White and Yellow copies:* Sealed in plastic bag with a custody seal (initialed and dated) and taped inside the top of the shipping container;
- 7.5.6.2 *Goldenrod copy:* Filed in appropriate home or field office project file; and
- 7.5.6.3 *Pink Copy:* Submitted to data management staff in home office.
- 7.5.7 Changes made to a COC will be accomplished by the following procedures:
- 7.5.7.1 Striking the incorrect information with a single line, and initialing and dating the strike;
- 7.5.7.2 Enter the correct information, and pertinent information as to why the change was made;
- 7.5.7.3 Changes made to a COC following original distribution will be accomplished by the procedures noted above with photocopies of the corrected COC distributed to the field office project file, project chemist, and the home office; and
- 7.5.7.4 Record the above activities in the sample control logbook.

7.5.8 All COCs shall be accounted for in the sample control logbook by recording the following information:

7.5.8.1 List all samples included on the COC with sample and ship date, shipper and invoice number;

7.5.8.2 Sample container manufacturer lot number; and

7.5.8.3 Comments (as applicable).

7.5.9 When a sample is split with a second party (e.g., client, agency) a separate COC must be prepared for those samples utilizing the following steps:

7.5.9.1 The sample collector shall verify that the COC is complete, accurate, and consistent with all other sample documentation;

7.5.9.2 The sample collector will sign the "Collected and Released By" box on the COC, marking the date and time custody is transferred to the second party;

7.5.9.3 The second party will sign the "Received By" box and mark the date and time custody is transferred; and

7.5.9.4 The goldenrod copy of the COC will be forwarded to the home or field office project file.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

8.1 Chain of Custody Record, following filing procedures described in Section 7.5.

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #5

ORGANIC VAPOR MEASUREMENT

1.0 PURPOSE

1.1 This standard operating procedure (SOP) describes the procedures and guidance to conduct soil gas field surveys or headspace measurements of organic vapors in environmental samples.

2.0 SCOPE

2.1 This field procedure is used in determining the concentrations of various volatile organic compounds (VOCs) in soil gas samples. It is applicable to all project team personnel and subcontractors who collect samples for organic vapor measurements.

2.2 The rapid detection of VOCs at hazardous waste sites during sampling, cleanup and remedial investigation activities allows onsite analytical screening of air, water, sediment, and soils. These measurements can be used to evaluate risk/exposure while performing site activities and as a basis for setting health and safety levels of protection.

2.3 Field measurements of volatile organic vapors will be achieved using one or more of the following instruments:

- Photoionization Detector (PID)
- Flame Ionization Detector (FID)
- Combustible Gas Indicator (CGI)
- Oxygen Meter (LEL/O₂)
- Direct Reading Colorimetric Indicator Tubes
- Field Gas Chromatograph (GC) with applicable detector

3.0 REFERENCES

- 3.1 *Volatile Organics in Soil Gas - Absorbent Tube Method*, FASP Method Number F080.008, U.S. Environmental Protection Agency (EPA), July 1990.
- 3.2 *Field Measurement of Organic Vapors*, Jacobs Engineering Group SOP No.15, November 1987.

- 3.3 *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*, U.S. Environmental Protection Agency (EPA), Office of Waste Programs Enforcement, and Office of Solid Waste and Emergency Response, September 1986.
- 3.4 *Technical Guidance for Corrective Measures - Subsurface Gas*, U.S. Department of Commerce, National Technical Information Service (NTIS), March 1985.
- 3.5 *Field Screening Methods Catalog, User's Guide*, United States Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC 20460, September 1988.

4.0 DEFINITIONS

- 4.1 Volatile Organic Compounds (VOCs) is a group of organic compounds that has a tendency to evaporate when exposed to air.
- 4.2 Photoionization Detector (PID) detects total concentrations of many organic and some inorganic gases and vapors. Molecules are ionized using ultraviolet radiation. A current is produced in proportion to the number of ions present.
- 4.3 Headspace gases are the accumulated gaseous components found above solid or liquid layers in closed vessels.
- 4.4 Flame Ionization Detector (FID) detects total concentrations of many organic gases and vapors. Gases and vapors are ionized in a flame. A current is produced in proportion to the number of carbon atoms present.
- 4.5 Initial Calibration is an analysis of analytical standards for a series of different specified concentrations used to define the linearity and dynamic range of the response of an instrument to the target compounds.
- 4.6 Continuing Calibration Verification is an analytical standard run periodically to verify the calibration of an instrument.
- 4.7 Combustible Gas Indicator (CGI) measures the concentration of a combustible gas or vapor. A filament, usually made of platinum, is heated by burning the combustible gas or vapor and the increase in heat is measured.
- 4.8 Ionization Potential (IP) is the potential difference through which a bound electron must be raised to free it from the atom or molecule to which it is attached. In particular, the ionization potential is the difference between the

initial state, in which the electron is bound, and the final state, in which the electron is at rest, at infinity.

5.0 GENERAL

- 5.1 The analysis of organic vapors by FID or PID, in conjunction with a gas chromatograph (GC) for an onsite, real-time assessment of potentially contaminated soil, water and air, has become an increasingly useful tool in measuring depth and lateral extent of contamination.
- 5.2 Organic vapor measurement is both cost and time effective.
- 5.3 Calibration and maintenance shall be as specified in Health and Safety Plan or, if unlisted, according to manufacturer specifications. At a minimum, calibrations shall be performed or checked daily, prior to start of field activities when using PID instruments.
- 5.4 Operation of PID instruments should also be tested using the calibration span gas whenever field readings are suspect.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager (PjM)** supervises the development of the necessary project planning documents. The PjM assigns trained, qualified personnel to conduct organic vapor measurements as described in the procedure, and ensures that all field personnel are thoroughly proficient in the use, maintenance, and calibration of all field equipment to be used. The PjM also ensures that the necessary equipment and supplies are obtained for the measurement of organic vapors.
- 6.2 The **Field Supervisor** is responsible for the supervision of daily operations as related to organic vapor measurements. This individual will oversee the collection and documentation of all field data generated. The Field Supervisor will ensure that the equipment used by the operator is calibrated at the appropriate frequency, and maintained and operated correctly at all times.
- 6.3 The **Quality Assurance/Quality Control (QA/QC) Officer** will review all QA plans and documents to ensure that all organic vapor measurements are precise, accurate, representative, complete, and comparable. The QA/QC officer may schedule and facilitate field audits and QA/QC reviews.

7.0 PROCEDURES

Photoionization Detector (PID) There are numerous portable *organic vapor meters* available which utilize the principle of photoionization. Project team members commonly use a Thermo Environmental® Model 580B Organic Vapor Monitor (OVM), which is relatively simple to operate. These instruments are portable, and contain a non-specific vapor/gas detector that employs the principle of photoionization to detect a wide variety of organic and inorganic chemical compounds. All instruments should be plugged into their respective charging units at the end of each day to ensure ample power supply for the next days use. If any instrument is not expected to be used for an extended period of time, it should be placed back into its shipping/storage case.

7.1 The **580B OVM** is intrinsically safe and will operate in continuous use for up to 10 hours before requiring battery recharging. The 580B OVM can be used in many applications including screening soil samples, screening ambient air conditions, monitoring breathing zones, and checking the presence of organic vapors at the well heads. The standard equipment required for field measurement of volatile organic vapors using the Thermo Environmental® model 580B OVM are an eV (electron volt) lamp assembly, span gas air calibration standard (100 ppmv isobutylene); and an AC-battery recharging unit. Commercially prepared standard span gases are available from companies who rent OVMs. The choice of standards is dependent on the monitoring requirements for the actual chemical compounds at each facility. Typically, zero air and 100 ppm isobutylene is sufficient for most applications.

Calibration. Instrument calibration or calibration check is required at the beginning of each workday. Calibration can also be tested any time a reading needs verification by connecting the instrument to the span gas sample and observing results. Prior to instrument calibration, a tedlar bag should be filled with 100 ppm isobutylene span gas. The tedlar bag should also be outfitted with a three- to four-inch piece of tygon (or other) tubing to direct the gas into the instrument. Calibration procedures are as follows:

7.1.1 After unplugging the instrument from its charging unit, insert the power plug to start up the instrument, and a "HELLO" will appear in the menu screen followed by "Lamp Out". Turn on the instrument by pressing the "On/Off" key (the left most key). The internal pump will then start up.

Allow the instrument to run for a few minutes to warm up. After a few minutes press the Mode/Store key. The instrument will ask the user if he wishes to "Log This Value?" Press the "-/CRSR" key for "no". This will exit the user to a sub menu with the following display R/COMM -/PARAM, +/ACCESS S/CLOCK;

- 7.1.2 To calibrate the instrument, select the "PARAM" mode by pressing the "-/CRSR" key. Press the "-/CRSR" key again to scroll through the parameters sub-menu where "Reset to Calibrate" will appear. Press the "Reset" button. The instrument will ask the user to "Restore Backup?". Press the "-/CRSR" button for "no". The instrument will then ask the user to begin entering zero air and to reset when ready;
- 7.1.3 Place the tygon tubing over the instrument inlet tube and expose instrument to ambient "clean" air. Once the ambient air is introduced, press the "Reset" button. The instrument will display "Zeroing". This should only take a few moments;
- 7.1.4 When the instrument has completed its zero air calibration it will ask for the concentration of span gas used. The instrument should default to 100 ppmv. Press the "+/INC" key to accept the 100 ppmv default span gas, then "Enter Span Gas - Reset When Ready" will appear in the menu;
- 7.1.5 Connect the 100 ppmv isobutylene span gas tedlar bag into the instrument. Press the "Reset" key when ready. This usually takes a bit longer than the zero air calibration;
- 7.1.6 When calibration is complete "Press Mode/Store" will appear in the menu screen. Press this key to view the concentration read during calibration. This also exits the user out of the calibration sub menu back to the main menu;
- 7.1.7 The manufacturer states that a detection of +/- 10 percent of the span gas is acceptable for calibration. Write the detected concentration on the Field Calibration Data Sheet in the appropriate column. Those instruments set up with the Max Hold feature will display the highest concentration read during the calibration;

- 7.1.8 If the calibration was successful, the instrument is now ready for use in the field. If an error occurred during the calibration, the user will have to re-calibrate following the previous steps outlined. Most errors occur as a result of poor gas flow or seal from the tubing of the tedlar bag to the sample inlet on the instrument; and
- 7.1.9 After calibration, the instrument should be left in the stand-by position until needed by pressing the "OFF" button. A "lamp-out" will appear in the display.
- 7.1.10 To begin taking measurements press the "ON" button. The internal fan will come on drawing in air to be sampled. Place the probe tip within an inch or two of the media to be measured. Ensure that no soil, water, or moisture is drawn into the probe tip. Read and record the concentration displayed. To clear the display, press the "Reset" button.
- To maintain a fully charged battery, turn off the instrument when not in use. Additional uses and time saving tips can be found in the users guide that accompanies each instrument.
- 7.1.11 The following calibration and operation information must be logged in the field notebook for quality assurance documentation:
- Instrument model and serial number;
 - Date;
 - Calibration gas concentration;
 - Initial span setting and actual reading; and
 - Comments (i.e., adjustments, cleaning requirements).
- 7.2 The **Photovac Tip I (TIP)** is applicable to the detection of VOCs to 0.1 ppmv in vapor samples. Soil gas VOC content is measured from the gas photoionization capacity. Air is continuously sampled by the TIP's air suction pump into the ionization chamber. Instrument readings provide overall volatile content. The TIP packs all necessary components in a single flashlight-sized casing, weighing about three pounds, and includes nozzle, filter, air pump, ionization chamber, UV lamp, electrometer, liquid crystal display (LCD) window, zero/span controls, power switch, and battery pack with external connections to 12 volt DC power or

recharge capability. TIP accessories include a headset, 1/4-inch Teflon® tubing, a tedlar bag, and a span gas cylinder. The span gas typically used is 100 ppmv isobutylene. Accessory items may be used for sample collection and analysis, or in the preparation of calibration standards. The TIP is used as a direct-reading instrument in conjunction with the Span Kit (Part No. TA103).

- 7.2.1 Calibration of the instrument will begin by first turning on the POWER switch to activate the TIP;
- 7.2.2 Unlock ZERO and SPAN controls by turning locking rings clockwise, and set SPAN control to 5;
- 7.2.3 Allow the TIP to sample ambient "clean" air. Adjust the ZERO control until LCD reads 0.00;
- 7.2.4 Connect bag of span gas to the TIP inlet and adjust SPAN control until LCD indicates the span gas concentration (nominal - 100 ppm isobutylene (2-methyl-1-propene). Disconnect span gas bag;
- 7.2.5 Sample ambient "clean" air again and readjust ZERO control until LCD reads 0.00, if necessary;
- 7.2.6 Lock SPAN and zero controls by turning locking rings counterclockwise;
- 7.2.7 Observe sample concentration changes on LCD. Concentration of total ionizables is displayed in the span gas equivalent units;
- 7.2.8 Do not allow the TIP to draw in any soil, water, or moisture; and
- 7.2.9 Press POWER switch after use to deactivate the TIP.

The **Flame Ionization Detection (FID)** uses ionization as the detection method, much the same as the PID, except that the ionization is caused by a hydrogen flame, rather than by a UV light. This flame has sufficient energy to ionize any organic species with an IP of 15.4 or less. The ions are then passed between two charged plates. The conductivity charge is measured and converted to ppmv measurements.

- 7.3 The Century Systems Organic Vapor Analyzer (OVA) is a portable FID unit that consists of two major parts: a 9-pound package (containing the sampling pump, battery pack, support electronics, FID, hydrogen gas cylinder, and an optional GC column), and a hand-held meter/sampling probe assembly.

- 7.3.1 The pressure of hydrogen gas in the FID unit must be sufficient for unit operation. A field sample contained in a tedlar bag or ambient air can be routed through the OVA into the detector, allowing all organic species to be ionized and detected simultaneously. Based on the sensitivity of the instrument to various compounds, a concentration is displayed on the display panel. The FID may be refilled with hydrogen gas by the operator if access to a hydrogen gas tank is provided.
- 7.3.2 Once the unit is assembled and switched on, followed by opening the hydrogen gas cylinder; value and sufficient hydrogen line pressure is obtained; the flame ignitor button must be pushed for several seconds to ignite the FID;
- 7.3.3 A low audible sound is made by the unit once ignition occurs. However, often this sound is not heard, indicating that either the flame did not light or background noises were greater than the ignition "click" sound;
- 7.3.4 The FID must be tested prior to field use by switching the concentration interval on the unit to the lowest setting (0-10 ppm), and placing a source of organic vapors (such as a marker pen or fuel tank vapor) up to the FID inlet wand to see if it provides a reading. If no reading is evident, the flame must be re-lit using the igniter button followed by the test procedure described.
- 7.3.5 A highly concentrated sample introduced to the FID often causes a flame-out in which another "click" sound may be heard and readings will decrease to zero. In this instance, the FID will need re-ignition.
- 7.3.6 Instrument attachments (needle valve) are available to read high concentration vapors. The proper readout range must be selected during instrument use.
- 7.3.7 Certified gas/vapor standards may be obtained through certified or approved vendors as necessary for identification or quantification of specific VOCs.
- 7.3.8 The OVA responds differently to different compounds. The following table presents relative responses as a percentage of the methane

standard. The instrument operator should adjust the readings accordingly if the compound being measured is known.

COMPOUND	RELATIVE RESPONSE (%)
Methane	100
Ethane	90
Propane	64
n-Butane	61
n-Pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Acetone	100
Methyl ethyl ketone	80
Methyl isobutyl ketone	100
Methanol	15
Ethanol	25
Isopropyl alcohol	65
Carbon tetrachloride	10
Chloroform	70
Trichloroethene	72
Vinyl chloride	35

- 7.4 **Combustible gas indicators (CGI)** are used to determine the potential for combustion or explosion of unknown atmospheres. These instruments, in combination with oxygen detectors and radiation survey instrumentation, should be the first monitors used when entering a hazardous area. In this sense they provide a general indication of the degree of immediate hazard to personnel and can be used to assist the safety officer in making decisions on levels of protection required at the site. However, they provide little or no information about the presence of compounds, hazardous or toxic, at trace level concentrations.

A CGI consists of three primary components: the sensor (hotwire, catalytic, solid state, etc.), signal processor, and readout display. A sample is introduced to the sensor either by diffusion into a passive sensor or by pumping.

The sensor produces a signal which is processed and displayed as the ratio of the combustible gas present to the total required to reach the lower explosive limit (LEL).

The LEL (also LFL, lower flammability limit) is defined as the lowest concentration of gas or vapor in air which can be ignited by an ignition source and cause an explosion or flame propagation. Conversely, the upper explosive limit (UEL) (also UFL, upper flammability limit) is the concentration of gas in air above which there is insufficient oxygen available to support combustion, and an explosion is unlikely. A flame, however, may burn at the gas-air interface, or should additional air enter the mixture, a very explosive atmosphere may develop. In general, the instruments respond in the following manner:

- When the meter indicates 0.5 LEL (50 percent), this means that 50 percent of the concentration of combustible gas needed to reach an unstable combustible situation is present. If the LEL of the gas is 5 percent in air, then the instrument indicates a 2.5 percent mixture is present;
- If the meter needle stays above 1.0 LEL (100 percent) it means that the concentration of combustible gas is greater than the LEL and less than the UEL and, therefore, immediately combustible and explosive; and
- When the meter needle rises above the 1.0 LEL (100 percent) mark and then returns to zero, this indicates the ambient atmosphere has a combustible gas concentration greater than the UEL.

7.4.1 Of the many instruments commercially available for detecting combustible or explosive gas, some are not certified safe for operation in the atmospheres they can detect. It is important to use only those monitors that are certified safe for use in atmospheres greater than 25 percent of the LEL.

