U.S. Department of Energy
National Nuclear Security Administration
Livermore Field Office, Livermore, California 94551

Lawrence Livermore National Laboratory
Lawrence Livermore National Security, LLC, Livermore, California 94551

UCRL-AM-109115-REV-15

LLNL Livermore Site and Site 300 Environmental Restoration Project Standard Operating Procedures (SOPs)

Editors

R. Goodrich
G. Lorega

ENVIRONMENTAL RESTORATION DEPARTMENT
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ERD

February 2016

Environmental Restoration Department

This work was performed under the auspices of the U.S. Department of Energy/National Nuclear Security Administration by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344.

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Table of Contents

Revised Table of Contents reflects revisions and updates to the "February 2016 SOP Manual." The following SOPs have been revised: 1.2, 1.5, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.10, 4.3, 4.7A, 4.10, 5.1, 5.3, 5.4, 5.5, 5.8, 5.10, 5.15, and 5.20. SOPs 1.11, 2.13 and 6.1 are obsolete and have been deleted. Three new SOPs have been added to this release including SOPs 1.18, 1.19, and 1.20.

02-16/ERD:gl

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02-16/ERD:gl

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.1: Field Borehole Logging—Revision: 6

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AUTHOR(S):
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APPROVALS:	Date
Department Head	4/30/12
Livermore Program Leader	4/18/12
Site 300 Program Leader	4/12/12

CONCURRENCE:	Date
QA Implementation Coordinator	4/19/12

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to describe the physical characteristics of sediments and rock encountered during auger, rotary, punch core or core drilling and when applicable documenting the procedures used during geophysical logging.

2.0 APPLICABILITY

The following procedures should be reviewed and followed by all personnel performing any borehole logging activities. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 American Society for Testing and Materials (1999), *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*, ASTM D1586-99, Vol. 04.08.

3.2 American Society for Testing and Materials (2006), *Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation*, ASTM D2113-06, Vol. 04.08.

3.3 American Society for Testing and Materials (2000), *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, ASTM D2488-00, Vol. 04.08.

3.4 Department of Health and Human Services, Centers for Disease Control and Prevention (2005), *NIOSH Pocket Guide to Chemical Hazards*, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

3.5 Department of Water Resources (1981), *Water Well Standards: State of California*, California Resources Agency, Bulletin 74-81.

3.6 Environmental Protection Agency (1987), *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

3.7 Johnson, R. B., and DeGraff, J. V. (1988), *Principles of Engineering Geology*, John Wiley and Sons, New York.

3.8 Terzaghi, K., Peck, R. B., and Mesri, G. (1996), *Soil Mechanics in Engineering Practice,* 3rd ed., John Wiley and Sons, New York.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Hydrogeology Team Leader (HTL)

The HTL is responsible for ensuring that the Drilling Work Plan and Sampling Plan are properly implemented by coordinating the work with the PL, RI, and Drilling Coordinator. The HTL is responsible for notifying the PL if the work scope changes significantly such that costs, schedules, or the achievement of its objectives are impacted. The HTL has the authority to make decisions in the field that differ from the Drilling Work Plan or Sampling Plan provided these decisions do not alter the original objective of the well and do not increase the total cost estimate for the well. Additionally, the HTL is responsible for performing a quality review of field observations recorded on the borehole logs.

5.6 Drilling Coordinator (DC)

The DC is responsible for providing necessary disposable supplies and materials for borehole logging.

5.7 Drilling Geologist Supervisor (DGS)

The DGS is responsible for conducting a quality review of field observations recorded on the borehole logs.

5.8 Hydrogeologist (HG)

The HG is responsible for reviewing daily borehole logs.

5.9 Drilling Geologist (DG)

The DG is responsible for making and recording geologic and hydrogeologic observations on the borehole log, and for communicating with the driller and recording drilling behavior observations.

5.10 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review the Drilling Work Plan and Sampling Plan distributed by the HG or the DGS.

5.11 Data Management Team (DMT)

The DMT is responsible for reviewing the Drilling Work Plan and Sampling Plan and the disposition of original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

6.1 Preparation

6.1.1 Obtain materials listed in the Drilling Geologist Equipment Checklist (Attachment A, SOP 1.3) and obtain the appropriate Personal Protective Equipment (PPE) as identified in the applicable IWS and/or Work Plan for the specific task being performed. SOP 4.1, Attachment B "Personnel Protective Equipment" provides a description of PPE, Levels A through D. The ES&H Manual, Document 11.1 provides general policy and information about PPE. There is a link from Document 11.1 to the PPE website that provides in-depth information on various types of PPE.

6.1.2 Review the Drilling Work Plan and meet with the HG, DGS, and DC to determine scope of work and logging intervals.

6.2 Safety Considerations

To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with IWS 12654 "Drilling in VOC and Mixed Waste-Contaminated Soils at the Livermore Site" and IWS 11578 "Drilling in VOC-Contaminated Soils at the Livermore Site." Drilling activities at Site 300 will be conducted in accordance with IWS 11276 "Site 300 Drilling Activity."

6.3 Logging Procedure

Field borehole logging is one aspect of drilling operations. Other aspects are covered in SOPs 1.3, "Drilling;" 1.2, "Borehole Sampling of Unconsolidated Sediments and Rock;" 1.4, "Well Installation;" and 1.5, "Initial Well Development." Every borehole should be logged whether or not a well will be installed. If coring is not conducted while drilling, cuttings should be logged while allowing for lag time due to depth. Lithologic contacts should be estimated based upon lithology changes and drill rig behavior. If continuous coring is conducted, the core should be logged while in the polyvinyl chloride (PVC) tray or an equivalent core barrel, prior to placing core in storage boxes. During operations, it is imperative to record observations made in the field, particularly, the source of any subsurface water entering the open borehole.

6.3.1 Auger Drilling

1. Observe cuttings and note drill rig behavior.
2. Collect split-barrel sample or continuous core as specified in the Work Plan.

6.3.2 Wireline Coring

1. Attempt continuous coring as specified in the Work Plan.
2. Record DG's and Drillers observations, e.g., drill cutting composition, mud/water or cutting color changes, fluid pressure, and rig behavior during operations and/or when there is potential only partial or no core recovery.

6.3.3 Rotary Drilling

1. Record DG's and Drillers observations, e.g., cuttings, note drill rig behavior, fluid pressure, and mud or water color changes. Obtain input from other driller if uncertain about lithology intervals.

6.4 Borehole/Well Construction Log Completion Procedure

Complete the Borehole/Well Construction Log as described below. Attachment A is an example of a blank boring log. The last digit in each Subsection below corresponds to the numbers listed in parentheses in Attachment A of this SOP. For example, the first description, 6.4.1 Borehole Location, should be entered in the space marked **(1)** BOREHOLE LOCATION on the blank boring log.

6.4.1 **Borehole Location**. Indicate on a map, the borehole location with respect to permanent natural and man-made features and any existing nearby wells. When feasible, record distance to at least two permanent locations or one location when directional (i.e., compass bearing) data are provided. Show a north arrow preferably oriented toward the top of the page.

6.4.2 **Project**. Identify the project as Lawrence Livermore National Laboratory (LLNL) Site 300 or Livermore Site. In addition, include the general area in which the borehole is located (e.g., off site, Building 834, T-5475).

6.4.3 **Borehole/Well Number**. The borehole/well number as provided by the approved Drilling Work Plan and/or Sampling Plan.

6.4.4 **Job Number**. Identifies the account number for the project.

6.4.5 **Logged By**. Identifies the individual(s) responsible for logging the borehole, performing field measurements, and collecting samples.

6.4.6 **Edited By**. Identifies the geologist who independently reviews and checks the boring/well log entries.

6.4.7 **Project Manager**. Identifies the HG.

6.4.8 **Drill Rig**. Identifies drill rig manufacturer and model.

6.4.9 **Drilling Contractor**. Identifies the drilling company and its city of origin.

6.4.10 **Driller/Helper**. Identifies drill rig operator and helper(s).

6.4.11 **Drilling Method**. Identifies the method(s) used to drill the borehole.

6.4.12 **Sample Method**. Identifies the method(s) used to collect lithologic and chemical samples.

6.4.13 **Hammer Weight/Drop**. The drive sampler hammer weight in pounds and drop distance in inches for the hammer used to advance drive samplers. If a hammer is not used, enter NA (not applicable).

6.4.14 **Bentonite Gel Used**. Indicate whether or not bentonite gel was used as a drilling fluid. If so, identify the product name and manufacturer. No polymer-bearing drilling fluid additives shall be used unless approved in advance by the Hydrogeology Team Leader.

6.4.15 **Borehole Diameter**. Diameter of final borehole in inches and tenths of an inch. Also note diameter of any pilot boreholes drilled.

6.4.16 **Borehole Started Time/Date**. Identifies time (24 h) and date when drilling began.

6.4.17 **Borehole Completed Time/Date**. Identifies time (24 h) and date when pilot borehole is drilled to total depth.

6.4.18 **Water Source**. Indicates whether or not water was introduced into the borehole during drilling and/or into the well during initial development. If so, identifies the source (e.g., fire hydrant location, faucet, and number).

6.4.19 **Well Construction Started Time/Date**. Identifies the time (24 h) and date when well construction begins, including reaming the pilot borehole in preparation for well construction.

6.4.20 **Well Construction Completion Time/Date**. Identifies time (24 h) and date when well installation is complete (placement of first grout lift). If well is abandoned, note as such.

6.4.21 **Well Head Completion**. Identifies the proposed type of well head completion (e.g., locking 9-in. diameter galvanized steel pipe ["stove pipe"] or Christy box).

6.4.22 **Depth to Water**. When possible, water levels in boreholes should be recorded when water is first encountered during drilling and thereafter as specified in the Work Plan. Before taking water level measurements, review SOP 3.1, "Water-Level Measurements." Include borehole/casing depth, water depth, time, and date using ground surface as the datum.

6.4.23 **Total Depth**. Record total depth of borehole in feet.

6.4.24 **Casing Depth**. Record total depth of well casing in feet.

6.4.25 **Screened Interval**. Include depth interval of perforated casing section in feet.

6.4.26 **Sandpack**. List depth interval of filter pack sand and fine sand in feet. Include manufacturer name and designation of sand.

6.4.27 **Well Development**. Identifies the method(s), and time (24 h), date, and estimated flow rate in gallons per minute (gpm) when initial well development was completed.

6.4.28 **Geophysical Logs**. Identify geophysical logging company, method(s), and date. If geophysical logging is not performed during initial drilling and well installation, enter NA (not applicable).

6.4.29 **Circulation**. Volume of fluid losses and the interval over which they occur. When the column is left blank, it indicates that no fluid loss was observed. Complete fluid loss (CL) means that no fluid returned to the surface during pumping. If possible, give quantitative estimates of major fluid losses (rate: in gpm, or estimate of total gallons lost). Although the above mentioned circulation loss applies primarily to air and mud rotary systems, it can also be used during auger drilling to indicate quantity of return of cuttings at the surface.

6.4.30 **OVA/PID Field Readings**. Record Organic Vapor Analyzer (OVA) or Photo Ionization Detector (PID) readings. The work area (breathing zone) should be monitored with the OVA/PID for each core run. A portion of each soil/rock sample submitted for analysis should also be monitored with the OVA/PID after being containerized in a plastic bag for 15 minutes.

6.4.31 **Sampler Type/Depth**. Give sampler type by the letter code listed below and identify the depth at the top of the sampling interval in feet below ground surface (bgs).

Sampler type	Inside diameter (in.)	Code
Standard penetrometer	1.38	SP
Split-barrel (small)	2.0	SBS
Split-barrel (large)	2.5	SBL
HQ wireline core	2.3	PC

6.4.32 **Blows/6 inches**. The number of blows required to drive the sampler 6 in. by a 140-lb hammer falling 30 in. Fifty blow counts per 6-in drive is considered "refusal," and sampling at this depth is usually terminated. In addition, a total of 100 blow counts per 18-in. drive, or no observed advance of the sampler during ten successive hammer blows, is also considered "refusal." During coring, leave this section blank. Normally, the second and third 6-in. intervals are recorded and added as the number of blows per feet.

6.4.33 **Inches Recovered/Inches Driven**. The length in inches of sediment or rock recovered on a sampling or core run divided by the length in inches the sampler is advanced. For example, a recovery ratio for 10 in. of recovery on a 18-in. sampling interval for a core run would be:

$$\frac{10}{18}.$$

6.4.34 **Sample Condition/Rock Quality Designation (RQD)**. The RQD value is a modified computation of percent rock core recovery that reflects the relative frequency of discontinuities or fractures. The RQD is determined by measuring and summing all the pieces of unbroken rock 4 inches (10.2 centimeters) and longer in length in a core run, and dividing this by the total core run length. The RQD is reported in the unreduced fraction form. Descriptions include: E = excellent (90-100%); G = good (75-90%); F = fair (50-75%); P = poor (25-50%); and VP = very poor (0-25%).

RQD	DESCRIPTION OF ROCK QUALITY
0-25	very poor
25-50	poor
50-75	fair
75-90	good
90-100	excellent

6.4.35 **Sample Identification (ID)**. Depth at the top of the sampling interval is given in feet and tenths of feet. The date and time of the sample is also given.

Livermore Site:

For soil samples collected at the Livermore Site, the sample designation distinguishes between unsaturated samples (B-#-depthU) and saturated samples (B-#-depthS). For example, a soil sample collected from borehole B-1604 at a depth of five feet in the unsaturated zone would be identified as B-1604-5.0U.

Site 300:

For soil samples collected at Site 300, no designation is made between unsaturated and saturated; instead, the sample name ends in "F" (for feet). For example, a soil or rock sample collected from borehole B-865-2133 at a depth of five feet would be identified as B-865-2133-5.0F.

Duplicate soil samples that are collected for quality control (QC) are to be named according to the following example: B-865-05-(150.3)-DUP-150.0F, where 150.3 is the depth of the real sample and 150.0 is the depth of the QC sample.

Ground water grab samples collected from the open borehole (before well installation) are to be named as shown in the following example: B-865-05-BGW-52.0F where 52.0 is the borehole depth at the time of sample collection.

6.4.36 **Analysis**. Identifies laboratory analysis to be performed on sample.

6.4.37 **Well Annulus/Borehole Filler**. Identifies the type of material used to fill the annulus space between the well and borehole wall (e.g., Monterey #3 sand, 0/30 sand, bentonite pellets, cement grout). Identifies the type of material used as borehole filler, either for backfill below the well bottom or for abandoning the borehole, if required (e.g., cement grout, bentonite chips, etc.). Material names are written vertically and arrows are drawn from the material name to the upper and lower contacts with adjacent materials.

6.4.38 **Well Casing**. Identifies the casing and screen used to construct the well. Casing and screen identification should include type of material (PVC, steel, etc.), schedule (Sch 40, Sch 80, etc.), and diameter. Screen identification should also include slot size (e.g., 0.02-inch). The well cap location should be noted. Casing and screen descriptions are written vertically and arrows are drawn from the description to the upper and lower contacts with adjacent descriptions.

6.4.39 **Depth in Feet**. Identifies the depth in feet. The depth on all pages other than the first page should be filled out by the drilling geologist in the field.

6.4.40 **Recovery/Sample Location**. Core recovery is shown graphically by an "x" in the recovery column on the log. The location of a sample collected for further evaluation is shown by a solid box. When partial sample loss occurs, it is often possible to determine why and where core loss has occurred. For example:

1. Rock stuck in drive shoe.
2. Coring from dense (stiff) material to soft material causing block-off.
3. Loss of cohesionless material.
4. Fell out during retrieval of core sampler.
5. Mechanical failures.

Note: If uncertain where sample loss has occurred, recovered interval is assumed to be from the top of the sampling interval.

6.4.41 **Contact**. Lithologic contacts are drawn in the contact column and extended across the lithologic description field. If the contact is identified by the driller, specify this in the lithologic description field. Three types of contacts are used:

1. Sharp. A sharp contact is indicated with a solid line.
2. Gradational. A gradational contact is indicated with hatches.
3. Approximate. An approximate contact is indicated by a dashed line and is used when the exact depth or nature of the lithologic contact is uncertain.

6.4.42 **Lithologic Description**. A continuous log of encountered geologic materials determined from borehole cuttings, samples, and core should be recorded on the Borehole/Well Construction Log. A system of description similar to the American Society for Testing and Materials (ASTM) method D 2488-90 (2000), *Standard Practice for Description and Identification of Soils* (Visual-Manual Procedure), is used for sediment, and a similar description is used for rock. Lithologic descriptions record direct field observations including the entry of any subsurface water into the borehole. Any interpretations included with these descriptions should be clearly noted by placing the interpretation in parentheses. The format is outlined below:

A. Fine-Grained Sediment Description Format.

   1. Contact depth in feet and tenths of a foot. For example, “(0'–5.1').”
   2. Textural Classification. The appropriate classification as listed in Attachment B. For example, “Sandy Silt.”
   3. Group Symbol. The appropriate Unified Soil Classification System (USCS) sediment group symbol as listed in Attachment C is written in parentheses after the textural classification. For example, “(ML).”
   4. Color. Soil color is named and coded using the Munsell Soil Color chart. The code should be in parentheses immediately following the written description. For example, “reddish brn (5YR, 4/4).” Presence of mottling and banding is also recorded.

5. Consistency/Penetration Resistance. For fine sediments use very soft, soft, medium, stiff, very stiff, and hard. These are estimated from drive sample hammer blows or other field tests. Blow counts may also be used, if reliable.

6. Moisture Content. Dry, damp, moist, wet (saturated). Attachment D contains a description for each moisture term. Omit moisture terms below the saturated zone and when drilling with mud or air-mist rotary systems.

7. Size Distribution. Approximate percentage of gravel, sand, fines (if possible, distinguish between silt and clay). Percentages should add up to 100%. For example, "80% silt, 20% f-sand."

8. Estimated Permeability. Very low, low, moderate, or high. These are based primarily on grain size, sorting, and the relative density of the cored material. See Section 6.4.44 for abbreviations used for estimated permeability. For example, "LEK."

9. Miscellaneous. Odor, contact and/or bedding dip, bedding features, cementation, structures, fractures, fracture fillings, fossils, formation name, minerals, oxidation, etc.

B. Coarse-Grained Sediment Description Format.

1. Contact depth in feet and tenths of a foot. For example, "(0'–5.1')."

2. Textural Classification. The appropriate textural classification as listed in Attachment B. For example, "Silty Gravel."

3. Group Symbol. The appropriate Unified Soil Classification System (USCS) sediment group symbol as listed in Table Attachment E is written in parentheses after the textural classification. For example, "(GM)."

4. Color. Soil color is named and coded using the Munsell Soil Color chart. The code should be in parentheses immediately following the written description. For example, "dk brn (7.5 YR, 3/4)." Presence of mottling and banding is also recorded.

5. Relative Density/Penetration Resistance. For cohesionless materials use very loose, loose, medium, dense, or very dense estimated from drive sample hammer blows or other field tests. Blow counts may be used, if reliable.

6. Moisture Content. Dry, damp, moist, and wet (saturated). Attachment D contains a description for each moisture term. Omit moisture terms below the regional water table and when drilling with mud or air-mist rotary systems.

7. Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay). Percentages should add up to 100%. For example, "80% gravel, 20% silt."

8. Grain Shape. Angular, subangular, subrounded, rounded, or well-rounded, for grains larger than sand size.
9. Grain Size. The largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
10. Estimated Permeability. Very low, low, moderate, or high. This is based primarily on grain size, sorting, and the relative density of the cored material. See Section 6.4.44 for abbreviations used for estimated permeability. For example, "HEK."
11. Miscellaneous. Odor, contact and/or bedding dip, bedding features, sorting, structures, fossils, cementation, geologic origin, formation name, minerals, oxidation, etc.

C. Fine-Grained Rock Description Format

1. Contact depth in feet and tenths of a foot. For example, "(76.5'–80')."
2. Textural Classification. The appropriate classification as listed in Attachment B. For example, "Sandy Siltstone."
3. Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. For example, "gry grn (5G, 5/2)." Presence of mottling and banding is also recorded.
4. Hardness. Very hard, hard, medium, soft, very soft. Attachment E contains a description for each hardness term.
5. Moisture Content. Dry, damp, moist, wet (saturated). Attachment D contains a description for each moisture term. Omit moisture terms below the saturated zone and when drilling with mud or air-mist rotary systems.
6. Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay). Percentages should add up to 100%. For example, "80% silt, 20% f-sand."
7. Estimated Permeability. Very low, low, moderate, or high. This is based primarily on grain size, sorting, and cementation. Estimate secondary permeability due to natural rock fractures when applicable. For example, "LEK." See Section 6.4.44 for abbreviations used for estimated permeability.
8. Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.
9. Fractures are identified by depth, angle, width, and associated mineralization if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]) should be stated. For example, "NF @90.8', 25 deg to axis, 0.1" wide, minor calcite."

D. Coarse-Grained Rock Description Format

1. Contact depth in feet and tenths of a foot. For example, "(122'–125.7')."
2. Textural Classification. The appropriate classification as listed in Attachment B. For example, "Sandstone."
3. Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. For example, "gry olive grn (5GY, 3/2)." Presence of mottling and banding is also recorded.
4. Hardness. Very hard, hard, medium, soft, very soft. Attachment E contains a description for each hardness term.
5. Moisture Content. Dry, damp, moist, and wet (saturated). Attachment D contains a description for each moisture term. Omit moisture terms below the saturated zone and when drilling with mud or air-mist rotary systems.
6. Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay). Percentages should add up to 100%. For example, "80% c-sand, 20% silt."
7. Grain Shape. Angular, subangular, subrounded, rounded, or well-rounded, for grains larger than sand size.
8. Grain Size. The largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
9. Estimated Permeability. Very low, low, moderate, or high. This is based primarily on grain size, sorting, and cementation. When applicable, estimate secondary permeability due to natural rock fractures. For example, "HEK." See Section 6.4.44 for abbreviations used for estimated permeability.
10. Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.
11. Fractures are identified by depth, angle, width, and associated mineralization, if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]), should be stated. For example, "NF @126.1', 35 deg to axis, 0.1" wide, minor calcite"

6.4.43 **Abbreviations Used for Lithologic Descriptions:**

PC = punch core
RC = rock core
v = very
f = fine
m = medium
mod = moderate

c = coarse
min = mineralization
w/ = with
SA = subangular
SR = subrounded
R = rounded
A = angular
soft sed = soft sediment deformation
def'm = deformation
DF = drilling fluid (mud)
x-beds = cross beds
@ = at
RQD = rock quality designation
ppm = parts per million
rx w/HCl = reaction with hydrochloric acid
FeOx = iron oxide
MnO2 = manganese oxide
P = plasticity

6.4.44 **Abbreviations Used for Permeability Estimates**

1 K = primary conductivity
2 K = secondary conductivity due to fracturing, mineralization, etc.
H = high
L = low
E = estimated
K = Hydraulic conductivity

6.4.45 **Core Fractures are Described as Follows:**

(Depth/fracture type (see below)/angle w/mineralization or other characteristics)

CIF = coring induced fracture
HIF = handling induced fracture
NF = natural fracture
HF = healed fracture

6.4.46 **General Abbreviations:**

DA = Drill Ahead
NR = No Recovery
dk = dark
lt = light
ylw = yellow/yellowish
brn = brown/brownish
grn = green/greenish
gry = gray/grayish
blk = black
bl = blue
ind = indurated

cmt = cemented
calc = calcite
qtz = quartz
SS = split spoon
S = sub
//////// = Gradational Contact
------- = Approximate Contact
_____ = Definite Contact

6.5 Post Operation

6.5.1 Store recovered sediment and rock core in core boxes using a black indelible pen to mark sample intervals/runs. Label each box with the location ID, site/OU, depth interval, and box number. Handle core per SOP 1.15, "Well Site Core Handling."

6.5.2 Perform post-work activities described in SOP 4.1, Section 6.4.

6.5.3 The DGS will perform a quality control review of the documents. After reviewing and editing the documents, the DG will make final versions available in his/her outbox on the ERD server (erdfilespace). The DG will deliver final versions of original documents to DMT and logbooks (when complete) for storage.

7.0 QUALITY ASSURANCE RECORDS

The ERD QA records identified below are to be created, managed, and preserved in accordance with SOP 4.10: Records Management.

7.1 Borehole/Well Construction Log

7.2 Field Logbook

8.0 ATTACHMENTS

Attachment A—Borehole/Well Construction Log

Attachment B—Textural Classifications (Table B-1)

Attachment C—Unified Soil Classification System (USCS) Group Symbols (Table C-1)

Attachment D—Moisture Classifications (Table D-1)

Attachment E—Rock Hardness Classification (Table E-1)

Attachment A

Borehole/Well Construction Log

Borehole/Well Construction Log

Page 1 of 2

(1) BOREHOLE LOCATION	(2) Project:		(3) Borehole/Well No.:
			(4) Job No.:
	(5) Logged By:		(6) Edited By:
	(7) Project Manager:		(8) Drill Rig:
	(9) Drilling Contractor:		
	(10) Driller/Helper:		
	(11) Drilling Method:	(12) Sample Method:	
	(13) Hammer Weight/Drop:	(14) Bentonite Gel Used:	
	(15) Borehole Diameter, Pilot:	Final:	
	(16) Borehole Started, Time/Date:	(17) Borehole Completed, Time/Date:	(18) Water Source:
Notes:	(19) Well Started, Time/Date:	(20) Well Completed, Time/Date:	
	(22) Water Depth		(21) Well Head Completion
	Boring/Casing Depth		
	Time		
	Date		

ABBREVIATIONS: ------- = Approx. Contact; //////// = Gradational Contact; @ = at; _____ = Definite Contact; 1 K = primary conductivity; 2 K = secondary conductivity due to fracturing, mineralization, etc.; A = angular; bl = blue; blk = black; brn = brown/brownish; c = coarse; calc = calcite; CIF = coring induced fracture; cmt = cemented; DA = Drill Ahead; def'm = deformation; DF = drilling fluid (mud); dk = dark; E = estimated; f = fine; FeOx= iron oxide; grn = green/greenish; gry = gray/grayish; H = high; HF = healed fracture; HIF = handling induced fracture; ind = indurated; K = Hydraulic conductivity; L = low; lt = light; m = medium; min = mineralization; MnO2 = manganese oxide; mod = moderate; NF = natural fracture; NR = No Recovery; P = plasticity; PC = punch core; ppm = parts per million; qtz = quartz; R = rounded; RC = rock core; RQD = rock quality description; rx w/HCl = reaction with hydrochloric acid; S = sub; SA = subangular; soft sed = soft sediment deformation; SR = subrounded; SS = split spoon; v = very; w/ = with; x-beds = cross beds; ylw = yellow/yellowish.

(23) Total Depth:	(24) Casing Depth:
(25) Screened Interval:	
(26) Sand Pack, #3	#0/30:
(27) Well Development Method: Time: Date:	Flow Rate:
(28) Geophysical Logs, Type: By: Date	(29) Circulation:

(30) OVA/PID Field Readings (ppm) Work Area	(30) Soil/Rock	(31) Sampler Type/Depth	(32) Blows 6 inches	(33) Inches Recovered/Inches Driven	(34) (Sample Condition/RQD	(35) Sample ID	(36) Analysis	(37) Well Annulus/Borehole Filler	(38) Well Casing	(39) Depth in Feet	(40) Recovery/Sample Loc.	(41) Contact	(42) LITHOLOGIC DESCRIPTIONS
										1			
										2			
										3			
										4			
										5			
										6			
										7			
										8			
										9			
										10			

Note: Numbers **1–42** listed on this log correspond to Subsections **6.4.1–6.4.42** of SOP 1.1.

Attachment A. Borehole/Well Construction Log.

Borehole/Well Construction Log (cont.) Page _2__ of _2___

ABBREVIATIONS ------- = Approx. Contact, ////// = Gradational Contact; @ = at, _____ = Definite Contact; 1 K = primary conductivity, 2 K = secondary conductivity due to fracturing, mineralization, etc., A = angular, bl = blue, blk = black, brn = brown brownish, c = coarse, calc = calcite, CIF = coring induced fracture, cmt = cemented, DA = Drill Ahead, def'm = deformation, DF = drilling fluid (mud), dk = dark, E = estimated, f = fine, FeOx = iron oxide, grn = green greenish, gry = gray grayish, H = high, HF = healed fracture, HIF = handling induced fracture, ind = indurated, K = Hydraulic conductivity; L = low; lt = light, m = medium, min = mineralization, MnO2 = manganese oxide, mod = moderate, NF = natural fracture, NR = No Recovery, P = plasticity, PC = punch core, ppm = parts per million, qtz = quartz, R = rounded, RC = rock core, RQD = rock quality description, rx w HCl = reaction with hydrochloric acid, S = sub, SA = subangular, soft sed = soft sediment deformation, SR = subrounded; SS = split spoon; v = very; w/ = with; x-beds = cross beds; ylw = yellow yellowish

(30) OVA PID Field Readings (ppm)		(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(2) Project:	(3) Borehole Well No
Work Area	Soil Rock	Sampler Type Depth	Blows 6 inches	Inches Recovered Inches Driven	Sample Condition RQD	Sample ID	Analysis	Well Annulus Borehole Filler	Well Casing	Depth in Feet	Recovery Sample Loc.	Contact	Notes:	
										1				
										2				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										10				
										1				
										2				
										3				
										4				
										5				
										6				
										7				
										8				
										9				
										10				

Note: The numbers listed in parentheses on this log correspond to the Subsections listed in Section 6.4 of SOP 1.1 [i.e., **(2) = 6.4.2**, etc.].

Attachment A. Borehole/Well Construction Log. (Continued)

Attachment B

Textural Classifications

Attachment B-1. Textural classifications for the Livermore Site and Site 300.

Type	Classification
Sediment:	
Fine grained	Gravelly silt, sandy silt, silt, clayey silt, sandy clay, silty clay, clay, organic silt, and organic clay.
Coarse grained	Sand, clayey sand, silty sand, gravelly sand, gravel, clayey gravel, silty gravel, and sandy gravel.
Rock:	
Fine grained	Sandy siltstone, siltstone, clayey siltstone, sandy claystone, silty claystone, claystone.
Coarse grained	Sandstone, clayey sandstone, silty sandstone, gravelly sandstone, conglomerate, clayey conglomerate, silty conglomerate, and sandy conglomerate.

Attachment C

Unified Soil Classification System (USCS) Group Symbols

Attachment C-1. USCS sediment symbols.

Fine-grained		Coarse-grained	
Group symbol	Group name	Group symbol	Group name
CL	Low to medium plasticity clays	GW	Well-graded gravel
ML	Nonplastic to medium plasticity silt	GP	Poorly graded gravel
OL	Organic clay or silt (lean)	GM	Silty gravel
CH	High plasticity clays	GC	Clayey gravel
MH	High plasticity silt	SW	Well-graded sand
OH	Organic clay or silt (fat)	SP	Poorly graded sand
PT	Peat	SM	Silty sand
		SC	Clayey sand

Attachment D

Moisture Classifications

Attachment D-1. Moisture classification.

Moisture term	Description
Dry	Absence of moisture to the touch.
Damp	Contains enough water to keep the sample from being brittle, dusty or cohesionless; is darker in color than the same material in the dry state.
Moist	Leaves moisture on your hand, but displays no visible free water.
Wet	Displays visible free water.

Attachment E

Rock Hardness Classification

Attachment E-1. Rock hardness classification.

Descriptive term	Defining characteristics
Very hard	Cannot be scratched with knife; does not leave a groove on the rock surface when scratched.
Hard	Difficult to scratch with knife; leaves a faint groove with sharp edges.
Medium	Can be scratched with knife; leaves a well-defined groove with sharp edges.
Soft	Easily scratched with knife; leaves a deep groove with broken edges.
Very soft	Can be scratched with a fingernail.

LLNL Environmental Restoration Department (ERD) Standard Operating Procedure (SOP)		
ERD SOP 1.2: Borehole Sampling of Unconsolidated Sediments and Rock—Revision: 7		
ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # ______ ERD	**AUTHOR(S):** M. Buscheck and V. Madrid	
	APPROVALS:	**Date**
	Department Head	12/21/15
	Livermore Site Program Leader	12/17/15
	Site 300 Program Leader	12/15/15
	CONCURRENCE:	**Date**
	Rebecca Goodrich QA Implementation Coordinator	1/7/16
Type of Procedure (per ES&H Manual, Document 3.4)		
☒ Informational Use	☐ General Use	☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to ensure acceptable, consistent, and safe procedures for collecting discrete soil and rock samples from the vadose zone and multiple water-bearing zones in the same borehole while preventing or minimizing any possibility for cross contamination.

2.0 APPLICABILITY

This procedure is applicable for all personnel performing borehole sampling, and should be fully reviewed prior to conducting these activities. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 American Society for Testing and Materials (1999), *Standard Test Method for Penetration Test and Split-barrel Sampling of Soils*, ASTM D 1586-99, Vol. 04.08.

3.2 American Society for Testing and Materials (2006), *Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation*, ASTM D 2113-06, Vol. 04.08.

3.3 American Society for Testing and Materials (2001), *Standard Practice for Thick Wall, Ring-lined, Split-barrel, Drive Sampling of Soils*, ASTM D 3550-01, Vol. 04.08.

3.4 Department of Water Resources (1981), *Water Well Standards: State of California*, California Resources Agency, Bulletin 74-81.

3.5 Dresen, M. D. and Hoffman, F. (1986), *Volatile Organic Compounds in Ground Water West of LLNL*, Lawrence Livermore National Laboratory, Livermore, Calif., July 1986, 46 pp. (UCRL-53740).

3.6 Hoffman, F. and Dresen, M. D. (1989), *A Method to Evaluate the Vertical Distribution of VOCs in Ground Water in a Single Borehole*, Lawrence Livermore National Laboratory, Livermore, Calif., February 1989, 8 pp. (UCRL-100509, Preprint).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is

adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI) /Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Hydrogeology Team Leader (HTL)

The HTL is responsible for ensuring that the Drilling Work Plan and Sampling Plan are properly implemented by coordinating the work with the PL, RI, and Drilling Coordinator. The HTL is responsible for notifying the PL if the work scope changes significantly such that costs, schedules, or the achievement of its objectives are impacted. The HTL has the authority to make decisions in the field that differ from the Drilling Work Plan or Sampling Plan provided these decisions do not alter the original objective of the well and do not increase the total cost estimate for the well.

5.6 Drilling Coordinator (DC)

The DC is responsible for reviewing the Drilling Work Plan and Sampling Plan and provides the interface between the Program Leader, Hydrogeologist, Drilling Geologist, and the field personnel; notifying Building Coordinators, Site Planning, and the Central Facilities & Infrastructure Department (Central F&I); coordinating any necessary surveys (utilities, biological, archaeological) prior to drilling; and monitoring the daily progress of drilling activities.

5.7 Drilling Geologist Supervisor (DGS)

The DGS is responsible for assisting in the preparation of the Drilling Work Plan and Sampling Plan prior to commencing related work activities; coordinating the Drilling Geologist's (DG) work schedule and related activities, ensuring that the DG has all necessary equipment to perform the field work accurately and safely, monitoring and reporting the progress of daily activities, and conducting a quality review of field observations recorded on the borehole logs.

5.8 Hydrogeologist (HG)

The HG's responsibility is to generate a Drilling Work Plan and Sampling Plan. The HG is responsible for the overall investigation, planning, assessment, and remediation within a study area. The HG is also responsible for reviewing borehole and geophysical logs.

5.9 Drilling Geologist (DG)

The DG is responsible for reviewing the Drilling Work Plan and Sampling Plan and conducting and documenting all borehole sampling activities, operational and safety procedures per the Integration Work Sheet (IWS) and work plan(s), and to inform the DC, HG, and DGS of the progress of daily activities, including any non-conformances with, or deviations from, the plan(s).

5.10 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review the Drilling Work Plan and Sampling Plan distributed by the HG or the DGS and to review the incoming analytical data received from the contracted analytical laboratories as a result of this work activity.

5.11 Data Management Team (DMT)

The DMT is responsible for reviewing the Drilling Work Plan and Sampling Plan and the disposition of original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

Borehole sediment and rock sampling is a useful technique for identifying/characterizing the geology, hydrogeology, and sources of contamination, and delineating contaminant distribution in both the unsaturated and saturated zones.

Methods of sediment and rock sampling include driving split barrel samplers, coring, and sampling of loose drill cuttings. It is very important that sampling procedures are followed rigorously as specified in the Drilling Work Plan and the Sampling Plan so that consistent, high quality analytical data that are representative of subsurface conditions can be obtained. It is essential that the sampling process does not introduce hazardous or foreign substances into the borehole or sample. It is also desirable that the sampling techniques preserve the integrity of all chemicals of interest at their *in situ* concentrations. In practice, these goals may not be fully achieved because the sample is inevitably disturbed somewhat by the mechanics of drilling, sampling, and handling. Collecting soil samples for volatile organic compound (VOC) analysis in accordance with U.S. EPA SW-846 Method 5035B (Closed System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples) minimizes sample handling and ensures minimal loss of volatile organic compounds (VOCs) during the sampling and analytical processes.

6.1 Preparation

6.1.1 The DG should obtain all soil, rock, and ground water sampling equipment that might be needed during borehole sampling as specified in the Drilling Work Plan and Sampling Plan and per the "Drilling Geologist Equipment Checklist" (Attachment A, SOP 1.3). Obtain the appropriate Personal Protective Equipment (PPE) as identified in the applicable IWS, Drilling Work Plan and/or Sampling Plan for the specific task being performed. SOP 4.1, Attachment B "Personnel Protective Equipment" provides a description of PPE, Levels A through D. The ES&H Manual, Document 11.1 provides general policy and information about PPE. There is a link from Document 11.1 to the PPE website that provides in-depth information on various types of PPE.

6.1.2 The DG conducts and documents daily safety meetings including topic, attendees, and the meeting time on the Daily Field Report, Attachment A.

6.1.3 The DG should obtain a Field Sampling Logbook to record sample numbers and Chain-of-Custody (CoC) document numbers per SOP 4.2, "Sample Control and Documentation."

6.2 Safety Considerations

To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with LLNL Integration Work Sheet (IWS) 12654 "Drilling in VOC and Mixed Waste-Contaminated Soils at the Livermore Site" and IWS 11578 "Drilling in VOC-Contaminated Soils at the Livermore Site." Drilling activities at Site 300 will be conducted in accordance with IWS 11276 "Site 300 Drilling Activity."

6.3. Sampling Environment

6.3.1 Ensure that nearby fuel tanks are sealed, that engine exhaust is not entering the sampling area, that workers and bystanders are not smoking, and that no other potential sources of hydrocarbon vapors are present. These extraneously introduced hydrocarbons can effect samples and show up in the analytical results.

6.4 Split-Barrel Sampling

6.4.1 Wash split-barrel sampler with detergent and analyte-free water provided by the contract analytical laboratories (CALs), and rinse, or steam clean per SOP 4.5, "General Equipment Decontamination." Collect a rinsate/equipment blank, from the interior of the sampler and submit for analysis per SOP 4.9, "Collection of Field QA/QC Samples" and as specified by the Sampling Plan. The Sample Plan and/or HG shall determine the necessity and frequency of equipment blanks during drilling activities.

6.4.2 Remove cuttings/slough from borehole and center bit.

6.4.3 Sample collection for volatile organic compounds (VOCs).

A. The Drilling Sampling Plan will prescribe the sampling method(s) to be used for soils to be collected and analyzed for VOCs, i.e., Terracore® sampling kit.

B. Use the TerraCore® sampling kit (or equivalent hermetically-sealed sample vials) to collect the sample(s) from the specific depth as specified in the Drilling Sampling Plan.

C. The kit contains one dry-weight container, two low-detection-level sodium bisulfate-preserved vials and one high-detection methanol-preserved vial. A sampler/plunger used to collect 5 to 10 grams of soil is also included in the kit.

D. Use the sampler plunger (with the plunger seated in the handle) by pushing it into the soil until the sample chamber is filled. A filled chamber will deliver approximately 5 to 10 grams of soil.

E. Wipe all soil or debris from the outside of the plunger. Having the soil plug flush with the mouth of the sampler, remove any excess soil extending beyond the mouth of the sampler.

F. Rotate the plunger that was seated in the handle 90 degrees until it aligns with the slots in the body. Place the mouth of the sampler into the 40-mL glass volatile organic analysis (VOA) vial and extrude the sample by pushing the plunger down. Quickly place the lid on the 40-mL VOA vial.

G. When capping the 40-mL VOA vial, ensure any soil or debris is removed from the top and/or threads of the vial.

H. Soil containing carbonate will effervesce when placed in the sodium bisulfate solution and could result in loss of VOCS or explosion of the VOA vial. If effervescing occurs when soil is placed in the sodium bisulfate solution then samples must be collected using two 40-mL vials containing 5-mL organic free water and a stir bar. When submitting samples in vials containing organic free water, the analysis must be performed within 48 hours. These vials can be purchased separately.

I. Fill the dry weight container half full of soil. This sample will be used to determine soils moisture content if needed.

J. Label the vials with the sample identification (borehole/well number followed by top of sample depth), sampling date, sample time, analysis type(s), and sample collector's initials per SOP 4.2. If applying LLNL sample label, do not cover the pre-measured tare weight labeled on the VOA vials.

K. Place the sample vials in the foam holder provided and place into the 1-gallon re-sealable bag. If a foam holder is not available, ensure that the sample vials are wrapped in bubble wrap prior to placing in the re-sealable bag. The vials should be kept upright at all times during sample collection and when placed in the foam holder or bubble wrap inside the cooler for courier pick up or sample shipment.

L. To facilitate rapid cooling, the TerraCore® sampling kit should be placed in an insulated cooler containing ice. Ice melt water is to be drained from the cooler throughout the day, and all loose ice must be double-bagged at the end of the day for courier delivery to the analytical laboratory. Blue Ice coolant packs should be used when shipping samples through the LLNL Shipping Department.

M. Document sample identification, time and date of sample, location, turnaround time, and analysis type(s) on the Analytical Sample Summary Sheet (Attachment B) and the Borehole/Well Construction Log (Attachment A, SOP 1.1).

6.4.4 Sample collection for volatile and semivolatile organic compound analysis:

A. Load pre-cleaned (steam cleaned) brass or stainless steel tubes into a split-barrel sampler. After the driller is certain all slough is removed from the auger and borehole, drive the sampler to desired depth in borehole.

B. To maximize sample integrity, collect the sample from the deepest tube, provided quality is good (i.e., no headspace) or as specified by the Sampling Plan.

C. Quickly observe lithology, seal the tube ends with Teflon tape, high-density polyethylene caps, and secure with duct tape.

D. Use an indelible marker to label the sample with identification (borehole/well number followed by top of sample depth), sampling date, sample time, analysis type(s), and sample collector's initials per SOP 4.2.

E. Immediately place the sample tube in a plastic bag and seal by tying a knot in the opening or place the sample in a Ziplock® bag. Double bag samples to keep them dry and/or prevent cross contamination when there is a concern.

F. To facilitate rapid cooling, all samples should be placed in an insulated cooler containing ice. Ice melt water is to be drained from the cooler throughout the day, and all loose ice must be double bagged at the end of the day for courier delivery to the analytical laboratory. Blue Ice coolant packs should be used when shipping samples through the LLNL Shipping Department.

G. Document sample identification, time and date of sample, location, turnaround time, and analysis type(s) on the Analytical Sample Summary Sheet (Attachment B) and the Borehole/Well Construction Log (Attachment A, SOP 1.1).

6.4.5 Sample collection for metal, high explosives (HE), and radiological analysis:

A. Load tubes into split-barrel sampler and drive sampler to desired depth in borehole. Stainless steel sample tubes should be used during metals sampling to prevent metal cross contamination.

B. Record lithology, seal the tube ends with Teflon tape, and secure with duct tape. Alternatively, sample can be transferred to a wide-mouth glass jar and sealed with duct tape.

C. Use an indelible marker to label the sample tube or jar with the identification (borehole/well number followed by top of sample depth), sampling date/time, sample analysis type(s), sample collector's initials per SOP 4.2.

D. Place the sample tube or glass jar in a plastic bag and refrigerate as described in Section 6.4.3 E.

E. If tritium analysis is to be performed, immediately refrigerate the sample tube or jar in plastic bags in an insulated cooler. If a jar is used, ensure that the jar is packed tightly to reduce air space, and that the lid is closed tightly and taped to help seal. If the samples are not immediately shipped to the analytical laboratory, they should be stored in a refrigerator. Samples held overnight will be transferred to a freezer.

F. Document sample identification, time and date of sample, location, turnaround time, and analysis type(s) on the Analytical Sample Summary Sheet (Attachment B) and the Borehole/Well Construction Log (Attachment A, SOP 1.1).

6.4.6 Sample collection for sieve analysis including hydrometer analysis:

A. Load tubes into split-barrel sampler and drive sampler to desired depth in borehole.

B. Record lithology, and transfer sample of granular soils to a gallon size plastic bag. Sample volume should be approximately 2,000 grams when medium contains chunks greater than 1-inch in size. Sample volume should be approximately 5,000 grams when medium contains chunks greater than 5-inches in size.

C. Use an indelible marker to label the bag or jar with the identification (borehole/well number followed by top of sample depth), sampling date/time, sample analysis type(s), sample collector's initials per SOP 4.2.

D. Samples for sieve analysis do not require refrigeration but should be kept in a sealed container.

E. Document sample identification, time and date of sample, location, turnaround time, and analysis type on the Analytical Sample Summary Sheet (Attachment B) and the Borehole/Well Construction Log (Attachment A, SOP 1.1).

6.5 Coring

6.5.1 Wash core barrel with detergent and water and rinse with clean water, or steam clean as per SOP 4.5. Collect a rinsate/equipment blank from the core barrel and submit for analysis as per SOP 4.9, "Collection of Field QA/QC Samples," when necessary.

6.5.2 Insert core barrel and core 10 ft or less.

6.5.3 Retrieve the core barrel with a wireline-overshot device or by removing rods. Place the core in a clean polyvinyl chloride (PVC) core tray or equivalent core barrel, ensuring that the core remains in stratigraphic sequence.

6.5.4 Collection of samples for VOC analysis.

A. Quickly observe lithology. Place a core segment of lithified sediment or rock approximately 3 to 6 in. long in stainless steel or brass cylinder tubes. Seal the ends with Teflon tape, cover with high-density polyethylene caps, and secure with duct tape. Wide-mouth glass jars sealed with duct tape may be used if specified in the Sampling Plan.

B. Use an indelible marker to label the sample with identification (borehole/well number followed by top of sample depth), sampling date/time, analysis type(s), and sample collector's initials per SOP 4.2.

C. Immediately place the sample in a bag, and refrigerate in an insulated cooler (Section 6.4.3 E).

D. Document sample identification, time and date of sample, location, turnaround time, and analysis type(s) on the Analytical Sample Summary Sheet (Attachment A) and the Borehole/Well Construction Log (Attachment A, SOP 1.1).

6.5.5 Collection of samples for metal, HE, and radiological analysis.

A. Record lithology, wrap a core segment of approximately 3 in. length with inert plastic tubing in an airtight plastic bag or in a wide-mouth glass jar, and seal with duct tape. Note: the sample must be packed tightly to reduce air space. Other acceptable sample containers are stainless steel or brass cylinder tubes. If these are used, seal the ends with Teflon tape, cover with high-density polyethylene caps, and secure with duct tape.

B. Use an indelible marker to label the sample with the identification (borehole/well number followed by top of sample depth), sampling date/time, sample analysis type(s), sample collector's initials, and LLNL/project name (optional).

C. Place the wrapped core segment, glass jar, or soil sample tubes in sealed bags and refrigerate as previously described in Section 6.4.3 E.

D. If tritium analysis is to be performed and samples are not shipped out immediately, samples should be transferred to a refrigerator at the end of the day, or a freezer if held overnight.

E. Document sample identification, time and date of sample, location, turnaround time, and analysis type(s) on the Analytical Sample Summary Sheet (Attachment B) and the Borehole/Well Construction Log (Attachment A, SOP 1.1).

6.5.6 Sample collection for sieve analysis including hydrometer analysis:

A. Extract sample from core and place into a gallon size plastic bag.

B. Record lithology, and transfer sample of granular soils to a gallon size plastic bag. Sample volume should be approximately 2,000 grams when medium contains chunks greater than 1-inch in size. Sample volume should be approximately 5,000 grams when medium contains chunks greater than 5-inches in size.

C. Use an indelible marker to label the bag or jar with the identification (borehole/well number followed by top of sample depth), sampling date/time, sample analysis type(s), sample collector's initials per SOP 4.2.

D. Samples for sieve analysis do not require refrigeration but should be kept in a sealed container.

E. Document sample identification, time and date of sample, location, turnaround time, and analysis type on the Analytical Sample Summary Sheet (Attachment B) and the Borehole/Well Construction Log (Attachment A, SOP 1.1).

6.5.7 Store remainder of core in boxes per SOP 1.15, "Well Site Core Handling."

6.6 Depth Sampling-Livermore Site

"Depth Sampling" uses the mud-rotary drilling technique and a wireline punch-coring system. This technique enables the collection of samples from several water-bearing zones in each borehole while preventing or minimizing cross contamination. The technique is not employed under normal drilling conditions and is only used at the discretion of the HTL, the DGS, in consultation with the PL. Attachment C is a schematic diagram of punch coring and depth sampling that shows a water-bearing zone encountered after sampling and drilling through two "shallower" water-bearing zones containing VOCs. During the drilling a mud cake forms along the borehole sidewall, which restricts the water flow from the upper water-bearing zones into the hole. In addition, the relatively dense drilling mud penetrates the formation and further restricts water flow into the borehole from the formation. These effects tend to isolate and therefore "protect" deeper water-bearing zones from the VOCs. The following procedures are used:

6.6.1 Use pure bentonite containing only polymers approved for use in drinking water wells and potable water from a pre-approved source(s).

6.6.2 Upon encountering a new water-bearing zone, the sampler is removed with a wireline while the drill rod remains in the borehole, and new mud is mixed in a dedicated tub. The new mud, pumped into the drill rod, displaces the old drilling mud, which may contain VOCs, into the annular space outside of the drill rod (Attachment C). The mud tub at the surface collects the spent mud and, subsequently, the cleaned core barrel, per SOP 4.5, is deployed through the new drilling mud to prevent contamination of the sampling equipment with VOCs that may have been in the previous drilling mud.

6.6.3 Core drill 1 to 2 ft to collect a sample of the sediment for chemical analysis (Attachment C).

6.6.4 Retrieve the core barrel with a wireline-overshot device.

6.6.5 To minimize potential displacement of pore water in the sample, retain the bottom-most tube for chemical analysis. If significant void space or drilling mud penetration is evident, discard the sample and collect and retain the next suitable sample.

6.6.6 Permeable lenses (<3 ft thick) may be sampled by quickly "stuffing" sediment core into a brass sample tube and noting the location on the borehole log.

6.7 Post Operation

6.7.1 Perform post-work activities described in SOP 4.1, Section 6.4.

6.7.2 Collect, inventory, and prepare all samples for shipment, per SOP 4.4, "Guide to the Handling, Packaging, and Shipping of Samples."

6.7.3 Complete CoC forms and shipping forms per SOP 4.2.

6.7.4 Record a daily summary of drilling and sampling in the Field Sampling Logbook per SOP 4.2, and on the Daily Field Report (Attachment A).

6.7.5 The DGS will perform a quality control review of the documents. After reviewing and editing the documents, the DG will make final versions available in his/her outbox on the ERD server (erdfilespace). The DG will deliver final versions of original documents to DMT and logbooks (when complete) for storage.

7.0 QUALITY ASSURANCE RECORDS

The ERD QA records identified below are to be created, managed, and preserved in accordance with SOP 4.10: Records Management.

7.1 Borehole/Well Construction Log

7.2 Chain-of-Custody Form

7.3 Document Control Logbook

7.4 Daily Field Report

7.5 Soil Analyses Form

7.6 Drilling Work Plan

8.0 ATTACHMENTS

Attachment A—Daily Field Report

Attachment B—Analytical Sample Summary Sheet

Attachment C—Schematic Diagram of Depth Sampling and Punch Coring

Attachment A

Daily Field Report

DAILY FIELD REPORT

Date	Project(s):
Name:	Project Manager:
Vehicle:	Job Number:

PID/OVA Calibration: Yes _____ No _____	Daily Site Safety Meeting Time ________
Time: _________	

Time	Activity

Page __ of __

Attachment A. Daily Field Report.

Attachment B

Analytical Sample Summary Sheet

Analytical Sample Summary Sheet

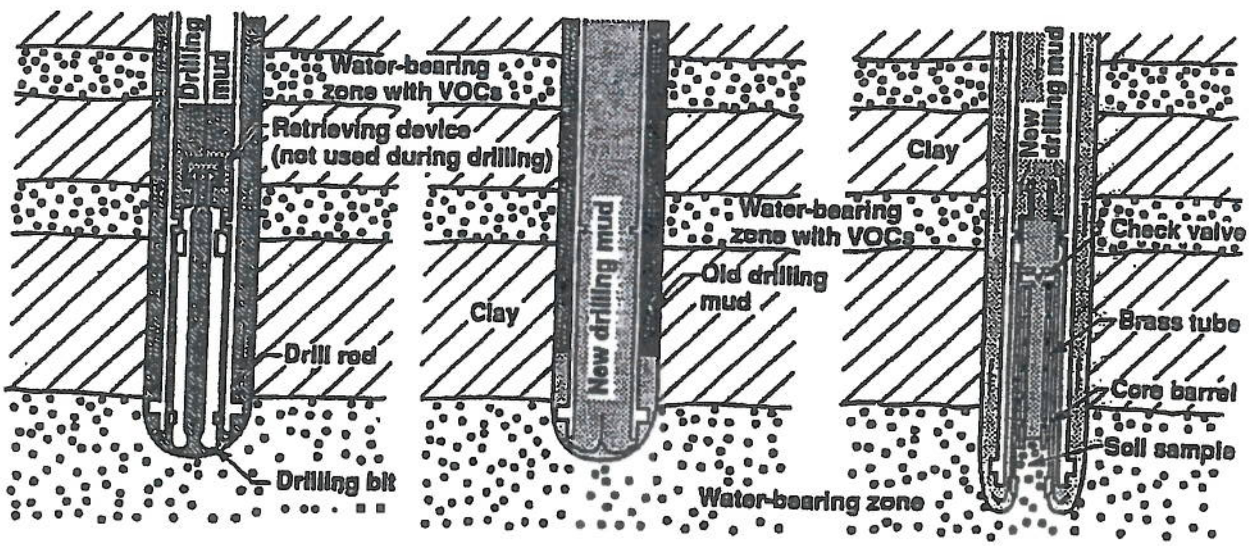
Location ID_____________

Sampling Date	Sample ID	Water Bearing Zone	Soil Type (USCS)	Laboratory	Analytic Method	Turn-around-time	COC#

Appendix B. Analytical Sample Summary Sheet.