7.4.2 Some combustible gas monitors provide readouts in units of percent LEL, some in percent combustible gases by volume, and some have scales for both. Many situations may occur where types of combustible gases to be encountered are unknown. In such instances the more explosive the calibration gas (the lower the LEL) the more sensitive the indication of explosivity, and thus the greater margin of safety. The operator should be familiar with the LEL concentrations for specific gases to effectively

use instruments that provide data in percent combustible (by volume) only.

7.4.3 Although monitors can be purchased that are factory calibrated using gases such as butane, pentane, natural gas, or petroleum vapors, methane calibration is the most common. The LEL of methane is 5 percent by volume in air, therefore, an air mixture containing 5 percent methane will be read as 100 percent LEL and will be explosive if a source of ignition is present. When combustible gases other than methane are sampled, the relative response of the detector for these other gases must be considered. Re-calibration to other gases may be possible; see manufacturer's recommendations. The relative sensitivity of the detector and the differences in LEL for different gases will produce varying meter responses equal to concentrations of different gases. Actual correlation equations that will convert the percent LEL (based on methane) read by the unit to a percent LEL for another combustible gas can usually be found in the operating manual.

7.4.4 Many units also have alarm systems which can be adjusted for various LELs and several are available that incorporate oxygen analyzers.

7.4.5 Maintenance and operating procedures include making certain that the instrument is clean and serviceable, especially at sample lines and detector surfaces. Following are the general operating procedures:

- Check battery charge level. Charge the battery as described in operating manual. Some units have charge level meters, while others have only low charge alarms;
- Turn unit to ON position, and allow instrument sufficient warm-up time. Verify that the sample pump is operable (if so equipped) when analyzer is ON;
- With the intake assembly is combustible gas-free ambient air, zero the meter by rotating the zero control until the meter reads 0 percent LEL;
- Calibrate unit against known concentration of a calibration gas by rotating the calibration control (span or gain) until the meter reads

the same concentration as the known standard. For those instruments with internal or nonadjustable span, a calibration curve should be prepared, using concentrations in the range expected to be encountered;

- If necessary, adjust alarm setting to appropriate combustibility setting; and
- Position intake assembly or cell in close proximity to area in question to get an accurate reading. If alarm occurs, or if readings reach the action levels designated in the safety plan, evacuate and assess the situation. If the instrument malfunctions, personnel should also evacuate the area.

7.4.6 During CGI operation it is important to keep in mind the following:

- Slow sweeping motions of intake or cell assembly will help assure that problem atmospheres are not bypassed. Cover an area from floor (ground) to ceiling, or above breathing zone;
- Operation of unit in temperatures outside of the recommended operating range may compromise the accuracy of readings or damage the instrument;
- Platinum filament detectors may be poisoned (reduced in sensitivity) by gases such as leaded gasoline vapors (tetraethyl lead), sulphur compounds (mercaptan and hydrogen sulfide) and silicon compounds;
- Many combustible gas detectors are not designed for use in oxygen-enriched or depleted atmospheres. If this condition is encountered or suspected, personnel should evacuate the area. Specially designed units are available for operation in such atmospheres;
- An oxygen detector should always be used in conjunction with explosimeters;
- Accurate data depends on regular calibration and battery charging (refer to the operating manual); and

- Effective utilization of the unit requires an operator with full understanding of operating principles and procedures for the specific instrument in use.

7.5 An **oxygen meter** uses an electrochemical sensor to determine the oxygen concentration in air. The sensor consists of two electrodes, a sensing and a counting electrode; a housing containing a basic electrolytic solution; and a semipermeable Teflon® membrane.

Oxygen molecules (O_2) diffuse through the membrane into the solution. Reactions between the oxygen and the electrodes produce a small electric current which is directly proportional to the sensor's oxygen content. The current passes through the electronic circuit. The resulting signal is shown as a needle deflection on a meter, which is usually calibrated to read 0-10 percent, 0-25 percent, or 0-100 percent oxygen.

The oxygen content in a confined space is of prime concern to anyone about to enter that space. Removal of oxygen by combustion, reduction reactions, or displacement by gases or vapors is a hazard that response personnel cannot detect. Consequently, remote measurements must be made before anyone enters any confined space.

The operation of oxygen meters depends on the absolute atmospheric pressure. The concentration of natural oxygen (to differentiate it from manufactured or generated oxygen) is a function of the atmospheric pressure at a given altitude.

7.5.1 At sea level, where the weight of the atmosphere above is the greatest, more O_2 molecules are compressed into a given volume than at higher elevations. As elevation increases, this compression decreases, resulting in fewer O_2 molecules being "squeezed" into a given volume. Consequently, an O_2 indicator calibrated at sea level and operated at an altitude of several thousand feet will falsely indicate an oxygen-deficient atmosphere (less than 19.5 percent).

7.5.2 High concentrations of carbon dioxide (CO_2) shorten the useful life of the oxygen detector cell. Therefore, the unit can be used in atmospheres greater than .05 percent CO_2 only with frequent replacing or rejuvenating of the oxygen detector cell.

- 7.5.3 Although several instruments can measure an oxygen-enriched atmosphere (O_2 greater than 21 percent), no testing or other work should ever be performed under such conditions because a spark, arc, or flame could lead to fire or explosion. Oxygen measurements are most informative when paired with combustible gas measurements. Together, they provide response personnel with quick and reliable data on the hazards they may encounter.
- 7.6 In evaluating hazardous waste sites, the need often arises to quickly measure a specific vapor or gas. **Direct-reading colorimetric indicator tubes** can successfully fill that need. The interaction of two or more substances may result in chemical changes. This change may be as subtle as two clear liquids producing a third clear liquid, or as obvious as a colorless vapor and colored solid producing a differently colored substance. Indicator tubes use this latter phenomenon to estimate the concentration of gas or vapor in air. Colorimetric indicator tubes consist of an impregnated glass tube with an indicating chemical. The tube is connected to a piston cylinder- or bellows-type pump.
- 7.6.1 A known volume of contaminated air is pulled at the predetermined rate through the tube. The contaminant reacts with the indicator chemical in the tube, producing a stain whose length is proportional to the contaminant's concentration.
- 7.6.2 A preconditioning filter may precede the substrate to remove contaminants (other than the one in question) that may interfere with the measurement. Filters are also used to react with the contaminant to change it into a compound that reacts with the indicating chemical, and to completely change a nonindicating contaminant into an indicating one.
- 7.6.3 Several indicating chemicals may be able to measure the concentration of a particular gas or vapor, each operating on a different chemical principle and each affected in varying degrees by temperature, air volume pulled through the tube, and interfering gases or vapors. A "true" concentration versus the "measured" concentration may vary considerably among and between manufacturers. To limit these sources of error, control the numerous types and manufacturers of tubes, and provide a degree of confidence to users, the National Institute of Occupational

Safety and Health (NIOSH) tests and certifies indicator tubes. Certified tubes have an accuracy of $\pm 35\%$ at $1/2$ the threshold limit value (TLV) of the chemical and $\pm 25\%$ at the TLV.

- To improve performance on all tubes, they should be refrigerated prior to use to maintain shelf life of approximately 2 years.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

Not applicable

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #6
UTILITY CLEARANCE

1.0 PURPOSE

1.1 This standard operating procedure (SOP) describes procedures to reduce the risk of contact with buried or above ground utility service lines.

2.0 SCOPE AND APPLICABILITY

2.1 This SOP applies to all field activities where there is possible contact with above ground utilities or sub-surface utilities.

3.0 REFERENCES

3.1 OSHA 1926.650 - 1926.652 *Excavations*

3.2 *Underground Services* - State Standards (e.g., California, Title 1 CCR 4216)

3.3 OSHA 1926.955 *Provisions for Preventing Accident Due to Proximity to Overhead Lines*

3.4 OSHA 1910-333 *Selection and Use of Work Practices in Sub-part S – Electrical*

4.0 DEFINITIONS

4.1 Kilovolt (kv) is one thousand volts.

5.0 GENERAL

Not applicable

6.0 RESPONSIBILITIES

6.1 It is the responsibility of the **Project Manager (PJM)** to assure full compliance with this SOP.

6.2 The **Field Supervisor** shall implement this SOP on site.

6.3 The **Site Health and Safety Officer** shall ensure full compliance with the SOP and report any deficiencies to the Health and Safety Manager and the PM.

7.0 PROCEDURES

7.1 Buried Utilities must be identified and located prior to beginning any field work.

- 7.1.1 A review will be made of any available property maps, blue lines, or as-builts prior to site activities.
- 7.1.2 During the project site walk, any discrepancies or new information regarding utility locations will be added to project maps.
- 7.1.3 The Field Supervisor shall consult the local utility locator service (Underground Service Alert [USA]) at least 48 hours in advance of conducting subsurface field work. USA will assign a "ticket" number to your site which will need to be recorded. This ticket number is valid for a limited time but, may be extended by contacting USA again. USA will notify utility representatives who will mark according to the utilities' color scheme¹. If necessary, utilities may be located using standard geophysical methods such as electromagnetic (EM), ground penetrating radar (GPR), magnetic gradient survey and/or a pipe locator.
- 7.1.4 Utility locations will be marked using the following color code, unless the facility locator uses a different color code:

COLOR	IDENTIFICATION
White	Work location
Red	Electrical lines
Yellow	Gas or oil lines
Orange	Telephone lines
Blue	Water lines
Green	Sewer lines

- 7.1.5 After utilities have been marked by the federal, state or local locator service, the Field Supervisor will clear utilities.
- 7.1.6 In addition to the above described utility locating methods, borings will be hand augured to approximately five feet for all locations within developed areas where there is a potential to impact buried utilities. The hole must be reamed by hand to at least the diameter of the drill rig auger or bit

¹ In California USA will not locate utilities on federal property, but will have information on any easements.

prior to drilling. For soil gas surveys, the survey probe shall be placed as close as possible to the hand auger.

7.1.7 Methods for utility clearance for horizontal and slant boring will be determined by the PjM and Health and Safety Manager.

7.1.8 All uncovered utilities must be supported. Any repairs or modifications to existing utility lines require the line to be locked-out/tagged-out prior to work.

7.1.9 At each location where trenching or excavating will occur using a backhoe or other heavy equipment, prior to ground-breaking, the soil must be probed with a magnetometer and/or a pole made of non-conductive material. Additional requirements for trenching/excavating activities can be found in Project Team Safety Manual.

7.2 The following table gives the required minimum clearances for working proximity to overhead power lines.

Nominal Voltage	Minimum Clearance
0-50 KV	10 ft., or one mast length; whichever is greater
50 KV +	10 ft., +4 inches for every 10 KV over 50 KV or 1.5 mast lengths; whichever is greater

If it is necessary to work without the minimum clearance, the overhead line must be de-energized or rerouted by the utility company or a competent electrical contractor.

7.3 Utility Clearance Form 7-1 must be completed and signed off by the Field Supervisor prior to commencement of relevant site work.

7.4 Any deviations from this SOP must be approved by the PjM after collaboration with Health and Safety Manager. Approval via telephone is acceptable in the event the PjM is not on site.

7.5 When repairing existing utilities, refer to the Health and Safety Plan Lock-Out and Tag-Out Procedure.

8.0 RECORD KEEPING REQUIREMENTS

8.1 Utility clearance form 7-1 must be completed and approved prior to commencement of work.

9.0 ATTACHMENTS

Utility Clearance Form 7-1

BENICIA SOP #7
COLLECTION OF SOIL SAMPLES

1.0 PURPOSE

- 1.1 To provide a standard operating procedure (SOP) for the collection of soil samples to determine the physical and chemical properties of site soil. Soil samples may be collected from the surface or subsurface as described in this procedure.

2.0 SCOPE

- 2.1 This procedure applies to all project team personnel and subcontractors who collect or handle samples of surficial or subsurface soil.

3.0 REFERENCES

- 3.1 U.S. Environmental Protection Agency (EPA). 1984. *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II*. Available Sampling Methods, Second Edition, EPA-600/4-84-076. December 1984.
- 3.2 Mason, B. J. 1983. *Preparation of Soil Sampling Protocol: Techniques and Strategies*, EPA-600/4-83-020. August.
- 3.3 Barth, D. S. and B. J. Mason. 1984. *Soil Sampling Quality Assurance User's Guide*, EPA-600/4-84-043. May.

4.0 DEFINITION OF TERMS

- 4.1 Surface soil is generally considered to be the top 6 inches of a soil horizon profile (i.e., soil from 0-to-6-inches below ground surface [bgs]). Depending on the program or project, however, soil to 2 feet bgs may be considered surface soil. For the purposes of this procedure, surface soil represents the soil occurring from 0- to- 6-inches bgs.
- 4.2 Subsurface soil represents the soil, silt, sand, and clay occurring between surface soil and bedrock.
- 4.3 Composite soil samples are combinations of aliquots of equal volume collected at various sample locations, or at various depths at a single location. Analysis of

composite samples yields a value representing an average over the various sampled sites or depths from which individual samples were collected.

- 4.4 Discrete soil samples are discrete aliquots from distinct sampling intervals, of a specific size, that are representative of one specific sample location at a specific point in time.
- 4.5 Continuous samplers are devices that allow a soil specimen to enter a split barrel during drilling. Both plastic and steel liners can be used inside the sample tube to retain the sample. In some formations, the soil sample may be considered "undisturbed."
- 4.6 Split-barrel samplers collect samples by driving a 1.5-inch nominal inner diameter, split barrel into a soil formation with a 140-pound hammer dropped 30 inches. For environmental applications, 2-, 2.5- and 3-inch inner diameter split barrels are not uncommon. If a standard 1.5-inch split barrel is used, the number of blows to drive the last 1 foot of the sample are referred to as the standard penetration resistance or N-value. See ASTM D-1586 for the specification for this type of sampler.
- 4.7 Ring-lined samplers are split barrels lined with removable rings. The rings are thin-walled and arranged in 1-, 2- or 6-inch increments to section the recovered soil sample. This device is used to collect soil samples for environmental applications and to collect relatively undisturbed soils in stiff and hard cohesive soils where it is not possible to push a sampler. See ASTM D3550 for the specification for this type of additional sampler.
- 4.8 Thin-walled tubes are used to recover relatively undisturbed soil samples by pressing the tubes into soil either hydraulically, or with a Denison or Pitcher sampler.

5.0 GENERAL

- 5.1 Soil samples are used to determine the physical, hydrogeologic, and chemical properties of site soil. Analytical data aid in the characterization of the site, identification of hazardous substance source areas, and determination of the nature and extent of contamination. A field sampling plan (FSIP) based on an

historical and current assessment of the site proposes the areas most likely to require sampling. However, field conditions may preclude collection of one or more predetermined samples and additional soil sampling may be required if unexpected subsurface conditions are encountered. Proper sampling techniques, proper selection of sampling equipment, and proper decontamination procedures as outlined in the FSIP and described in the Quality Assurance Project Plan (QAPP) eliminates cross-contamination and introduction of contaminants from external sources.

5.2 Soil conditions can vary widely at a site. These variations can affect the rate of contaminant migration through the soil. Therefore, detailed records are maintained during sampling activities, particularly with respect to location, depth, color, odor, lithology, hydrogeologic characteristics, and readings derived from field monitoring equipment. All soils are classified in the field by a geologist, hydrogeologist, or soil scientist using the Unified Soil Classification System (USCS), and as described in SOP 3.0 Field Classification and Description of Soils. Color of the samples is determined in the field using a Munsell Color Chart.

5.3 Equipment used during the collection of surface or subsurface soil samples may include, but are not limited to:

5.3.1 Hand lens;

5.3.2 Stainless steel spoons/trowels, and stainless steel hand augers;

5.3.3 Stainless steel split-spoon, split-barrel, or continuous sampler;

5.3.4 Stainless steel bowls/pans;

5.3.5 Tape;

5.3.6 Field notebook/logbook/boring log;

5.3.7 Waterproof and permanent marker;

5.3.8 Paper towels or Kimwipes;

5.3.9 Aluminum foil or Teflon® sheets;

5.3.10 Appropriate decontamination equipment;

- 5.3.11 Appropriate health and safety equipment;
 - 5.3.12 Appropriate sample containers and labels, sample cooler and ice;
 - 5.3.13 Chain(s) of custody (COC); and
 - 5.3.14 Munsell soil color charts and grain size charts.
- 5.4 Before collection of any soil samples, all sampling devices are decontaminated. If dedicated or disposable equipment is used, it is rinsed with deionized water. Mobile decontamination supplies are provided so that equipment can be decontaminated in the field. Each piece of sampling equipment is decontaminated before initiation of sampling operations, and between each sampling location or interval. The decontamination solutions are replenished with clean solutions between each site, but may be replenished more frequently if necessary. The procedures presented in the SOP 11.0, Sampling Equipment Decontamination, will be followed for decontamination of field equipment and for personnel decontamination.
- 5.5 If volatile organic compounds (VOCs) are among the contaminants expected at a particular site, an additional aliquot of soil from each sample location may be field-screened using appropriate air monitoring equipment using the following procedure:
- 5.5.1 In a clean glass jar or sealable-type plastic bag, half fill the container with an aliquot of soil;
 - 5.5.2 Cover the mouth of the jar with aluminum foil or tightly seal the plastic bag;
 - 5.5.3 Place the sample in a warm area for approximately five to ten minutes, to allow VOCs to volatilize to the headspace;
 - 5.5.4 Push the probe of the organic vapor monitor through the aluminum foil and into the headspace, or into the plastic bag. Be sure that the tip of the monitor does not come in contact with the sample; and
 - 5.5.5 Record the maximum deflection of the instrument gauge in the field logbook.

- 5.6 For QC and QA samples (field duplicate and split samples), homogenization for non-VOC parameters may be required, depending on DQOs. Homogenization for VOC samples shall not be performed.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager** develops or directs the preparation of a detailed Field Site Investigation Plan (FSIP) which describes the sampling procedures to be used and ensures that the procedures achieve the objectives of the investigation.
- 6.2 The **Field Supervisor** ensures that soil samples are collected according to procedures outlined in the FSIP and the QAPP or provides rational and justifiable decisions in circumstances where deviations from the FSIP or QAPP are necessary due to field conditions or unforeseen problems. The field supervisor also ensures that samples are handled, labeled, and shipped according to procedures outlined in the FSIP and the QAPP.