Attachment C

Schematic Diagram of Depth Sampling and Punch Coring



Attachment C. Schematic diagram of depth sampling and punch coring (Dresen and Hoffman, 1986). Arrows indicate direction of mud circulation.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.3. Drilling—Revision: 6

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to ensure acceptable, consistent, and safe drilling procedures for the installation of ground water and soil vapor monitor and extraction wells, ground water injection wells, and piezometers. Atypical wells for specialized applications may not be covered under this SOP and may require an addendum to this SOP or a separate SOP.

2.0 APPLICABILITY

This procedure is applicable for all personnel performing drilling operations and shall be fully reviewed prior to conducting these activities. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Barcelona, M. J., Gibb, J. P., Helfrich, J. A., and Garske, E. E., *Practical Guide for Ground Water Sampling*, Washington, D.C., U.S. Government Printing Office, EPA 600/2-85-104, 1985.

3.2 Department of Water Resources (1981), *Water Well Standards: State of California*, California Resources Agency, Bulletin 74-81.

3.3 Occupational Safety and Health Administration Hazardous Waste Operations and Emergency Response (29 CFR 1910.120).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Manager (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified; institution requirements of the Findings and Determination are followed, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner. When it becomes necessary to relocate a drill site, the SSO has the authority to make the final decision regarding the new location based on safety considerations.

SOP Specific Responsibilities

5.5 Hydrogeology Team Leader (HTL)

The HTL is responsible for ensuring that the Drilling Work Plan and Sampling Plan are properly implemented by coordinating the work with the PL, RI, and Drilling Coordinator. The HTL is also responsible for coordinating with the PL to ensure that the drilling is consistent with Program Site Execution Plans and objectives, the work is authorized, and funding is available to complete the work prior to starting work. The HTL is responsible for notifying the PL if the work scope changes significantly such that costs, schedules, or the achievement of its objectives are impacted. The HTL has the authority to make decisions in the field that differ from the Drilling Work Plan or Sampling Plan provided these decisions do not alter the original objective of the well and do not increase the total cost estimate for the well.

5.6 Drilling Coordinator (DC)

The DC is responsible for reviewing the Drilling Work Plan and Sampling Plan and provides the interface between the Program Leader, Hydrogeologist, Drilling Geologist, and the field personnel; notifying Building Coordinators, Site Planning, and the Maintenance and Utilities Services Department (MUSD); coordinating any necessary surveys (utilities, biological, archaeological), permits (e.g. hot work permits), Findings and Determinations (F&Ds), and ensuring mudpits are in place prior to drilling; and monitoring the daily progress of drilling activities against procurement release orders. The DC is also responsible for ensuring drilling crew and geologist have training required in IWS and have reviewed applicable SOPs prior to conducting work. The DC is responsible for evaluating safety considerations in locating drill sites and interfacing with the HG and HTL as needed to relocate drill site to accommodate safety considerations.

5.7 Drilling Geologist Supervisor (DGS)

The DGS is responsible for assisting in the preparation of the Drilling Work Plan and Sampling Plan prior to commencing related work activities; coordinating the Drilling Geologist's (DG) work schedule and related activities, ensuring that the DG has all necessary equipment to perform the field work accurately and safely, monitoring and reporting the progress of daily activities, and conducting a quality review of field observations recorded on the borehole logs. The DGS is responsible for working with the DC, HTL, and Drilling Geologist to ensure that applicable SOPs and drilling work plans and sampling plans are followed.

5.8 Hydrogeologist (HG)

The HG's responsibility is to generate a Drilling Work Plan and Sampling Plan. The HG is responsible for the overall investigation, planning, assessment, and remediation within a study area. The HG is also responsible for reviewing borehole and geophysical logs.

5.9 Drilling Geologist (DG)

The DG is responsible for reviewing the Drilling Work Plan and Sampling Plan and conducting and documenting drilling, operational and safety procedures per the Integration Work Sheet (IWS) and the work plan(s), and to inform the DC, HG, and DGS of the progress of daily activities, including any non-conformances with, or deviations from the plan(s).

5.10 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review the Drilling Work Plan and Sampling Plan distributed by the HG or the DGS.

5.11 Data Management Team (DMT)

The DMT is responsible for reviewing the Drilling Work Plan and Sampling Plan and the disposition of original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

The drilling process should minimally alter the medium that is being investigated. It is essential that the drilling process does not introduce hazardous or foreign substances into the borehole or create conduits that facilitate the spread of existing contaminants. Various methods are used for drilling including hollow-stem augers, mud rotary (e.g., Mito Rotary Drill Rig), air or air-mist rotary, direct push, and sonic. In areas of multiple water-bearing zones at Site 300, conductor casings or intermediate casings may be used to isolate each encountered water-bearing zone.

6.1 Preparation

Drilling work shall be performed only when a current, valid Subcontract Release is in place. The DC is responsible for coordinating with the drilling contractor to obtain well-specific drilling estimates and schedules per the Drilling Work Plan for procurement release orders, working with the TRR to obtain release orders, notifying the TRR if cost or schedules are estimated to exceed release order limits, and working with the TRR to modify the release order before the cost or schedule limit is exceeded. Work performed in the absence or in exceedance of a release order will be considered an unauthorized procurement.

To prepare for drilling, the following steps are taken in chronological order:

6.1.1 Prepare the Drilling Work Plan and Sampling Plan. These plans are prepared by the HG or DGS who should review existing geologic and hydrogeologic information to determine drilling locations and estimate key parameters (e.g., sample depths, depth and thickness of geologic units, types and concentrations of soil and/or ground water contaminants, etc.). The Drilling Work Plan should include scope of work, drilling and sampling strategy, purpose of borings/wells, geophysical logging, and safety considerations. The Sampling Plan should include details regarding the number and depth of soil, rock, or ground water samples to be collected, sample identification names, turnaround times, analyses, and analytical laboratory.

6.1.2 Review the Drilling Work Plan and Sampling Plan. These plans are distributed via email to the DG, HG, HTL, DGS, DC, DMT, and the QAIC to review. The development and subsequent review of the Drilling Work Plan and Sample Plan is the initial step of the drilling preparation process. As part of the preparatory process, inform the appropriate Environmental Analyst of pending drilling activities as necessary. The DG should meet with the DC, HG, HTL, and DGS to discuss site conditions before drilling begins.

6.1.3 The DC or their designee will obtain an approved release order from an ERD Technical Release Representative (TRR) for the borehole/well and track the drilling progress against the release order for the duration of the work activity.

6.1.4 The DC should verify that underground utilities have been surveyed and necessary permits or approvals have been issued including F&Ds, National Environmental Policy Act (NEPA), wildlife, and archaeological surveys required by the PROC-CON-003 Soil Excavation and Permit process. Livermore Site drilling locations must be cleared to 5 ft below ground by MUSD personnel using "air knife" machinery to the maximum anticipated diameter of the borehole. The DC should also ensure the working areas are cleared of all brush and minor obstructions, as necessary.

6.1.5 The DG should obtain all soil, rock, and ground water sampling equipment that might be needed during the drilling and installation of the well as specified in the Drilling Work Plan and Sampling Plan and per the "Drilling Geologist Equipment Checklist" (Attachment A, SOP 1.3). Obtain the appropriate Personal Protective Equipment (PPE) as identified in the applicable IWS and/or Drilling Work Plan for the specific task being performed. SOP 4.1, Attachment B "Personnel Protective Equipment" provides a description of PPE, Levels A through D. The ES&H Manual, Document 11.1 provides general policy and information about PPE. There is a web-link from Document 11.1 to the PPE website that provides in-depth information on various types of PPE.

6.1.6 Decontaminate all downhole drilling and sampling equipment, including the drilling rig table or platform (SOP 4.5, "General Equipment Decontamination").

6.1.7 Ensure that no foreign materials are introduced into the borehole without the DC's approval. Use of solvents, glues, oil, or cleaners in the borehole is prohibited. Non-hydrocarbon based lubricants are acceptable for drill rod threads. The Material Safety Data Sheets (MSDSs) for the lubricants should be available. Use pure bentonite powder containing no polymers or chemical additives of any kind. Mud stabilization additives may be allowed in certain situations. The HG and/or HTL may grant such approval after communication with the appropriate regulatory agencies. Record the brand name and manufacturer of the bentonite and any drilling additive used on the Borehole Well Construction Log (SOP 1.1, "Field Borehole Logging," Attachment A). Handling and/or disposal of drilling-derived material (e.g., drill mud) will be managed in accordance with SOP 1.8, "Disposal of Investigation-Derived Wastes (Drill Cuttings, Core Samples, and Drilling Mud)."

6.1.8 Ensure that the drilling rig is free of any mud, leaking hydraulic lines, and excess grease that could be dislodged during drilling. If a leak occurs during drilling, place a drip pan or absorbent pad under the leak to contain it. Terminate drilling activities until the leak is repaired if it cannot be sufficiently contained. If air-rotary drilling is to be used, ensure that air systems include an in-line filter to remove all oil from the compressed air.

6.1.9 Prepare a Controlled Area (approximately 50 ft radius exclusion zone around drill rig delineated by barricades, caution tape, and appropriate signage) and conduct daily safety meeting(s). The DG should regulate access to the Controlled Area, obtain appropriate signs, and enforce PPE and training requirements. The DG conducts and documents daily safety meetings including topic, attendees, and the meeting time on the Daily Field Report (Attachment C, SOP 1.2), "Borehole Sampling of Unconsolidated Sediments and Rock."

6.2 Safety Considerations

6.2.1 Prior to drilling, perform the applicable preparation activities described in SOP 4.1, "General Instructions for Field Personnel". Personnel who are new to the LLNL project will receive direct field supervision and on-the-job training (OJT) from a qualified SARA/OSHA trained supervisor for at least the first 24 hours of field activity using the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.2.2 To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with IWS 12654 "Drilling in VOC and Mixed Waste-contaminated Soils at the Livermore Site" and IWS 11578 "Drilling in VOC-contaminated Soils at the Livermore Site". Drilling activities at Site 300 will be conducted in accordance with IWS 11276 "Site 300 Drilling Activity." Anyone can stop work at anytime if an unsafe condition is observed. The DC, HG, and DGS shall be notified immediately of the condition and the 'Stop Work' decision.

Monitoring Contaminated Areas During Drilling

6.2.3 Volatile Organic Compounds (VOCs)

The Drilling Geologist will use an Organic Vapor Meter (OVM)/photoionization detector (PID) or an Organic Vapor Analyzer (OVA)/flame ionization detector (FID) to monitor the highest concentrations of VOCs in air, where the drilling mud exits the borehole and flows into a mud tub or pit. If the hollow stem auger method is used, then the air will be monitored at the top of the borehole.

Prior to conducting work in an uncharacterized area or where high concentrations of VOCs are suspected that cannot be effectively monitored using a PID or FID detector, contact the Environmental Safety & Health (ES&H) Team to conduct a survey, if necessary. Frequently monitor drill cuttings and the work area for VOCs. Cease drilling operations and contact the RI as specified on the IWS, the ERD SSO, and/or the ES&H Team when:

- Readings exceed the time-weighted average (TWA) values, or exceed half of the threshold limit values (TLV) for known or suspected chemicals (see Attachment B for selected contaminant exposure limits),
- Breathing zone concentrations recorded by the field monitoring exceed twice background concentrations,
- 5 ppm is measured in the absence of background concentrations,
- There is evidence of contamination that could impact worker health and safety, or the environment, or
- Any other potentially unsafe conditions that are observed.

6.2.4 Radiological Constituents or Contaminants Other than VOCs

The ES&H Team is consulted to monitor an area contaminated with radiological constituents. The ES&H Team shall be contacted where high concentrations of other contaminants (e.g., PCBs, beryllium, mercury) are known or suspected that cannot be effectively monitored by ERD personnel.

6.3 Operation

6.3.1 Use the Borehole/Well Construction Log (SOP 1.1, Attachment A) to document field information and comments. Complete all lines on the forms. Use the letter designation “NA” (not applicable) or “NK” (not known) in all blank spaces. If some steps or procedures are not performed as described, state the reason on the Borehole/Well Construction Log and the Daily Field Report (Attachment C, SOP 1.2). The instructions for this form are included in SOP 1.1, “Field Borehole Logging.” Also complete a chronology of daily events on the Daily Field Report.

6.3.2 Borehole logging must conform with procedures provided in SOP 1.1. Borehole sampling for subsequent chemical/radiological analysis must conform with procedures described in SOP 1.2.

6.3.3 Screen samples of the drilling mud for VOCs using the PID or FID prior to entering lower hydrogeologic units to prevent possible cross-contamination between shallow and deeper zones. Prevent possible cross-contamination between shallow and deeper permeable water bearing zones as specified by the Work Plan.

6.3.4 Monitor the work environment in accordance with SOP 4.1 during all phases of the work.

6.3.5 Collect all soil/rock samples as specified in the Sampling Plan in accordance with SOP 1.3. Collect and store all cored sediments or rock according to SOP 1.15, "Well Site Core Handling."

6.3.6 If water is encountered in the borehole in which mud was not used, a bailed sample will be collected and placed on "Hold" until the HG/DGS authorizes the sample analysis. The HG/DGS will authorize the analysis based on the usefulness of the information obtained regarding potential contaminants. Samples should be named according to SOP 4.2, "Sample Control and Documentation." Record sampling information including the sample depth on the Borehole/Well Construction Log (SOP 1.1, Attachment C). Follow other appropriate SOPs such as SOP 2.4, "Sampling Monitor Wells with a Bailer" and SOP 4.3, "Sample Containers and Preservation."

6.3.7 In the event that an uncased borehole is left open more than 24 hours, the DG should consult with the HG to evaluate the need to take measures to prevent cross-contamination of water-bearing zones within the borehole, such as the installation of conductor casing.

Note: If the borehole is left unattended at any time, the DG should ensure that the borehole is covered and protected.

6.4 Post Operation

6.4.1 Perform post-work activities described in SOP 4.1, Section 6.4.

6.4.2 The DC should ensure that a daily driller's report is maintained and submitted by the drilling contractor. The report should give a complete description of the number of feet drilled, number of hours on the job, shutdown due to breakdown, length of casing set, materials used, and other pertinent data.

6.4.3 Handle all soil cuttings and waste materials according to SOP 1.8, "Disposal of Investigation-Derived Wastes (Drill Cuttings, Core Samples, and Drilling Mud)."

6.4.4 If temporary casing is needed (for reasons such as lost circulation or excessive caving), decontaminate the casing as outlined in SOP 4.5. The use of temporary casing is well-specific, the details of which use should be decided upon by the DG and HG.

6.4.5 The abandonment of any boring or well should be in accordance with appropriate state regulations and follow the procedures in SOP 1.7, "Well Closure."

6.4.6 The DG should deliver documents, and any other relevant information to the DGS to perform a quality control review. After reviewing and editing the documents, the DG will make final versions available in his/her outbox on the ERD server (erdfilespace). The DG will deliver final versions of original documents to DMT.

7.0 QUALITY ASSURANCE RECORDS

The ERD QA records identified below are to be created, managed, and preserved in accordance with SOP 4.10: Records Management.

7.1 Borehole/Well Construction Log

7.2 Chain-of-Custody Form

7.3 Field Logbook

7.4 Daily Field Report

8.0 ATTACHMENTS

Attachment A—Drilling Geologist Equipment Checklist

Attachment B—Exposure Limits for Selected Contaminants (Table B-1)

Attachment A

Drilling Geologist Equipment Checklist

Drilling Geologist Equipment Checklist

____ 300-ft weighted measuring tape
____ Any applicable permits (e.g., excavation, utility clearance, burn permits)
____ Applicable documents (e.g., SSP, IWSs, SOPs, work plan, sample plan)
____ Appropriate clothing (e.g., coveralls, steel-toed safety shoes, gloves)
____ Barricades/traffic cones
____ Buckets and brushes
____ Caution tape
____ Company ID sign for vehicle
____ Cooler with ice
____ Core boxes (tops, center dividers, bottoms)
____ Deionized water
____ Detergents (e.g., Alconox, Liquinox, TSP)
____ Disposable Teflon or polyethylene bailers
____ Document control logbook
____ Duct tape
____ Field forms (i.e., borehole/well construction forms, COC forms, daily field report forms)
____ Field notebook
____ Fire extinguisher
____ First aid kit
____ Geological Society of America rock color chart
____ Glass jar
____ Grain-size sieves
____ Hand lens (loop)
____ Hard hat
____ Hearing protection
____ Imhoff cone
____ Knife
____ Measuring wheel, measuring tape or ruler (engineering scale–10ths of feet)
____ Munsell soil/rock color chart
____ Nitrile or latex sampling gloves
____ Organic vapor meter (OVM, PID, or FID) or gamma beta meter if required
____ pH paper
____ Plastic bags
____ Permanent marking pen
____ Personnel Protective Equipment
____ Protractor
____ Rock hammer
____ Safety glasses
____ Safety shoes

____ Sample containers/labels
____ Sampling gloves (vinyl, latex, or nitrile, as appropriate)
____ Signs listing responsible persons, restricted entry, hearing protection/hard hat/safety glasses/safety shoes required
____ Soil sample tubes/caps
____ Steel measuring tape with engineering scale
____ Steel spatula or putty knife
____ Stopwatch or watch with second hand
____ String
____ Teflon tape (4 in. wide)
____ Water-level meter
____ Zip-Loc plastic bags

Attachment B

Exposure Limits for Selected Contaminants

Table B-1. Exposure limits for selected contaminants.

Chemical name	Exposure limits (TWA[b])	IDLH[c]
Arsenic[a]	0.002 mg/m^3[d] [15 min]	5 mg/m^3
Barium[a]	0.5 mg/m^3	50 mg/m^3
Benzene[a]	0.1 ppm	500 ppm
	1 ppm[e]	
Beryllium[a]	0.002 mg/m^3 (10 CFR 850, section 22)	4 mg/m3
	0.01 mg/m^3 [15 min] [e]	
	0.0002 mg/m^3 (AL) [f]	
Freon 113	1000 ppm	2,000 ppm
	(7600 mg/m^3)	
	1250 ppm[e]	
	(9500 mg/m^3)	
Mercury[a]	Alkly compounds: 0.01 mg/m^3, 0.03 mg/m3 [15 min]	2 mg/m^3
	Aryl compounds: 0.1 mg/m^3	10 mg/m^3
	Elemental and inorganic forms: 0.025 mg/m^3	10 mg/m^3
PCBs[a]	Chlorodiphenyl (42% chlorine): 1 mg/m^3	5 mg/m^3
	Chlorodiphenyl (54% chlorine): 0.5 mg/m^3	5 mg/m^3
Tetrachloroethylene	25 ppm	150 ppm
Toluene	100 ppm	500 ppm
	(375 mg/m^3)	
	150 ppm[e]	
	(560 mg/m^3)	
Trichloroethylene	25 ppm	1,000 ppm
Tritium[g]	0.2 mg/m^3	10 mg/m^3
	0.6 mg/m^3[e]	
Uranium[a]	0.2 mg/m^3	10 mg/m^3
	0.6 mg/m^3[e]	

Notes appear on the following page.

Table B-1. Exposure limits for selected contaminants. (Continued)

Notes:

[a] **Contaminants cannot be effectively monitored in the field using a PID or FID. Contact the ES&H Team to conduct a survey if working in an uncharacterized area or where high levels of these contaminants are suspected.**

[b] **Time-weighted average (TWA) concentrations for up to an 8-h workday during a 40-h workweek, unless noted otherwise.**

[c] **Immediately Dangerous to Life or Health concentrations.**

[d] **Indicates a ceiling value which should not be exceeded at any time.**

[e] **Short-term exposure limit is a 15-min TWA exposure that should not be exceeded at any time during a workday.**

[f] **The Action Level (AL) for beryllium is considered an exposure limit in that any exceedance above the AL requires notification to DOE and posting as a regulated Beryllium Work Area (BWA).**

[g] **There is no TLV or TWA for tritium. The MSDS for tritium uses the same TLV/TWA as for natural Uranium and is included in the table and in the Site Safety Plan for LLNL CERCLA Investigations at Site 300.**

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.4: Well Installation—Revision: 6

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CONCURRENCE:	Date
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Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to ensure proper well design and installation. Wells provide a means of collecting representative ground water samples and water-level data from a distinct water-bearing zone. Wells can also be used to extract contaminated ground water, or reinject treated ground water.

2.0 APPLICABILITY

This procedure is applicable for all personnel performing well installation operations, and shall be fully reviewed prior to conducting these activities. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Department of Water Resources (1991), *California Well Standards*: *State of California*, Resources Agency, Bulletin 74-90 (Supplement to Bulletin 74-81).

3.2 Driscoll, F. G. (1986), *Ground Water and Wells*, Johnson Division, St. Paul, Minnesota.

3.3 U.S. Environmental Protection Agency (1987), *A Compendium of Superfund Field Operations Methods*, EPA/540/p-87/001.

3.4 California Environmental Protection Agency, Department of Toxic Substances Control (1994), *Monitoring Well Design and Construction for Hydrogeologic Characterization*.

3.5 American Society of Testing and Materials (2004), *Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers*, ASTM D5092-04.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD

FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI) /Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Hydrogeology Team Leader (HTL)

The HTL is responsible for ensuring that the well is installed according to the Drilling Work Plan by coordinating with the Drilling Coordinator, Drilling Geologist Supervisor, and Drilling Geologist. The HTL has the authority to make decisions in the field that differ from the Drilling Work Plan provided these decisions do not alter the original objective of the well and do not increase the total cost estimate for the well.

5.6 Drilling Coordinator (DC)

The DC is responsible for coordinating with the driller, Drilling Geologist, Drilling Geologist Supervisor, and HTL to ensure that all supplies are available and that the well is installed according to the Drilling Work Plan.

5.7 Drilling Geologist Supervisor (DGS)

The DGS is responsible for coordinating with the Drilling Geologist, DC, and HTL to ensure the well is installed according to the Drilling Work Plan.

5.8 Hydrogeologist (HG)

The HG Is responsible for coordinating with the HTL, DC, DGS, and the Drilling Geologist to ensure that the well is installed according to the Drilling Work Plan.

5.9 Drilling Geologist (DG)

The DG is responsible for coordinating with the driller, HTL, DC, and DGS to ensure the well is installed according to the Drilling Work Plan.

5.10 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review the Drilling Work Plan and Sampling Plan distributed by the HG or the DGS and to review the incoming analytical data received from the contracted analytical laboratories as a result of this work activity.

5.11 Data Management Team (DMT)

The DMT is responsible for reviewing the Drilling Work Plan and Sampling Plan and the disposition of original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

Well installations create permanent access for collecting ground water samples, measuring aquifer characteristics, and extracting ground water or reinjecting treated water. Wells should only minimally alter the medium being sampled.

6.1 Preparation

6.1.1 Review Drilling Workplan for preliminary well completion information. After drilling, analysis, and logging, the original objectives may change. The HG and/or HTL may change how the well is to be completed. This change will be communicated to the DG by the HG and/or HTL and documented on the As-built report (Attachment A).

6.1.2 The DG should obtain all soil, rock, and ground water sampling equipment that might be needed during the drilling and installation of the well as specified in the Drilling Work Plan and Sampling Plan and per the “Drilling Geologist Equipment Checklist” (Attachment A, SOP 1.3). Obtain the appropriate Personal Protective Equipment (PPE) as identified in the applicable IWS and/or Drilling Work Plan for the specific task being performed. SOP 4.1, Attachment B “Personnel Protective Equipment” provides a description of PPE, Levels A through D. The ES&H Manual, Document 11.1 provides general policy and information about PPE. There is a web-link from Document 11.1 to the PPE website that provides in-depth information on various types of PPE.

6.1.3 Ensure that no foreign materials are introduced into the borehole without the DC’s approval. Use of solvents, glues, oil, or cleaners in the borehole is prohibited. Mud stabilization additives may be allowed in certain situations. The HG and/or HTL may grant such approval after communication with the appropriate regulatory agencies.

6.1.4 Decontaminate all equipment and well casing, screen, centralizers, etc. prior to monitor well installation per SOP 4.5, “General Equipment Decontamination.” It is not necessary to decontaminate pre-cleaned well casing, screen, and centralizers supplied in factory-sealed containers, unless exposed to possible contamination.

6.2 Safety Considerations

To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with IWS 11578 “Drilling in VOC-contaminated Soils at Livermore Site,” LLNL IWS 12654 “Drilling in VOC and Mixed Waste-contaminated Soils at the Livermore Site,” and LLNL IWS 11276 “Site 300 Drilling Activity.”

6.3 Operation

6.3.1 Drill all boreholes at least 4 in. greater in diameter than the outer diameter of the casing to be installed (minimum required work space in annulus is 2 in.). When setting a conductor casing, it is preferable to complete the casing a foot or more into the underlying clay or other fine-grained unit, if present. Bottom seals and the conductor casing annulus seal should be placed using Type II/IV cement/2% bentonite grout or bentonite chips as directed by the HG, HTL, or DGS. Approved grout accelerators, such as Cal Seal, are permitted for bottom and conductor casing annulus seals to decrease setting times.

Record the following on the Borehole/Well Construction Log (SOP 1.1, Attachment A) and/or the Monitoring Well As-Built Report (Attachment A):

A. Depth from surface grade of the following:

1. Bottom of the boring,
2. Overdrill (bottom) seal,
3. Well casing and screen,
4. Filter pack,
5. Fine filter pack,
6. Bentonite seal,
7. Grout,
8. Cave-in (slough),
9. Centralizers, and
10. Conductor casing, if permanent.

Note: Does not include wellhead completion specifications.

B. Composition of the grout, seals, and filter pack.

C. Casing/screen material and casing/screen inside diameter.

D. Screen slot size and the anticipated wellhead completion.

E. Type and amount of supplies used for well construction.

Note: Due to failure to reach specified depths, loss of tools, inadvertent contamination, or any other cause approved by the DC, HG or HTL, the well or borehole should be abandoned as discussed in SOP 1.7, “Well Closure.”

6.3.2 Use Schedule 80 PVC casing with 0.020-in. screen slot size for wells installed exclusively as monitor wells unless instructed otherwise by the DC, HG or HTL. If the well is installed to perform as an injection, extraction, or production well, the DC, HG, HTL, and DG, will determine the filter pack and screen slot size based on lithologic descriptions on the Borehole/Well Construction Log as per SOP 1.1, “Field Borehole Logging,” interpretation of geophysical logs as performed per SOP 1.6, “Borehole Geophysical Logging,” and if available, sieve analyses of the lithology in the screened interval. In addition, these personnel will determine the casing material (generally Schedule 80 PVC, stainless steel, or low carbon steel) based on site-specific conditions such as water quality, installation objectives, required tensile and compressive strengths.

6.3.3 Use stainless steel centralizers on all well installations unless the casing is being installed through hollow-stem augers. Fasten centralizers to the well casing by mechanical fasteners radially spaced about the casing at 120 or 90° degrees. Install centralizers at the top and bottom of the screened casing and on the blank casing at 5 to 10 ft below ground surface. Provide a description of the centralizer fastening device and the locations on the Borehole/Well Construction Log (Attachment A, SOP 1.1) and Monitoring Well As-Built Report (Attachment A).

6.3.4 Place a filter pack in the annulus adjacent to the well screen in all monitor wells. The filter pack limits the transmission of sand and fines from the formation to the well, and stabilizes the formation. The filter pack should not extend within 5 ft of any water-bearing zone other than the one to be monitored. Well design should be modified to allow for a sufficient filter pack without threat of interconnecting water-bearing zones.

A. Fill the annulus between the well screen and borehole wall with washed Lonestar Lapis Luster #3 Monterey-type sand (or an equivalent 8 × 20 U.S. standard sieve size or filter pack approved by the HG) extending a minimum of 1 ft above the screen before swabbing. A cap should be placed over the top of the well casing before pouring the sand down the annulus to prevent sand from entering the casing.

B. When determined by the DC, HG or HTL, the filter pack is emplaced using a tremie pipe. For this, install a sand slurry composed of sand and potable water through the tremie pipe into the annulus throughout the entire screened interval and over the top of the screen. Continuously tag the depth of the filter pack to ensure that bridging does not occur.

C. Compact the filter pack by making a few passes with a bailer (swabbing) prior to the installation of the bentonite seal. Fully cover the screen after the sand has settled with sufficient filter material. Install at least 2 ft of sand above the top of a 5- to 10-ft-long screen. Increase the minimum filter pack thickness by approximately 1 ft for each additional 10 ft of screen. Cover the #3 sand with a minimum 1-ft layer of finer-grained Lonestar Lapis Luster Monterey-type sand #0/30 (or equivalent). The #0/30 sand is not added until it is verified that the #3 sand extends above the screen as discussed above. Attachment B displays a typical installation using the #0/30 sand.

D. Ascertain the depth of the top of the sand after compaction using a weighted tape or tremie pipe recorded by the DG.

6.3.5 Place a bentonite seal between the filter pack and grout to prevent infiltration of cement into the filter pack and the well. The bentonite should not be added until it is determined that there has been no settling of the filter pack. The steps below discuss the use of bentonite. Attachment B displays a typical installation using bentonite. A fine sand (#0/30) may be used on top of the bentonite seal if conditions warrant as determined by the driller and DG and approved by the DC.

A. Fill the annulus between well casing and borehole with a bentonite seal at least 3 ft thick (vertically) in the interval between the fine sand above the filter pack and the grout seal. Bentonite seal thickness may be increased by an extra foot for each additional 50 ft of depth for deep wells (200 ft or more).

B. Use uncoated bentonite pellets with a minimum purity of 90% sodium montmorillonite (with no additives and certified by the National Sanitation Foundations (NSF) to ANSI/NSF Standard 60, Drinking Water Treatment Chemicals - Health Effects) and a minimum dry bulk density of 75 lb/cu ft for 1/2-in. pellets. Place a cap over the top of the well casing and slowly pour the bentonite pellets directly down the annulus. Pour the pellets from different points around the casing to ensure even distribution in the annulus. Test the borehole for bridging of the bentonite during application. Bentonite chips, certified to ANSI/NSF Standard 60, may be used to reduce bridging problems and costs. Add enough approved clean water, usually 10 to 20 gal, to completely hydrate the bentonite.

C. Tag the top of the bentonite seal with a tremie pipe or a weighted tape to verify that the proper thickness of seal has been placed in the annulus.

D. Allow at least 1 h for the bentonite pellets to hydrate prior to placing grout.

6.3.6 Fill the well annulus with grout from the top of the bentonite seal to the surface. Only Type II/IV [American Society for Testing and Materials (ASTM C-150)] cement without accelerator additives may be used, unless otherwise specified by the DC. Place the grout in the well annulus as follows:

A. Completely fill the annulus between the well casing and borehole wall.

B. Place the grout with a tremie pipe unless the borehole is dry and does not exceed a depth of 30 ft. The tremie pipe typically used is 1.25-in. PVC.

C. Pump the grout through this pipe to the bottom of the open annulus until undiluted grout flows from the annulus at the ground surface. Deeper annular depths and larger diameter boreholes may require large amounts of grout. In these cases, set grout in 100 to 150-gal lifts, allowing sufficient time for the grout mix to set between lifts. Use approved accelerators such as Cal-Seal, to decrease setting times only with approval of the DC. Certain subsurface/borehole conditions may require an initial small lift of grout (<15 ft) to prevent rupturing the bentonite seal. The DG should check with the DC, HG, and a HTL on each completion.

D. The grout should consist of a neat cement mix composed of 2 lb of commercial bentonite powder, certified to ANSI/NSF Standard 60, and approximately 6.5 gal of water added per 94-lb bag of cement. Only grout mixed with approved water should be used.

E. After the grout has set (about 72 h), fill any depression in the grout due to settlement with a grout mix similar to that described above. Install a copper grounding rod (see ERD electrical engineering or DC for specifications) with the exposed end looped back into the cement.

F. The DG shall write with an indelible marker, the well ID number, screened interval, and total depth of the well, on the well casing and cap.

6.3.7 Install a protective stove pipe or a below-grade vault around all monitor wells. This will normally be done at a later date by LLNL technicians. Prior to installation, the DG should ensure temporary wellhead protection by placing barriers around the well. The minimum elements in the protection design should include:

A. Protective stove pipe (above grade).

1. Install a minimum 2 ft × 2 ft, 3-in.-thick concrete pad, such that surface drainage is diverted away from the wellhead.

2. Secure a metal stovepipe to the concrete pad. The stovepipe must keep precipitation out of the well and is secured by a padlock. The exact height of the top of the well casing and stovepipe is recorded electronically.

3. Place the well identification label on the protective casing.

B. Vault (installed below grade when wells are located in streets, parking lots, or sidewalks).

1. Install the vault so that surface drainage is diverted away from the vault.

2. The lid of the vault must keep fluids out of the vault and have a key locking system.

3. Install a traffic-rated vault for installations in streets or parking lots.

6.4 Post Operation

6.4.1 Perform post-work activities described in SOP 4.1, Section 6.4.

6.4.2 Return the site to its original condition, using best reasonable efforts, and notify the DC that the well is completed and is ready for surveying and pump installation.

6.4.3 Arrangements will be made to have the LLNL Survey Team survey the elevation from mean sea level of the cement pad or the edge of the vault to the nearest 0.01 ft. A shiny, metal well identification tag (shiner) is attached to the survey location (concrete pad or edge of vault) by the Survey Team with the well ID stamped on the tag. The survey data will be submitted to the DMT.

6.4.4 The DGS will perform a quality control review of the documents. After reviewing and editing the documents, the DG will make final versions available in his/her outbox on the ERD server (erdfilespace). The DG will deliver final versions of original documents to DMT and logbooks (when complete) for storage.

7.0 QUALITY ASSURANCE RECORDS

The ERD QA records identified below are to be created, managed, and preserved in accordance with SOP 4.10: Records Management.

7.1 Borehole/Well Construction Log

7.2 Document Control Logbook

7.3 Monitoring Well As-Built Report

8.0 ATTACHMENTS

Attachment A—Monitoring Well As-Built Report

Attachment B—Typical Monitor Well

Attachment A

Monitoring Well As-Built Report

Project ____________________

Location ____________________

Job No. ____________________

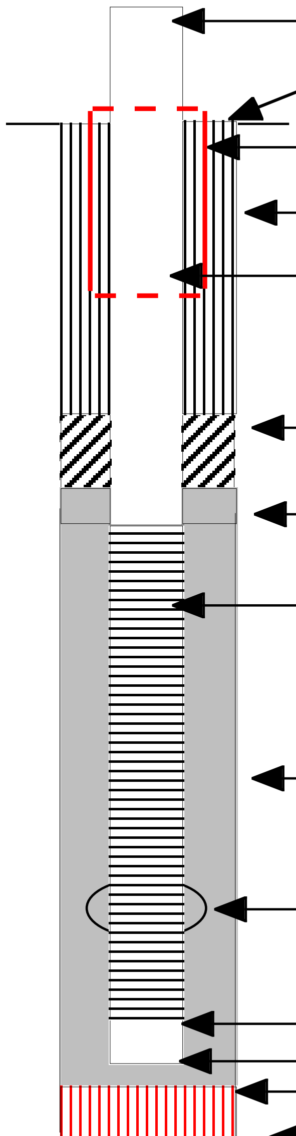
Observed By ____________________

Boring/Well No. ____________________

Driller/Installer ____________________

Date ____________________

NOTE: final wellhead completion details not included



Top of well casing (+/- ft above/below ground surface)

Ground surface

Surface/Conductor casing I.D./Type __________

Depth to bottom __________ Height above/below ground surface __________

Grout type ____________________

No. of sacks __________

Well Casing I.D. ____________________

Type of casing ____________________

Bentonite seal type ____________________

No. of sacks __________

Depth to top __________

Fine filter pack size __________

No. of sacks ____________________

Depth to Top __________

Well screen I.D. ____________________

Type of screen ____________________

Slot size __________

Depth to top __________

Filter pack size __________

No. of sacks __________

Depth to top __________

Centralizer locations @ ______________ ft.,

______________ ft., and ______________ ft.

Bottom of screen, Depth ____________________

Bottom of casing/Sump/End cap, Type __________ Depth __________

Bottom seal, Type of seal __________ Depth to top __________

Bottom of borehole

ERD-SOP-9-00-rtd

Remarks ____

____

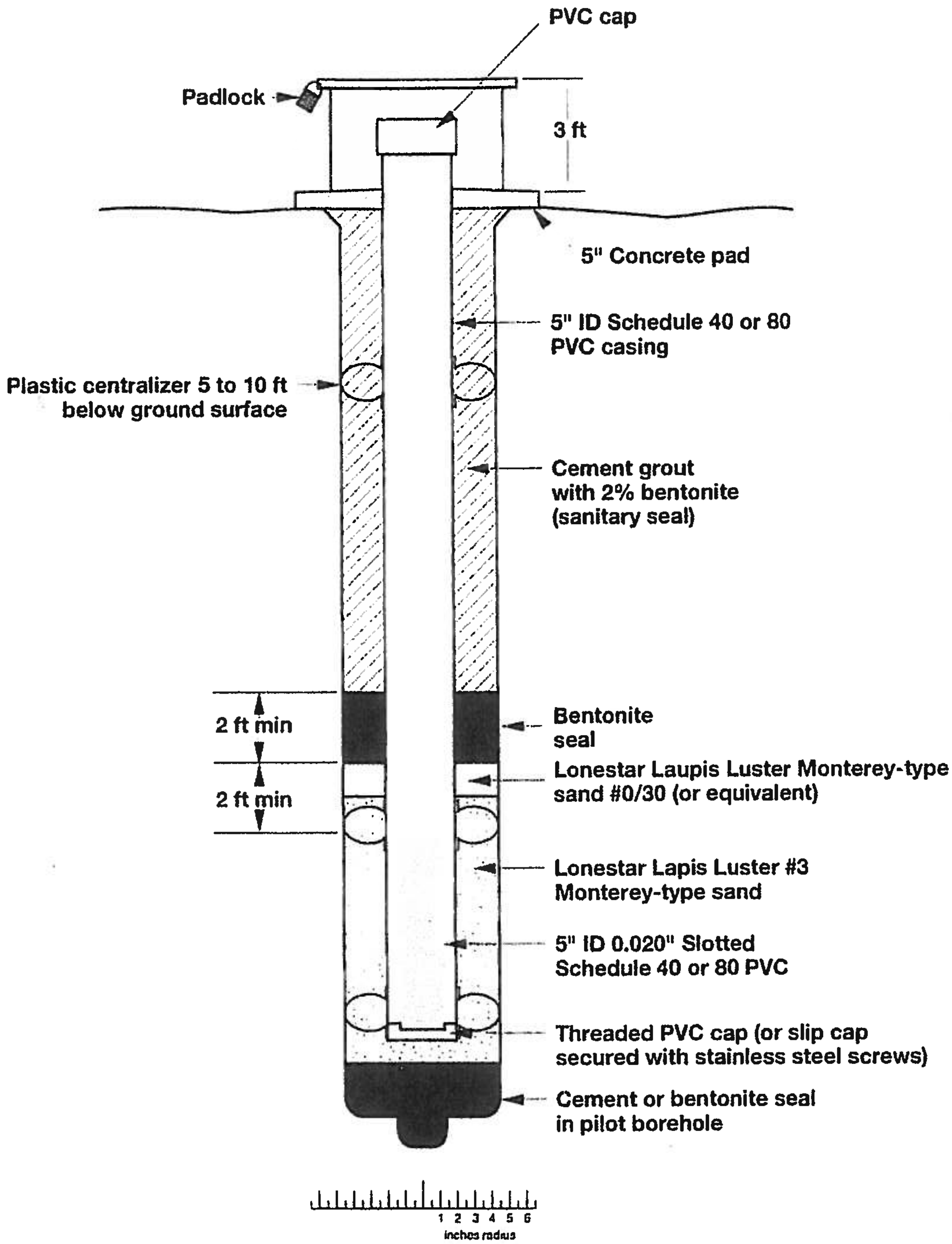
____

ERD Approval By ____________________

Attachment A. Monitoring Well As-Built Report.

Attachment B

Typical Monitor Well



ERD-LSR-06-0028

Attachment B. Typical Monitor Well.

LLNL Environmental Restoration Department (ERD) Standard Operating Procedure (SOP)	
ERD SOP 1.5: Initial Well Development—Revision: 7	
	AUTHOR(S): **M. Buscheck and V. Madrid**
ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # ERD	**APPROVALS:** **Date** Jesse Yow 12/21/15 **Department Head** 12/17/15 **Livermore Site Program Leader** Leslie Ferry 12/15/15 **Site 300 Program Leader**
	CONCURRENCE: **Date** Rebecca Goodrich 1/7/16 **QA Implementation Coordinator**
Type of Procedure (per ES&H Manual, Document 3.4) ☒ Informational Use ☐ General Use ☐ Continuous Use	

1.0 PURPOSE

The purpose of this SOP is to describe procedures for initial well development. The purpose of initial well development is to remove materials introduced into the ground water, sand pack, and well screen during drilling and well installation. Initial well development is conducted while the drilling rig is still on location. Final well development will be conducted later in accordance with SOP 1.14: "Final Well Development/Specific Capacity Tests at LLNL Livermore Site and Site 300".

2.0 APPLICABILITY

This procedure is applicable for all personnel performing initial well development operations, and should be fully reviewed prior to conducting these activities. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Barcelona, M. J., Gibb, J. P., Helfrich, J. A. and Garske, E. E., *Practical Guide for Ground Water Sampling*, Washington, D.C., U.S. Government Printing Office, EPA 600/2-85/104, 1985.

3.2 Driscoll, F. G. (1986), *Groundwater and Wells*, Johnson Division, St. Paul, Minnesota.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Hydrogeology Team Leader (HTL)

The HTL is responsible for ensuring the initial well development is performed according to the Drilling Work Plan by coordinating with the Drilling Coordinator, and Drilling Geologist. The HTL has the authority to make decisions in the field that differ from the Drilling Work Plan provided these decisions do not alter the original objective of the well and do not increase the total cost estimate for the well.

5.6 Drilling Coordinator (DC)

The DC is responsible for coordinating with the driller and Drilling Geologist to ensure all supplies are available to conduct initial well development according to this SOP.

5.7 Drilling Geologist Supervisor (DGS)

The DGS is responsible for reviewing initial well development data for QA/QC purposes and to ensure the data are transferred to the Data Management Team.

5.8 Drilling Geologist (DG)

The DG is responsible for working with the driller, the HTL, and the DC to ensure that the initial well development is conducted according to this SOP.

5.9 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review analytical data received from the contracted analytical laboratories for any samples collected during initial well development.

5.10 Data Management Team (DMT)

The DMT is responsible for generating routine quarterly sampling plans and distributing to the SC to supply to field personnel. DMT is also responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

The primary methods used to develop wells are surge-block/bail and air lift. These techniques are used to increase well production and reduce water turbidity by removing introduced sediments from the formation filter pack and well screen area.

6.1 Preparation

6.1.1 The DG should obtain relevant information on each well to be developed (e.g., drilling technique, drilling fluid losses, anticipated aquifer yield, screened interval, anticipated contaminants, etc.).

6.1.2 The DG should obtain all soil, rock, and ground water sampling equipment that might be needed during the drilling and installation of the well as specified in the Drilling Work Plan and Sampling Plan and per the "Drilling Geologist Equipment Checklist" (Attachment A, SOP 1.3). Obtain the appropriate Personal Protective Equipment (PPE) as identified in the applicable IWS and/or Drilling Work Plan for the specific task being performed. SOP 4.1, Attachment B "Personnel Protective Equipment" provides a description of PPE, Levels A through D. The ES&H Manual, Document 11.1 provides general policy and information about PPE. There is a web-link from Document 11.1 to the PPE website that provides in-depth information on various types of PPE.

6.1.3 Decontaminate all equipment used during initial well development per SOP 4.5, "Equipment Decontamination."

6.1.4 Obtain sufficient collection containers such as 55-gal drums or portable tankers for temporary storage of well development water according to SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids, or SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids." At Site 300, purged water is typically discharged directly to the cuttings pit, adjacent to the well. Ensure that:

A. Containers have no leaks.

B. Containers, such as 55-gal drums, are stabilized to prevent spillage.

C. Containers are field manageable. The use of truck- or trailer-mounted tanks may be necessary for particularly large volumes of water.

D. Containers are labeled as non-potable purge water.

6.1.5 Check the source(s) of water to be introduced into the borehole. Use analyte-free water. Request analysis if none exist prior to field operations.

6.2 Safety Considerations

To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with IWS 12654 "Drilling in VOC and Mixed Waste-contaminated Soils at the Livermore Site", IWS 11578 Drilling in VOC-contaminated Soils at the Livermore Site," and IWS 12545 "Operation of the AMS

TR7000 Well Management System." Drilling activities at Site 300 will be conducted in accordance with IWS 11276 "Site 300 Drilling Activity."

6.3 Operation

Initial well development should be performed as soon as practical after well installation. Development may begin prior to fully installing the sanitary seal, as determined by the HTL.

6.3.1 Measure depth to water according to SOP 3.1, "Water Level Measurements," and measure the total depth of the well.

6.3.2 Record all information on the Initial Well Development Data Form (Attachment A).

6.2.3 Remove any residual drilling mud from the casing by bailing or flushing with potable water through a tremie pipe. Introduce just enough water to remove the drilling mud.

6.3.4 Segregate removed drilling mud from the formation water, if possible. Use drilling contractor's mud tank to collect unthinned drilling mud and initial muddy formation water.

6.3.5 Begin initial well development using a surge-block/bailer based on the number of well casing volumes. Depending on site specific conditions, follow with additional surge-block/bailing, airlift, or a combination of the two methods

Surge-block/bailer

Use a surge-block/bailer until the water is relatively sediment-free (less than 3 ml/L sediment measured within an Imhoff cone). If a well cannot produce enough formation water because the aquifer yields insufficient water, small amounts of potable water may be introduced only with the approval of the HG or HTL. When most of the sediment is removed, continue development with formation water only, if possible.

Air Lift

To prevent forcing a pocket of air into the sand pack while air lifting and possibly reducing the yield of the well, it is important to use dual tube airlifting. This process involves diverting an air line into an eductor pipe in the well to create a vacuum that "lifts" the ground water to the surface. Two-inch PVC as the eductor pipe, and 1-in. tremie pipe with a "J" attachment as the air line may be used. In this arrangement, the "J" end extends several inches into the bottom opening of the 2-in. PVC. At the surface, compressed air is fed through the tremie pipe, travels down through the submerged "J" tube, and travels back to the surface through the 2-in. PVC. This process creates a vacuum in the PVC casing that "lifts" the ground water out of the well and allows for easy containment of the purged water. Start dual-tube air lifting about 10 ft above the top of the screen, and use just enough air pressure to develop a flow. Gradually increase air pressure to maximize flow. Make periodic water level measurements to ensure the water level in the well casing does not fall below the top of the screen to avoid injecting air or fines into the sand pack. Surge air pressure periodically to make the water column rise and fall. Note the time it takes for the water to clear between successive rounds of surging. Effective surging is indicated by decreasing time for water to clear. Ensure that the compressed air is filtered before introduction into the well. All collected purge water should be treated or disposed in accordance with SOP 4.7A or SOP 4.7B.

6.3.6 Visually note the initial water color, clarity, odor and pH (using pH paper) of the purge water, and record on the Initial Well Development Data Form (Attachment A). The pH is checked primarily to ensure there is no grout or cement contamination. The majority of the ground water falls in a pH range of between 7 and 9. If the pH of the purged water at the end of development is above 9.5, the condition of the well should be evaluated for grout invasion. This is especially apparent if the pH is higher at the start of development and slowly declines as more water is removed from the well, but rises to higher levels upon ceasing the purging process. Further air development may need to be performed until a lower pH is obtained.

6.3.7 Record all initial well development method(s) including flow rate, water clarity, odor, water levels, recovery rates, quantity of water evacuated, pH, and sediment content (using a 1-liter Imhoff cone).

6.3.8 Develop the well until it is sediment free. An Imhoff cone should be used to determine when there is no further improvement in well sediment levels. As a general rule of thumb, sediment should consist of 3 ml/L or less in the cone when initial development is complete. A final pH check using pH paper should be conducted to ensure there is no cement contamination. Water chemistry parameters, including pH, specific conductance, temperature, and when possible, dissolved oxygen, and redox potentials, will be carefully scrutinized at the first routine sampling event to ensure the well was properly developed.

6.3.9 Contain all water produced during development. Determination of the appropriate treatment prior to disposal will be based on a chemical analysis of the water or at Site 300, purge water can be discharged directly to the mud pit adjacent to the well. If the drill site does not contain a mud pit, then the DC is responsible for managing the initial well development effluent in accordance with SOP 4.7A and SOP 4.7B.

6.3.10 The initial well development flow rate will be estimated based on measuring extraction flow rate and water levels during recovery. This initial well development estimated flow rate will be reported on the Initial Well Development Data Form. In some cases, the yield is too low for any purging device. These cases should be labeled as low yielding monitoring wells or dry-out wells (SOP 2.7, "Presample Purging and Sampling of Low-Yielding Monitor Wells").

6.3.11 Collect a bailed water post-development sample as specified in the Sampling Plan. The HG or HTL will specify the required analyses. Post-development samples are identified differently than routine bailed water samples. For example, a post-development bailed water sample collected from well W-815-2110 would be identified as well W-815-2110-IWD (Initial Well Development). Post-development samples should be collected after full recovery of the static water level, if practical. The static water level should be measured before sampling and recorded on the Borehole/Well Construction Log.

6.4 Post Operation

6.4.1 Perform post operation activities as described in SOP 4.1, "General Instructions for Field Personnel," Section 6.4.

6.4.2 The DGS will perform a quality control review of the documents. After reviewing and editing the documents, the DG will make final versions available in his/her outbox on the ERD server (erdfilespace). The DG will deliver final versions of original documents to DMT and logbooks (when complete) for storage.

7.0 QUALITY ASSURANCE RECORDS

The ERD QA records identified below are to be created, managed, and preserved in accordance with SOP 4.10: Records Management.

7.1 Borehole/Well Construction Log

7.2 Chain-of-Custody Form

7.3 Document Control Logbook

7.4 Initial Well Development Data Form

8.0 ATTACHMENTS

Attachment A—Initial Well Development Data Form

Attachment A

Initial Well Development Data Form

WEISS ASSOCIATES

WELL DEVELOPMENT DATA

By: ______________________ Sheet _____ of _____

Well No. / Location: ______________________ Job Name: ______________________

Date: ______________________ Job No: ______________________

Development Method(s): ______________________

Depth to Water Before Development (ft): ______________________ Sounded Depth (ft): ______________________

Screened Interval (ft-ft): ______________ Spec. Depth (ft): ______________ Well Diameter (in): ______________

Time	Depth to Water (ft)	Gallons Pumped	Flow Rate (gpm)	Comments (water clarity, odor, methods, sounded depth, etc.)

Well Development Summary

Depth to Water During Pumping (ft): ______________________ Approximate Yield: ______________________

Depth to Water After Development (ft): ______________________ Average Pumping Rate (gpm): ______________________

Sounded Depth After Development (ft): ______________________ Pumping Rate Range (gpm): ______________________

Total Pumping Time (min): ______________________ Total H_2O Injected (gals): ______________________

Total Amount Evacuated (gals): ______________________

Note: All depths measured in feet below ground water surface (bgs).

Attachment A. Initial well development data form.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.6: Borehole Geophysical Logging—Revision 6

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#
ERD

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APPROVALS:	**Date**
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CONCURRENCE:	**Date**
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Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

1.1 Borehole geophysics is a subsurface characterization method that involves *in situ* measurement of the physical properties of geologic materials penetrated by boreholes. Properly calibrated borehole geophysical (wireline) measurements can be used to define lithologic units, make correlations between wells, and estimate detailed quantitative hydrogeologic property profiles of the lithologic units.

1.2 This SOP specifies procedures for conducting standard borehole geophysical logging operations at the Livermore Site and Site 300. The standard suite of geophysical logs used (summarized in Attachment A) at the two sites may include:

A. Natural Gamma Radiation Log (NGL).

B. Electromagnetic Induction Log (IL).

C. Spontaneous Potential Log (SP).

D. Electrical Resistivity Log (E-Log).

E. Guarded Electrode Resistivity Log (GL).

F. Borehole Video Log (BVL).

G. Three-Arm Caliper Log (CL).

H. Acoustic Borehole Televiewer (BHTV).

I. Digital Optical Televiewer (OPTV)

J. Neutron Log (NL).

K. Full Waveform Sonic (FWS)

L. Deviation Survey (DS).

2.0 APPLICABILITY

2.1 Geophysical logging shall be performed only when a current, valid Subcontract Release is in place. The Hydrogeology Team Leader is the Technical Release Representative (TRR) for the geophysical logging contract and is responsible for ensuring services rendered by the subcontractor meet contractual requirements.

2.2 ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

2.3 The main application of borehole geophysics at LLNL is subsurface characterization. Geophysical logs are semi-continuous calibrated physical property measurements of the materials penetrated by the borehole. Because of this, the logs are internally consistent, and can be used to correlate lithologic indicators between boreholes. A wide variety of borehole geophysical logging tools that measure several different physical properties are available. Not all available logging tools are needed for a given logging operation. In order to select an appropriate suite of geophysical tools for a given site, it is important to consider the conditions in the borehole which are influenced primarily by the hydrogeology encountered and the drilling method used.

2.4 Livermore Site boreholes are commonly fluid filled due to mud rotary drilling operations and because saturated formation conditions are encountered between 30 and 120 ft below ground surface (bgs). Given these borehole conditions, the recommended logging suite for the Livermore Site boreholes consists of the following logs: CL, NGL, SP, E-Log, Guard Log and IL. The order the logs are run is determined by borehole conditions.

2.5 Saturated formation conditions at Site 300 are encountered at a wide range of depths between 15 and 500+ ft bgs, depending mainly on surface elevation. Site 300 boreholes are commonly air filled above the water table because minimal quantities of fluid are introduced into the borehole during air-mist rotary drilling operations. Therefore, the recommended logging suite for Site 300 boreholes consists of the following logs: CL, NGL, IL, and OPTV. The order the logs are run is determined by borehole conditions. If the Site 300 are mud-rotary driven or water-filled air/mist rotary drilled, the GL is also recommended.

2.6 NGL and IL logs can be run in air-filled or fluid-filled, uncased boreholes or polyvinyl chloride (PVC)-cased wells. In addition, NGL logs can be run in air filled or fluid filled steel cased wells. Whenever possible, geophysical logging costs can be minimized by logging several wells per mobilization. This approach minimizes mobilization costs and eliminates rig standby costs.