7.0 PROCEDURES

- 7.1 Surface soil samples may be collected as either discrete or composite samples using either a stainless steel spoon or trowel.

Discrete surface soil samples will be collected using the following procedures:

- 7.1.1 Don clean, disposable latex surgical gloves and impervious outer gloves to prevent cross-contamination and provide personal protection. New gloves will be donned for sample collection at each location, or whenever gloves are torn or otherwise compromised;
- 7.1.2 Remove any surface vegetation prior to sample collection with a decontaminated shovel or sampling spoon;
- 7.1.3 If a shovel is used, follow with a decontaminated stainless steel scoop or trowel to remove a thin layer of soil from the area which comes into contact with the shovel;
- 7.1.4 Use a decontaminated stainless steel spoon or trowel to collect the soil sample from 0- to- 6-inches bgs (unless stated otherwise in site-specific FSIP) from the respective soil sample location;

- 7.1.5 Remove pebbles, roots, etc. from the sample as the sample is collected; and
 - 7.1.6 Place the sample in the appropriate sample container. Seal and label the sample container and handle according to SOP 9.0, Packing and Shipping of Environmental Samples.
- 7.2 Composite surface soil samples will be collected using the following procedure:
- 7.2.1 Place soil samples for analyses other than VOCs in a decontaminated stainless steel, glass, plastic, or disposable collection container, and thoroughly mix by hand using the technique described for QA/QC duplicates on Section 7.14. Ensure that the container used for homogenization and the sampling utensils do not interfere with the analytes of interest (e.g., an aluminum pan should not be used for soil samples submitted for inorganic analyses);
 - 7.2.2 Divide the homogenized material equally among the appropriate sample containers;
 - 7.2.3 Seal the sample containers tightly and handle according to SOP 9.0, Packing and Shipping of Environmental Samples;
 - 7.2.4 If the sample is located in a residential yard setting, fill the holes with stockpiled soil or commercial topsoil to achieve the original grade, and replace and water sod; and
 - 7.2.5 Each composite sample will be collected following the procedure for discrete soil sampling with the exception that aliquots of soil collected from multiple locations are mixed in the collection container.
- 7.3 Soil samples for analysis of VOCs will be collected using a hand driven sampler fitted with stainless steel tubes. If using Encore™ samplers for VOC analysis, see SOP 32.0, Field Sampling with Encore™. Upon collection, the stainless steel sample tubes will then be sealed tightly with Teflon® sheeting, capped with rubber caps, and handled according to SOP 9.0, Packing and Shipping of Environmental Samples.

7.4 Shallow subsurface soil samples are defined as either discrete or composite samples collected from less than 5 feet bgs. Subsurface soil samples can be collected using a wide variety of sampling equipment and devices including thin-wall tube samplers and various types of hand augers such as bucket-type hand augers, continuous-flight hand augers, and post-hole hand augers. Of these sampling methods, only the thin-wall tube sampler collects an undisturbed soil sample. Sampling procedures for discrete soil samples are as follows:

7.4.1 Don clean, disposable latex surgical gloves to prevent cross-contamination and provide personal protection. New gloves will be donned for sample collection at each location, or whenever gloves are torn or otherwise compromised;

7.4.2 Check and clear each subsurface soil sample location prior to intrusive activities using as-built drawings, geophysical surveys (e.g., ground penetrating radar), or have clearances performed by the local utility company;

7.4.3 Remove any surface vegetation with a decontaminated shovel;

7.4.4 Use a decontaminated hand auger (or other similar equipment) to advance the boring to the depth immediately above the sampling interval;

7.4.5 Periodically remove all cuttings from the borehole and place them on a plastic sheet or directly on the ground surface if appropriate;

7.4.6 If the sample is to be collected using the same hand auger, decontaminate the auger bucket, or replace with a decontaminated bucket, prior to collecting the sample;

7.4.7 Collect the discrete sample by advancing the sampling equipment (e.g., hand auger bucket or thin-wall tube sampler) to the appropriate depth and retrieve the soil sample. Discrete soil samples for VOC analysis will be collected using a hand-driven sampler fitted with stainless steel or brass tubes or with the Encore™ sampler;

7.4.8 Place sample in a decontaminated stainless steel, brass, glass, plastic or disposable collection container;

- 7.4.9 Repeat process for deeper interval samples if necessary;
- 7.4.10 Seal the sample container tightly, and handle them according to the procedures in SOP 9.0, Packing and Shipping of Environmental Samples; and
- 7.4.11 Upon completion of sampling, abandon the borehole as described in SOP 14.0, Borehole Abandonment.
- 7.5 Collect vertical composite samples using the procedure above with the following variation: aliquots of soil will be collected at more than one sampling depth and placed in a single collection container prior to mixing. Follow procedures for mixing and sampling as described in the surface soil composition section.
- 7.6 Equipment commonly used to collect deep subsurface soil samples includes, but is not limited to, ring-lined samplers fitted with stainless steel tubes, split-barrel samplers, continuous core samplers, and thin-walled tubes. These types of sampling equipment are used in conjunction with a drill rig, and are either pushed, hammered, or drilled into the interval to be sampled. The interval(s) to be sampled may be either predetermined and specified in the FSIP, or determined according to criteria observed during advancement of the drilling equipment (which should also be specified in the FSIP). The following procedures focus on collection of soil samples for chemical analysis, using either a split-spoon or split-barrel sampler. Soil samples obtained for physical characterization are typically collected using similar procedures.

7.6.1 Continuous Sampler (physical characterization)

- Don clean, disposable latex surgical gloves to prevent cross-contamination and provide personal protection. New gloves will be donned for sample collection at each location, or whenever gloves are torn or otherwise compromised;
- Using the drilling equipment (e.g., hollow stem augers), advance the soil boring to the depth immediately above the sampling interval;

- Attach the continuous sampler to the rods or cable and insert into the hollow-stem augers (or casing) and lower it to the bottom of the borehole;
- Advance the sampler ahead of the augers into the undisturbed sampling interval;
- Retrieve and split open the sampler; and
- Log the samples in accordance with the SOP 3.0, Field Classification and Description of Soils.

7.6.2 Ring-Lined Sampler (physical characterization or chemical analysis)

- Using the drilling equipment (e.g., hollow stem augers), advance the soil boring to the depth immediately above the sampling interval;
- Assemble the sampler with the appropriate number of brass or stainless steel rings, attach to drill rod and lower to the bottom of the hole;
- Push or drive the sampler a distance equal to the length of samples to be collected. If the sampler is driven, record the weight of hammer used, height of drop and the number of blows to drive the sampler in 6-inch increments;
- Retrieve the sampler and remove the rings of soil as needed for chemical and physical analysis; and
- Handle the samples according to the procedure outlined above under Continuous Core Sampler starting with "Log the samples..."

7.6.3 Split-Barrel Sampler

- After the boring has been advanced to the desired sampling interval and excess cuttings removed, attach the split-barrel sampler to the sampling rods and lower in the borehole;
- Position the hammer over the sampling rods, then mark the rods in three or four successive 6-inch intervals.;

- Drive the sampler with blows from the 140-pound hammer dropped from 30 inches (in some instances the hammer may be substituted with a 280- or 400-pound hammer), and count the number of blows applied to each 6-inch increment. Discontinue driving the sampler if:
 1. 50 or more blows have been applied during one of the increments; and/or
 2. There is no observed advance of the sampler during the application of 25 successive blows.
- Retrieve and open the sampler, record the percent recovery or the length of sample recovered, and handle the samples according to the procedure outlined in Section 9.0.

7.7 In order to assess the accuracy and precision of the field methods and laboratory analytical procedures, quality assurance/quality control (QA/QC) surface and subsurface soil samples are collected during the sampling program according to the site-specific FSIP. QA/QC samples may be labeled with QA/QC identification numbers or fictitious identification numbers if blind submittal is desired, and are sent to the laboratory with the other samples for analyses. The frequency, types, and locations of QA/QC samples which are collected are specified in the site-specific FSIP.

7.8 An equipment rinsate sample is intended to check if decontamination procedures have been effective and to assess potential contamination resulting from sample handling using non-disposable or non-dedicated equipment (e.g., sampling trowels, mixing bowls, etc.). Procedures for collection are as follows:

7.8.1 Rinse the decontaminated sampling apparatus with deionized water. Allow the rinsate to drain from the sampling apparatus directly into the sample bottle;

7.8.2 Add any preservatives associated with the soil sample analytical methods to the rinsate sample;

7.8.2 Specify (on the COC) the same analytical methods for rinsate samples as is specified for the soil samples;

- 7.8.3 For validation reasons, assign the rinsate sample an identification number and label as rinsate samples, not as blanks; and
- 7.8.4 Place the rinsate sample in a chilled cooler and ship it to the laboratory with the other samples.
- 7.9 An extra volume of sample media may be collected during the sampling event for performance of matrix spike (MS)/matrix spike duplicate (MSD) analyses by the laboratory to assess laboratory accuracy, precision, and matrix interference. Following shipment of the samples to the laboratory, the laboratory prepares MS and MSD samples by aliquotting the soil matrix collected in the field and splitting the material into three separate sets of containers. Note that sample aliquots for volatile analysis are never homogenized. However, homogenization of the sample may be required for all non-volatile analyses, based on project-specific requirements. The laboratory spikes the split samples with appropriate analytes prior to performing the extraction in order to evaluate the total of the spiked compound and whatever quantity of the compound may be present in the sample. Results of the analyses are compared with the results of the primary sample and the known concentrations of the spike compounds. The percent recovery and relative percent difference are calculated and results are used to evaluate the precision and accuracy of the analytical method for various labeled "extra volume samples for MS/MSD." The sample volumes required for these analyses should be coordinated with the laboratory and are described in the site-specific FSIP.
- 7.10 Ambient samples are used to assess the range of concentrations of potential contaminants and naturally occurring inorganic compounds in the vicinity of the site which are not the result of site activities. These samples are taken from areas not anticipated to have been impacted by historical site operations (i.e., away from source areas and upwind).
- 7.10.1 The ambient samples are collected at the locations and depths specified in the site-specific FSIP. If the locations are not specified, a nearby park or other area void of industrial activity, for example, may be suitable for collection of ambient samples. The soil type should be as close as possible to the onsite characteristic samples. If appropriate, information

can be obtained from various state and local agencies (e.g. Soil Conservation Service, Solano County Department of Environmental Management) that could aid in selection of ambient soil sampling locations. Ambient soil samples should be collected following the same procedure as that used for the onsite soil samples.

7.11 Performance evaluation or pre-spiked soil samples may be used to assess laboratory extraction efficiency and accuracy in constituent identification and quantification. Because these samples are helpful in assessing the potential bias of analytical methods, they are also commonly used to evaluate the accuracy of non-standard methods or mobile laboratory procedures. These samples are generally prepared by an independent laboratory and can be shipped to the field in pre-sealed containers or sample containers that are the same as those used to collect environmental samples (not all methods may be available) and are to be included with the samples sent to the laboratory performing the analysis of site soil samples. The analytes of interest and corresponding analyte concentrations for the spike samples must be specified in the request to the independent laboratory providing the samples in accordance with the site-specific FSIP. These samples are assigned an identification number, stored in a chilled cooler, and shipped blind to the laboratory with the other samples.

7.12 QA duplicate (a.k.a. split) samples may also be used to assess laboratory accuracy in constituent identification and quantification. QA duplicate samples consist of two or more representative sample volumes from one homogeneous soil sample obtained from one sampling location. Equal volumes of representative aliquots from the mixture prepared according to Section 7.14 are submitted to two or more laboratories for analysis. Volatile samples are collected independently without prior homogenization. The results of each laboratory are compared as a check on the laboratory accuracy.

The party receiving the QA duplicate sample completes a "Receipt for Samples Form" and provides a copy to project team to document their receipt of the QA duplicate sample. The QA duplicate sample volume collected by the sampling team is preserved, packaged and submitted for analysis in the same manner as the other characteristic samples in accordance with the site-specific FSIP.

7.13 Field duplicate samples are collected to assess the precision of field and laboratory components of field samples and matrix heterogeneity. Duplicate samples are similar to split samples, except that duplicate samples may also include environmental variability as the result of having two independent, consecutive (6 inch deeper), split-spoon soil samples collected by repeating the entire sampling process immediately after the original sample has been collected. Homogenization of field duplicates will not be performed if project objectives include evaluation of matrix heterogeneity.

7.13.1 To maximize the information available in assessing total precision, collect duplicate samples from locations suspected of the highest contaminant concentration. Use field measurements (such as HNu data) or visual observations, past sampling results, and historical information to select appropriate locations for duplicate analyses.

7.13.2 The duplicate sample is handled and preserved in the same manner as the primary sample and assigned a sample number, stored in a chilled cooler, and shipped to the laboratory with the other samples. Whenever possible, the sample identification numbers for the characteristic sample and its duplicate are independent such that the receiving laboratory is not able to distinguish which samples are duplicates prior to analysis.

7.14 Obtaining QA/QC samples in a soil or sediment matrix may require homogenization of the sample aliquot prior to filling sample containers. However, volatile organic samples are the exception; samples being analyzed for volatile organic compounds must be taken from discrete locations prior to mixing. This practice is necessary to prevent loss of volatile constituents and to preserve, to the extent practicable, the physical integrity of the volatile fraction. Homogenization of the sample for remaining parameters may be necessary to create a representative sample volume if sample heterogeneity is not being evaluated. Moisture content, sediments, and waste materials may inhibit the ability to achieve complete mixing prior to filling sample containers. Therefore, when homogenization is requested, it is extremely important that soil samples be mixed as thoroughly as possible to ensure that the sample is a representative as possible of the sample location. When homogenization is requested, the following procedure should be followed:

7.14.1 The soil is extruded from the sampling apparatus (i.e., drive sampler) or collected by a stainless steel trowel and emptied into the decontaminated stainless steel tray or bowl. Use a decontaminated stainless steel spoon or trowel when extruding any sample from the sampling apparatus. Homogenization should be accomplished by then mixing with a decontaminated stainless steel or Teflon® instrument.

7.14.2 The method of choice for mixing is referred to as quartering and can be performed in a bowl or tray of an appropriate material (material depends on the parameters to be analyzed for). The soil in the sample pan is divided into quarters. Each quarter is mixed, then all quarters are mixed into the center of the pan. This procedure is followed several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material over.

7.14.3 The extent of mixing required will depend on the nature of the sample and should be done to achieve a consistent physical appearance prior to filling sample containers.

7.14.4 Once mixing is completed, the sample should be divided in half and containers should be filled by scooping sample material alternatively from each half.

7.14.5 Potential Problems

- (1) The higher the moisture or clay content, the more difficult it is to homogenize the sample.
- (2) A true homogenization of soil, sediment, or sludge samples is almost impossible to accomplish under field conditions.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

8.1 Completed COC documentation is to be placed in the project file.

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #8

ANALYSIS OF SOIL SAMPLES BY FIELD PORTABLE X-RAY

FLUORESCENCE (XRF) SPECTROMETRY

1.0 PURPOSE

- 1.1 The purpose of this standard operating procedure (SOP) is to provide detailed instructions for the preparation of soil samples and the analysis of elements by X-ray fluorescence (XRF) using a Spectrace model 9000 field portable x-ray fluorescence (FPXRF) Analyzer (or equivalent).

2.0 SCOPE AND APPLICABILITY

- 2.1 This method is primarily used for the analysis of environmental soil samples, but can be used for screening of most solid waste, including sludge and sediment samples. Some common elements such as Li, Be, Na, Mg, Al, Si and P may not be detected by FPXRF. Generally elements of atomic number 16 or greater can be detected and quantitated by FPXRF.
- 2.2 These detection limits apply to a clean matrix of quartz sand free of interelement spectral interferences using long count times and a relatively new radioisotope source. The actual working method detection limits will vary depending on type of detector used, type of excitation source, strength of excitation source, count times used to irradiate the sample, physical matrix effects, chemical matrix effects, and interelement spectral interferences. A method detection limit (MDL) study should be performed on the first day of project startup.
- 2.3 Use of this method is restricted to personnel either trained and knowledgeable in the operation of an XRF instrument or under the supervision of a trained and knowledgeable individual.

3.0 REFERENCES

- 3.1 *Method 6200 - Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations In Soil and Sediment, EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846 Third Edition, January 1995 (Draft).*

3.2 *Standard Operating Procedure For Total Metals By Energy Dispersive X-Ray Fluorescence Spectroscopy*, OnSite Environmental Laboratories, August 25, 1995.

4.0 DEFINITIONS

4.1 SRM - Standard Reference Materials

4.2 NIST - National Institute of Standards and Technology

5.0 GENERAL

5.1 Soil samples are prepared for analysis following the sequence of drying, pulverizing and sieving the sample. Approximately twenty grams of sample are dried under a heat lamp or in oven for approximately 15 minutes and pulverized by mortar and pestle. The ground sample is then sieved using a 10 mesh sieve. Approximately five grams of the sieved are is analyzed under preset energy conditions for the elements of concern. The software is programmed to calculate final concentrations by "Fundamental Parameters". The software algorithms will correct for matrix effects and calculate the final concentration by an iterative process.

5.1.1 Equipment and Supplies

- FPXRF with a mercuric iodide (HgI_2) detector and a data processing unit, Model Spectrace 9000 (or equivalent);
- Battery charger and spare backup battery;
- Heat lamp: to dry samples;
- Polyethylene sample cups: 31 millimeters (mm) to 40 mm in diameter with collar;
- Mylar XRF window film: 2.5 um film thickness;
- Mortar and pestle: for grinding samples;
- Containers: 4 ounce glass jars to contain soil samples;
- Sieves: 10-mesh for preparing soil samples;
- Plastic bags: for collection and homogenization of samples;

- Pure element standards: supplied by instrument manufacturer;
- Initial calibration standard, Environmental Resource Associates (ERA) elements and concentrations will vary depending on batch test results;
- Continuing calibration standard, NIST SRM, catalog number 2711 (or equivalent);
- Inorganics blank sand, ERA, catalog number 058 (or equivalent); and
- Lab grade detergent: for washing mortar and pestle.

6.0 RESPONSIBILITIES

- 6.1 The **Project Chemist** is responsible for the overall XRF sample preparation, XRF sample analysis, data compilation, data verification and XRF record keeping. The data must meet all QA/QC requirements and be reproducible upon request.
- 6.2 The **Project Geologist** will be responsible for the coordination of all field activities including the collection of samples for field analysis and shipping of samples to a stationary laboratory.
- 6.3 The **Field Technician** will work under the direction of the project chemist and the project geologist. Responsibilities will include assisting in sample collection, sample preparation, sample analysis, and data compilation.

7.0 PROCEDURES

- 7.1 **Energy Calibration.** An energy calibration must be run using a pure metal standard prior to instrument calibration and sample analysis. The energy calibration will reset the instrument gain, resolution, and peak offset in order to compensate for drifts due to temperature variations.
- 7.2 **Instrument Blank.** An inorganics blank sand from ERA (or other vendor) is analyzed at the beginning of each day to verify that the instrument is properly zeroed. The concentrations in the instrument blank cannot exceed $\frac{1}{2}$ the PQL. If any target analyte exceeds $\frac{1}{2}$ the PQL, corrective action procedures such as rerunning the blank or rerunning the energy calibration must be taken.

- 7.3 **Initial Calibration Verification (ICV).** An ICV must be run at the beginning of each day. The ICV is a ERA (or other vendor) SRM standard. All target elements must be within $\pm 50\%$ of the certified value.
- 7.4 **Continuing Calibration Verification (CCV).** The CCV standard is NIST SRM #2711. A CCV standard must be run every 10 samples and at the end of the day. All target elements must be within $\pm 50\%$ of the certified value. Since the concentration of antimony in the standard is below the instrument MDL value, barium will be used to monitor the source performance. Samples must be bracketed by an acceptable CCV.
- 7.5 **Field Laboratory Sample Duplicate.** A mobile laboratory sample duplicate must be performed at a 10% frequency (every 10 samples). The duplicate sample would be a undisturbed sample aliquot requiring an independent sample preparation step. The relative percent difference (RPD) between the initial and duplicate result must be $\leq 50\%$. If the element of interest is at a concentration within five times of the MDL, the RPD criterion will not apply.
- 7.6 **Field Sample Duplicate.** Field sample duplicates must be collected at a 10% frequency (every 10 samples). The relative percent difference (RPD) between the initial and duplicate result must be $\leq 50\%$. If the element of interest is at a concentration within five times of the MDL, the RPD criterion will not apply.
- 7.7 **Method Detection Limit (MDL) Study.** A MDL study must be performed on the first day at the job site. The MDL study shall be conducted after the instrument setup, energy calibration and ICV have been completed and all acceptance criteria are met.
- 7.8 **Practical Quantitation Limit (PQL).** The PQL is determined by taking the standard deviation determined in the MDL study and multiplying it by ten.
- 7.9 **Actual Step-Wise Procedure Example (Spectrace Model 9000 field portable XRF analyzer)**
- 7.9.1 **Instrument Setup.** Arrange the components with the printer and computer to the left and the card cage to the right of the head unit. Verify that battery pack is fully charged. Turn all components on. If the instrument begins to beep, turn the defrost switch OFF, and the cooler

switch ON to initiate detector cooling. Wait at least one hour for detector to reach operating temperature. Initiate the software program by typing in 'SSXRF' at the command prompt. Change directory to C:\6000 to initiate the energy calibration. Press F5 softkey to change directions.

- 7.9.2 **Energy Calibration.** Prior to calibration verification and sample analysis, the analyst must run an energy calibration. Lead will be used as the energy calibration check. This procedure resets the instrument gain, resolution, and peak offset relative to a pure lead standard, which compensates for drift due to changing temperature conditions.

Verify that computer is set to the correct directory. Place the lead disk in the sample chamber and press F7 to initiate the energy calibration. The calibration takes approximately seven minutes. Print out a copy of the instrument settings listed on the PHA status page, initial/date, and file in the instrument logbook.

Perform an energy calibration at the beginning of each day. The instrument will reset internal parameters. If error message is encountered, review instrument operation manual or call manufacturer to resolve problem. Do not proceed with sample analysis until energy calibration is successfully completed.

- 7.9.3 **Instrument Blank.** Blank the instrument using the teflon block provided. If instrument fails to blank itself, review instrument operation manual or consult with manufacturer.

- 7.9.4 **Method Detection Limit (MDL) Study.** An MDL study must be performed on the first day of field operations. All non-detects will be reported at the MDL value.

If the ICV or CCV are grossly in error or if the analyst suspects instrument problems, a new MDL should be performed.

To perform the MDL study, set the count time to 200 seconds and analyze the blank sand three times. To calculate the MDL, multiply the average standard deviation value by three.

The same count time used to determine the MDL must be used for all subsequent samples and standards. Any change to the count time, will require a new MDL study.

7.9.5 **Practical Quantation Limit (PQL).** The PQL is calculated by multiplying the average standard deviation from three blank sand runs.

7.9.6 **Sample Preparation.** Transfer sample from the field provided 4 ounce glass jar into a plastic bag labeled with the field ID. Homogenize the soil sample as thoroughly as possible by shaking the bag vigorously. Record any unusual material (particularly debris associated with firing range activities; i.e. pellets, cartridges, clay shards, etc.) or soil conditions in the field logbook.

Transfer 25 grams of soil sample onto a labeled plastic weigh boat and place the weigh boat under the heat lamp for 15 minutes or until sample appears to contain less than 20% moisture. Minimize the sample thickness in order to assure uniform drying. The use of a microwave oven to dry samples is not recommended since field studies have shown that microwave drying can increase variability between FPXRF data and confirmatory data. Additionally, high levels of metals in a sample can cause arcing in the microwave oven. The remaining contents in the plastic bag shall be transferred into a disposable sample vial with cap.

Once the sample appears to be dry, grind the homogenized dried sample using a mortar and pestle so that at least 90% of the original sample passes through a 10 mesh sieve.

Collect the fines in a new labeled plastic bag. Place approximately five grams of the sieved sample into a sample cup for analysis and keep the remaining sieved sample for confirmation analysis if required. It is important that the confirmation sample aliquot be as identical as possible as the aliquot taken for XRF analysis.

The sample cup must be one-half to three-quarters full at a minimum. Discard the material that did not pass through the sieve into a open drum designated for investigation-derived waste (IDW).

Cover the sample cup with a 2.5 micron Mylar film and secure film is place using the O-ring provided with each sample cup. The film must be stretched to remove all wrinkles and abberations. If the film contains any flaws, discard and use a new piece.

All reusable equipment including mortar, pestle, and sieves must be thoroughly rinsed with a solution of Alconox and deionized water. The equipment should be dried under the heat lamp for approximately 10 minutes.

The sample is now ready for analysis. Before beginning analysis, the instrument calibration must be initially verified.

7.9.7 Initial Calibration. The instrument is pre-calibrated by the manufacturer prior to shipment. The calibration procedure used is the 'Effective Energy Fundamental Parameters Calibration' as defined in the instrument's operation manual.

The calibration must be initially verified by running an initial calibration verification (ICV) at the beginning of each day. This calibration check is performed by analyzing an ERA certified standard. The count time used should be identical to that used for the MDL study. If adequate sensitivity can be achieved using a reduced count time, perform a new MDL study using the reduced count time and analyzed samples. Record the count time on the analysis worksheet.

Setup the calibration table for all elements of interest by entering the certified values from the ERA standard documentation.

Change directories using the F5 softkey into the appropriate method directory. Highlight the calibration option line for the current method. Press F1 softkey to begin calibration. Follow screen instructions and insert the SRM standard into the sample chamber.

Calculate the percent difference (%D) for each target analyte and record the value on the analysis worksheet (Attachment 2). The sample type would be ICV. The acceptance criteria is $\pm 50\%$ of the certified value for each analyte.

If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line or the y-intercept value for the analyte. Continue to reanalyze and readjust until the %D meets acceptance criteria.

7.9.8 Continuing Calibration. A continuing calibration verification (CCV) is performed after every 10 samples and at the end of the day. Additionally, if instrument malfunction is suspected, a CCV should be performed to assure that instrument operation is acceptable. The CCV is an NIST SRM, catalog number 2711.

The CCV acceptance criteria is $\pm 50\%$ difference (%D). Record the CCV concentrations and %D values in the field logbook. If the result varies from the true value by more than 50% for the analytes of interest, rerun the CCV. If CCV is out a second time, re-zero, recalibrate, and rerun the CCV. If an acceptable CCV cannot be obtained, contact the manufacturer for guidance.

No further samples should be analyzed until the CCV is acceptable. Reanalyze all samples run after the last acceptable CCV.

7.9.10 Sample Analysis. Sample analysis may begin following a successful ICV or CCV. Up to ten samples may be analyzed before a new calibration check is necessary.

The samples are analyzed under the same energy conditions and count time as the calibration standards.

Place the sample cell in the XRF chamber. Using the cursor, highlight the appropriate analysis method and press F1 softkey. Enter the sample ID at the prompt and press the spacebar to start analysis. The instrument will analyze all energy levels programmed into the method and display the final concentrations for all elements programmed into the method.

Record the final results on the analysis worksheet (attachment 2).

7.9.11 Typical Analytical Sequence

Once the MDL is established, the typical daily analytical sequence would be as follows:

<u>RUN #</u>	<u>SAMPLE TYPE</u>
1	Teflon blank
2	Pb standard
3	ICV
4	Blank sand
5	Sample 1
6	Sample 2
7	Sample 3
8	Sample 4
9	Sample 5
10	Sample 6
11	Sample 7
12	Sample 8
13	Sample 9
14	Sample 10
15	Sample duplicate
16	CCV
17	Sample 11
18	Sample 12
etc.	etc.

The analytical sequence must end with an acceptable CCV standard.

7.9.11 Data Interpretation. Any detected value above the MDL but below the PQL will be J flagged and considered an estimated value.

If the blank produces any absolute values greater than $\frac{1}{2}$ the PQL, corrective action must be taken since the potential for false positives and negatives is greatly enhanced.

Samples that produce a negative value with an absolute value greater than $\frac{1}{2}$ the PQL should be re-analyzed. If the results continue to produce a negative with an absolute value greater than $\frac{1}{2}$ the PQL, recheck instrument calibration by running the CCV.

Sample results greater than ambient values will require additional sampling at a lower depth.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

- 8.1 An XRF Analysis Logbook will be maintained at the jobsite. The logbook will contain the following sections: (1) MDL information, (2) analysis information, and (3) calibration information. Upon project completion, the XRF Analysis logbook will be placed in the project file.
- 8.2 The XRF data will be either hand entered or directly downloaded from the instrument into a laptop computer. The database will be managed using Microsoft Access with multiple query options available. Using ArcView, a map of the location will be available showing sampling locations and analytical results to assist in the decision making process.

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #9

PACKING AND SHIPPING OF ENVIRONMENTAL SAMPLES

1.0 PURPOSE

- 1.1 The purpose of this standard operating procedure (SOP) is to provide a guide for packing and shipping environmental samples with the appropriate chain of custody (COC) records. This SOP is in accordance with all applicable transportation regulations and analytical requirements, and proper COC records.

2.0 SCOPE AND APPLICABILITY

- 2.1 These procedures apply to all field personnel including Project team and subcontractors involved in packing and shipping environmental samples. Samples determined to be hazardous shall be managed in accordance with the Health and Safety Plan, Section 407.

3.0 REFERENCES

- 3.1 40 Code of Federal Regulations (CFR) 261.4. 1990. *Identification and Listing of Hazardous Waste*, Federal Register, Chapter 1, pg. 35, 1 July 1990.
- 3.2 Environmental Resource Center. 1992. *Hazardous Waste Management Compliance Handbook*, Van Nostrand Reinhold, New York.
- 3.3 U.S. Environmental Protection Agency (USEPA). 1987. *A Compendium of Superfund Field Operation Methods*, Office of Solid Waste and Emergency Response, Directive 9355.0-14.
- 3.4 U.S. Environmental Protection Agency (USEPA). 1985. *Characterization of Hazardous Waste Sites: A Method Manual*, Volume I, Site Investigation.
- 3.5 U.S. Environmental Protection Agency (USEPA). 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document.

4.0 DEFINITION OF TERMS

- 4.1 Absorbent Material. Packing material with absorbent capacity. This includes asbestos-free vermiculite and perlite.
- 4.2 Chain of Custody Record. Sample custody tracking record, which also provides direction to the laboratory for sample analysis. This record must accompany the

related samples from the time of sample collection, through shipping, and to laboratory receipt. Guidance for completing, handling, and storing of COC records is provided in SOP 4.0.

- 4.3 Courier. Person who maintains personal custody of packaged samples and COC records while delivering the samples from the field to a specified laboratory.
- 4.4 Custody. A sample is under custody if one or more of the following criteria are met:
- 4.4.1 When it is in an individual's physical possession;
 - 4.4.2 When it is in view of an individual, after being in their physical possession;
 - 4.4.3 When it was in an individual's physical possession and then locked up so no one could tamper with it; and
 - 4.4.4 When it is in a designated and identified secure area, controlled and restricted to authorized personnel only.
- 4.5 Custody Seals. When samples are shipped to the laboratory, they must be placed in padlocked containers or containers sealed with custody seals. Custody seals should have perforations stamped in the seal so that an attempt to remove the seal will be clearly evident by the torn perforations. Custody seals shall be signed and dated by the sample collector.
- 4.6 Environmental Samples. Air, water, soil, and sediment samples collected during an environmental investigation and sent to a laboratory for analysis. These are differentiated from hazardous materials based on contamination levels as described in Section 5.0.
- 4.7 Hazardous Samples. Samples that are determined by the field team to be potentially hazardous. These are typically samples from chemical and fuel drums or tanks, samples of sludge or floating product, environmental samples from known areas of very high chemical concentration, samples with very high photoionization detector (PID) readings, or samples that are grossly contaminated. These samples shall be differentiated from environmental samples by knowledgeable field personnel and shipped as hazardous materials.

- 4.8 Packing Material. Material used to absorb moisture or dampen shock during sample shipment. Examples include bubble wrap, vermiculite, Styrofoam®, and kitty-litter.
- 4.9 Receipt. Acquisition of samples from the person who had custody of the samples. On receipt of the samples, a sample inventory and inspection of the custody seals shall be performed by the recipient. After checking the samples, the COC must be signed by the receiver and the date and time must be recorded. This information is then legal evidence that the COC had been maintained until the time of receipt. The responsibility for sample custody is then transferred to the receiver.
- 4.10 Relinquishment. Transfer of sample custody. Relinquishment of samples to a receiver requires the relinquisher's signature, date, and time to be entered on the COC. Samples should not be relinquished without rechecking the samples against the COC records and determining that all samples are present, intact, and show no signs of tampering. The relinquisher's signature is evidence that the samples have been checked.
- 4.11 Shipping Manifest. U.S. Department of Transportation (DOT) document that describes the material being transported, identifies the generator and transporter(s), and instructs the transporter(s) on any special handling requirements.

The shipping manifest serves three purposes:

- 4.11.1 It serves as a tracking device to trace shipments of hazardous substances;
- 4.11.2 It provides information on the contents manifested during transport emergencies; and
- 4.11.3 It is used for record keeping and reporting on hazardous substance shipping by the USEPA and the disposal facility.

Shipping manifests must accompany hazardous samples. These are described in detail in the Health and Safety Plan.

It is anticipated that no samples collected during this project will require classification as hazardous.

5.0 GENERAL

5.1 Environmental samples and quality control samples are collected, labeled, and sealed in the field and custody is maintained as defined in Project Team SOP 4.0, Sample Management.

5.2 40 CFR Part 261.4 describes sample shipping requirements as:

5.2.1 "... a sample of solid waste or a sample of water, soil, or air, which is collected for the sole purpose of testing its characteristics or composition, is not subject to any requirements of this part (hazardous materials shipping requirements) when:

- The sample is being transported to a laboratory for the purpose of testing; or
- The sample is being transported back to the sample collector after testing.

5.3 In order to qualify for the(se) shipping standard(s), the sample collector shipping samples to a laboratory and a laboratory returning samples to a sample collector must:

5.3.1 Comply with U.S. Department of Transportation (USDOT), U.S. Postal Service (USPS), or any other applicable shipping requirements; or

5.3.2 Ensure that the following information accompanies the sample(s) if the sample collector determines that USDOT, USPS, or other shipping do not apply to the shipment of the sample:

- Sample collector's name, mailing address, and telephone number;
- Laboratory's name, mailing address, and telephone number;
- Quantity of the sample;
- Date of shipment; and
- sample description (e.g., soil, sludge, aqueous).

5.4 Samples shall be assessed to determine potential hazard. Potentially hazardous samples are required by law to be properly handled and labeled. Good judgment

on the part of the sample coordinator is also necessary to identify hazardous samples.

- 5.5 Samples collected from chemical or fuel drums and tanks, free product from a well, leachates, sludges, and samples with headspace readings noted above are all hazardous samples. In general, any material that is a potential threat during transport can be considered hazardous.
- 5.6 Samples determined to be nonhazardous by the sample coordinator are environmental samples. They are to be labeled, packaged, documented, and shipped as described in Section 7.0 of this SOP.