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4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI) /Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Hydrogeology Team Leader (HTL)

The HTL is responsible for ensuring that the Geophysical Logging program in the Drilling Work Plan is properly implemented by coordinating the work with the Drilling Geologist Supervisor and Drilling Coordinator. The HTL is responsible for notifying the PL if the Geophysical Logging program changes significantly such that costs, schedules, or the achievement of its objectives are impacted. The HTL has the authority to make decisions in the field that differ from the Geophysical Logging program in the Drilling Work Plan provided these decisions do not alter the original objective of the well and do not increase the total cost estimate for the well.

5.6 Drilling Coordinator (DC)

The DC is responsible for notifying the geophysical logging contractor, coordinating, and scheduling geophysical logging activities.

5.7 Drilling Geologist Supervisor (DGS)

The DGS is responsible for working with the DC, HTL, and Drilling Geologist to ensure that applicable SOPs and the geophysical logging program specified in the Drilling Work Plan is followed. The DGS is also responsible for working with the Data Management Team (DMT) to ensure that geophysical data is uploaded into the ERD database.

5.8 Hydrogeologist (HG)

The HG is responsible for reviewing the geophysical logs.

5.9 Drilling Geologist (DG)

The DG's responsibility is to provide the geophysical logging contractor with a logging program and documenting all logging operations on the *Wireline Logging Summary* (Attachment B), ensuring that the correct logs are run in the specified order, and all calibration and QA/QC procedures specified in the *Proposed Borehole Geophysical (Wireline) Log Measurement Protocols for Environmental Monitor, Injection, and Extraction Wells* are carried out. The *Log Quality Control Check List* excerpted from the *Proposed Wireline Measurement Witness Responsibilities and Check Lists for Environmental, Monitoring, Injection, an/or Extraction Wells* provides additional QA/QC guidance to be followed when completing the Wireline Logging Summary (referenced documents are stored on ERD's server and are accessible via the following pathway <erdfilespace/departmentspace/QA_ESH/SOPs>).

5.10 Geophysical Logging Contractor

The geophysical logging contractor's responsibility is to provide a qualified logging engineer (person qualified and familiar with logging equipment, operations**,** LLNL procedures) and the following:

- Properly calibrated logging tools.
- Sufficient back-up tools to ensure that all requested services will be successfully performed.
- Ensure that all measurements have a common depth basis (i.e., depth-matched data).
- Mud/mud filtrate resistivities (R_m, R_{mf}).
- Borehole corrected data.

- Paper copy field prints of all logs at the proper depth and horizontal scales.
- Paper and reproducible copy final prints of all logs at the proper depth and horizontal scales.
- Mud density and viscosity.
- Log ASCII standard (LAS)-formatted diskettes containing all digital measured and processed log data.
- CDs containing color image files of OPTV log runs.

5.11 Data Management Team (DMT)

The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

6.1 Discussion

6.1.1 Borehole geophysical measurements are obtained from geophysical logging tools suspended in uncased boreholes or cased wells. These tools measure a variety of physical properties of geologic materials penetrated by the borehole, including:

A. Formation electrical resistivity or conductivity.

B. Formation electrochemical contrasts between the borehole and *in situ* fluids.

C. Formation natural gamma ray emissions.

D. Borehole diameter.

E. Formation acoustic velocity.

F. Formation hydrogen ion concentrations.

G. Acoustic reflectance of the borehole wall.

6.1.2 Measurements are made as the tool is pulled up the borehole at a constant rate on a multi-conductor armored cable (or wireline) using a power supply at the surface (Attachment C). Measurement depth is controlled by passing the cable over a calibrated sheave. Downhole data are transmitted via the cable to a computer at the surface where the data are stored and processed. Geophysical logs are paper copy records of borehole measurements plotted with amplitude on the horizontal axis and depth on the vertical axis.

6.2 Office Preparation

6.2.1 Develop a logging program that is consistent with the expected borehole conditions and characterization objectives. The logging program should specify all pertinent borehole information, such as:

A. Borehole identification number.

B. Borehole location.

C. Bit size.

D. Surface elevation (if available).

E. Services requested (logs) and order for running logs.

F. Drilling fluid type.

G. Casing details.

H. Amplitude and depth scales for each log.

6.2.2 Coordinate drilling operations with desired logging conditions.

A. E-Log, FWS, and GL cannot be run in air-filled or cased boreholes.

B. BHTV should not be run in an air-filled borehole.

C. OPTV should not be run in mud filled boreholes.

6.2.3 Notify the logging contractor 24 to 48 hr ahead of time of the required logging tools and appropriate contractual information (e.g., release numbers, etc.) before logging operations begin.

6.2.4 When logging operations are planned for existing wells, notify the Engineering Group two to three weeks prior to logging to schedule pump removal(s), if necessary.

6.3 Safety Considerations

To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with IWS 11578 "Drilling in VOC-contaminated Soils at Livermore Site," LLNL IWS 12654 "Drilling in VOC and Mixed Waste-contaminated Soils at the Livermore Site," and LLNL IWS 11276 "Site 300 Drilling Activity." The work will be conducted under the direction of a DG.

6.4 Field Preparation

6.4.1 Provide the logging engineer with a logging program (usually included in the Drilling Work Plan), and discuss any unusual conditions or departures from standard protocol prior to logging operations.

6.4.2 Provide logging engineer with the following information for the log header:

A. Borehole location.

B. Borehole ground level elevation.

C. Borehole depth.

D. Fluid level.

E Depth of any potentially problematic zones.

6.4.3 Prepare surface electrode locations for those wells to be logged by E-log and/or Guard log by wetting the site daily to lower electrode contact resistances.

6.4.4 When logging mud-rotary boreholes, a 2- to 5-gal sample of the drilling mud will be collected during borehole conditioning and set aside for the logging contractor to determine mud resistivity (Rm), mud cake resistivity (Rmc), mud filtrate resistivity (Rmf), mud density, and mud viscosity.

6.4.5 Remove pumps from any wells prior to cased-hole logging operations.

6.5 Logging Order

6.5.1 Livermore Site

In uncased boreholes, run the E-Log, followed by natural gamma ray, guarded electrode resistivity log, and induction log. Because the caliper log could disturb the mud cake that protects the borehole, causing the borehole to collapse, the caliper log should be run last. If unusual borehole conditions develop, which could significantly increase the risk of losing a logging tool, the DG and DC should be notified before continuing logging operations.

6.5.2 Site 300

In uncased boreholes, the caliper log is usually run first to evaluate any unusual hole conditions (i.e., large diameter "wash outs" or small diameter "tight" zones). In situations where an OPTV log is desired and borehole stability is known to be good, it is preferable to run the OPTV tool first in order to obtain the best quality image. If unusual borehole conditions develop, which could significantly increase the risk of losing a logging tool, the DG and DC should be notified before continuing with logging operations.

6.5.3 Both Sites

E-Logs, guard logs, FWS, and BHTV must be run in uncased, fluid-filled boreholes. Electromagnetic induction logs cannot be run in metallic cased wells, but yield excellent results in PVC-cased boreholes. Natural gamma ray logs can be run in cased wells or uncased boreholes.

6.6 Calibration

6.6.1 Basically, there are three types of tool calibration standards:

1. Primary calibration standards involve permanent test pits, which are primarily used to calibrate logging tool prototypes, and shop standards.
2. Secondary or shop calibration standards are transportable calibration standards that are referenced to the primary standards. Shop standards are often too bulky to be easily transported to field sites. Logging sondes should be checked against these standards on a monthly basis.

3. Tertiary or field standards are compact enough that they can be easily taken to the field to verify that the sonde calibration has not drifted from the shop calibration at each logging job.

6.6.2 Conduct all tool calibration and QA/QC procedures in accordance with the guidelines provided in the *Proposed Borehole Geophysical (Wireline) Log Measurement Protocols for Environmental Monitor, Injection, and Extraction Wells*.

6.7 General

6.7.1 Document all logging operations on a *Wireline Logging Summary* (Attachment B).

6.7.2 Always repeat geophysical logs over intervals of at least 50 ft., including completion interval(s), intervals of log response extremes, and any zones of questionable data on the main log. Display repeat sections on all field and final prints.

6.7.3 Clearly display all log scales at the top and bottom of all field and final prints.

6.7.4 Clearly display all shop and field calibration records on all field and final prints.

6.8 Natural Gamma Log (NGL) Operation

NGL tools detect gamma radiation emitted by radionuclides in the formation. The most common natural gamma ray emitting radionuclides are Potassium (^{40}K) and Uranium- and Thorium-series daughter products (^{214}Pb and ^{214}Bi). NGL are commonly used to characterize stratigraphy and make correlations between wells. They can also be used to infer quantitative estimates of effective porosity and hydraulic conductivity of the materials penetrated by the borehole. This log is widely used because it can be run in air- or fluid-filled conditions, drill pipe, and cased or uncased holes.

6.8.1 NGLs record gamma radiation emitted from the formation in counts per second (cps) or American Petroleum Institute (API) units. The recommended scale for field prints is 0–100 or 0–200 API units or counts increasing from left to right (LTR).

6.8.2 NGLs should be run at a logging speed of 10 ft/min, or slower.

6.8.3 NGL field and final prints should include standard source (e.g., API calibrator) calibration and a three-min. stability check documentation.

6.8.4 Use only 1.25 by 6 in. (or 1 by 8 in.) sodium iodide (NaI) crystal or other high efficiency detectors.

6.7.5 Use a 5-sec time constant for 1 by 6 in. detectors and a 4-sec time constant for 1 by 8 in. detectors.

6.7.6 In final prints, display NGL profiles in the left track (API Track 1) with API or CPS units increasing LTR.

6.9 Electromagnetic Induction Log (IL) Operation

Induction tools operate on the principle of electromagnetic induction. An electrical current is induced in the formation by generating a radio frequency (20–40 kHz), alternating current in the transmitting coil of the IL tool. The induced current is proportional to the formation electrical conductivity and is measured by a receiver coil spaced 1.5 to 2.0 ft from the transmitter. IL tools can be run in air-filled or fluid-filled conditions, and uncased boreholes or wells that are cased with non-electrically conductive material. IL logs are ideal for characterizing stratigraphy and making correlations between wells. They are also useful for inferring formation porosity.

6.9.1 The IL log is recorded in electrical conductivity units of millisiemens/meter (mS/m). Field and final prints should display both electrical conductivity in mS/m on the right of the depth track (display RTL, in API Track 3) and electrical resistivity in ohm-m (LTR 2-3 cycle logarithmic display, in API track 2). Horizontal scales should be selected to maximize the amount of log that remains "on scale."

6.9.2 Run the IL log at 20 ft/min.

6.9.3 IL final prints should include tool shop and field calibration documentation.

6.9.4 In final prints, display IL profiles on the tracks to the right of the depth track in electrical resistivity (ohm-m) 2-3 cycle logarithmic units increasing to the right in API Track 2, and conductivity mS/m units decreasing to the left in API Track 3.

6.10 Galvanic Resistivity (E-log or Guard) Operation

Both Electric Log (E-Log) and GL tools measure apparent formation resistivity directly. An electrical current (I) is passed between a current source electrode on the logging tool and a current return electrode at the surface. Electrical potential differences (V) are measured between electrodes on the surface and at depth. The resulting V/I ratios are converted to apparent resistivities, using algorithms based upon the electrode array geometries and potential theory. Because these electrical tools are galvanically coupled directly to the earth with their electrodes, the techniques are called galvanic resistivity methods. Galvanic resistivity logs are ideal for characterizing stratigraphy and making correlations between wells. They are also useful for inferring formation porosity. These logs must be run in fluid-filled, uncased boreholes.

6.10.1 Galvanic resistivity log 16-in. normal (R_{SN}), 64-in. normal (R_{LN}), and guard (R_G) resistivities are recorded in units of ohm-meter (ohm-m). Field and final prints should display electrical resistivity in 2-3 cycle logarithmic ohm-m (LTR display in API Tracks 2 or 3). Horizontal scales should be selected to maximize the amount of log that remains "on scale."

6.10.2 Run the galvanic resistivity logs at 20 ft/min.

6.10.3 Galvanic resistivity final prints should include tool field calibration documentation.

6.10.4 In final prints, display galvanic resistivity profiles on the track to the right of the depth track (API Tracks 2 or 3) in 2-3 cycle logarithmic electrical resistivity (ohm-m) units increasing to the right.

6.11 Spontaneous Potential Log (SP) Operation

SP is an electrochemical phenomena resulting from salinity differences between the mud filtrate and *in situ* waters and the passage of saline waters through clays. High clay mineral content zones act as cation selective membranes, allowing cations to pass but repelling anions. This selectivity will result in a cation deficiency on the more saline side of the membrane and a cation surplus on the low salinity side. If the *in situ* waters are more saline than the mud filtrate, the electrical potential (with respect to some distant reference point) opposite clay zones will be positive with respect to that opposite sands and gravels. If the mud filtrate is more saline than the *in situ* waters, the opposite will occur. SP logs must be run in fluid-filled, uncased boreholes and are used to characterize stratigraphy and formation water salinity.

6.11.1 The SP curve is a relative measurement and is presented in units of millivolts (mv).

6.11.2 Run SP logs at 20 ft/min.

6.11.3 SP final prints should include tool field calibration documentation and three-minute electrode stability checks.

6.11.4 In final prints, display SP profiles in API Track 1 (left hand track) in mv units increasing LTR.

6.12 Borehole Video Log (BVL) Operation

BVL cameras are used to view uncased boreholes and cased wells. Best results are obtained in air-filled or clear fluid-filled conditions. Both black and white and color cameras are used to evaluate fractured bedrock, inspect borehole “washouts,” and inspect casing conditions.

6.12.1 Display the depth and well identification on video log and videotape.

6.12.2 Centralize the borehole video camera in the hole.

6.12.3 Make repeat runs over intervals specified by the DG.

6.12.4 Allow sufficient time for the BVL camera to equilibrate with downhole temperature and humidity conditions to ensure that the camera lens does not fog up. Distilled water can be poured in the borehole to clear fogged camera lenses.

6.12.5 Adjust brightness, contrast, and other image controls to optimize image clarity.

6.13 Three-Arm Caliper Log (CL) Operation

Three-arm calipers are used to measure borehole diameter as a function of depth. CLs consist of three to four arm sensors. CLs are usually run first when conducting uncased borehole logging operations at Site 300, and last at the Livermore Site. CLs may be run in air-filled or fluid-filled boreholes.

6.13.1 Scale the Three-Arm Caliper Log at 1 division per inch. The log should range from 3 in. to 18 in. for most boreholes.

6.13.2 Run a repeat section over any part of the hole designated by the DG.

6.13.3 Indicate the drill bit diameter on the log.

6.14 Full Waveform Sonic (FWS) Logs

FWS logs measure the acoustic inverse velocity (interval transit time) of the material penetrated by the borehole. This is accomplished by conducting multiple miniature seismic refraction shots as the sonde containing one (or two) acoustic transmitter(s) and two receivers is retrieved from the bottom of a fluid-filled uncased borehole. FWS logs are useful in correlating lithology between boreholes, evaluating porosity, indicating fractured or permeable zones, evaluating rock strength and elasticity, and identifying the top of the water table. FWS logs can also be used to measure the integrity of annular materials in a PVC cased well.

6.14.1 The FWS interval transit time (ITT) is displayed at μsec/ft RTL in API Tracks 2 and 3.

6.14.2 FWS tools should be run with centralizers.

6.14.3 Magnetostrictive (FWS) sources should be polarized prior to the logging job (piezometric sources need not be).

6.14.4 Run FWS at 10 to 15 ft/min.

6.14.5 Monitor FWS signals at both receivers to ensure that the automated picking algorithm does not skip cycles.

6.14.6 If possible, record full acoustic wave forms for both receiver and enhance with post processing before running the picking algorithm.

6.15 Neutron Log (NL)

The NL is used to determine total porosity under saturated conditions, measure the amount of moisture in unsaturated zones, and to characterize lithology. NLs measure the concentration of hydrogen ions in the material (formation and fluid) penetrated by the borehole. This is accomplished by bombarding the borehole wall with high energy neutrons and noting the energy decay at one or more distances from the neutron source. NL can be run in air-filled or fluid-filled boreholes as well as in PVC or steel cased wells.

6.15.1 NL use chemical radioactive sources or neutron generators. Because of this, they can only be run in cased environmental wells and special protocols must be developed.

6.15.2 NL are statistical tools like the NGL and should be run at slow logging speeds (e.g., 10–15 ft/min or slower) to improve statistics.

6.15.3 NL data should be presented as logarithmic count rates (cps or API units) LTR or neutron porosity (hydrogen index units linear RTL in API Tracks 2 and 3).

6.16 Acoustic Borehole Televiewer (BHTV)

BHTV logs are run to provide acoustic images of the borehole wall. This is accomplished by reflecting high frequency acoustic energy (at direct incidence) from the borehole wall. BHTV products are borehole wall acoustic reflectance and acoustic caliper images of the entire 360° degree borehole wall. These images can then be enhanced and interpreted on an interactive workstation to provide detailed structural and stratigraphic information about the material penetrated by the borehole. BHTV logs are run in fluid-filled, uncased boreholes.

6.16.1 BHTV should only be run in mud rotary drilled, uncased boreholes.

6.16.2 Run BHTV at 10 ft/min or slower.

6.16.3 Run BHTV tool with centralizers.

6.16.4 Run BHTV up into surface casing as a check.

6.16.5 Use interactive workstation enhancement and interpretation for BHTV images.

6.17 Optical Televiewer (OPTV)

OPTV logs are run to provide a detailed and orientated 360 degrees image of the borehole. The OPTV tool consists of a charged coupled device (CCD) video camera that can operate in either dry or water-filled portions of the borehole providing that the water-filled portion is optically clear. A light source composed of a circular series of LEDs at the bottom of the tool illuminates the borehole through a clear viewing glass. Light reflected from the borehole wall is captured by a hyperbolic mirror inside the probe. The mirror routes this reflected radial image from the borehole wall to the CCD camera. This radial image is reference to magnetic north by an onboard magnetic compass. These images can then be enhanced and interpreted to provide detailed structural and stratigraphic information about the material penetrated by the borehole.

6.17.1 OPTV should only be run in air-mist rotary drilled, uncased boreholes.

6.17.2 Check the OPTV's tool directional reference (magnetic north) with a Brunton compass prior to logging.

6.17.3 Run OPTV at 4 ft/min or slower.

6.18 Borehole Deviation Survey (DS) Log

A DS log (a.k.a. dipmeter log) records the deviation of a borehole or well from true vertical. Deviation logs are used to determine the azimuth and inclination of the borehole at any point along its path. A borehole DS can be performed in air- or fluid-filled boreholes or wells.

6.19 Field Post Operation

6.19.1 Compare geophysical log measurements to lithologic information determined from drive samples and cores, and information from nearby wells during and after logging operations.

6.19.2 Discuss all geophysical log anomalies with logging engineer. Contact the HG or HTL immediately if any QA/QC issues arise that cannot be resolved at the drill site.

6.19.3 When multiple logs are run in the same hole, ensure that log profiles are keyed to the same depth reference. This can be done by comparing the depths of characteristic log responses from thin (1-ft to 3-ft-thick) claystone intervals on each log.

6.19.4 Compare main log with repeat section to check log repeatability. The logging engineer can provide field overplots to accomplish this.

6.19.5 The Geophysical Logging Contractor will provide five field print copies of all logs at the proper depth and horizontal scales before leaving the site.

6.19.6 Resistivities (E-Log, GL, and IL) should all agree in clay zones.

6.19.7 Depth scale: Site 300 is 5"/100 ft; Main Site is 10"/100 ft.

6.20 Office Post Operation

6.20.1 Communicate any changes in final log specifications or corrections to the logging contractor within 1 to 2 days after logging operations.

6.20.2 Log ASCII standard (LAS)-formatted diskettes of all digital logging data should be received within 1 to 2 weeks of the completion of logging operations.

6.20.3 Inspect logging tool calibration documentation for each log product.

6.20.4 The Geophysical Logging Contractor should perform depth matching and borehole corrections before delivering final displays.

6.20.5 LAS diskettes should contain all measured data (include repeat sections and calibration) and processed results (depth matched and borehole converted data).

6.20.6 Final log prints of both measured and final processed displays will be delivered within 1 to 2 weeks of completion of logging operations.

6.21 Documentation of Failures

6.21.1 Calibration Failures

All borehole geophysical tool fabricators supply tool calibration protocol with their sondes. The logging vendor should attach records of the appropriate dated and signed shop and field calibration records to all final log prints. Departures from published calibration protocol and/or standards are noted on the *Wireline Logging Summary* (Attachment B).

6.21.2 Depth Control Failures

Borehole geophysical log depth control is established by passing the logging cable over a calibrated sheave. Depth control failures are noted by comparing driller's depths to logger's depths and logger's depths on multiple trip logging jobs. Depth control problems are noted on the *Wireline Logging Summary* (Attachment B).

6.21.3 Repeat Failures

Borehole geophysical measurements are repeatable physical property measurements. Borehole geophysical vendors run short (50 to 200 ft) repeat sections (Section 6.7.2) of logs to demonstrate that their results are repeatable. Direct measurement tools, such as resistivity logs, have very narrow repeat measurement tolerance. Statistical measurement tools such as the radioactive logs have broader repeat measurement tolerances. Departures from published repeat standards are noted on the page 1 of the *Wireline Logging Summary* (Attachment B). Failure to repeat a logging measurement may be due to borehole conditions beyond the control of the Geophysical Logging Contractor. If this is the case, it should be noted on the *Wireline Logging Summary* (Attachment B).

6.21.4 Inconsistency with Offset Borehole or Well Log Results

Borehole geophysical results should be easily correlated between nearby boreholes and/or wells. Abrupt changes in the character of borehole geophysical logs between offset boreholes/wells can occur due to changes in subsurface geology, borehole conditions, and/or logging equipment failure. Inconsistencies of borehole geophysical logs that occur between boreholes/wells should be noted on page 1 of the *Wire logging Summary* (Attachment B). If these inconsistencies are due to subsurface geology or borehole conditions, note that as well.

6.21.5 Tool Specific Check Failures

Some borehole geophysical data quality checks are tool specific, such as caliper measurements of casing inside diameter and gamma ray stability checks. Failures of these tool specific quality checks should be noted on page 1 of the *Wireline Logging Summary* (Attachment B). It should also be noted if these failures are due to borehole conditions or not.

6.21.6 Presentation Failures

Borehole geophysical data quality may be good, but appears to be bad because of poor presentation by the Geophysical Logging Contractor. Borehole geophysical log presentation failures should be noted on the *Wireline Logging Summary* (Attachment B).

7.0 QUALITY ASSURANCE RECORDS

7.1 Quality Assurance reports that the borehole geophysical logging tools are: (1) working properly, (2) used according to their design, and (3) properly calibrated should be compiled for each logging job. The borehole geophysical logging contractor must document that the log products meet these conditions, and the DG must verify these conditions. The front of the *Wireline Logging Summary* (Attachment B) provides a convenient summary matrix to document any log product quality problems.

The ERD QA records identified below are to be created, managed, and preserved in accordance with SOP 4.10: Records Management.

Specific borehole geophysical data quality assurance records are:

A. Wireline Logging Summary, compiled by the DG.

B. Any QA/QC electronic mail and/or memoranda generated by the DG and/or HG/HTL for a specific log suite.

C. Deliver final versions of Geophysical Logs and Wireline Logging Summary documents to DMT.

8.0 ATTACHMENTS

Attachment A—Geophysical Logs

Attachment B—Wireline Logging Summary

Attachment C—Schematic Diagram of Borehole Geophysical (Wireline) Logging Operation

Attachment A

Geophysical Logs

Attachment A. Geophysical logs.

Geophysical log	Description	Primary purpose
Natural Gamma Log (NGL)	Used in air- or fluid-filled, cased or uncased borehole, <14 in. diam. Measures natural gamma radiation emitted by the formation.	Characterize lithology; determine stratigraphic correlations.
Electromagnetic Induction Log (IL)	Used in air- or fluid-filled, uncased or PVC-cased boreholes, 2-10 in. diam. Measures formation electrical conductivity between 2 coils, 20 in. apart by using electromagnetic induction.	Characterize lithology; determine stratigraphic correlations. Estimate formation porosity.
Spontaneous Potential (SP)	Used in fluid-filled, uncased borehole only.	Characterize lithology; evaluate formation water salinity.
Electrical Resistivity (E-Log)	Used in fluid-filled, uncased borehole only.	Characterize lithology; determine stratigraphic correlations. Estimate formation porosity.
Borehole Video Log (BVL)	Used in air- or fluid-filled; cased or uncased borehole. Produces a video tape of the borehole (or casing) using a downhole camera.	Characterize lithology and evaluate fractures in open hole; evaluate casing and screen in cased hole.
Three-Arm Caliper Log (CL)	Used in air- or fluid-filled, cased or uncased borehole. Measures borehole diameter using 3 or 4 radially spaced arms.	Determine borehole rugosity in open hole or damaged casing in cased hole.
Acoustic Borehole Televiewer (BHTV)	Used in fluid-filled, uncased boreholes. Produces an acoustical image of the borehole well and acoustical measurement of borehole diameter.	Characterize lithology; determine stratigraphic correlations.
Full Waveform Sonic (FWS) Log	Used in fluid-filled, uncased boreholes. Measures formation acoustical in velocity (interval transit time).	Characterize lithology; provide velocity information for seismic interpretation; estimate formation porosity.
Guarded Electrode Resistivity Log (GL)	Used in fluid-filled uncased boreholes. Measures formation electrical resistivity.	Characterize lithology; determine stratigraphic correlations. Estimate formation porosity.
Neutron Log (NL)	Used in air or fluid PVC- or steel-cased boreholes only.	Characterize lithology; determine relative volumetric moisture content of the formation.
Digital Optical Televiewer (OPTV)	Used in air- or fluid-filled, uncased boreholes. Produces a digital image of the borehole well.	Characterize lithology, determine dip, strike, frequency, and aperture of fractures.
Borehole Deviation Survey (DS) Log	Used in air- or fluid-filled and PVC-or steel-cased wells.	Determine azimuth and inclination of borehole. Calculates true depth of borehole at any point.

Attachment B

Wireline Logging Summary

WIRELINE LOGGING SUMMARY

GENERAL INFORMATION:

Operating Company	Well Name	Division	State / Province	County / Parish	Country
Section	Township / Survey	Range / Block	Surface Location		API Number
Log Job No	Prospect / Field	Well Type ☐ Exploration ☐ Production ☐ Proj Inj ☐ Proj Prod ☐ EOR ☐ Other ______			Accession Number
Logging Service Order #	Service Company	Logging Engineer	Service Co District	Logging Unit	Lease Number / LSD Number
Start Date	Bit Size	Last Casing Size / Depth	Chevron Witness	F E Specialist / Date	I D Number

LOG QUALITY

This section applies only to the logs delivered at the well site

SEPARATE COMBINATION TOOLS INTO INDIVIDUAL SERVICES

LOG / SERVICE	1.	2	3	4.	5.	6.	7	8.	9.	10
(✓) Check only those boxes where problems exist — SUITE # / RUN #										
CALIBRATION FAILURES?										
DEPTH CONTROL FAILURES?										
REPEAT FAILURES? Check if the failure is caused by borehole conditions										
ARE THE LOGS CONSISTENT WITH OFFSETS? Check if the failure is caused by borehole conditions										
TOOL SPECIFIC CHECKS FAILURES? Check if the failure is caused by borehole conditions										
PRESENTATION FAILURES?										
LOG QUALITY RATING 1 (Poor) to 4 (Excellent) Scale (4 can be given if the failure is caused by borehole conditions)										

LOG QUALITY COMMENTS:
Explain all problems in the LOG QUALITY section

DATA SUMMARY

LOG INTERVALS

	BOTTOM	TOP
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

SIDEWALL CORES

	TOTAL
Total SWS Attempted	
Recovered	
Misfired	
Lost Bullets	
No Recovery	

FORMATION TESTER

	TOTAL
Pressure Attempts	
Good Pressure Sets	
Fluid Attempts	
Good Fluid Samples	

WELL CONDITIONS

Maximum Temperature ______
Maximum Deviation ______
Pump Down or Drillpipe Assist Required ______
Yes ______ No ______
Was pressure control equipment used? ______
Yes ______ No ______

TIME SUMMARY

(Use quarter hour increments)

TOTAL JOB LOGGING TIME (1st rig up to final rig down) ______ hrs

OPERATIONS LOST TIME (Hole conditioning, etc) ______ hrs

TOTAL LOGGER DOWNTIME ______ hrs

NUMBER OF FAILURES > 30 MIN ______

OPERATIONAL EFFICIENCY RATING 1 (Poor) to 4 (Excellent) Scale ______

Attachment B. Wireline Logging Summary.