6.0 RESPONSIBILITIES

- 6.1 The **Sample Collector** shall ensure that the samples are correctly collected, labeled, tracked by COC records, and stored until they are delivered to the sample coordinator. The sample collector shall be responsible for informing the sample coordinator of sampling conditions and if any of the samples are potentially hazardous. The sample collector shall pack the coolers, ensure that the COC records are correct, and ship the samples as described in Section 7.0. The sample coordinator shall determine which samples are potentially hazardous and ship them accordingly.
- 6.2 The **Field Supervisor** shall be aware of these procedures and schedule accordingly, taking into account that packing hazardous samples requires more materials (e.g., properly labeled paint cans and manifests) and more time than packing environmental samples.

7.0 PROCEDURES

- 7.1 Determine the maximum allowable weight of each cooler (Federal Express limit is 150 pounds).
- 7.2 Place sample container in a zip-lock type bag and seal, squeezing as much air as possible from the bag before closing. Place the sample container bag into another zip-lock type bag to ensure the samples and sample labels remain dry during shipment. Glass jars or bottles can be wrapped in bubble wrap before placing them into zip-lock type bags or placed into the zip-lock type bags and

placed in the cooler with sufficient packing material to ensure safe transport of the jars.

- 7.3 Secure the cooler's drain plug in the closed position, and seal with tape.
- 7.4 When using the breakable sample containers (e.g., glass), the containers must be protected from breakage with the use of packing material, such as asbestos-free vermiculite, perlite, Styrofoam beads, or bubble wrap. Place these materials among the sample containers so that the risk of breakage is greatly reduced.
- 7.5 Depending on the length of the time that the samples are expected to remain in the shipping cooler, ice may need to be double-bagged in zip-lock type bags. If double-bagging is required, fill 1 quart zip-lock-type bag with ice, seal, and place the bag into another 1 quart bag with the sealed end first. Seal bag. Position the bags equally in the shipping cooler and pack the ice and samples in alternate layers. Use enough ice to ensure that the samples will remain sufficiently chilled through shipment to contract laboratory. Pack the shipping cooler with sufficient packing material to maintain a tightly packed shipment, if appropriate. For water samples, place the bottles upright to provide additional stability. Do not use blue ice because its heat capacity is lower than regular ice. Do not use dry ice. If the field crew is informed by the laboratory that the samples are not being chilled sufficiently, additional ice may be required.
- 7.6 If shipping via commercial carrier (e.g., Federal Express), write the carrier's airbill number on the COC, place the appropriate pages of the COC inside a zip-lock bag, and seal the bag with a signed, dated custody seal. The COC has four pages: the top two (white and canary) are sealed inside the zip-lock bag and taped to the inside lid of the cooler. The pink page goes to project data management, and the goldenrod copy is placed in field files. The COC sent to the laboratory must be completed with all designated information, the pages must be originals (not photocopies), and the COC must be unique to the samples contained in the cooler. If any field crib sheet is used to note sample collection times, a copy must follow every copy of the COC.
- 7.7 If a courier from the laboratory is collecting the samples and delivering them to the laboratory, have the courier confirm that all samples listed are present and then sign the COC. Place the top two copies of the COC inside a zip-lock bag,

and seal the bag with a custody seal signed by the courier. Place the zip-lock bag containing the custody record inside the cooler; close and latch the cooler.

- 7.8 Wrap strapping tape completely around the cooler on both sides of the latch.
- 7.9 Affix "This Side Up" labels on all four sides of the cooler and "Fragile" labels on at least two sides, if necessary.
- 7.10 Affix the shipping label with the address and telephone number of the laboratory and the Project Team field office.
- 7.11 Affix signed custody seals in two places on the cooler that will be broken if the cooler is opened.
- 7.12 The laboratory should be notified if the samples are being delivered via courier. They should be prepared to receive and check the samples and sign the COC as the sample receiver.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

Copies of the COC should be placed in the central project file.

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #10

PRESERVING ENVIRONMENTAL SAMPLES IN THE FIELD

1.0 PURPOSE

- 1.1 The purpose of this project team standard operating procedure (SOP) is to ensure that the chemical integrity of a sample is maintained from time of collection until chemical analysis.

2.0 SCOPE AND APPLICABILITY

- 2.1 This SOP documents the procedures and chemicals to be used for the preservation of field samples. The environmental media addressed in this SOP include soil, sediment, solid waste, and aqueous samples. These procedures apply to all Project team personnel and subcontractors involved with the collection, shipping and chemical analysis of environmental samples.

3.0 REFERENCES

- 3.1 American Public Health Association, 1985. *Standard Methods for the Examination of Water and Wastewater*, 16th Edition.
- 3.2 40 CFR 136, Code of Federal Regulations, dated July 1, 1990.
- 3.3 State of California, 1989. Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure, Leaking Underground Fuel Tank Task Force.
- 3.4 United States Environmental Protection Agency (USEPA), 1991. Statement of Work for Organics Analysis, Document Number OLMO1.0, USEPA Contract Laboratory Program, June.
- 3.5 USEPA. 1990a. Statement of Work for Inorganics Analysis, Document Number ILMO1.0, USEPA Contract Laboratory Program, March. November.
- 3.6 USEPA. 1990b. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, Final Update I, USEPA Office of Solid Waste,
- 3.7 USEPA. 1982. *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-82-055, December

4.0 DEFINITIONS

- 4.1 Holding Time. (Maximum Holding Time) is the maximum length of time that may elapse before sample preparation (extraction or digestion) or analysis is completed. It is calculated from the date and time of collection in the field. Holding times are usually measured to the nearest day with the exception of those analyses that must be completed within 24 or 48 hours.
- 4.2 Preservation refers to temperature control and/or pH adjustment procedures performed to prevent or slow the loss of target analytes through precipitation, volatilization, decomposition, or biodegradation.
- 4.3 Temperature is defined as the temperature within the refrigerator, cooler or ice chest that holds the samples. Samples shall be held at 4 degrees Celsius ($^{\circ}\text{C}$) ($\pm 2^{\circ}\text{C}$ represents the acceptable range).

5.0 GENERAL

- 5.1 Most chemical and biological reactions and many physical processes are slowed by lowering the temperature. Therefore, as a general rule, all samples need to be cooled at the time of collection and maintained slightly above freezing until preparation for final analysis. This restriction is not critical in the case of metals analysis since most metals exist in the form of involatile salts. Exceptions include liquid mercury and organometallic compounds such as tetraethyl lead. Hexavalent chromium is kept cold to slow its reduction to trivalent chromium.
- 5.2 Soil samples and other solid samples, including sediments, sludges, and solid waste, shall be preserved by cooling to $4^{\circ}, \pm 2^{\circ}\text{C}$. Soil and solid samples require no other preservatives. However, analysis must be performed within the method-specific holding time requirements.
- 5.3 Aqueous samples may be presumed to be homogenous and amenable to chemical preservation. In addition to keeping such samples cold, the following general approaches shall be employed depending on the analyte(s):
- 5.3.1 Volatile acids (HCN , H_2S) are rendered involatile in the presence of strong base (NaOH , pH greater than $[\gt] 12$);

- 5.3.2 Volatile bases (ammonia) are rendered involatile in the presence of strong acid (H_2SO_4 , pH less than [$<$] 2);
- 5.3.3 Biodegradation of organic compounds is retarded under strongly acidic conditions (HCl or H_2SO_4 , pH $<$ 2);
- 5.3.4 Dehydrohalogenation (loss of HCl) of chlorinated solvents is counteracted in the presence of acid (HCl, pH $<$ 2);
- 5.3.5 Oxidation of target analytes by the chlorine found in drinking water is eliminated by destroying the chlorine with a reducing agent such as sodium thiosulfate; and
- 5.3.6 Many soluble metal salts tend to adhere to the walls of the container or they form precipitates with time. This can be prevented by the addition of nitric acid to a pH of $<$ 2, which maintains the metals as soluble nitrate salts.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager** shall ensure that the sampling procedures used, including provisions for proper storage, preservation and shipping, are adequate to maintain sample integrity until custody is assumed by the laboratory. The project manager shall develop or direct the preparation of a detailed sampling plan for sampling air, water, biota, sediment, soil, or waste, which shall describe the procedures used to preserve samples during the interval from sampling until receipt by the laboratory.
- 6.2 The **Field Supervisor** or his or her designate shall be responsible for ensuring the competence of field sampling personnel and their training. The field supervisor shall ensure that specified preservation and storage procedures are followed during sampling. The field supervisor shall ensure that samples are properly preserved, stored, and shipped to the laboratory.

7.0 PROCEDURES

- 7.1 With the exception of the stainless-steel sleeves used to capture soil boring samples, all sample containers will be supplied in advance by the subcontracting laboratories.

- 7.2 The required chemical preservatives for aqueous samples will normally be added to the appropriate containers by the subcontracting laboratories before delivery to the field. There are two reasons why already-preserved containers are preferred. First, the laboratory scheduled to perform the analysis maintains control over sample integrity and container cleanliness and, second, field crews are generally not equipped to "appropriately handle" hazardous chemicals like hydrochloric acid. However, it may become necessary to add additional preservation to achieve the proper pH.
- 7.3 The sample management officer is responsible for maintaining adequate supplies of containers and preservatives.
- 7.4 Field personnel should ensure that the appropriate containers and preservatives are used to collect the samples.
- 7.5 Sample preservatives should be identified on the chain of custody (COC).
- 7.6 Solid samples, whether in metal sleeves, wide-mouth glass jars, or other containers, will be labeled and secured appropriately, then placed immediately in an ice chest containing sufficient ice to maintain a temperature range of $4^{\circ} \pm 2^{\circ}$ C through delivery to the laboratory.
- 7.7 Sufficient ice chests and quantities of ice to manage all samples collected during the day (or shift) shall be maintained at the sampling site.
- 7.8 Samples are maintained in ice or, if available, in refrigerators, within a range of $4^{\circ} \pm 2^{\circ}$ C, from the time the sample control manager assumes custody until the samples are packed for shipment and relinquished to the shipper or other transport agent.
- 7.9 All samples are shipped in ice chests packed with sufficient ice to maintain a temperature range of $4^{\circ} \pm 2^{\circ}$ C for at least 24 hours.
- 7.10 The receiving laboratory will measure the temperature within the ice chest immediately upon assuming custody of a shipment of samples. This temperature will be noted on the COC form. Temperatures in excess of 6° C will be reported immediately to the project chemist. After consultation with the project manager, the project chemist will communicate whether re-sampling is necessary.

7.11 With respect to procedures for maintaining a temperature range of $4^{\circ} \pm 2^{\circ} \text{ C}$, aqueous samples will be treated as described above, for solid samples.

7.12 Groundwater samples for dissolved metals analysis are filtered before preservation with nitric acid. The filtrate is added directly to the 500-mL or 1-liter (L) plastic container which has been supplied with the proper amount of 1:1 nitric acid.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

Not applicable

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #11

SAMPLING EQUIPMENT DECONTAMINATION

1.0 PURPOSE

- 1.1 This standard operating procedure (SOP) provides the step-by-step procedures for field decontamination of sampling equipment. Decontamination of equipment and personal protective equipment is designed to ensure that the introduction and transfer of contamination is eliminated and to protect the health and safety of project personnel.

2.0 SCOPE AND APPLICABILITY

- 2.1 This procedure applies to all project team personnel and subcontractors collecting samples in environments in which hazardous substances are expected to be present. Equipment covered by this SOP includes the measurement devices, pumps, and bailers.

3.0 REFERENCES

- 3.1 United States Environmental Protection Agency (USEPA). 1990. Procedures to Schedule and Complete Sampling Activities in Cooperation with EPA Region VII Environmental Services Division. February.
- 3.2 USEPA Region VII. 1991. Environmental Services Division Operations and Quality Assurance Manual. February.
- 3.3 USEPA. 1987. A Compendium of Superfund Field Operations Methods, Volumes I and II. EPA/540/P-87/001a&b.
- 3.4 USEPA. 1992. Standard Operating Safety Guidelines; Publication 9285.1-03. June.
- 3.5 The Code of Federal Regulations, 1993. Title 29, 1910.120. July.
- 3.6 Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. October 1985.

4.0 DEFINITIONS

- 4.1 Decontamination area. An area that is not expected to be contaminated and is upwind of the exclusion zone

- 4.2 Exclusion zone. The area in which contaminants are known or suspected to be present.
- 4.3 Health and Safety Plan. A plan developed to ensure that all hazards associated with a site are evaluated prior to site entry.
- 4.4 Measurement/monitoring equipment. Any equipment used to check or evaluate site conditions.
- 4.5 Potable. Drinkable.
- 4.6 Sampling equipment. Any equipment used during the process of sample collection.

5.0 GENERAL

- 5.1 Decontamination consists of physically removing contaminants from personnel or equipment. To prevent the transfer of harmful materials, procedures have been developed and are implemented before anyone enters a site and continue throughout site operations.
- 5.2 A decontamination plan should be based on the worst-case scenario (if information about the site is limited). The plan can be modified, if justified, by supplemental information. Initially, the decontamination plan assumes all protective clothing and equipment which leave the exclusion zone are contaminated. Based on this assumption, a system is established to wash and rinse all non-disposable equipment. Decontamination plans will be site-specific and presented in the Site Safety and Health Plan (SSHP) for each site.
- 5.3 The type of decontamination procedures and solutions needed at each site will be determined after considering the following site-specific conditions:
- 5.3.1 Type of equipment to be decontaminated;
 - 5.3.2 Type of contaminant(s) present; and
 - 5.3.3 Extent of contamination.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager** is responsible for ensuring overall compliance with this procedure.

- 6.2 The **Field Supervisor** is responsible for assigning equipment and technicians to perform decontamination tasks. Each field person assigned to the project must review the project Health and Safety Plan for appropriate decontamination procedures.

7.0 PROCEDURES

- 7.1 All sampling equipment used at the site must be cleaned both before activities begin and after each sample is collected.
- 7.2 The level of decontamination depends primarily on the types of contaminants and the nature of the site activities. In general, as the toxicity of the contaminants and the magnitude of potential contamination of personnel is increased, the decontamination process becomes increasingly more extensive and thorough.
- 7.3 The decontamination area should be located in the contamination reduction zone between the buffer and exclusion zone.
- 7.3.1 The decontamination area must have space for placement of several small wash tubs for cleaning small pieces of equipment and personal protective equipment. There should also be adequate storage capacity in the decontamination area for storing unused drums and used drums containing spent decontamination fluids, waste, and trash until these items can be relocated or properly disposed.
- 7.3.2 The decontamination area should be located, if possible, where decontamination fluids and soil wastes can be easily discarded or discharged after receipt of analytical results which determine if discharge parameters have been met. Decontamination wastewater should be managed in accordance with the Investigation Derived Waste Plan. Wastewater will be collected and stored onsite until it can be properly disposed.
- 7.4 The following is a list of equipment that may be needed to perform decontamination:
- 7.4.1 Concrete or synthetic material-lined decontamination pad;

- 7.4.2 Brushes, garden-type water sprayers (without oil-lubricated, moving parts), rinse bottles, flat-bladed scrapers;
 - 7.4.3 Sump or collection system for contaminated liquid;
 - 7.4.4 Wash tubs and buckets;
 - 7.4.5 Hot water, high-pressure sprayer;
 - 7.4.6 Disposal drums;
 - 7.4.7 Sponges or paper towels;
 - 7.4.8 Laboratory-grade, non-phosphate detergent (Liquinox or equivalent);
 - 7.4.9 ASTM type II reagent grade water or laboratory-grade deionized water;
 - 7.4.10 Plastic sheeting; and
 - 7.4.11 Methanol.
- 7.5 At the completion of each sampling activity the outside of the filled sample container may be decontaminated as follows:
- Be sure that the bottle lids are on tight; and
 - Wipe the outside of the bottle with a paper towel, and properly dispose of the towel.
- 7.6 The following procedures should be followed when decontaminating sample shipment:
- 7.6.1 Heavy equipment, hand tools, and sampling devices contaminated in the exclusion zone must be decontaminated before re-use or removal from the site. Equipment and tools must be cleaned periodically to reduce continual contact with contamination. All equipment must be decontaminated before it is taken off-site to leave contamination on the site. Sampling equipment must also be decontaminated between samples to prevent cross-contamination of the samples. All major reusable equipment and other tools used for site investigation activities should be decontaminated prior to leaving the site area.
- 7.6.2 Cleaning should consist of scrubbing to remove encrusted materials followed by a detergent and water wash and potable water rinse using a

high-pressure, low volume water spray or steam cleaning unit. High pressure and/or heat should be used only as necessary and with caution because they can spread contamination and cause burns.

- 7.6.3 Additional rinses with other solvents, such as methanol and hexane, may be used if warranted by the nature of the chemicals encountered. These solvents may present additional inherent hazards of chemical exposure and special precautions must be taken when handling these chemicals. An MSDS or other equivalent information must accompany the chemicals on-site.
- 7.6.4 Sampling equipment must be decontaminated to ensure the integrity of the samples and to prevent cross-contamination. It is common to use solvents and acids (e.g. acetone and nitric acid) to decontaminate equipment between samples. These chemicals must also be handled with care.
- 7.6.5 Decontamination should be performed at a designated equipment decontamination area on the site. An excavated sump may be used to collect wash water as needed. Following decontamination, the clean equipment should be stored on plastic sheeting.
- 7.6.6 The undercarriage of all vehicles (e.g. truck, etc.) should be cleaned prior to driving them off the site. At the conclusion of site work, all major equipment should be thoroughly cleaned using the method described above.
- 7.7 Waste derived during decontamination will be managed as described in the Investigation Derived Waste Management Plan.
- 7.8 Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded in the field logbooks as per SOP 1.0, Field Logbook. The information entered in the field logbook concerning decontamination should include the following:
 - 7.8.1 Decontamination personnel;
 - 7.8.2 Decontamination solution used;
 - 7.8.3 Date, start and end times; and

BENICIA SOP #12

IMMUNOASSAY TEST KIT PROCEDURES

1.0 PURPOSE

- 1.1 The purpose of this standard operating procedure (SOP) is to provide general instructions for performing immunoassay screens on soil and groundwater samples using field test kits.

2.0 SCOPE AND APPLICABILITY

- 2.1 This method may be used as a screening tool for environmental soil and aqueous samples. Many types of immunoassay test kits are commercially available for a variety of testing scenarios including PAHs, BTEX, PCBs, and TNT. The instructions provided with the chosen test kit will be adhered to.
- 2.2 The sensitivity for the testing is influenced by the type of target contaminant present in the sample and the selectivity of the immunosorbent antibody for that target contaminant.
- 2.3 Use of this method is restricted to personnel either trained and knowledgeable in the operation of the immunoassay test kit or under the supervision of a trained and knowledgeable individual.

3.0 REFERENCES

- 3.1 *Soil Screening for Polynuclear Aromatic Hydrocarbons by Immunoassay*, EPA Method SW4035, Rev. 0, SW-846, Third Edition (Update III) December 1996.

4.0 DEFINITIONS

- 4.1 Immunoassay. Method of semi-quantitatively identifying specific compound concentrations in soil or groundwater samples by measuring the amount of antibodies that bind to the compound.

5.0 GENERAL

- 5.1 The following is a description of steps necessary to complete an analysis using a typical immunoassay kit.
- 5.2 An accurately weighed soil sample is collected and extracted using a known volume of extraction solution (typically methanol). The sample extract is filtered

and a known volume of the filtrate is diluted to a final volume (specified in kit instructions). The sample extract is now ready for the assay portion of the test.

- 5.3 The assay is performed for all standards, control samples, field samples and duplicates. An aliquot of the standard, control sample, or sample extract is mixed with enzyme conjugate reagent. The resulting solution is then mixed with antibody coupled magnetic particles. The enzyme conjugate competes with the target compound present in the sample for binding to the antibody coupled magnetic particles during a specified incubation period. The antibody coupled magnetic particles with bound target compound and bound enzyme conjugate are then magnetically separated from any unbound enzyme conjugate by decanting off the solution in the presence of a magnetic field.
- 5.4 Color reagent is then added to the antibody coupled magnetic particles with bound target compound and bound enzyme conjugate and the solution is allowed to develop color during a specified incubation period (typically 20 minutes).
- 5.5 Stopping solution is then added to the sample to stop the coloring reaction. The intensity of the color is measured using a spectrophotometer within a specified time period after the stopping solution is added to the sample. The intensity of the color of the solution is inversely proportional to the concentration of target compound in the original sample.
- 5.6 To obtain the actual soil sample concentration in units of ppb, multiply the instrument reading by the dilution factor of 100 (this factor will vary if higher sample dilutions are performed).

6.0 RESPONSIBILITIES

- 6.1 The **Project Chemist** is responsible for the overall sample preparation, sample analysis, data compilation, data verification, and record keeping. The data must meet project QA/QC requirements.
- 6.2 The **Project Geologist** will be responsible for the coordination of all field activities including the collection of samples for field analysis and shipping of samples to a stationary laboratory.

- 6.3 The **Field Technician** will work under the direction of the project chemist and the project geologist. Responsibilities will include assisting in sample collection, sample preparation, sample analysis, and data compilation

7.0 PROCEDURES

- 7.1 The procedures used for analysis using immunoassay field test kits vary by manufacturer. The instruction manual provided with each test kit will be adhered to.
- 7.2 **Equipment and Supplies.** The manufacturer provides the materials, reagents, and instrumentation required for the preparation and analysis of soil samples with the following exceptions:
- 7.2.1 Permanent marking pen;
 - 7.2.2 Protective gloves;
 - 7.2.3 Waste Container;
 - 7.2.4 Scoopula with handle;
 - 7.2.5 Blotting paper for decanting steps (kitchen type paper towels); and
 - 7.2.6 Polystyrene weighing dishes (or equivalent).

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

8.1 QA/QC GENERAL REQUIREMENTS

- 8.1.1 Follow the manufacturer's instructions for the test kit being used;
- 8.1.2 Do not use test kits past their expiration date;
- 8.1.3 Do not use tubes or reagents designed for use with other kits; and
- 8.1.4 Use the test products within their specified storage and operating temperature limits.

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #13

IN SITU GROUNDWATER SAMPLING

1.0 PURPOSE

- 1.1 This standard operating procedure (SOP) describes the procedure for collecting *in situ* groundwater samples.

2.0 SCOPE

- 2.1 This procedure applies to all project team personnel and subcontractors involved in the collection of *in situ* groundwater samples.

3.0 REFERENCES

- 3.1 QED Groundwater Specialist, Current Edition. HydroPunch® Users Guide, Edition No. 010191.

4.0 DEFINITIONS

- 4.1 Groundwater. Water in the saturated zone (confined or unconfined)

5.0 GENERAL

- 5.1 *In situ* groundwater sampling techniques (HydroPunch® or equivalent) will be conducted in order to evaluate the groundwater without the installation of a temporary or permanent well casing.
- 5.2 The device utilized to collect an *in situ* sample will be the HydroPunch II® or equivalent. The HydroPunch® tool is specifically used to collect groundwater samples by exposing a well screen after a well tip has been driven into the formation. Usage procedures provided in the manufacturer's instruction manual will be followed.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager and Rig Geologist** shall ensure that the HydroPunch® or equivalent procedures used are in compliance with the procedures presented in this SOP.

- 6.2 The **Field Supervisor** shall assure that the HydroPunch® (or equivalent) procedures used are in compliance with the sampling plan and this SOP and that the field team members are trained and competent in the procedures to be used.

7.0 PROCEDURES

- 7.1 Several *in situ* groundwater sampling apparatuses are commercially available. The selection of sampling apparatus will be based on individual site conditions. The HydroPunch® apparatus is widely used and is described in this SOP. HydroPunch® *in situ* sampling is designed to provide the capability to obtain a representative formation water sample without a permanent well installation. Two different HydroPunch® tools are available for use; HydroPunch®I and HydroPunch®II.
- 7.2 The HydroPunch®I tool body consists of a stainless steel outer tube, an inner sample chamber, sample chamber Teflon® check valves, and a drive point on the bottom, all of which can be dismantled for cleaning. The HydroPunch® tool may be driven into place using a 140 pound drop hammer on a downhole wireline. The outside diameter of the tool is 1.66 inches and the length is 63.25 inches.
- 7.2.1 At each HydroPunch®I sample location, a solid (dummy) cone is advanced to a few feet above the shallow sampling interval, just below the top of the saturated zone. The tool is then replaced with the HydroPunch®I, and subsequently advanced to the desired sample depth and a sample obtained. The HydroPunch®I is then retracted out of the hole for sample collection (groundwater node sampling) or temporarily left in place for either bailing or peristaltic pumping (hydrocarbon mode sampling). When collecting water samples in silty-clays, it may be necessary to leave the HydroPunch®I in the ground for an extended time (possibly overnight) in order to allow the sampler to fill.
- 7.3 HydroPunch®II operates similar to HydroPunch®I. This device is driven into the formation soil to the desired sampling interval. The body of the tool is then pulled back about 2 feet. Once the O-ring seal on the cone is broken, groundwater flows into the open end of the HydroPunch®II through the intake

screen, past the lower check valve, into the sample chamber, and finally out the upper check valve. When the tool is full, the sample is collected by pulling the tool toward the surface.

7.4 At the sampling interval, an upward pull opens the inlet section of the tool to allow groundwater to flow into the sample chamber. In the groundwater mode sampling, Teflon[®] check valves in the HydroPunch[®] seal the sample chamber when the inlet is closed, which allows the groundwater sample to be brought to ground surface. The sample is then transferred from the sample chamber (approximately 1 liter) to the appropriate sample container.

7.5 Sample containers will be documented and labeled. These procedures for sample collection, preserving samples, sample management, and packing and shipping samples will be done in accordance with the appropriate SOPs.

7.6 Decontamination of the HydroPunch[®] (or equivalent) will be provided on the truck-mounted rig which has a self-contained rod-washing attachment which directs a hot-water jet from a steam cleaner onto the rods.

7.6.1 The waste fluids generated will be pumped directly from the sealed washer into Department of Transportation approved 55-gallon drums. Drums will be stored and disposed of according to procedures described in the Investigation Derived Waste Plan.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

Not applicable

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #14

BOREHOLE ABANDONMENT

1.0 PURPOSE

- 1.1 This standard operating procedure (SOP) provides the steps to be followed for the proper destruction of soil borings. Adherence to this SOP is necessary to eliminate the borehole and well structure as a potential pathway for the preferential migration of poor-quality water, pollutants, and contaminants; and to prevent a possible hazard to humans and animals.

2.0 SCOPE

- 2.1 These procedures apply to all project team personnel and subcontractors filling soil borings during environmental investigations and monitoring programs. This procedure describes the minimum acceptable practices. Specific state and local regulations should be referenced for different or more stringent requirements.

3.0 REFERENCES

- 3.1 Aller, et al. 1989. *Handbook of Suggested Practices for the Design and Installation of Ground-water Monitoring Wells*: National Water Well Association, U.S. Environmental Protection Agency (EPA), EPA 600/4-89/034, pp 255-261.
- 3.2 American Society for Testing and Materials (ASTM). Standard D5299, "*Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities.*"
- 3.3 Driscoll, F.G. 1986. *Groundwater and Wells*, pp. 627-629. Johnson Filtration System, Second Edition.

4.0 DEFINITIONS

- 4.1 Destruction. The complete sealing of a borehole with grout or other impermeable materials to allow restoration of the original hydrogeologic conditions and/or to prevent contamination of the aquifer.
- 4.2 Plugging. The complete filling of a borehole or well with an impermeable material that prevents flow into and through the borehole or well.

- 4.3 **Soil Boring.** A hole drilled or bored into the earth for the collection of soil samples, usually for obtaining geologic and/or environmental information.

5.0 GENERAL

- 5.1 The sealing materials must be chemically compatible with the anticipated contaminants and chemically inert so they do not offset the quality of the soil or groundwater encountered. Manufacturer certifications of cleanliness will be maintained in project files.
- 5.2 A proper soil boring plug requires that these procedures are followed and well documented. Factors that determine the specific procedures include:
- 5.2.1 Diameter of borehole;
 - 5.2.2 Depth of the borehole;
 - 5.2.3 Hydrogeologic setting;
 - 5.2.4 Type and degree of contamination and the zone or zones where contamination occurs; and
 - 5.2.5 State and local regulatory requirements.
- 5.3 Because of the diversity of specific procedures based on the above variables, only the general procedures that must be performed for abandonments are provided in this SOP. Specific state and local regulations should be referenced for different or more stringent requirements.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager** shall ensure that the methods and procedures used for soil boring plugs are in compliance with these procedures and the requirements of the appropriate local, state, and federal enforcement agencies. Alternate abandonment requirements and procedures from local agencies in addition to modifications resulting from unusual conditions must be documented, approved by the affected parties, and at a minimum be "equal to" these procedures in terms of protection obtained. The Project Manager shall (if required by any of the enforcing agencies) notify agencies and schedule inspection of the abandonment operations.

- 6.2 The **Field Supervisor** shall ensure that the abandonment procedures used are in compliance with the sampling plan and this SOP and that the field team members are trained and certified competent in the procedures to be used. The Field Supervisor shall be knowledgeable of the requirements for abandonments and shall maintain adequate documentation of the procedures and materials used to ensure the soil boring abandonment has been properly performed and is defensible.

7.0 PROCEDURES

- 7.1 A soil boring must be plugged upon completion of its intended use (e.g., soil collection, geophysical measurements, and/or lithological determination). The methods used must be pre-approved by the affected parties; all procedures must be well documented to ensure defensibility.
- 7.2 A number of materials may be used for sealing soil borings satisfactorily, including concrete, cement grout, neat cement, bentonite, or combinations of these materials. Each material has certain characteristics and distinctive properties; therefore, one material may be especially suited for doing a particular job.
- 7.3 The selection of the material must be based on the depth of soil boring, the nature of the formations penetrated, the type and concentration of chemicals present, the material and equipment available, and the location of the boring with respect to possible outside sources of contamination.
- 7.4 Combinations of materials are frequently required to increase the effectiveness of the seal and/or the workability of placement. The specifics must be satisfactorily addressed with the regulatory agencies.
- 7.5 Regardless of the type of material or combination of materials used for abandonments, the sealant must be free of contaminants and must minimize potential chemical alteration of the groundwater quality and/or adjacent soils. Any deviations from the material specified must be well documented and pre-approved by the affected parties before its use.
- 7.6 Upon completion of the soil boring to the desired depth, the augers/drill stems should remain in place to the maximum depth achieved unless the borehole will remain open with the augers removed.

- 7.7 Grout is then placed, via a tremie pipe, in one continuous grouting procedure from bottom to top to prevent segregation, dilution, and bridging of the sealant. The end of the tremie pipe must always remain immersed in the slurry of grout throughout the emplacement procedure.
- 7.8 The augers/drill stems are incrementally removed as the surface of the grout rises. A 3-foot segment of grout should be maintained in the lead auger/drill stem to prevent boring wall collapse and mixing with the sealant materials.
- 7.9 The grouting procedure is continued until the ground level is obtained. In areas where surface features (i.e., grass, concrete, or asphalt) are present, the level of grout should be left below the ground level for completion of the destruction to its original condition.
- 7.10 Grout must be placed in one continuous grouting procedure from bottom to top to prevent segregation, dilution, and bridging of the sealant. The end of the tremie pipe must always remain immersed in the slurry of grout throughout the emplacement procedure.
- 7.11 Upon proper curing of the grout, a concrete cap or other material to match existing grade must be placed on top of the grout to prevent potential surface water infiltration.
- 7.12 For destructions leaving the casing in place, the grout pipe should be placed inside the well casing and a packer installed above the perforations. The cement grout should be applied through the perforations by a pressure grouting method at a predetermined pressure and for a minimum duration. This should be determined by calculations of the perforation area or conservative estimates of annular pore space volume.
- 7.13 If the well does not have an existing annular seal, then after the grout has set, the well casing should be perforated at a higher point and the pressure grouting operation repeated until grout returns to the ground surface through the annular space between the drilled hole and the well casing.
- 7.14 If the well has a cement seal, the grouting procedure should continue until the grout volume approximately equals the calculated pore space.

7.15 To ensure that the well was properly destroyed, documentation of the calculated volume of the well bore and the volume of the grout used must be maintained. Any discrepancies must be documented, explained, and reported to the Field Supervisor.

8.0 RECORD KEEPING REQUIREMENTS AND REFERENCE TO FORMS

Not applicable

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #15
WELL DEVELOPMENT

1.0 PURPOSE

- 1.1 This standard operating procedure (SOP) describes procedures to develop microwells, monitoring, extraction, and injection wells.

2.0 SCOPE

- 2.1 This SOP applies to all project team personnel and subcontractors developing wells for environmental investigations and monitoring programs.

3.0 REFERENCES

- 3.1 American Society for Testing and Materials (ASTM), 1994. ASTM Standards on Groundwater and Vadose Zone Investigations, Standard 509-290: Standard Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers, pp 288-289.

4.0 DEFINITIONS

- 4.1 Overpumping. The simplest method of removing fines by pumping at a higher rate than the well will be pumped when put into service. This technique, by itself, does not provide for flow reversals.
- 4.2 Backwashing or Rawhiding. A surging action consisting of alternately lifting a column of water a significant distance above the pumping water level and letting the water fall back into the well.
- 4.3 Mechanical Surging. Forcing water into and out of a screen by operating a plunger up and down in the casing. The tool normally is called a surge block, surge plunger, or swab. A heavy bailer may also be used to produce the surging action.

5.0 GENERAL

- 5.1 Well development serves to remove the finer grained material from the well screen and filter pack that may otherwise interfere with water flow and water quality analyses. Development restores the groundwater properties disturbed during the drilling process and improves the hydraulic characteristics of the filter

pack and hydraulic communication between the well and the hydrologic unit adjacent to the well screen. Methods of well development vary with the physical characteristics of hydrologic units in which the monitoring well is screened and with the drilling method used.

- 5.2 Well development generally should not occur less than 24 hours following surface completion. Any well(s) completed using mud rotary drilling will be developed within 72 hours. In addition, development is to be completed at least 72 hours before baseline or routine quarterly well sampling.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager** assures that well development procedures are in compliance with the procedures presented in this SOP.
- 6.2 The **Rig Geologist/Field Technician** is Responsible for completing the appropriate forms and documentation of the well development. All field measurements and comments are recorded in the field logbook and on the attached Well Development/Purging form. If some steps or procedures are not performed as described in this SOP, the reason must be stated on the appropriate form or submitted as an attachment thereto.
- 6.3 **Quality Assurance** assures that the well development procedure is being implemented through periodic field audits.

7.0 PROCEDURES

- 7.1 Following installation and construction of a microwell, monitoring well, extraction well, or injection well, the following procedures should be followed to ensure proper development of the well.
- 7.2 **DECONTAMINATION.** Before development, all water level measurement probes, meters, bailers, pumps, and other development devices shall be decontaminated. Each piece of development equipment shall be decontaminated prior to and between development operations and wells. The procedures specified in the SOP 11.0 for Sampling Equipment Decontamination shall be followed.