OPERATIONS SUMMARY: (Include times of bit reaching TD, Circulation, Wiper trips; Logger's arrival & release from location; All wireline runs into hole including rig up, time in, on bottom, off bottom, time out, Incomplete log run due to tool failure or hole problems; Well site computed logs; Provide as detailed a chronology as possible)

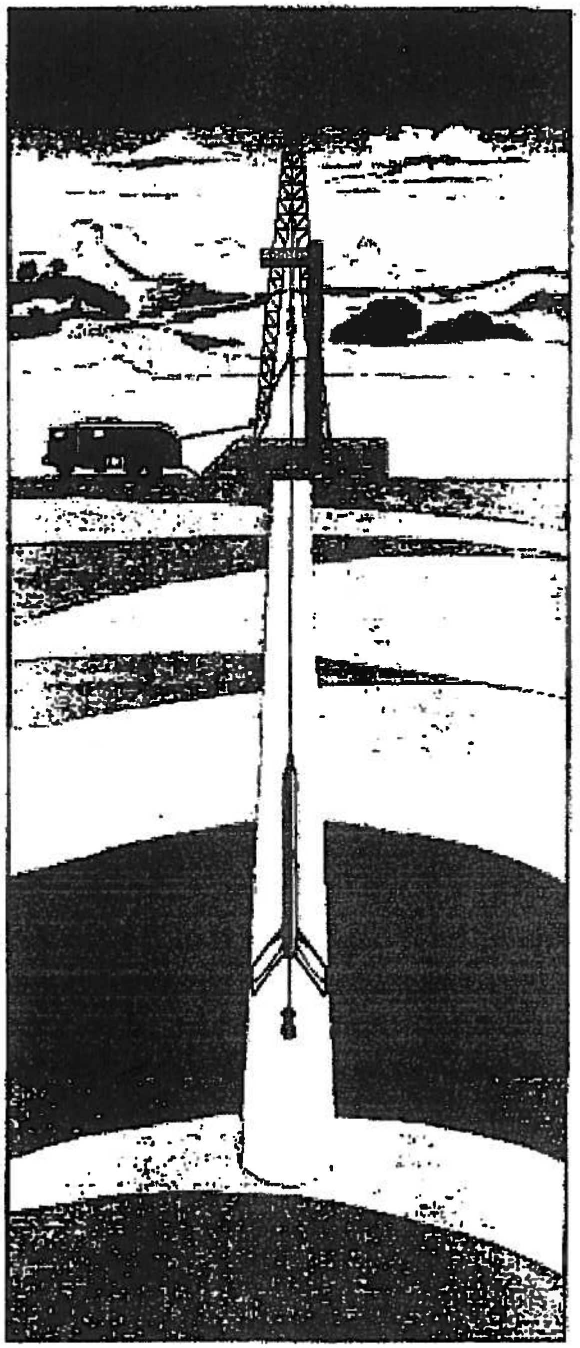
OPERATING COMPANY	WELL NAME							IDENTIFICATION NO.
Date	Operations (Chronologically)	Time Summary Start	End	TD Driller / Logger	BHT	Hrs. of Circ.	Down Time Hrs.	Remarks (Calibration, repeatability, tool problem, etc.)

REMARKS & EXPLANATIONS: (Include any special circumstances that might have affected the logging operation, i.e. Were backup tools available? Was lost time due to equipment or operator error? Are there any questions concerning charges on the service order? Do any topics need to be discussed with salesmen? Were any tools logged out of tolerance? etc.)

Attachment B. Wireline Logging Summary. (Continued)

Attachment C

Schematic Diagram of Borehole Geophysical (Wireline) Logging Operation



Attachment C. Schematic diagram of borehole geophysical (Wireline) Logging Operation.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.7: Well Closure—Revision: 5

<table>
<tr><td rowspan="3">ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#
ERD</td><td colspan="2">AUTHOR(S):
M. Taffet</td></tr>
<tr><td>APPROVALS:

Jesse Yow
Department Head

[signature]
Livermore Program Leader

Leslie Ferry
Site 300 Program Leader</td><td>Date

4/30/12

4/13/12

4/12/12</td></tr>
<tr><td>CONCURRENCE:

Rebecca Goodrich
QA Implementation Coordinator</td><td>Date

4/19/12</td></tr>
<tr><td colspan="3">Type of Procedure (per ES&H Manual, Document 3.4)
☒ Informational Use ☐ General Use ☐ Continuous Use</td></tr>
</table>

1.0 PURPOSE

The purpose of this SOP is to describe methods for decommissioning wells *in situ* by perforation and subsequent grout injection or by the removal of construction materials followed by grout injection. The well closure technique is commonly dependent on the nature and type of well completion materials. *In situ* well closure involves casing perforation and is used when metal casing cannot be easily removed. Well closure by removal of casing is employed for any well material where it is practical to drill the well out using hollow stem augers or a rotary technique with a drill bit. This latter method is primarily used for wells constructed completely with polyvinyl chloride (PVC) casing. The Drilling Geologist Supervisor (DGS) will determine if a combination of closure methods is required for wells with one or more conductor casings, which are usually constructed of steel. Local regulatory agencies will be consulted if, for any reason, a well cannot be decommissioned solely by the methods discussed within this SOP.

2.0 APPLICABILITY

ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes. This procedure is applicable to wells that are to be permanently sealed, based on the present or future potential for a well to act as a conduit for the vertical migration of hazardous materials in ground water or when a well is no longer needed (requires regulatory concurrence). Other characteristics may also provide cause for sealing a well. A well meeting any of the criteria listed below should be considered for closure:

A. Multiple screened intervals or a single screened interval over several water-bearing zones.

B. Lack of annular seal.

C. Any well suspected of allowing migration of contaminants to non-contaminated zones.

D. Threatened water supply wells located at or near an existing plume margin.

E. Unknown or undocumented well construction details.

F. Improper well construction or damaged well.

G. Abandoned well (DWR, 1981).

H. Data from a well is no longer needed.

3.0 REFERENCES

3.1 Department of Water Resources (1991) *Water Well Standards: State of California*, California Resources Agency, Bulletin 74-90 (Supplement to Bulletin 74-81).

3.2 LLNL (2005a), *Site Safety Plan for Lawrence Livermore National Laboratory CERCLA Investigations at Site 300*, Environmental Protection Department, Lawrence Livermore National Laboratory (UCRL-AR-21172 Rev. 4).

3.3 LLNL (2005b), *Site Safety Plan for Lawrence Livermore National Laboratory CERCLA Investigations at Livermore Site*, Environmental Protection Department, Lawrence Livermore National Laboratory (UCRL-AR-21174 Rev. 3).

4.0 DEFINITIONS

See SOP glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified; institution requirements of the Findings and Determination are followed, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

5.5 Hydrogeology Team Leader (HTL)

The HTL is responsible for ensuring that the Well Abandonment Plan is properly implemented by coordinating the work with the PL, RI, and Drilling Coordinator. The HTL is also responsible for coordinating with the PL to ensure that the well closure activities are consistent with Program Site Execution Plans and objectives, the work is authorized, and funding is available to complete the work prior to starting work. The

HTL is responsible for notifying the PL if the work scope changes significantly such that costs, schedules, or the achievement of its objectives are impacted. The HTL has the authority to make decisions in the field that differ from the Well Abandonment Plan provided these decisions do not alter the original objective of the well abandonment and do not increase the total cost estimate for the well abandonment.

5.6 Drilling Coordinator (DC)

The DC is responsible for reviewing the Well Abandonment Plan and provides the interface between the PL, Hydrogeologist, Drilling Geologist, Hydrogeologist, the Drilling Contractor, and the field personnel.

5.7 Drilling Geologist Supervisor (DGS)

The DGS is responsible for assisting in the preparation of the Well Abandonment Plan prior to commencing related work activities; coordinating the Drilling Geologist's (DG) work schedule and related activities, ensuring that the DG has all necessary equipment to perform the field work accurately and safely, monitoring and reporting the progress of daily activities, and conducting a quality review of the field forms used to record well abandonment details. The DGS is responsible for working with the DC, HTL, and Drilling Geologist to ensure that applicable SOPs and drilling work plans and sampling plans are followed.

5.8 Hydrogeologist (HG)

The HG is responsible for determining wells that may require abandonment due to meeting any of the requirements in Section 2.0 and generating a Well Abandonment Plan. The HG should obtain concurrence from the PL and the HTL prior to proceeding with closure of an existing well. The HG also assists the DC in determining the best strategy for successful and proper abandonment.

5.9 Drilling Geologist (DG)

The DG is responsible for reviewing the Well Abandonment Plan and conducting and documenting drilling and well abandonment, operational and safety procedures per the Integration Work Sheet (IWS) and the work plan(s), and to inform the DC, HG, and DGS of the progress of daily activities, including any non-conformances with, or deviations from, the plan(s).

5.10 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review the Well Abandonment Plan distributed by the HG or the DGS.

5.11 Data Management Team (DMT)

The DMT is responsible for reviewing the Well Abandonment Plan and the disposition of original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

The abandonment process should minimally alter the geologic medium surrounding the well to be abandoned. It is essential that the process does not introduce hazardous or foreign substances into the well or borehole, create conduits that facilitate the spread of existing contaminants, and that the process adequately removes well materials and seals the resulting borehole.

6.1 Office Preparation

Prior to commencement of field work, all personnel performing well abandonment activities shall review this SOP. Well abandonment at the Livermore Site and Site 300 may be performed using the following methods:

6.1.1 *In Situ* Closure

A. Obtain all pertinent records such as well completion logs, drillers' logs, water level measurements, perforated intervals, and any required permits or access agreements.

B. Obtain PL concurrence for well closure.

C. Obtain necessary permits for off-site wells and permission to access wells if on private property.

D. Obtain Mills Knife perforation equipment and air compressor, making sure the correct shoes are available for each casing diameter.

E. Determine the depth intervals of clay-rich zones greater than 5-ft thick from geophysical logs (gamma ray), drillers' logs, or other well logs.

F. Determine zones to perforate from evaluation of logs, taking into account the zones that have been perforated previously.

G. Determine or estimate the depth of any nearby ground water contaminant plumes for each well location.

H. Coordinate schedule/actions with DC.

6.1.2 Well Removal

A. Obtain all pertinent records such as well completion logs, drillers' logs, water-level measurements, perforated intervals, and any required permits or access agreements. Conduct a downhole camera survey if additional information is necessary.

B. Coordinate schedule/actions with DC.

6.2 Safety Considerations

6.2.1 Prior to drilling, perform the applicable preparation activities described in SOP 4.1, "General Instructions for Field Personnel". Personnel who are new to the LLNL project will receive direct field supervision and on-the-job training (OJT) from a qualified SARA/OSHA trained supervisor for at least the first

24 hours of field activity using the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.2.2 To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with IWS 12654 “Drilling in VOC and Mixed Waste-contaminated soils at the Livermore Site” and IWS 11578 “Drilling in VOC-contaminated soils at the Livermore Site.” Drilling activities at Site 300 should be performed in accordance with IWS 12684“Site 300 Drilling Activity.” Prior to well abandonment, pumps may need to be removed from a well using the pump truck and following IWS 12722 “ERD Site 200 Hydraulic Pump Truck Operator” at the Livermore Site and IWS 11339 “ERD Site 300 Hydraulic Pump Truck Operation” at Site 300. Anyone can stop work at anytime if an unsafe condition is observed. The DC, HG, and DGS shall be notified immediately of the condition and the ‘Stop Work’ decision.

6.3 Field Preparation

Follow procedures outlined and/or referenced in this SOP when performing field work.

6.3.1 Remove pump and piping from the well.

6.3.2 Confirm that there are no obstructions in the well. For deep wells (more than 100 ft deep), run video logs and geophysical logs as needed to ascertain casing condition, presence and nature of existing perforations, and location of high and low permeability intervals.

6.3.3 Check drill rig access to the well.

6.3.4 Remove existing vault or stovepipe and concrete pad, if necessary.

6.4 Operation

Follow procedures outlined and/or referenced when performing field work.

6.4.1 Document the following for all wells**:**

A. Well name.

B. Sounded depth of well.

C. Water level, if applicable.

D. Casing size and materials.

E. Drilling company and driller.

F. Drilling Supervisor and Drilling Geologist.

G. Date/time for start and completion of closure.

H. Closure method(s) and materials used.

I. If no survey data exists, prepare a detailed site map accurately showing the well in relation to permanent features.

6.4.2. *In Situ* Closure

A. Select intervals to perforate from the drillers' log, geophysical log, and video log if available. Determine if previously perforated zones should be re-perforated due to possible compromise of casing.

B. Operate Mills Knife perforator to cut six 1-in. slots per foot, with four rows at 90 degrees from one another.

C. Perforate all previously unperforated low-permeability zones greater than 5-ft thick within the plume (if a plume exists), and selected low-permeability zones greater than 5-ft thick between the static water level down to 20 ft below the estimated base of plume (if existing) or to 5 ft below the saturated zone.

D. If casing conditions permit, perforate all low-permeability zones (thicker than 5 ft) that occur between the estimated plume base (if existing) and total depth.

E. Calculate the minimum volume of grout required to seal the well.

F. Pump the grout from the bottom of the well to the surface through a tremie pipe using a cement mixture (2 lb of commercial bentonite powder and approximately 6.5 gal of water added per 94-lb bag of cement).

G. When the grout reaches the surface, verify that the volume of grout used is equal or greater than the calculated volume in Step E.

H. Apply pressure from the surface using either an air-actuated packer or a welded cap (at the surface). Apply at least 50 pounds per square inch of pressure for approximately 1 to 2 hr until stable.

I. The following day, seal the surface by perforating a zone from 2 to 20 ft and top off to the surface with a final stage of grout.

6.4.3 Well Removal

A. Drill out the casing using hollow stem augers or a different type of drilling method, as determined by the HTL, DC, and DGS with input from the driller. For both methods, the drill bit should be slightly larger than the diameter of the original well borehole to remove all of the filter pack.

B. To the extent feasible, ensure that all of the casing has been removed. When using a drill bit, frequently check and document that pieces of casing are in the cuttings. Also note any decrease in drill rig chattering, which may indicate that the bit has deflected off the casing.

C. Once the well and sandpack are completely removed, an open borehole remains. Calculate the minimum volume of grout required to fill the open borehole.

D. Pump the grout from the bottom of the borehole to the surface through a tremie pipe (grouting with a tremie pipe is not required for dry boreholes that do not exceed 30-ft depth). Place the tremie pipe 5 to 10 ft off the bottom of the borehole and pump a cement mixture (2 lb of commercial bentonite powder mixed with approximately 6.5 gal of water per 94-lb bag of cement) through this pipe until undiluted grout flows from the borehole at the ground surface. The tremie pipe should be withdrawn gradually during this process.

E. When the grout reaches the surface, verify that the volume of grout used is equal or greater than the calculated volume in Step C.

F. While waiting for the grout to set, cover and barricade the borehole to prevent introduction of foreign material and to protect the public.

G. After the grout has set (about 72 hr), fill any depression in the grout due to settling. Use a grout mixture similar to that described above.

6.5 Post Operation

6.5.1 Perform post-work activities described in SOP 4.1, Section 6.4, including equipment decontamination, proper waste disposal, equipment inventory, documentation review, and field form and logbook delivery to the DMT.

6.5.2 The DC should ensure that all field forms are maintained and submitted. The DG's report should give a complete description of work performed, number of hours on the job, shutdown due to breakdown, length of casing removed/perforated, materials used, and other pertinent data.

7.0 QUALITY ASSURANCE RECORDS

The ERD QA records identified below are to be created, managed, and preserved in accordance with SOP 4.10: Records Management.

7.1 Field Forms

7.2 Logbooks

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Division (ERD) Standard Operating Procedure (SOP)	
ERD SOP 1.8: Disposal of Investigation-Derived Wastes (Drill Cuttings, Core Samples, and Drilling Mud)	
REVISION: 3 ENVIRONMENTAL RESTORATION DIVISION CONTROLLED COPY # THIS IS A RED STAMP ERD	AUTHOR(S): T. Carlsen and S. Gregory REVIEWER(S): J. Aarons*, L. Berg, and L. Ferry
EFFECTIVE DATE: January 1999	Page 1 of 13
APPROVAL Date Albert L Lamarre 5/4/99 Division Leader APPROVAL Date 5/4/99 Hydrogeology Group Leader	CONCURRENCE Date 4/27/99 QA Implementation Coordinator

*Weiss Associates

1.0 PURPOSE

To ensure that investigation-derived waste (IDW) consisting of drill cuttings, unused core samples, and drilling mud/initial muddy development water from Site 300 and Livermore Site are properly disposed of in a manner consistent with the protection of human health and the environment using the guidance provided by Reference 3.12 below. This guidance states that "the management of investigation-derived wastes (IDW) must ensure protection of human health and the environment and comply with certain applicable or relevant and appropriate requirements (ARARs)." The guidance further states that "as a general rule, it will be necessary to use best professional judgment, in light of the site-specific conditions, to determine whether an option is protective of human health and the environment." The following SOP reflects LLNL's evaluation of ARARs and its best professional judgment concerning the management of investigation-derived drill cuttings, core samples, and drilling mud.

2.0 APPLICABILITY

The following procedure and information is applicable to all activities which can generate investigation-derived wastes (i.e., drill cuttings, core samples, and drilling mud/initial muddy development water). The following sections describe the handling, screening and disposal of drilling wastes containing: volatile organic compounds (VOCs), petroleum products, metals, tritium, uranium, and high-explosive (HE) compounds.

3.0 REFERENCES

3.1 10 CFR 61.55.8-40-112 and 8-40-205 BAAQMD, Bay Area Air Quality Management District (Revised draft 1/11/89) Regulation 8, Organic Compounds Rule 40 Aeration of Contaminated Soil and Removal of Underground Storage Tanks.

3.2 California Regional Water Quality Control Board–Central Valley Region (1992), *Water Quality Control Plan (Basin Plan) For the California Regional Water Quality Control Board Central Valley Region*, Second Edition.

3.3 California Regional Water Quality Control Board–San Francisco Bay Region (1982), *Water Quality Control Plan (Basin Plan), San Francisco Bay Basin*, *State of California*, Oakland, CA.

3.4 Carlsen, T. M., Ed. (1991), *Lawrence Livermore National Laboratory Site 300 Environmental Investigations Quarterly, April-June 1991*, Lawrence Livermore National Laboratory, Livermore Calif. (UCAR-10194-91-2).

3.5 Crow and Lamarre (1990), *Remedial Investigation of the High-Explosives (HE) Process Area*, Lawrence Livermore National Laboratory Site 300 (UCID-21920).

3.6 Foxboro Company (1985), Instruction Manual Foxboro Model 128 Century Organic Vapor Analyzer, M1 61 1-132.

3.7 Hoffman, F. and M. D. Dresen (1990), "A Method to Evaluate the Vertical Distribution of VOCs in Ground Water in a Single Borehole," *Ground Water Monitoring Review,* Spring 1990, 10(2), 95-100.

3.8 Isherwood, W. F. (1994), letter to Vincent Chrisitian, California Regional Quality Control Board, San Francisco Bay Region (2), regarding using soils concerning trace levels of contaminants as fill, dated November 18, 1994.

3.9 Jackson, C. S. (1995), letter to Vincent Chrisitian, California Regional Quality Control Board, San Francisco Bay Region (2), regarding beneficial reuse of soils containing metals slightly exceeding background values, dated July 24, 1995.

3.10 Marshack, J. B. (1989), *The Designated Level Methodology for Waste Classification and Cleanup Determination*, California Regional Water Quality Control Board—Central Valley Region.

3.11 409.9 SJCAPCD, San Joaquin County Air Pollution Control District (1988), *RULE 409.9 Volatile Organic Compound Emissions from Decontamination of Soil* (Adopted Nov. 29, 1988, Effective July 1, 1989).

3.12 State of California Leaking Underground Fuel Tank Task Force (1988), *Leaking Underground Fuel Tank (LUFT) Field Manual*.

3.13 Title 22, California Code of Regulations, Chapter 11, Section 66261.24 (Register 95, No. 42; 10-20-95) and Appendix 11 (Register 95, No. 21; 5-26-95).

3.14 Title 22, California Code of Regulations, Chapter 18, Section 66268.40 (Register 95, Nos. 7-8; 2-24-95) and (Register 92, Nos. 15-17; 4-24-92).

3.15 U.S. Environmental Protection Agency (EPA) (1991), *Guide to Management of Investigation-Derived Wastes,* U.S. EPA, Office of Solid Waste and Emergency Response, Publication 9345.3-03FS, October 1991.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Division Leader

The Division Leader's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Hydrogeologic Group Leader (HGL)

The HGL's responsibility is to ensure that proper procedures are followed for activities (i.e., drilling, borehole logging and sampling, monitor well installations and development) and to oversee the disposal of all investigation derived wastes.

5.3 Drilling Supervisor (DS)

The DS schedules all drilling related activities and coordinates the drilling contractor schedules and equipment needs.

5.4 Drilling Coordinator (DC)

The DC provides the interface between the DS and the field activities and is responsible for estimate the contaminants likely to be present, and the quantity of drilling spoils that may be generated.

5.5 Drilling Geologist (DG)

The DG is responsible for disposing investigation derived waste properly per the requirements of this SOP.

5.6 Engineering Group

The Engineering Group is responsible for determining a disposal area.

5.7 Task Leader (TL)

The TL are responsible for the overall investigation, planning, assessment, and remediation within a study area.

6.0 PROCEDURE

6.1 Discussion

6.1.1 According to available guidance (Reference 3.15), the EPA expects soil IDW to be returned to the source if short-term protectiveness of human health and the environment is not an issue. Therefore, in the long term, the IDWs that could pose a risk to human health and the environment will be addressed by the final action. Unfortunately, it is often impossible to return drill cuttings and cores back to the borehole when the borehole is completed as a well. Thus, a review of ARARs was conducted to determine the best disposal methods for such IDW. Also, State law allows Regional Boards to waive waste discharge requirements (WDRs) for a specific discharge or types of discharges where it is not against the public interest [California Regional Water Quality Control Board (RWQCB) 1992]. As listed in Table IV-1 of the Central Valley Region Basin Plan, drilling mud is one type of discharge which has a WDR waiver. The specific procedures related to drilling mud are discussed later in this SOP.

6.1.2 Attachment A lists ARARs that may be applicable to drill cuttings, core samples, and drilling mud. Attachment A also describes actions taken to comply with substantive portions of each regulation, as required by EPA, 1991. As a result of our review of these ARARs, we feel the best management practices are observed when drill cuttings are disposed of in the immediate vicinity of the drilling activity. However, due to programmatic constraints at the Livermore Site, it is often not possible to dispose of drill cuttings in the vicinity of the boreholes. Therefore, drill cuttings are disposed of at the designated Drilling Cuttings/Laydown Area on site.

6.1.3 Chemical analyses on drilling wastes are usually performed in areas of known or suspected contamination or in previously unexplored areas. Drilling wastes from areas with an extensive historical record of sampling and chemical analyses that detected no chemical contamination are generally not chemically analyzed.

6.1.4 The disposal criteria in this procedure were developed to ensure that no wastes, which are above the Resource Conservation and Recovery Act (RCRA) hazardous waste levels, or waste with specified levels (described below) of HE or radioactive contaminants are disposed of on the ground surface near the borehole. When necessary, LLNL Hazardous Waste Management Division (HWM) will dispose of investigation-derived hazardous wastes.

6.2 Preparation

6.2.1 Estimate contaminants, concentrations, and quantity of waste for planning the proper disposal method for the IDW, excavation of the proper size mud pit (when applicable), and mud transportation capacity (when applicable).

6.2.2 Determine location for placement of drill cuttings or installation of pit to contain drilling mud. For Site 300, when drilling off site, haul drilling spoils to a designated area on site determined by the Site 300 Environmental Analyst (EA) and Site Manager. Drill cuttings and mud pit should not be visible from a road. If drilling is performed on a hill, ensure that no stream of water or drilling mud will flow down the hillside. If drill cuttings or mud cannot be hidden from view due to the proposed drilling location, consult the DC, EA, Engineering Group, and Site Manager. At the Livermore Site, contact the Engineering Group to determine disposal locations. Usually, drilling spoils will be disposed of at the Drill Cuttings/Laydown Area.

6.2.3 Construct mud pit (as determined by 6.2.2):

A. Scrape off the top 1 to 2 ft of soil and save for restoration phase.

B. Install an animal escape ramp into pit as soon as it is excavated. The ramp should be repositioned each evening to ensure an adequate escape route. Place a barrier around the pit to prevent any animals or people from inadvertently walking into the pit.

6.2.4 Perform the applicable preparation activities described in SOP 4.1, "Instructions for Field personnel" (i.e., calibrate field equipment, don PPE).

6.3 Drilling Waste Containment

6.3.1 Air-mist or Mud-rotary Drilling (Site 300 On-site). Place drilling waste in the approved mud pit location.

6.3.2 Air-mist or Mud-rotary Drilling (Livermore Site On and Off-site and Site 300 Off-site). Place all drilling waste in a container(s) for transport to disposal area.

6.3.3 Auger Drilling (Livermore Site and Site 300 On-site). Place drill cuttings on plastic sheeting placed on the ground or in containers until transport to disposal area.

6.3.4 Auger Drilling (Livermore Site and Site 300 Off-site). Place all drilling waste in a container(s) for transport to disposal area.

6.3.5 If contaminant type(s) or concentrations are suspected or determined in drilling spoils to be hazardous, the drilling wastes should be segregated by depth to isolate the spoils from the contaminated zones. These spoils should be placed on plastic or in hazardous waste drums.

6.4 Screening of Drilling Waste

6.4.1 Screen core samples or cuttings using a photoionization detector (PID) or flame ionization detector (FID) meter approximately every 5 ft of drilling, or at a reduced permeability interface where there is a likelihood of contaminant accumulation (volatile compounds only).

6.4.2 For mud-rotary drilling techniques, collect aliquots of drilling mud from the mud tank or trailer for field PID or FID meter screening prior to disposal. Screen each load of the mud separately (volatile compounds only).

6.4.3 If VOC contamination of the drilling spoils is encountered (10 $ppm_{v/v}$), segregate the spoils from the previously clean spoils, and increase the frequency of screening as directed by the DG. Collect samples of the spoils and submit for laboratory analysis.

6.4.4 Screening Method for VOCs using an PID or FID:

1. Collect enough drilling waste (drilling mud or cuttings) to fill two 40 ml vials (or equivalent containers).
2. Immediately empty the two vials into a new, clean plastic bag. Capture approximately 1 liter of air in the bag before sealing. Shake the bag well. Then place the bag on a stationary surface (in the sun, if possible) to allow the headspace to come into equilibrium with the waste. The length of time the headspace is allowed to equilibrate will depend on ambient temperature and humidity conditions; 2 minutes if temperature is >90° F, at least 5 minutes if >70° F, 10 minutes if 70° to 50° F, and 15 minutes if <50° F. In extremely hot conditions, if the bag is allowed to sit too long, a buildup of water vapor in the bag may affect a PIDs performance. An FID should not have any negative effects from water vapor.
3. Insert the tip of the PID or FID probe into the headspace of the plastic bag by piercing it with the probe. Avoid making contact with mud, soil, or water with the instrument tip to prevent these materials from being sucked into the instrument.
4. Read the meters' display to obtain a total VOC concentration of the headspace in parts per million on a volume to volume basis ($ppm_{v/v}$).
5. Record this reading on the borehole well construction form, and refer to the criteria below for disposal.

6.4.5 When radiological contamination is suspected, notify the Environmental Safety and Health [ES&H] Team 1 (Site 300) or Team 4 (Livermore Site) prior to drilling. Survey the drill cuttings as directed by Team 1 or Team 4. When the screening method detects activity two times the background level, collect samples for laboratory analysis per the TL. Tritium should be analyzed by either LLNL Environmental Sciences or a contract analytical laboratory using the "Soil Water Distillation" technique (detection limit is between 200 to 1,000 pCi/L or 0.02 to 0.1 picocuries per gram [pCi/g] at 10% moisture) or the "Beta Scan" technique (detection limit is approximately 10,000 pCi/L or 1.0 pCi/g at 10% moisture). Provide the analytical results from the samples taken when the screening method detected activity twice the background level, to the LLNL HWM Division and the appropriate EA to determine the appropriate method of waste disposal.

6.5 Disposal of Drilling Waste

The following disposal procedures are to be used only when there is sufficient historical data that delineates contaminants and their concentrations. If no historical data is available, a variety of analyses, as determined by the TL should be performed first to ensure that all potential contaminants in the wastes are understood for proper disposal.

6.5.1 Disposal procedure for waste containing VOCs:

TCE is the predominant purgeable halocarbon contaminant at Site 300 and the Livermore Site. The U.S. EPA Toxic Concentration Leachate Procedure (TCLP) maximum contaminant concentration of 0.5 mg/L in the resulting extract has been selected for our disposal criteria. Using the TCLP, soluble constituents in a soil sample are extracted using a 20:1 dilution (by weight). In order to insure that the extract concentration of TCE does not exceed 0.5 mg/L, a value of 10 mg/kg is the disposal criteria above which the soil will be dealt with in a manner to ensure maximum environmental protection as described below.

A. Drilling waste <10 mg/kg total VOCs:

Dispose of drill cuttings (1) at the ground surface near the well site, (2) as fill, or (3) in the designated disposal area. If cuttings are disposed of near the well site, spread cuttings out as much as is practical. When appropriate, discharge drilling mud to a pit or sump with a minimum of 2 ft of freeboard (Site 300) or 1 ft of freeboard (Livermore Site). For off-site drilling activities, transport drill cuttings and mud on site for disposal in the designated disposal area.

B. Drilling waste >10 mg/kg total VOCs:

Place drill cuttings temporarily on plastic sheeting at well site or Corp. Yard in a 6-in. lift to promote aeration and reduce VOC concentrations. Discharge drilling mud directly to drums, or leave temporarily in mud tank or trailer. After drilling completion, re-evaluate the spoils VOC concentration. If concentrations remain above 10 mg/kg, dispose of the waste appropriately as determined by HWM, in consultation with the appropriate EA.

6.5.2 Disposal procedure for waste containing total petroleum hydrocarbons (TPH), gasoline or diesel product:

The Leaking Underground Fuel Tank (LUFT), Field Manual (3.12) sets a TPH concentration of 1,000 mg/kg in soil as a hazardous waste classification criterion and suggests that a lower value may be necessary on a case-by-case basis. The Bay Area Air Quality Management District (BAAQMD), San Joaquin County Air Pollution Control District (SJCAPCD), and Alameda County define TPH-contaminated soil as a soil that exhibits 50 mg/kg by weight TPH, but they exempt soil that is removed for sampling purposes (409.9 SJCAPCD; and 8-40-112 and 8-40-205 BAAQMD).

A. Drilling waste <100 mg/kg TPH (equivalent to 10,000 $ppm_{V/V}$ on the OVM):

Dispose of drill cuttings (1) at the ground surface near the well site, (2) as fill, or (3) in the designated disposal area. If cuttings are disposed of near the well site, spread cuttings out as much as is practical. When appropriate, discharge drilling mud to a pit or sump with a minimum of 2 ft of freeboard (Site 300) or 1 ft of freeboard (Livermore Site). For off-site drilling activities, transport drill cuttings and mud on site for disposal in the designated disposal area.

B. Drilling waste >100 mg/kg TPH:

Store drilling waste on site covered with plastic sheeting or in drums until a determination on the feasibility of enhanced soil bioremediation (ESB) is made by the TL. If ESB is to be used, transport the waste to the ESB site and follow steps below. If ESB is not feasible, treat and/or dispose of the waste appropriately as determined by HWM, in consultation with the appropriate EA.

1. Spread soil to a thickness of 6 to 12 inches.

2. Water weekly and biweekly.

3. Till soil and fertilize as necessary

Note: Details on the ESB can be found in Reference 3.4.

6.5.3 Disposal procedure for waste containing metals:

A. Drilling waste below Soluble Threshold Limit Concentrations (STLCs):

Dispose of drill cuttings (1) at the ground surface near the well site, (2) as fill, or (3) in the designated disposal area. If cuttings are disposed of near the well site, spread cuttings out as much as is practical. When appropriate, discharge drilling mud to a pit or sump with a minimum of 2 ft of freeboard (Site 300) or 1 ft of freeboard (Livermore Site). For off-site drilling activities, transport drill cuttings and mud on site for disposal in the designated disposal area.

B. Drilling waste above STLCs:

Dispose off site as hazardous waste through HWM.

6.5.4 Disposal procedure for waste containing tritium:

At present, no Federal or State hazardous waste guidelines exist for tritium in soil. The most pertinent guideline is the classification threshold for tritium concentration as a Class A solid waste at 40.0 curies per cubic meter (10 CFR, Section 61.55). This value is approximately equivalent to 40,000 microcuries per liter (mCi/L) or 40,000,000,000 picocuries per liter (pCi/L).

A. Drilling waste below "Beta Scan" Practical Quantitation Limit (PQL); 1 pCi/g or a Lab counting of <5 pCi/g:

Dispose of drill cuttings (1) at the ground surface near the well site, (2) as fill, or (3) in the designated disposal area. If cuttings are disposed of near the well site, spread cuttings out as much as is practical. When appropriate, discharge drilling mud to a pit or sump with a minimum of 2 ft of freeboard

(Site 300) or 1 ft of freeboard (Livermore Site). For off-site drilling activities, transport drill cuttings and mud on site for disposal in the designated disposal area.

B. Drilling waste above "Beta Scan" PQL or a Lab counting of >5 and <60 pCi/g:

If tritium contamination is known or expected to be encountered within a particular zone, segregate the spoils to minimize the quantity of spoils and dispose of as determined by HWM, in consultation with the appropriate EA.

C. Drilling waste results >60 pCi/g:

Dispose of mud or cuttings as radioactive waste determined on a case-by-case basis by the ECBGL in consultation with HWM and the appropriate EA, in accordance with applicable ARARs.

6.5.5 Disposal procedure for waste containing other radionuclides:

A. Drilling mud and cuttings are considered to have no LLNL-added radioactivity if the alpha activity is <15 pCi/g soil and the beta activity is <25 pCi/g:

Dispose of drill cuttings (1) at the ground surface near the well site, (2) as fill, or (3) in the designated disposal area. If cuttings are disposed of near the well site, spread cuttings out as much as is practical. When appropriate, discharge drilling mud to a pit or sump with a minimum of 2 ft of freeboard (Site 300) or 1 ft of freeboard (Livermore Site). For off-site drilling activities, transport drill cuttings and mud on site for disposal in the designated disposal area.

B. Drilling waste are considered to have rad added if the alpha activity is >5 pCi/g soil and the beta activity is >25 pCi/g:

Dispose of IDW as determined by HWM, in consultation with the appropriate EA.

6.5.6 Disposal procedure for waste containing high explosives (HE):

There are no Federal or State criteria for establishing hazardous concentrations of HE compounds in soil. However, using the *Designated Level Methodology for Waste Classification and Cleanup Determination* (Marshack, 1989), LLNL Site 300 has established Designated Levels (DLs) for Cyclotetramethylene-Tetranitramine (HMX) and Cyclotrimethylene-Trinitramine (RDX). The DLs are the concentrations above which a soil may result in degradation of underlying ground water quality. The disposal criteria used are based upon a toxicological literature review presented in Reference 3.5.

A. Drilling waste <31.5 ppm RDX and <315.0 ppm HMX:

Dispose of mud, cuttings, and unused core samples on ground surface at well site.

B. Drilling waste >31.5 ppm RDX and/or >315.0 ppm HMX:

Treat or dispose of waste appropriately as determined by HWM and the appropriate EA.

6.5.7 Disposal procedure for waste containing other detectable contaminants or multiple contaminants:

Dispose of IDW as determined by HWM, in consultation with the appropriate EA.

6.6 Site Restoration

6.6.1 As soon as drilling and, if applicable, well installation has been completed, restore the area to predrilling conditions.

6.6.2 Till drill cuttings and unused soil core left at the well site with the native topsoil so that the nutrients and seed bank within the topsoil is introduced to the cuttings.

6.6.3 Leave a minimum of 2 ft of freeboard in the pit after depositing the drilling mud. The pit should be filled as soon as possible to minimize the amount of time the excavation is open.

6.6.4 Allow a sufficient amount of time for the drilling mud to solidify (one to many months), depending on the season and amount of precipitation.

6.6.5 After drilling mud has solidified, cover the hardened mud with the topsoil that was removed prior to excavation. The site should return to predrilling appearance after the vegetation has been re-established.

6.7 Procedure Exceptions

In developing this SOP, every effort was made to ensure compliance with all ARARs, as required in EPA, 1991. But as recognized in EPA, 1991, it is often necessary to use the best professional judgment, in light of site-specific conditions. Any deviations from this procedure must be approved by the Division Leader or designee only after it is determined that such actions are still protective of human health and the environment.

7.0 QUALITY ASSURANCE RECORDS

7.1 Borehole/Well Construction Log

7.2 Document Control Logbook

8.0 ATTACHMENT

Attachment A— Livermore Site and Site 300 ARARs

Attachment A

Potential Federal, State, and Local ARARs Table

Attachment A. Potential Federal, State, and local ARARs.

ARAR	Comments	LLNL actions taken to comply with ARARs
Federal		
1. Clean Air Act (CAA) [42 USCA 7401–7642] [40 CFR 50–69]	National primary and secondary ambient air quality standards (NAAQS) are defined under Section 109 of the CAA and are listed in 40 CFR 50.	Soils do not contain contaminants regulated under NAAQS.
2. Clean Air Act [42 USCA 7412] [40 CFR 61.92]	National Emission Standards for Hazardous Air Pollutants (NESHAPs) are specific to industrial emissions. 40 CFR 61.92 limits emissions of radionuclides to those amounts that would cause any member of the public to receive, in any one year, a maximum effective dose equivalent of 10 millirems per year (mrem/y).	Aeration of tritiated soils does not exceed dose limits.
3. Land Disposal Restrictions (LDRs) RCRA [40 CFR 268]	Any waste placed in land-disposal units must comply with LDRs by either attaining specific performance or technology-based standards.	Aeration of contaminated soils near boring in area of contamination is not considered “placement” under LDR restrictions, and is consistent with final site remedy.
State		
4. Hazardous Waste Control Act (Health and Safety Code, Section 25100– 25395), CCR, Title 22, ch. 30: Minimum Standards for Management of Hazardous and Extremely Hazardous Wastes	HCWA controls hazardous wastes from their point of generation through accumulation, transportation, treatment, storage, and ultimate disposal. All potentially hazardous materials are handled in accordance with standard chain-of-custody procedures. These requirements are, therefore, applicable to all treatment alternatives.	All soil, other than VOC-containing soil, determined to be hazardous waste will be submitted to LLNL’s Hazardous Waste Management Division for proper disposal following all applicable regulations. VOC-contaminated soil will be aerated in area of contamination.
Criteria for Identifying Hazardous Wastes [Title 22, ch. 30, 66693–66776]	Tests for identifying hazardous characteristics are set forth in these regulations.	All soil, other than VOC-containing soil, determined to be hazardous waste will be submitted to LLNL’s Hazardous Waste Management Division for proper disposal following all applicable regulations. VOC-contaminated soil <10 ppm will be aerated in area of contamination.

Attachment 1. (Continued)

ARAR	Comments	LLNL actions taken to comply with ARARs
Persistent and Bioaccumulative Toxic Substances [Title 22, ch. 30, 66699]	Total Threshold Limit Concentrations (TTLCs) and Soluble Threshold Limit Concentrations (STLCs) have been established for selected toxics to be used in establishing whether waste is hazardous. If a chemical is either listed or tested and found hazardous, then remedial actions must comply with the hazardous waste requirements under Title 22.	All soil, other than VOC-containing soil, determined to be hazardous waste will be submitted to LLNL's Hazardous Waste Management Division for proper disposal following all applicable regulations. VOC-contaminated soil <10 ppm will be aerated in area of contamination.
5. Porter-Cologne Water Quality Control Act [WC13000–13806], as administered by the State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Board (RWQCB) under CCR Title 23, subch. 15, 1050–2836.	Establishes authority for State and Regional Water Boards to determine site-specific discharge requirements and to regulate disposal of waste to land.	Aeration of contaminated soils comply with substantive sections of these regulations due to low volume of contaminants.
6. Fish and Game Regulations on Pollution	Prohibits water pollution with any substance or material deleterious to fish, plant, or bird life.	Aeration of contaminated soils in area of contamination will not result in water pollution deleterious to biota.
7. Air Resources Act (Health and Safety Code, section 3900 et. seq.)	Establishes allowable discharge standards for point sources within each air pollution control district, and establishes ambient air quality standards.	Aeration of contaminated soils comply with substantive sections of these regulations due to low volume of contaminants.
8. Bay Area Air Quality Management District (8-40-112; 8-40-205) San Joaquin County Air Pollution Control District (409.9)	Requires permitting of VOC air discharges (e.g., from an air-stripping unit).	Soil that is removed for sampling purposes is exempt.
9. Central Valley Regional Water Quality Control Board Designated Level Methodology	Provides guidance in establishing acceptable levels of soil contamination which will not impact ground or surface waters.	Methodology used to establish RDX and HMX designated levels.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.10: Soil Vapor Surveys—Revision: 6

AUTHOR(S):
S. Gregory

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#
ERD

APPROVALS:	Date
Department Head	4/30/12
Livermore Program Leader	4/18/12
Site 300 Program Leader	4/12/12

CONCURRENCE:	Date
QA Implementation Coordinator	4/19/12

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

*Weiss Associates

1.0 PURPOSE

This procedure describes collection of representative samples and accurate analytical measurements of soil vapor from discrete subsurface depths.

2.0 APPLICABILITY

This procedure applies to *in situ* subsurface soil vapor sampling for volatile organic compounds (VOCs) present in the vadose zone. These procedures are applicable to soil vapor surveys conducted at the LLNL Livermore Site and Site 300. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The

Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

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3.3 Lamarre, A., Crow, N., Vonder Haar, S., McIlvride, W., Ferry, R., Pavletich, J., Caufield, R., Anderson, E., and Wade, M. (1989), "Trichloroethylene Contaminant Plume Definition at the Lawrence Livermore National Laboratory Site 300 General Services Area and Adjacent Ranches, Southeast Of Livermore, California," (Abstract) In Trans., American Geophysical Union Annual Meeting Held In San Francisco, 24 October 1989.

3.4 Silka, L. R. (1988), "Simulation of Vapor Transport Through the Unsaturated Zone–Interpretation of Soil-Gas Surveys," *Ground Water Monitoring Review*, pp. 115-123.

3.5 Vonder Haar, S., Pavletich, J., McIlvride, W., and Taffet, M. (1989), *Soil Vapor Survey at the LLNL Site 300 General Services Area, Adjacent Portions of the Connolly and Gallo Ranches, and the Site 300 Landfill Pit 6 Area*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-21183), 47 p. plus 1 appendix.

3.6 Vonder Haar, S., Ferry, R., and Lamarre, A. (1991), *Comparison of Two Soil-Vapor Survey Techniques and Their Relationship to TCE Concentrations in Underlying Ground Water at Lawrence Livermore National Laboratory Site 300*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-107360), 67 p. plus 4 appendices.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Soil Vapor Survey (SVS) Project Manager

The SVS Project Manager is responsible for preparing the Sampling Plan, planning the logistics, and scheduling the utility line locators and technician support.

5.6 SVS Technician

The SVS technician is responsible for performing all necessary equipment maintenance, collecting samples according to this procedure and sampling plan, and documenting field-work.

5.7 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review the Work Plan and Sampling Plan distributed by the PM.

5.8 Data Management Team (DMT)

The DMT is responsible for reviewing the Drilling Work Plan and Sampling Plan and the disposition of original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

6.1 Discussion

6.1.1 SVSs are used mainly as a screening tool to determine the concentration of volatile organic compounds (VOCs) in soil vapor as a result of volatilization from the soil and/or ground water. The primary SVS method currently used is the passive collection technique utilizing GORE-SORBER® modules.

6.1.2 The GORE-SORBER® passive soil-vapor technique provides a means to collect and detect trace quantities of a broad range of VOCs and semi-volatile organic compounds (SVOCs) near the ground surface (see Attachment A). The GORE-SORBER® module and methodology are described in detail in Attachment B. It is strongly recommended that site activities that disturb the natural equilibrium of vadose zone not be conducted during the time when the modules are in the subsurface. Such activities include: drilling (especially air-rotary), installation/operation of soil vapor extraction systems, construction or excavation, air sparging, etc.

6.2 Safety Considerations

6.2.1 Prior to participating in a soil vapor survey, perform the applicable preparation activities described in SOP 4.1, "General Instructions for Field Personnel".

6.2.2 To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with LLNL Integration Work Sheet (IWS) 11578 "Drilling in VOC-Contaminated Soils at the Livermore Site" and IWS 12654 "Drilling in VOC and Mixed Waste-Contaminated Soils at the Livermore Site". Drilling activities at Site 300 will be conducted in accordance with IWS 11276 "Site 300 Drilling Activity." Anyone can stop work at anytime if an unsafe condition is observed. The SVS Project Manager and SSO shall be notified immediately of the condition and the 'Stop Work' decision.

6.3 Office Preparation

6.3.1 Collect the equipment and materials needed to conduct the survey per Attachment C for GORE-SORBER®.

6.3.2 Acquire a map of sample locations from the SVS PM. Obtain a logbook from the DMT per ERD SOP 4.2 "Sample Control and Documentation." The SVS PM reviews the existing vapor, soil, and ground water data and plots the locations of the contaminant plume(s), roads, buildings, utilities, etc. on a map to determine the grid pattern and line spacing for the sample points.

The SVS PM selects the appropriate compound specific survey and required analyses from standard or custom lists.

6.3.3 Verify with the SVS PM that the proposed soil vapor sample locations have been properly cleared by an underground line locator and that all necessary surveys have been conducted and permits obtained as required by the PROC-CON-003 Soil Excavation and Permit process prior to excavation.

6.3.4 The SVS PM will determine if blank and duplicate samples shall be collected at the start of the day, about half way through the day, and at the end of the day. This is in addition to the collection of proper QC samples as required by SOP 4.9: Collection of Field QC Samples.

6.4 Field Preparation

Document all field and operation activities in the SVS field logbook and Daily Field Report.

Mark proposed sample locations on ground with stakes in undeveloped areas and with spray paint on pavement. Pre drill holes for larger projects to speed module installation.

Ensure proper storage of GORE-SORBER® Modules until deployment in the field. **DO NOT** store them near potential sources of organic vapors including petroleum fuels, fuel exhaust, solvents, paints, adhesives, foam insulating materials, etc.

Gather required tools and sampling supplies

- Slide hammer slam bar, or electric rotary drill to obtain a 1/2-inch to 1-inch diameter and a three foot deep pilot hole.
- Stainless steel insertion rod (supplied by W.L. Gore & Associates). Obtain extra rods for large projects.
- Corks with attached screw eyes (supplied by W.L. Gore & Associates).
- String cord to allow installation of module to desired depth (supplied by W.L. Gore & Associates).
- Chain of Custody and Installation/Retrieval Log forms (supplied by W.L. Gore & Associates).

6.5 Passive GORE-SORBER® SVS Operation

6.5.1 Module Installation

- Drive/drill a 1/2- to 1-inch diameter pilot hole to a depth of three feet below grade.
- Wearing surgical gloves, remove the GORE-SORBER® Module from the numbered container and re-seal the jar. Verify that the module ID number matches the ID number on the container.
- Follow GORE Procedure (Attachment B).
- When working in pavement, an “eye” screw can be screwed into the top of the cork to facilitate removal.

- DI water can be sprayed on a dry soil surface before the tile probe is used to help with installation.

Note: Modules can be hung above ground to sample ambient background air for QA concerns. Modules can also be hung in vadose zone wells to sample vapor in the well-bore.

6.5.2 Module Retrieval

The SVS PM determines the module exposure period, which is usually 10 to 21 days. (Note: 21 days is preferred for TCE, DCE, PCE, and related VOCs)

- Refer to Typical Installation Diagram for Gore Sorber® (Attachment A).
- Holes can be grouted as needed, especially in pavement areas.

6.5.3 Documentation and Shipping

- Document field activities and provide original documentation/forms to the DMT.
- Complete “GORE-SORBER® Screening Survey Installation and Retrieval Log” form (Attachment D).
- Complete “GORE-SORBER® Screening Survey Chain of Custody ” form (Attachment E).
- Refer to SOP 4.2: Sample Control and Documentation, and SOP 4.4: Guide to Packaging and Shipping of Samples for sample documentation and shipping procedures.
- Submit samples to LLNL Shipping Department (Building 411 – Room 1608) for delivery using an overnight courier.

6.6 Post Operation

6.6.1 Decontaminate and store equipment properly per SOP 4.5, “General Equipment Decontamination”.

6.6.2 Review logbooks and field forms for completeness and accuracy per SOP 4.2, “Sample Control and Documentation”.

7.0 QUALITY ASSURANCE RECORDS

7.1 Final Analytical Data (either in µg/sorbant or $ppm_{v/v}$)

7.2 Field Logbooks

7.3 Daily Field Report

7.4 GORE-SORBER® Screening Survey Installation and Retrieval Log

7.5 Chain-of-Custody forms

8.0 ATTACHMENTS

Attachment A—Schematic of a Typical Installation Diagram for Gore Sorber®

Attachment B—Passive GORE-SORBER® Methodology for Module Storage, Installation, and Retrieval Including Figures

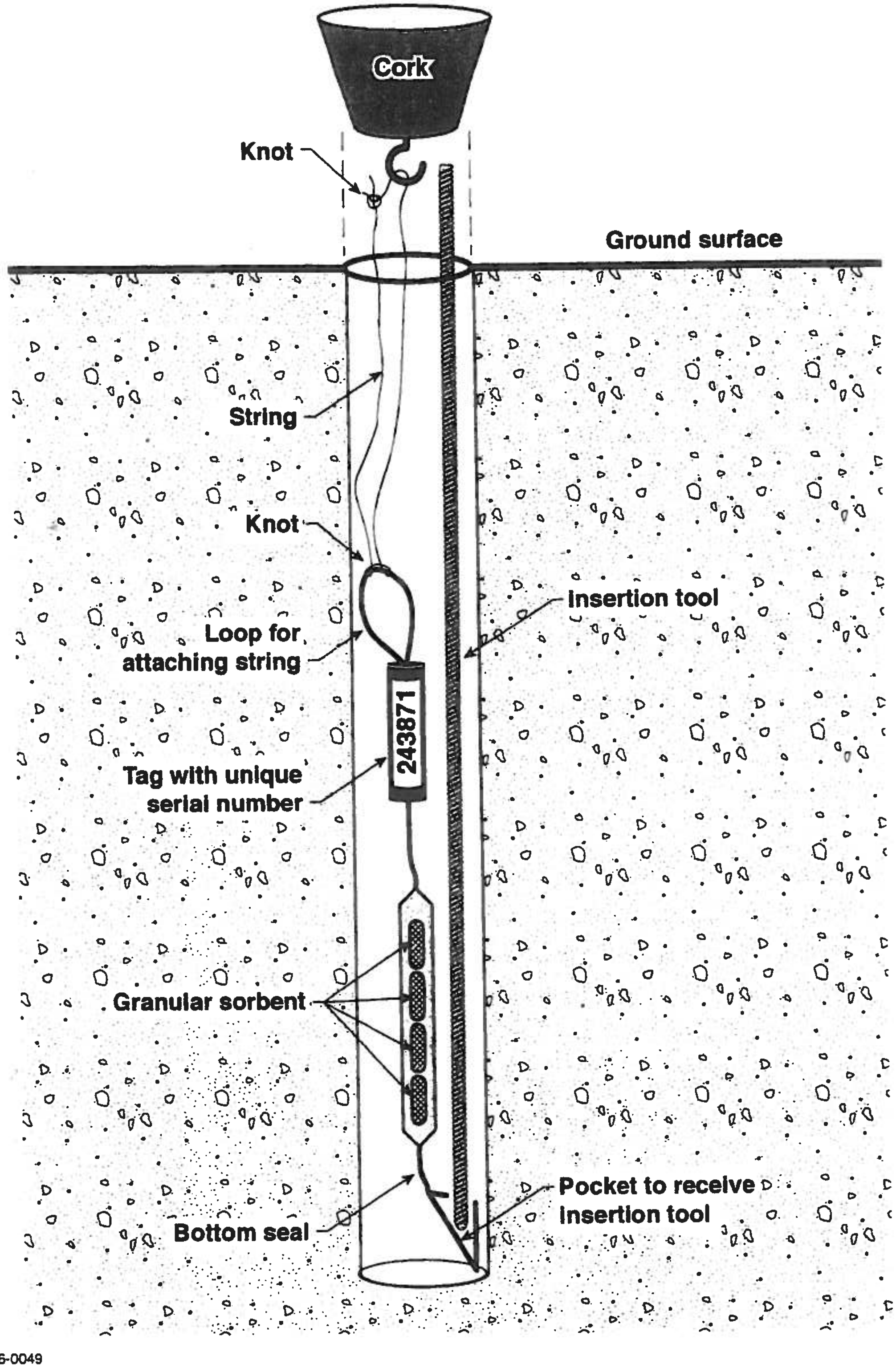
Attachment C—Equipment Checklist

Attachment D—GORE-SORBER® Screening Survey Installation and Retrieval Log

Attachment E—GORE-SORBER® Screening Survey Chain of Custody

Attachment A

Schematic of a Typical Gore Sorber® Installation



Attachment A. Schematic of a typical Gore-Sorber® installation.