- 7.3 **WATER LEVEL MEASUREMENT.** Measure static water level and well depth following procedures outlined in Field Measurement of Water Levels, SOP 27.0. Calculate the volume of water in the well casing.
- 7.4 **METERS.** Electronic equipment used during development includes a water level measurement probe, a pH meter, a temperature meter, and a conductivity meter. Before going into the field, it shall be verified that these instruments are operating properly. The pH, and conductivity meters must be calibrated prior to use everyday. Field measurements for pH, temperature, and conductivity shall be made in accordance with the appropriate SOPs and in accordance with the manufacturer's instruction.
- 7.5 Ensure that field parameter monitoring equipment, sampling port, sample coolers (when needed), are protected from direct sunlight exposure, other sources of heat, or high temperatures. An umbrella and/or tarp temporarily secured to the sampling vehicle/equipment can be used to eliminate direct sunlight exposure.
- 7.6 **DEVELOPMENT – MICROWELLS/MONITORING WELLS.** For development of microwells/monitoring wells the following procedures shall be performed at each well.
- 7.6.1 Bail groundwater using a sand bailer or similar device to remove the majority of sediment from the bottom of the well;
- 7.6.2 Surge the screened section of the well in 5-foot increments with a surge block;
- 7.6.3 Bail approximately one to three casing volumes of water to remove the dislodged sediments following surging;
- 7.6.4 Pump the well until representative water, free of the drilling fluids, cuttings, or other materials introduced during well construction is obtained. All water introduced to the well during the installation to control heaving sands will be removed. As such, this volume of water introduced is not to be used to determine the number of casing volumes actually removed for development purposes;
- 7.6.5 Well development will be considered complete when the following parameters have stabilized in three consecutive readings and relatively

sediment free water is being produced from the well. Field parameters should be measured at five to fifteen minute intervals until well development has achieved the minimum requirements outlined above.

- pH levels ± 0.1 pH units
- Specific conductance $\pm 5\%$
- Temperature $\pm 0.5^\circ\text{C}$

7.6.6 Should the well bail/pump dry prior to removal of the required water volume, the well will be allowed to recover, and bailing/pumping will resume. The process will be repeated until relatively sediment free water is produced.

7.6.7 Water removed from the development will be handled in accordance with the Investigative Derived Waste Plan.

7.7 WELL DEVELOPMENT - EXTRACTION/INJECTION WELLS. For well development of extraction/injection wells the following procedures shall be performed at each well.

7.7.1 Following initial sand bailing, the well will be swabbed with a surge block starting just below the static water level until free movement of water through the screen is initiated. All water added during the drilling and installation of the well will be removed.

7.7.2 More aggressive surging will continue as the surge block is gradually lowered in through the screened interval(s). The amount of material (i.e., sediment) will be measured and recorded in the Field Logbook periodically (for example every half hour), and removed using a sand bailer.

7.7.3 Upon completion of the swabbing and bailing, a temporary submersible pump should be installed and operated at above the design discharge rate for a specified period of time.

7.7.4 Extraction wells are considered developed when:

- Relatively sediment free water is produced; and

- All of the water added during the installation and a minimum of three to five well pore volumes (well casing plus gravel pack pore space) have been removed.

7.8 All equipment and procedures used during well development shall be documented in field logbooks as detailed in SOP 1.0 Field Logbook and a Well Development/Purging Log.

8.0 RECORDKEEPING REQUIREMENTS AND REFERENCE FOR FORMS

8.1 The Well Development/Purging Forms should be placed in the project file upon project completion.

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #16

SURFACE WATER SAMPLING

1.0 PURPOSE

- 1.1 This standard operating procedure (SOP) provides descriptions of surface water sampling methods and procedures.

2.0 SCOPE

- 2.1 This SOP applies to all project personnel and subcontractors involved with surface water sampling methods and procedures.

3.0 REFERENCES

- 3.1 Brown and Caldwell, Hazardous Materials Field Procedures Manual, September, 1991.

4.0 DEFINITIONS

Not applicable

5.0 GENERAL

- 5.1 The choice of sample locations in surface waters is an important consideration which must be addressed prior to sample acquisition, since it will often affect the selection of sampling equipment. Selection of representative locations will depend on many factors including stream dimensions, shape, flow rate (velocity), inputs and discharges.
- 5.2 The selection of sample locations will be detailed in the Field Site Investigation Plan (FSIP), however samplers should anticipate accommodating infield adjustment. Most often depth integrated and/or cross-sectional composite samples are preferable to single-point grabs. In practice safe access and handling as well as other physical limitations will be influential factors during sample acquisition at hazardous waste contaminated sites.
- 5.3 Whether sampling from the shore or a vessel, health and safety considerations must be addressed. A person collecting samples from a sharply sloping or slick shore may need to be fitted with a safety harness secured to a immobile object on shore. Back-up personnel should be available to assist and pull the

investigation team member to safety if necessary. If a sample is to be collected from a vessel, each person must be equipped with a life preserver and/or life line.

- 5.4 In certain cases, the sampled material may pose a safety hazard, and care must be taken in collecting and containing it. This is particularly true when a surface oil is floating on the water.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager** is responsible for ensuring that the selected sampling location and method(s) will meet the objectives of the FSIP.
- 6.2 The **Field Supervisor** must coordinate with the Project Manager and the Field Geologist to ensure that the most applicable sampling location and method is being employed.
- 6.3 The **Field Geologist** is responsible for ensuring that the surface water is sampled in the appropriate methods as coordinated with the Project Geologist and the Project Manager.

7.0 PROCEDURE

- 7.1 Surface water samples will be obtained as follows:
- 7.1.1 The number of samples to be taken will be decided before the sampling trip. The number and amounts of samples needed by the laboratory must be known in advance, or extra samples must be taken;
- 7.1.2 Grab samples will be taken from the part of the stream with the highest flow velocity;
- 7.1.3 Whenever possible, samples will be obtained directly into laboratory-provided containers (Teflon®, glass, or stainless steel);
- 7.1.4 After the bottles are sealed, the outsides of the bottles will be rinsed with deionized water and dried;
- 7.1.5 Water samples will be described in detail, including color and texture of a suspected sediment;
- 7.1.6 Samples will be labeled with site name, sampling time, and date. Sample jars will be handled using chain of custody (COC) procedures and kept cool during transport and storage before analysis;

- 7.1.7 Whenever possible, field observations (pH, temperature, conductivity, etc.) will be made at the source rather than from containers; and
- 7.1.8 Samples will be collected first from those areas that are suspected of being the least contaminated. Areas of highest contamination will be saved for last. This minimizes the risk of cross contamination.
- 7.2 Samples from shallow depths near the shore surface can be readily collected by merely submerging the sample container. The method is advantageous when the sample might be significantly altered during transfer from a collection vessel into another container. This is the case with samples collected for oil and grease analysis since considerable material may adhere to the sample transfer container, and produce inaccurately low analytical results. Similarly the transfer of a liquid into a small sample container for volatile organic analysis could result in significant aeration and resultant loss of volatile species. Though simple, representative and generally free from substantial material disturbances, it has significant shortcomings when applied to hazardous waste, since the external surface of each container would then need to be decontaminated.
- 7.2.1 Submerging the sample container to collect a surface water sample cannot be done if preservatives are added to the container prior to sample collection.
- 7.2.2 In general the use of a sampling device, either disposable or constructed of a nonreactive material such as glass, stainless steel, or Teflon[®], is the most prudent method. The device should have a capacity of at least 500 ml, if possible, to minimize the number of times the liquid must be disturbed, thus reducing agitation of any sediment layers.
- 7.2.3 A 1-liter stainless steel or glass beaker (with pour spout and handle) works well. It is easily cleaned and considerably less expensive than Teflon[®]. Though still more expensive than other plastics it is more durable and generally more inert under field conditions. Also useful are large stainless steel ice scoops and ladles available from commercial kitchen and laboratory supply houses.
- 7.3 It is often necessary to collect liquid samples at some distance from shore or the edge of the containment. In this instance an adaptation which extends the reach

of the technician is advantageous. Such a device is the pond sampler. It incorporates a telescoping heavy-duty aluminum pole with an adjustable beaker clamp attached to the end (see use of pond sampler for the collection of surface water samples, this section). The beaker previously described, a disposable glass or plastic container, or the actual sample container itself, can be fitted into the clamp.

7.3.1 In situations where cross contamination is of concern, use of a disposable container or the actual container is always advantageous. The cost of properly cleaning usually outweighs the cost of disposal of otherwise reusable glassware or bottles. This is especially true when the cleanup must be done in the field and the decontaminate rinsate must be contained and disposed. The potential contamination of samples for volatile organic analysis by the mere presence of organic solvents necessary for proper field cleaning is usually too great to risk.

7.3.2 Another method of extending the reach of sampling efforts is the use of a small peristaltic pump (see peristaltic pump for sampling surface water bodies, this Section). In this method the sample is drawn in through Teflon[®] tubing and pumped directly into the sample container. This system allows the operator to reach out into the liquid body, sample from depth; or sweep the width of narrow streams.

7.4 It may on occasion be necessary to sample large bodies of water where a near surface sample will not sufficiently characterize the body as a whole. In this instance again the above mentioned pump is quite serviceable. It is capable of lifting water from depths in excess of 6 meters. Since the lift capacity is actually measured as the distance above the hydrostatic surface, it is possible to withdraw samples from depths significantly below the water surface. It should be noted that this lift ability decreases somewhat with higher density fluids and with increased wear on the pump tubing. Similarly increases in altitude will decrease the pumps ability to lift from depth.

7.4.1 When sampling a liquid stream which exhibits a considerable flow rate, it may be necessary to weight the bottom of the suction line. The stainless steel strainer suction weight supplied with the ISCO samplers (or equivalent) usually works well. A heavier weight can be constructed by

filling a short (7.5 cm to 10 cm) length of Teflon® tubing with lead and plugging both ends with tight-fitting Teflon® plugs. This weight can then be clamped with stainless steel band clamps to the suction tubing.

7.4.2 Situations may still arise where a sample must be collected from depths beyond the capabilities of a peristaltic pump. In this instance an at depth sampler may be required, such as a Kemmerer, ASTM Bomb (Bacon Bomb), Van Dorn sampler, or equivalent. These devices work well; however, care must be utilized in selecting devices that are made of materials that will not contaminate the sample.

- Van Dorn samplers are not generally recommended for organics as they are clamped with stainless steel band clamps to the suction tubing.
- Kemmerer samplers are available on special order or adaptable for sample collection for organic analysis by substituting Teflon® for the rubber or plastic stoppers. If the device is further ordered with stainless steel metallic parts in addition to Teflon® stoppers it becomes a very versatile sampler.
- The submersible pumps discussed in conjunction with groundwater sampling (Section 17.0) may also be useful in this application.

7.5 A dipper or other container constructed of inert material, such as stainless steel or Teflon®, can be used to transfer liquid wastes from their source to a sample bottle. This prevents unnecessary contamination of the outer surface of the sample bottle that would otherwise result from direct immersion in the liquid. Use of this device also prevents the technician from having to physically contact the waste stream. Depending upon the sampling application, the transfer vessel can be either disposed of or reused. If reused, the vessel should be thoroughly rinsed and/or decontaminated prior to sampling a different source. It should also be noted that preservatives must be added following sample collection if the sample is collected by submerging the container.

A transfer device can be utilized in most sampling situations except where aeration must be eliminated (samples for volatile organic analysis) or where

significant material may be lost due to adhesion to the transfer container. Procedures for use include the following:

- 7.5.1 Submerge a precleaned stainless steel dipper or other suitable device with minimal surface disturbance. Allow the device to fill slowly and continuously. Retrieve the dipper/device from the surface water with minimal disturbance;
 - 7.5.2 Remove the cap from the sample bottle and slightly tilt the mouth of the bottle below the dipper/device edge. Empty the dipper/device slowly, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence. Continue delivery of the sample until the bottle is almost completely filled. Leave adequate space to allow for expansion;
 - 7.5.3 Select appropriate bottles and preserve the sample if necessary as per guidelines in SOP 10.0, Preserving Environmental Samples in the Field;
 - 7.5.4 Check that a Teflon[®] liner is present in the cap if required. Secure the cap tightly; and
 - 7.5.5 Label the sample bottle with an appropriate sample tag. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Record the information in the field logbook and complete the COC form.
- 7.6 The pond sampler consists of an adjustable clamp attached to the end of a two or three piece telescoping aluminum tube that serves as the handle. The clamp is used to secure a sampling beaker. The sampler is not commercially available, but it is easily and inexpensively fabricated. The tubes can be readily purchased from most hardware or swimming pool supply stores. The adjustable clamp and sampling beaker can be obtained from most laboratory supply houses.

The pond sampler is used to collect liquid waste samples from disposal ponds, pits, lagoons, and similar reservoirs. Grab samples can be obtained at distances as far as 3.5 m from the edge of the ponds. The tubular aluminum handle may bow when sampling very viscous liquids if sampling is not done slowly. Procedures for use include the following:

- 7.6.1 Assemble the pond sampler. Make sure that the sampling beaker and the bolts and nuts that secure the clamp to the pole are tightened properly;
 - 7.6.2 With proper protective garment and gear, take grab samples by slowly submerging the precleaned beaker with minimal surface disturbance. Retrieve the pond sampler from the surface water with minimal disturbance;
 - 7.6.3. Remove the cap from the sample bottle and slightly tilt the mouth of the bottle below the dipper/device edge, and empty the sampler slowly, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence. Continue delivery of the sample until the bottle is almost completely filled;
 - 7.6.4 Select appropriate sample bottles and preserve the sample if necessary as per guidelines in SOP 10.0;
 - 7.6.5 Check that a Teflon[®] liner is present in the cap if required. Secure the cap tightly;
 - 7.6.6 Label the sample bottle with an appropriate sample tag. Be sure to label the tag carefully and clearly, addressing all the categories and parameters. Record the information in the field logbook and complete the COC documents; and
 - 7.6.7 Properly clean and decontaminate the equipment prior to reuse or storage using recommended guidelines of SOP 11.0.
- 7.7 This collection system consists of a peristaltic pump capable of achieving a pump rate of 1- to 3-gpm, and an assortment of Teflon[®] tubing for extending the suction intake. A battery operated pump is preferable as it eliminates the need for DC generators or AC inverters.

The system is highly versatile. It is portable and the sample collection is conducted through essentially chemically nonreactive material. It is practical for a wide range of applications including streams, ponds, and containers. This procedure can both extend the lateral reach of the sampler and allow sampling from depth. Likewise, it can function both as a well purge and a sample

collection system. The chief disadvantage of this method is the limited lift capacity of the pump, approximately 8 meters. Procedures for use include the following:

- 7.7.1 Install clean, medical-grade silicone tubing in the pump head, as per the manufacturer's instruction. Allow sufficient tubing on discharge side to facilitate convenient dispensation of liquid into sample bottles and only enough on the suction end for attachment to the intake line. This practice will minimize sample contact with the silicone pump tubing;
- 7.7.2 Select the length of suction intake tubing necessary to reach the required sample depth and attach to intake side of pump tubing. Heavy-wall Teflon, of a diameter equal to the required pump tubing, suits most applications. (Heavier wall will allow for a slightly greater lateral reach.);
- 7.7.3 If possible, allow several liters of sample to pass through system before actual sample collection. Collect this purge volume and then return to source after the sample aliquot has been withdrawn;
- 7.7.4 Fill necessary sample bottles by allowing pump discharge to flow gently down the side of bottle with minimal entry turbulence. Cap each bottle as filled;
- 7.7.5 Select appropriate bottles and preserve the sample if necessary as per guidelines in SOP 10.0;
- 7.7.6 Check that a Teflon[®] liner is present in the cap if required. Secure the cap tightly;
- 7.7.7 Label the sample bottle with an appropriate tag. Be sure to complete the tag with all necessary information. Record the information in the field logbook and complete the COC documents; and
- 7.7.8 Allow system to drain, then disassemble. Return tubing to lab for decontamination (if feasible). See SOP 11.0 for general decontamination procedures.

8.0 RECORD KEEPING REQUIREMENTS

- 8.1 Notes about sampling method, equipment, location, and field measurements will be written in a field logbook.

9.0 ATTACHMENTS

Not applicable

BENICIA SOP #17

GROUNDWATER PURGING AND SAMPLING

1.0 PURPOSE

- 1.1 This standard operating procedure (SOP) provides the detailed procedures for collecting groundwater samples in the field. Observations made during sample collection shall be recorded in the field logbook as specified in this SOP.

2.0 SCOPE

- 2.1 This procedure applies to all Project team personnel and subcontractors who purge groundwater monitoring wells and collect groundwater samples.

3.0 REFERENCES

- 3.1 U.S. Environmental Protection Agency (USEPA). 1990. Procedures to Schedule and Complete Sampling Activities in Cooperation with EPA Region VII Environmental Services Division. February.
- 3.2 USEPA Region VII. 1991. Environmental Services Division Operations and Quality Assurance Manual. February.

4.0 DEFINITIONS

- 4.1 Groundwater. Water in a saturated zone or stratum beneath the surface of land or beneath the bottom of surface water.
- 4.2 Purging. The operation by which stagnant groundwater in a monitoring well is removed to allow replacement by, formation groundwater.
- 4.3 Custody. The physical control of an object, in this case of an environmental sample.
- 4.4 Chain of custody (COC). Refers to the individuals who, sequentially over a period of time, have physical custody of the sample.
- 4.5 COC Record. The documentation of the COC showing times, dates, and names of the individuals relinquishing and receiving the samples identified on the record.

5.0 GENERAL

Generally, groundwater samples will only be collected from *in situ* points and monitoring wells. However, groundwater samples may also be collected from individual, industrial, or municipal production wells. See SOP 16.0 for surface water sampling procedures.

Organic vapor concentrations may be measured by the OVM and recorded in the field log book during purging and sampling activities.

5.1 PURGING EQUIPMENT. Supplies that may be required during well purging include:

- 5.1.1 Written description of wells including identification (ID) numbers, locations, elevations and well construction details;
- 5.1.2 Well keys;
- 5.1.3 Electronic water level indicator with sufficient length to reach bottom of deepest well to be sampled. Meter should be capable of measurement to nearest 0.01 inch and have both an audio and visual signal. A Solinst® brand meter or equivalent is acceptable;
- 5.1.4 Assorted tools (knife, screwdriver, tools for opening well boxes);
- 5.1.5 PVC, Teflon®, stainless steel, or disposable bailer (bottom-filling) with single-check valve;
- 5.1.6 Polypropylene rope, stainless steel cable or new 20-lb test mono-filament fishing line;
- 5.1.7 Variable-rate submersible pump with control unit, electrical generator, extension cord, and fuel, if the water level is greater than 25 feet and when the diameter of the well casing allows. Grundfos Redi-Flo2® or equivalent is acceptable. Flexible reinforced tubing for submersible pump;
- 5.1.8 Centrifugal pump with a foot valve to avoid aerated water from the pump falling back into well. Centrifugal pumps can only be used when the water level is within 25 feet of the ground surface. Disposable flexible tubing will be discarded between each purged well to avoid cross contamination;

- 5.1.9 Thermometer capable of displaying results to nearest 0.1° centigrade;
 - 5.1.10 pH meter capable of displaying results to nearest 0.01 pH unit;
 - 5.1.11 Conductivity meter capable of displaying results to nearest 1.0 μ mhos/cm;
 - 5.1.12 Squeeze bottle filled with deionized water;
 - 5.1.13 Polyethylene or glass container (nominal 8-oz) for samples for field parameter measurements;
 - 5.1.14 Paper towels or Kimwipes;
 - 5.1.15 Calculator;
 - 5.1.16 Field logbook;
 - 5.1.17 Pen and waterproof permanent marker;
 - 5.1.18 Appropriate forms for field record;
 - 5.1.19 55-Gallon drum or other type of holding tank for storing purged water;
 - 5.1.20 Appropriate decontamination equipment (refer to SOP 11.0, Sampling Equipment Decontamination); and
 - 5.1.21 Appropriate health and safety equipment (refer to project specific Health and Safety Plan).
- 5.2 The following equipment will be used during well sampling efforts. Several of the equipment items listed below are used for groundwater purging efforts. Special details regarding this equipment are presented in Section 5.1.
- 5.2.1 Electronic water level indicator;
 - 5.2.2 PVC, Teflon[®], stainless steel, or disposable bailers (bottom filling) with single check valve;
 - 5.2.3 Polypropylene rope, stainless steel wire or 20-lb test monofilament fishing line, or industrial type twine;
 - 5.2.4 Thermometer, pH meter, and conductivity meter with automatic temperature compensation;
 - 5.2.5 Squeeze bottle filled with deionized water;

- 5.2.6 Cooler with ice;
- 5.2.7 Chain of custody forms and sample labels, and sample bottles with appropriate preservatives;
- 5.2.8 0.45-Micron (or laboratory specified) filters and peristaltic pump (for dissolved metals sampling);
- 5.2.9 Flexible tubing;
- 5.2.10 Paper towels or Kimwipes;
- 5.2.11 Appropriate forms for field record, field logbook, and pen and waterproof permanent marker;
- 5.2.12 Appropriate decontamination equipment; and
- 5.2.13 Appropriate health and safety equipment.

6.0 RESPONSIBILITIES

- 6.1 The **Project Manager** shall assure that the sampling procedures used to obtain samples will represent the environment being investigated. Trace levels of contaminants from external sources will be eliminated through the use of good sampling techniques and proper selection of sampling equipment.
- 6.2 The **Field Supervisor** shall ensure that specified sampling procedures are followed; samples are labeled, handled, and controlled correctly; and strict chain-of-custody is initiated, maintained, and documented.
- 6.3 Personnel responsible for collecting groundwater samples will do so in accordance with this SOP.

7.0 PROCEDURES

All information and procedures will be documented in the field log book or on the water sampling log.

- 7.1 The procedures specified in SOP 11.0, Sampling Equipment Decontamination shall be followed for decontamination of field purging and sampling equipment and for personnel decontamination. Decontaminate all water level measurement probes, bailers, and other sampling devices prior to each sampling event. If new, dedicated equipment is used, thoroughly decontaminate and rinse it with

distilled water before placement in the well. Mobile decontamination supplies shall be provided so that equipment can be decontaminated in the field. Check all measuring devices for proper operation. Calibrate any instruments as necessary. Decontaminated solutions shall be placed in the container with purged well water for disposal.

7.2 Field measurements for pH, temperature, and specific conductance shall be made in accordance with SOPs and the manufacturer's instructions. Electronic equipment used during purging and sampling, and equipment-specific procedures, include:

7.2.1 temperature (SOP 23.0, Field Measurement of Temperature)

7.2.2 pH meter (SOP 22.0, Field Measurement of pH)

Calibration: Prior to use every day
Recalibrated if turned off

Procedure: Done in the shade
Record ambient temperature.

7.2.3 conductivity meter (SOP 24.0, Field Measurement of Specific Conductance)

Calibration: Prior to use every day
Recalibrated if turned off

7.2.4 water level measurement probe (SOP 25.0, Field Measurement of Water Levels)

7.2.5 Due to the required sensitivity of pH measurements, measurement and calibration data related to these parameters shall be recorded on the corresponding forms attached to this SOP. Calibration times and all new data shall be recorded in the logbook.

7.3 The purpose of well purging is to remove stagnant water from the well and obtain representative water from the geologic formation being sampled, while minimizing disturbance to the collected samples. Before a sample is taken, the well shall be purged until a minimum of three well purge borehole volumes have been removed and field parameters (pH, temperature, and electrical conductance) have stabilized or until the well is pumped or bailed dry. The well

will be allowed to recover prior to sampling, all wells should be sampled within 24 hours of purging. Evacuated well water shall be managed as outlined in the site-specific FSIP and the water may be contained for proper disposal. Necessary precautions shall be taken to prevent spilling of water under this circumstance.

For well purging, the following procedures should be performed at each well:

- 7.3.1 Note the condition of the outer well casing, concrete well pad, protective posts (if present), and any unusual conditions of the area around the well in the field logbook. The well may also be photographed;
- 7.3.2 Take appropriate readings in the breathing zone with air monitoring equipment (PID) according to the health and safety plan. If air monitoring readings are elevated (above background) at the wellhead initially, breathing zone readings should be taken throughout purging and sampling activities;
- 7.3.3 Note the condition of the inner well cap and casing;
- 7.3.4 Identify the measuring point (e.g., notch on north side, top of PVC well casing);
- 7.3.5 Measure and record the depth of the static water level with a water level indicator (to nearest 0.01 foot) from the measuring point on the well casing and record the time. The measurement should be made at a minimum of two times, until two consecutive readings are within 0.01 foot of each other;
- 7.3.6 Measure and record the total depth of well from the same measuring point on the casing with a water level indicator;
- 7.3.7 Calculate the volume of water in the well casing in gallons based on feet of water and casing diameter.

Calculate the casing unit volume using the following equation:

$$\begin{aligned}\text{Casing Unit Volume} &= \frac{\pi \Phi_{fr.}^2 (\Delta h_{fr.}) (7.48 \text{ gallons / ft.}^3)}{4} \\ &= 0.041 (\Phi_{in.})^2 (\Delta h_{fr.})\end{aligned}$$

where $\Phi_{in.}$ = well casing diameter in inches

$\Delta h_{fr.}$ = (well depth in feet) - (depth to water in feet)

0.041 = conversion factor;

- 7.3.8 Obtain an initial sample from the purge pump for field measurements of temperature, conductivity, and pH, and for observation of water quality;
- 7.3.9 Evacuate three to five volumes of water in the casing or until dry with a bailer or pump and retain for disposal;
- 7.3.10 Take temperature, conductivity, and pH measurements after evacuation of each one-half of a well casing, at a minimum, to determine whether the water chemistry has stabilized. The following values between consecutive readings indicate adequate stability of the water chemistry:
- pH within ± 0.1 pH unit
 - temperature within $\pm 0.5^\circ\text{C}$
 - conductivity within ± 5 micromhos per centimeter ($\mu\text{mhos/cm}$);
- 7.3.11 If the chemistry is not stable, continue purging, measuring temperature, pH, and conductivity after each one-half well volume, until such stability has been recorded; and
- 7.3.12 If the well goes dry during purging, then samples can be collected as soon as volume has recharged back into the well, for water collection.
- 7.4 Collect samples for chemical analysis within 24 hours after purging is complete. For slow recovering wells, collect the sample immediately after a sufficient volume is available. Use the following sampling procedure at each well:
- 7.4.1 Assemble decontaminated sampling equipment;
- 7.4.2 Fill out identification labels for sample bottles for each well;

7.4.3 If bailers are used:

- Use new or decontaminated line attached to the bailer for each well;
- If not using a disposable bailer, decontaminate the bailer following purging and prior to sampling, whether or not the bailer is dedicated, to remove any contamination from the bailer that may be associated with purging stagnant water from the well;
- Lower the bailer slowly and gently into contact with the water in the well;
- Lower the bailer to the same depth in the well each time, within the screened interval; and
- Retrieve the bailer smoothly, and slowly drain the water into the sample containers through the bailer's bottom discharge control device.

7.4.4 The individual sample bottles should be filled in the order given below:

- Volatile organic compounds (VOCs);
- Semivolatile organic compounds (SVOCs);
- Metals;
- General minerals;
- Other parameters; and
- Field test parameters (pH, specific conductance, and temperature).

7.4.5 VOC sample vials should be completely filled so the water forms a convex meniscus at the top, then capped so that no air space exists in the vial. Turn the vial over and firmly tap it to check for the presence of bubbles in the vial. If air bubbles are observed in the sample vial, remove lid and add additional water. Replace lid and check for bubbles again. Repeat until no bubbles remain in the sample vial.

- Fill containers for SVOCs, metals, general minerals, and other parameters analyses to almost full. Preserve and manage samples as detailed in the site-specific FSIP;

- Samples for metals and general minerals (cations, anions, alkalinity, TDS) will be filtered in the field using a peristaltic pump and a new 45-micron (or laboratory specified) disposable filter. Filtering in the field will be conducted by initially collecting water into clean, laboratory supplied, unpreserved bottles for appropriate parameters. New, disposable tubing and a new in-line disposable filter will be attached to the peristaltic pump. Sample water will then be drawn from the clean containers into the tubing and filter via the pump allowing 20-40 ml of water to pass uncaptured to rinse tubing and filter. Upon rinsing the tubing and filter, filtered water will be recaptured into the appropriate clean, laboratory supplied, preserved (if appropriate) bottles. The filtered sample will then be managed as detailed in the site-specific FSIP.
- Record time of sampling;
- Replace and lock the well cap; and
- Complete field documentation including the chain of custody (COC).

7.5 The first step in sampling a production water well, either municipal or private, is to obtain as much information about the well as possible. This includes depth of the well, formation in which the well is completed, screen depth and length, diameter of casing, and when and who installed the well. Verify as much of this material as possible by reviewing drilling logs, if available. Using this information, determine the amount of water to be evacuated from the well. An inspection of the system should be performed to locate the well, pump, storage tanks, and any treatment systems that might be present. The sample access point should be close to the well head and before the storage tank and treatment system. Note in the field log where the sample was collected and any systems between the well head and sample location.

7.5.1 Most production wells contain semi-permanently mounted pumps that limit the options available for groundwater sampling. Existing in-place pumps may be line shaft turbines, commonly used for high-capacity wells; submersible pumps commonly used in domestic wells for high-head, low capacity applications and, more recently, for municipal and

industrial uses; and jet pumps commonly used for shallow, low-capacity domestic water supplies.

- 7.6 The well sampling order depends on expected levels of contamination in each well, if known, and is determined prior to sampling. Generally, wells should be sampled in an order such that the least contaminated wells are sampled first and the most contaminated wells are sampled last. Quality Assurance/Quality Control (QA/QC) samples are collected during groundwater sampling according to the site-specific FSIP.

QA/QC samples may be labeled with QA/QC identification numbers (or fictitious identification numbers if blind submittal is desired), and sent to the laboratory with the other samples for analyses.

7.6.1 A field blank is used to assess possible contamination resulting from deionized water, sample containers, or laboratory procedures. A sample bottle is taken empty to the field and filled at a contaminant free area with deionized water. A field blank is collected from each batch of deionized water that is used for field procedures. The blank sample is assigned an identification number, stored in an iced cooler, and shipped to the laboratory with the other samples. To minimize potential bias by the receiving laboratory, blank samples are submitted blind.

7.6.2 Trip blanks are prepared by the laboratory and used to assess potential volatile organic contamination occurring during sample custody in the field and shipment to the receiving laboratory. One trip blank set is generally included in each cooler containing groundwater samples designated for volatile organic analyses (VOA). The set usually consists of two or more 40-milliliter (ml) VOA vials, from the same bottle lot as those containers used for site samples, filled with deionized water.

Check the vials for air bubbles by inverting each vial and firmly tapping the side of the vial while inspecting for bubbles. If bubbles are present, return the vials to the laboratory. The trip blanks are only opened by laboratory personnel.

7.6.3 An equipment rinsate sample is intended to check if decontamination procedures have been effective and to assess potential contamination

resulting from containers, preservatives, sample handling, and laboratory analysis. For the well sampling operation:

- Collect a rinsate sample from the decontaminated sampling equipment (bailer or pump) or filter equipment before it is used to obtain the sample;
- Rinse the decontaminated sampling apparatus with deionized water and allow the water to flow into the sample bottles;
- Collect rinsate sample for the same parameters that are being analyzed in the groundwater samples;
- Complete COC forms and attach completed sample labels to each bottle. Place samples in an iced cooler, and ship it to the laboratory with the other samples; and
- Rinsate samples shall be preserved in the same manner as field samples.

7.6.4 QA duplicate samples are used to assess laboratory accuracy in constituent identification and quantification. QA duplicate samples consist of representative sample volumes from one groundwater sampling location. To maximize the information available in assessing total precision, duplicate samples should be collected from locations of varying contaminant concentrations. Field measurements, visual observations, and past sampling results and information on site operations may be used to select appropriate locations for duplicate analyses. Equal volumes are submitted to two or more laboratories for analysis using identical methods for preservation, packaging, and submission. The party receiving the QA duplicate sample completes a "Receipt for Samples Form" and provides a copy to the project team. The results are compared as a check on laboratory accuracy. Because two samples are analyzed, environmental variability and precision (from one location to another) is assessed.

7.6.5 Field duplicate samples are collected to assess the total precision of field and laboratory components of the field investigation. Field duplicate

samples are similar to QA duplicate samples except that the samples are stored in the same cooler and shipped to the same laboratory. Whenever possible, the sample identification numbers for the characteristic sample and its duplicate shall be independent such that the receiving laboratory is not able to distinguish which samples are duplicates prior to analysis. This minimizes the potential for laboratory bias.

- 7.6.6 An extra volume of sample media may be collected during the sampling event for performance of matrix spike (MS)/matrix spike duplicate (MSD) analyses by the laboratory to assess laboratory accuracy, precision, and matrix interference. The samples are collected in the same manner as duplicate samples and are labeled extra volume samples for MS/MSD. The sample volumes required for these analyses are coordinated with the laboratory and described in the FSIP. Following shipment of the samples to the laboratory, the laboratory prepares MS and MSD samples and calculates the percent recovery and relative percent difference in concentrations between the samples.
- 7.6.7 Performance Evaluation (PE), or pre-spiked audit samples, may be used to assess laboratory extraction efficiency and accuracy in constituent identification and quantification. These samples are helpful in assessing potential bias of analytical methods. They are also commonly used to evaluate the accuracy of the laboratory procedures. These samples are generally prepared by an independent laboratory and shipped in pre-sealed containers to the field to be included with the samples sent to the laboratory performing the analysis of site samples. The analytes of interest and corresponding analyte concentrations for the spike samples are specified in the request to the independent laboratory providing the samples in accordance with the FSIP. These samples are assigned an ID number, stored in an iced cooler, and shipped blind to the laboratory with the other samples.
- 7.6.8 Background groundwater samples are used to assess the range of concentrations in the vicinity of the site which are not the result of site activities. These samples are taken from areas not anticipated to have

been impacted by historical site operations (i.e., away from the containment source areas and hydraulically upgradient).

The background samples are collected at the locations and depths specified in the FSIP. At a minimum, background groundwater samples are collected for each hydrostratigraphic zone sampled. Where possible, the background wells are constructed and developed in the same manner as the site monitoring wells.

- 7.6.9 When field filtering is conducted for water parameters, filter blanks will be collected as part of water sampling QC activities. One field filter blank will be conducted for each lot of filters purchased for the project. Filter blanks will be collected with laboratory supplied distilled water and the same procedures used to collect filtered water samples.
- 7.7 Samples are identified, handled, and recorded as described in this SOP and in accordance with standard sample handling protocols indicated in the FSIP.
- 7.8 Field notes are kept in a bound field logbook. The following information is recorded using waterproof ink:
 - 7.8.1 Names of personnel, including name of sampler;
 - 7.8.2 Weather conditions;
 - 7.8.3 Project number and project title;
 - 7.8.4 Chain of custody numbers;
 - 7.8.5 Location and well number, condition of the well, and initial and final static water level, total well depth, and measuring point;
 - 7.8.6 Date and time of sampling;
 - 7.8.7 Decontamination information;
 - 7.8.8 Field forms for well evacuation and water quality sampling (see attached);
 - 7.8.9 Analyses to be performed by the laboratory;
 - 7.8.10 Equipment calibration information;
 - 7.8.11 Method of purging, volume of water purged before sampling, and purge start/stop times;

7.8.12 Pumping rate (if applicable);

7.8.13 Field parameter measurements during purging;

7.8.14 Sample volume, number, and container types, method of sample collection, and sample preservation;

7.8.15 QA/QC samples collected; and

7.8.16 Irregularities or problems.

8.0 RECORD KEEPING REQUIREMENTS

8.1 Copies of all documentation pertinent to groundwater purging and sampling will be placed in the project file at the conclusion of the project.

9.0 ATTACHMENTS

Not applicable

Appendix F
Standard Operating Procedures
Part 2