Attachment B

Passive GORE-SORBER® Methodology for Module Storage, Installation, and Retrieval Including Figures

W. L. GORE & ASSOCIATES, INC.

GORE SORBER® EXPLORATION SURVEY GORE SORBER® SCREENING SURVEY

IMPORTANT -- READ THIS FIRST

GORE-SORBER® Screening Survey
Module Storage, Installation, and Retrieval Information

NOTE: If you have any questions regarding installation and retrieval of your modules, please call Ray Fenstermacher, Jay Hodny or Diane Cooper (410) 392-7600

GENERAL
We strongly recommend that site activities which disturb the natural equilibrium of soil gas migration not be conducted during the time when the modules are in the subsurface. Such activities include, but are not limited to, installation/operation of soil vapor extraction systems, drilling (especially air-rotary), excavation on the site or in the near vicinity, air sparging, etc.

STORAGE
GORE-SORBER® Modules are specially cleaned and stored after manufacturing. They must remain sealed in their vials in the shipping boxes until deployment. **DO NOT** store them near potential sources of organic vapors, including petroleum fuels, fuel exhaust, solvents, or in areas of new construction or remodeling where paints, adhesives, foam insulating materials, etc. may be present.

REQUIRED TOOLS/SUPPLIES
GORE-SORBER Modules can be installed at any depth. Usually they require only a narrow pilot hole (approximately 1/2-inch to 3/4-inch in diameter) typically drilled or driven to a depth of 2 to 3 feet using hand tools (depending on project objectives, installation depth may vary at your site).

The following items are provided by GORE:
- Shipping boxes containing individually numbered passive soil gas collectors (Modules), including trip blanks:
- Stainless steel insertion rod, in threaded sections (for placement of modules in pre-drilled/driven pilot holes);
- Corks with screw eyes attached;
- String (cord) to allow the module to be installed to the recommended depth; and
- Chain of Custody and Installation/Retrieval Log.

Additional tools (to be supplied by the customer) required for installation may include:
- Equipment to lay out and mark sample locations (scaled map, measuring tapes, pin flags, spray paint);
- Disposable gloves and equipment decontamination supplies
- Slide hammer/tile probe (slam bar) or electric rotary hammer drill (AC power outlet or portable generator and extension cords required) with carbide-tipped bits or augers (1/2 to 1-inch diameter up to 36 inches long) information on where these items can be purchased is provided below as a courtesy and does not represent any endorsement of these products or suppliers:

Item	Supplier	Phone No.
* Slide Hammer/Tile Probes	Forestry Supplies	(800) 647-5368
* Carbide Drill Bits (36" long)	KV Associates, Inc.	(508) 539-3002
* Rotary Hammer Drill	SKILL-BOSCH Power Tools	(800) 334-5730

* Art's Manufacturing Supply (dba AMS) has all these items (800) 635-7330

W. L. Gore & Associates, Inc.
100 Chesapeake Blvd., P.O. Box 10
Elkton, MD 21922-0010
Phone: 410/392-7600
Fax: 410/506-4780

Accuracy Counts

MODULE INSTALLATION

- Always obtain utility clearance before digging or probing.
- **We do not recommend installation of modules within 15 feet of monitoring wells, utility trenches or other conduits which may act as a preferential pathway for soil vapor migration.**
- Drive/drill narrow pilot hole at desired pre-marked location.
- Wearing clean surgical gloves, remove module from numbered container and re-seal the jar (this numbered container should correspond to the numbered module ID tag - please verify this).
- Measure and cut a section of cord that is suitable for your installation.
- Tie one end of the cord to the loop in the module, and tie the other end of the cord to the screw-eye in the appropriate size cork.
- Place insertion rod into the pre-cut pocket at the base of the module and lower it into the hole. If you encounter resistance remove the module and ream the hole and re-insert the module.
- Once deployed to the desired depth, press the insertion rod against the side of the hole and twist slightly to release the module. Remove the rod and push any excess cord into the pilot hole and plug it with the cork.
- Indicate the module number, date and time of installation and any pertinent comments on the installation/retrieval log. Write the module serial number on the site map adjacent to the appropriate map location.
- Clean the tile probe or drill bit and the insertion rod prior to use at the next location. Replace the surgical gloves as necessary before handling any modules.
- Following module installation, the modules selected as **trip blanks** should be kept in the sample box provided and stored as described above in "STORAGE" until sample retrieval.

MODULE RETRIEVAL

- Following the module exposure period (usually 10 - 14 days) identify and check each module location in the field using the site map.
- Remove the cork with a penknife or cork screw. Grasp the cord and pull the module from the ground; **verify the module ID number**. Cut off and discard the cork and cord. Place the entire module in its labeled container and tightly secure the lid.
- Replace the sample container in the box. Where possible, please attempt to keep modules in numbered sequence to expedite sample check-in and processing.
- Complete the module retrieval date/time on the installation/retrieval log.
- **Do not** use Styrofoam "peanuts" as packing material. Bubble packing is acceptable. Water ice can be added if desired, but cooling in general is not necessary. If shipping with ice, please take precautions to keep boxes dry (perhaps shipping in a cooler).
- Return the samples with insertion rod and paperwork (preferrably by overnight courier) to:

Screening Modules Laboratory
W.L. Gore & Associates, Inc.
100 Chesapeake Blvd.
Elkton, MD 21921
Phone: (410) 392-7600

Attn: NOTIFY LAB IMMEDIATELY UPON DELIVERY!!

IMPORTANT: Samples should not be shipped for weekend or holiday delivery at GORE.

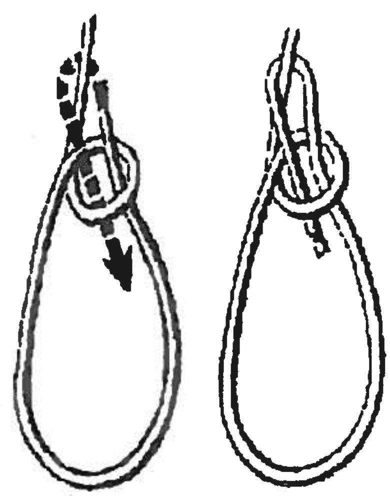
W. L. GORE & ASSOCIATES, INC

GORE SORBER EXPLORATION SURVEY   GORE SORBER SCREENING SURVEY

W.L. Gore & Associates, Inc. recommends either of the following methods for tying string to our GORE-SORBER® Modules for field installation:

The Bowline Knot

Begin by forming an overhand loop in the standing part of the line. Then take the free end up through the eye, around the standing part and back where it came from. Pull to tighten. This knot will not slip if tied correctly.



Doubled-up line:

If the module is to be installed to a depth of 3 feet, then cut a section of string that is twice that depth....in this case 6 feet. Bring the cut ends of the string together and run one of these through the loop in the module. Run one of the cut ends through the eye screw/cork (provided by GORE), and tie a knot that will not slip.

W. L. Gore & Associates, Inc.
100 Chesapeake Blvd., P.O. Box 10
Elkton, MD 21922-0010
Phone: 410/392-7600
Fax: 410/506-4780

Accuracy Counts

DESCRIPTION OF SERVICE FOR SOIL GAS APPLICATIONS

Screening Survey Applications

GORE-SORBER® Screening Surveys employing GORE-SORBER® Modules (patented passive soil vapor sampling devices) have been used successfully at many sites for determining subsurface areas impacted by VOCs and SVOCs. Organic compounds commonly detected include fluorinated and chlorinated solvents, straight- and branched chain aliphatics, aromatics, and polycyclic aromatic hydrocarbons (PAHs). Many of these compounds are associated with a wide range of petroleum products, including gasoline, mineral spirits, heating oils, creosotes, and coal tars. GORE-SORBER Screening Surveys have also been used successfully to screen for nitroaromatic explosives.

Common applications include detection of compounds to: 1) trace soil and ground water plumes in porous and fractured media, 2) monitor progress of subsurface in-situ remedial actions, 3) to provide baseline data for real estate transfer assessments, and 4) to reduce groundwater monitoring costs. Prudent use of this technology can optimize and reduce soil and groundwater sampling efforts resulting in significant cost savings over the life of site assessment and remedial action programs.

Description Of GORE-SORBER Screening Modules

A typical GORE-SORBER Screening Module consists of several separate GORE-SORBER® passive sorbent collection devices (sorbers). A typical sorber is 15 to 25 millimeters (mm) long, with a 3 mm inside diameter (ID), and contains 40 milligrams (mg) of a suitable granular adsorbent material depending on the specific compounds to be detected. Typically, polymeric and carbonaceous resins are used for their affinity for a broad range of VOCs and SVOCs. The sorbers are sheathed in the bottom of a one (1) foot length of vapor-permeable insertion and retrieval cord which is fashioned with a loop. This construction is termed a GORE-SORBER module. Both the retrieval cord and sorbent container are constructed solely of inert, hydrophobic, microporous GORE-TEX® expanded polytetrafluoroethylene (ePTFE, similar to Teflon® brand PTFE). The loop is used as a means of tying the module to a string for installation and retrieval. Attachment 1 shows a typical screening module.

A unique feature of ePTFE membranes are that they are hydrophobic and exclude liquid water, yet they do not retard vapor transfer, thus allowing VOC and SVOC vapors to freely penetrate the module and collect on the adsorbent material. This ability to protect the sorbent media from contact with ground and soil pore water without retarding soil vapor diffusion facilitates the application of GORE's soil vapor screening methods in very low permeability and poorly drained soils.

Quality Assurance (QA) Measures

As standard practice, all modules are individually numbered and tracked throughout the entire manufacturing, field deployment, and analytical process. Completed modules are subjected to a final cleaning process and then sealed into a clean glass vial with a Teflon liner. All modules are transported to and from the customer's site in sealed glass vials and boxes supplied by GORE. Five to ten percent additional trip blanks will accompany the modules to and from the site. Associated manufacturing blanks and trip blanks are always tested with each project as controls. Full details of GORE's QA measures are documented in our Quality Assurance Manual.

Screening Survey Installation and Retrieval Procedures

Installation of the modules is typically performed by the customer. Although GORE-SORBER modules can be installed to any depth, a slam bar or electric rotary hammer-drill is typically used to auger a 3/4 to 1-inch diameter pilot hole for the deployment of the modules to an average depth of two (2) to three (3) feet below grade.

After the pilot hole is completed, modules are tied to a section of cord and inserted into the completed boreholes, using the stainless steel insertion rod supplied by GORE. The cord is typically fastened to a cork, which is tamped flush with the ground surface to assist in retrieval of the module, and to seal the annulus of the boring. Additional modules that are designated as trip blanks should be noted on the installation/retrieval log and left (unopened) in the shipping box for the duration of the field exposure.

Module retrieval requires that field personnel locate the module, remove the cork, grasp the cord and manually pull the module from each location. Corks and cord are separated from the module and discarded. The exposed modules are resealed in their respective designated shipping vials and placed in the supplied shipping box. Boxes with field-exposed modules and trip blanks are returned along with the Chain-of-Custody (COC) form to GORE's laboratory in Elkton, MD usually via overnight courier.

Screening Module Exposure Time
GORE's suggested module exposure time is 10 to 14 days.

Analytical Procedures
On receipt of the modules at the GORE laboratory, each box is opened, the samples are logged, and the COC is inspected. Samples are then transferred to a temporary holding facility with a positive pressure zero-air supply until analysis.

Analytical instrumentation consists of gas chromatographs and mass selective detectors, as well as automated thermal desorption units. Sample preparation simply involves cutting the tip off the bottom of the sample module and transferring an exposed sorbent container (sorber) to a thermal desorption tube for analysis. Sorbers remain clean and protected from dirt, soil, and groundwater by the insertion/retrieval cord, and require no further sample preparation. The replicate samples remain in the zero-air container until discarded. Laboratory QC is described below:

Level 2 Screening Method Quality Assurance:
This is our standard analytical screening method, which is essentially a modified EPA method 8260A/8270B. Before each run sequence, two instrument blanks, a sorber containing 5μg BFB (Bromofluorobenzene), and a method blank are analyzed. The BFB mass spectra must meet the criteria set forth in Statement of Work (SOW) for Organic Analysis Multi-Media Multi-Concentration (SOW OLM 010.0 and revisions) before samples can be analyzed. A BFB-containing sorber is also analyzed after every 30 samples and/or trip blanks, as is a method blank. Standards containing our target compounds at three calibration levels of 5, 20, and 50μg are analyzed at the beginning of each run. The %RSD criterion for all target compounds is less than 35% RSD. If this criterion is not met for any target compound, the analyst has the option of generating second- or third-order standard curves, as appropriate. A second-source reference standard, at a level of 10μg per target compound, is analyzed after every ten samples and/or trip blanks, and at the end of the run sequence. No surrogates are added. Positive identification of target compounds is determined by the presence of the target ion, at least two secondary ions, retention time versus reference standard, and the analyst's judgment. All analytical data are reported as mass of analyte, in micrograms (μg) per sample.

Laboratory data deliverables packages can be provided at the customers request, and may include all analytical results for samples, standards and blanks, and mass spectra comparisons with standards for all detects.

Interpretation of Screening Survey Data

In general, the detection of VOCs and SVOCs in field-exposed modules indicates that potential sources (i.e. soil adsorbed-, dissolved- and separate-phase organics) of the detected compound(s) may exist in proximity to the module location. The module will adsorb migrating gases present in the adjacent media (soil or water). The processes that govern the movement of gases in the subsurface are complex, involving interactions between the soil, soil moisture, pore gasses, ground water, and the volatile contaminant. Chemical and microbiological processes can further influence the presence of soil gases, by reacting with or metabolizing these compounds.

Vapor pressure, water solubility, molecular weight, and the Henry's Law partitioning coefficient, are all important chemical parameters to consider when interpreting soil vapor data. The Henry's Law coefficient reflects a compound's behavior when partitioned into air and water, which aids in understanding an organic chemical's likely state in the subsurface. An understanding of the site geology (geologic structure, geochemistry), hyrogeolology and operational history are also important when interpreting the distribution of soil gases.

Contour Maps of Soil Vapor Analytes

Graphic presentation of the data extracted from GORE-SORBER Modules is normally presented by overlaying the contamination patterns detected during analysis onto CAD maps supplied by the customer. Either minimum surface curvature or kriging models (GEOSOFT® Mapping Software) are employed. Standard "B-sized" (11" x 17") color contour plots are included with each project, however "E-size" (24" x 36") plots are available, if requested. The site plan base map(s) provided by the customer must include a scaled drawing with relevant site features, and an overlay containing the sample locations for the survey.

Tentatively Identified Compounds (TICs)

Some of the modules may contain non-target analytes (compounds not on GORE's target list). GORE can provide tentative identification of prominent non-target compound peaks (TICs). These compounds can include non-target soil vapor analytes, and contaminants introduced during sample transport and installation/retrieval activities.

Reporting of Results

The results of the GORE-SORBER Screening Survey will be summarized in a brief report, which will include the chain of custody, analytical data summary table, sample chromatograms, and color contour maps. A laboratory analytical data deliverables package incorporating results of samples, standards and blanks, and mass spectra compared to standards for all detects can be provided as an option.

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GORE-SORBER® Screening Surveys
Analytical Options

COMPOUND SPECIFIC SURVEYS

All options include soil gas collectors, analysis, three color contour maps and final report in duplicate

A1 Gore Standard VOCs/SVOCs

Analysis via TD/GC/MS with results quantified for the following analytes:

Methyl t-butyl ether	1,1,1-Trichloroethane	Toluene	m,p-Xylene	Undecane
trans-1,2-Dichloroethene	Benzene	Octane	o-Xylene	Naphthalene
1,1-Dichloroethane	Carbon tetrachloride	Tetrachloroethene	1,3,5-Trimethylbenzene	Tridecane
cis-1,2-Dichloroethene	1,2-Dichloroethane	Chlorobenzene	1,2,4-Trimethylbenzene	2-Methyl naphthalene
Chloroform	Trichloroethene	Ethylbenzene	1,4-Dichlorobenzene	Pentadecane

A2 Fuel Hydrocarbons

Analysis via TD/GC/MS with results quantified for the following analytes:

Methyl t-butyl ether	Ethylbenzene	Octane	Pentadecane	Naphthalene
Benzene	m,p-Xylene	Undecane	1,3,5-Trimethylbenzene	2-Methylnaphthalene
Toluene	o-Xylene	Tridecane	1,2,4-Trimethylbenzene	

A3 Selection of ANY EIGHT (8) compounds from Gore Standard VOCs/SVOCs list (A1)

Analysis via TD/GC/MS with results quantified for any eight compounds selected from the A1 list (see above).

A4 Gore Standard VOCs/SVOCs (A1) plus Additional PAHs

Analysis via TD/GC/MS with results quantified for the following analytes:

Methyl t-buryl ether	Trichloroethene	1,2,4-Trimethylbenzene	Acenaphthylene
trans-1,2-Dichloroethene	Toluene	1,4-Dichlorobenzene	Acenaphthene
1,1-Dichloroethane	Octane	Undecane	Fluorene
cis-1,2-Dichloroethene.	Tetrachloroethene	Naphthalene	Phenanthrene
Chloroform	Chlorobenzene	Tridecane	Anthracene
1,1,1-Trichloroethane	Ethylbenzene	2-Methyl naphthalene	Fluoranthene
Benzene	m,p-Xylene	Pentadecane	Pyrene
Carbon tetrachloride	o-Xylene		
1,2-Dichloroethane	1,3,5-Trimethylbenzene		

A6 Gore Standard VOCs/SVOCs (A1) plus Explosives

Analysis via TD/GC/MS with results quantified for the following analytes:

Methyl t-butyl ether	Trichloroethene	1,2,4-Trimethylbenzene	3-Nitrotoluene
trans-1,2-Dichloroethene	Toluene	1,4-Dichlorobenzene	4-Nitrotoluene
1,1-Dichloroethane	Octane	Undecane	1,3-Dinitrobenzene
cis-1,2-Dichloroethene	Tetrachloroethene	Naphthalene	2,6-Dinitrotoluene
Chloroform	Chlorobenzene	Tridecane	2,4-Dinitrotoluene
1,1,1-Trichloroethane	Ethylbenzene	2-Methyl naphthalene	1,3,5-Trinitrobenzene
Benzene	m,p-Xylene	Pentadecane	2,4,6-Trinitrotoluene
Carbon tetrachloride	o-Xylene	Nitrobenzene	4-Amino-2,6-dinitrotoluene
1,2-Dichloroethane	1,3,5-Trimethylbenzene	2-Nitrotoluene	2-Amino-4,6-dinitrotoluene

A7 CUSTOM Target List

Analysis via TD/GC/MS with results quantified for a target list of compounds as defined by the customer.

A10 Gore Chlorinated VOCs

Analysis via TD/GC/MS with results quantified for the following analytes:

1,1-Dichloroethene	Chloroform	Trichloroethene	1,1,2-Trichloroethane	1,2-Dichlorobenzene
trans-1,2-Dichloroethene	1,1,1-Trichloroethane	Tetrachloroethene	1,1,1,2-Tetrachloroethane	1,3-Dichlorobenzene
1,1-Dichloroethane	Carbon tetrachloride	Chlorobenzene	1,1,2,2-Tetrachloroethane	1,4-Dichlorobenzene
cis-1,2-Dichloroethene	1,2-Dichloroethane			

- addition of vinyl chloride to the above options is possible for an additional fee

NON-COMPOUND SPECIFIC SURVEYS

A9a Gore Total Petroleum Hydrocarbons (TPH)

Analysis via TD/GC/MS with non-compound specific results. Suitable for sites impacted with petroleum hydrocarbons where compound specific results are not required. Similar to a conventional "TPH" analysis for soil or ground water, but with some significant differences from conventional analysis. Compound specification can be added post-survey without further sampling or analysis for an additional fee.

A9b Gore Gasoline & Diesel Range Petroleum Hydrocarbons (GRPH/DRPH)

Analysis via TD/GC/MS similar to above option, but with results presented for gasoline and diesel range hydrocarbons separately. Compound specific results can be added post-survey without further sampling or analysis for an additional fee.

Miscellaneous Add-on Options

Expedited Turnaround Time..By Quotation (25% to 50%)

Normal turnaround time for DATA on sample sets less than 100 is approximately two weeks following receipt of samples at the laboratory. Expedited turnaround of sample data can be reviewed on a project by project basis. Samples are generally analyzed in the order in which received. Expedited charges will only be assessed if the required data delivery date cannot be met without adjustments to the project run sequence.

QA Deliverables....:..8% surcharge

Laboratory data deliverables packages include BFB tune data, initial calibration data, sample, trip blank, field blank, method blank and instrument blank chromatograms

Library Search/TICs (Only available in addition to Standard Analysis).........$5/Compound/Module

Selection Criteria

for

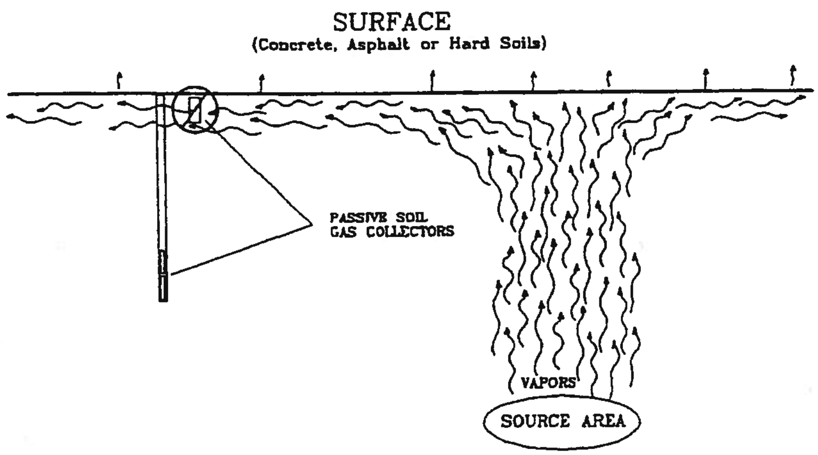
Passive Soil Gas Technology

as recommended by
W. L. Gore & Associates, Inc.

Collector Installation to Recommended Depths

Soil gas collectors should be designed for installation and retrieval at depths greater than 2 feet without additional casing of the pilot hole.

NJDEP[1] and NGWA[2] guidelines clearly state that the recommended depth for any soil gas should be 2 to 3 feet below ground surface. Significant loss of sensitivity will occur when sampling for soil gas at shallow depths. This loss of sensitivity is a function of higher outgassing rates near the soil surface, increased microbial activity, and greater impact on the shallow soil environment from precipitation, temperature, and other atmospheric parameters. Under paved or impermeable surfaces, the potential for concentrating soil gas vapor and horizontal migration of soil gases increases the need for adhering to the guidelines for installation depths.



Unimpeded Vapor Migration to the Sorbents

The combination of liquid water condensing inside the collector and the natural tendency for closed-end containers to impede the migration of gases has a significant impact on overall sensitivity.

Allowing soil gases (organics as well as water vapor) to migrate freely or "flux" past the sorbents is important. Closed-end collectors, such as glass vials or tubes, impede the natural migration of vapors to the sorbent. Additionally, glass vials promote condensation on the inside of the collector when installed in the subsurface. This condensed water acts as a "sorbent" by "scrubbing" organic gases back into the dissolved phase making them less available for adsorption on the solid sorbent.

Protection of Sorbents from Soil and Liquid Water

Collector design must employ materials of construction that are chemically inert, and must ensure that the sorbents are protected from direct contact with liquid water or soil particles.

The collector materials must be chemically inert and rugged enough to withstand handling in the field, insertion and retrieval from the subsurface, exposure to the subsurface, and shipping. Direct contact of the sorbent with liquid water or soil particles destroys the integrity of a soil gas sample.

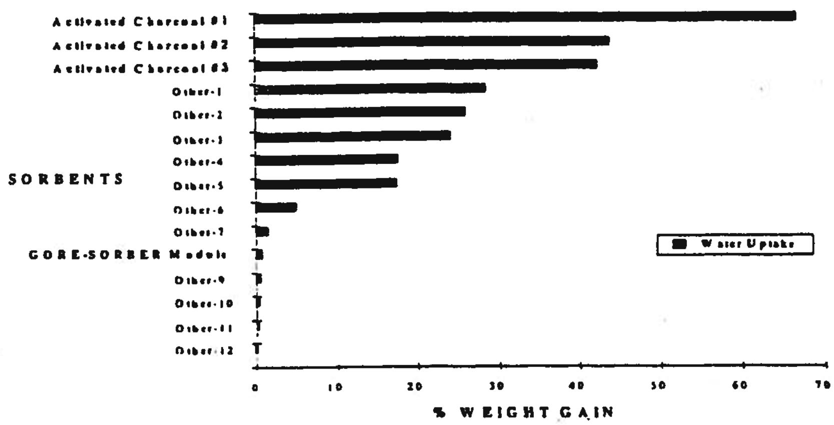
Sorbent Type

Selection of a single sorbent system that optimizes sensitivity to target compounds, hydrophobicity, and minimization of competition for sorption sites by different target compounds is the responsibility of the passive soil gas provider.

Research has been completed that focused on measuring each of these parameters for a wide variety of sorbents. Clearly, the use of activated carbon as a sorbent is unacceptable due to the high uptake of water vapor - some types adsorb up to 70% of their own weight in water vapor.

- **The result is decreased sensitivity as less sorption sites are available for organic soil gases.**

FIGURE 3: Water Sorption Data for Selected Sorbents



Sorbent Packaging

The use of collectors with poorly packaged sorbents introduces variability that impacts results adversely and cannot be measured.

The packaging of sorbents for use in the subsurface must ensure that no sorbent is lost during field use or shipping (every collector must have an identical amount of sorbent). This is a critical consideration due to the relative nature of passive soil gas results. The primary value of the results is the relative distribution of adsorbed compounds across the area of interest.

Sorbent Amount

The impact of having too little sorbent in a passive soil gas collector minimizes overall sensitivity and increases the chance of sorbent saturation at high soil gas concentrations.

Analytical Method

When specifying the analytical method, it is important to consider the overall objective of the soil gas survey and the expectations for applying the results.

The selection of an analytical method is an important criteria as this can have a significant impact on compound identification, QA/QC, data quality, data integrity, and cost. The facility analyzing the soil gas samples must follow a relevant QA/QC plan, have experience in soil gas analysis, and have supporting credentials and approvals for soil gas analyses.

[1] Field Sampling Procedures Manual, ed. J.R. Schoenleber and P.S. Morton, New Jersey Department of Environmental Protection and Energy, 364pp., 1992

[2] Devitt, Dale A., Evans, Roy B., Jury, William A., and Starks, Thomas H., Soil Gas Sensing for Detection and Mapping of Volatile Organics, National Groundwater Association, Dublin, OH.

Why Passive Soil Gas?

The primary objective of employing a passive soil gas technology is similar to all environmental screening level methods. The objective is to reduce the overall cost of an investigation or long-term monitoring program, while increasing the sampling density relative to conventional methods.

Passive soil gas technology was developed and has evolved due to the limitations of other screening techniques, particularly active soil gas. For sites with impact from VOCs and permeable soils, active soil gas methods have been proven effective.

However, active soil gas methods are not applicable on sites with low permeability or poorly-drained soils. This is primarily due to the lack of available soil gases for detection in the short sampling intervals used. The time-integrated, sorbent based approach of passive sampling overcomes these limitations and has been validated on these type of sites.

For investigations where SVOCs or PAHs are the target compounds, passive soil gas technology can be applied successfully. (Research shows that compounds up to and including pyrene can be detected successfully in the vapor phase.) Active soil gas systems are normally limited to VOC investigations.

Passive soil gas systems have also been successfully applied in delineating deeper ground water plumes (up to 100 ft. with appropriate conditions). Due to their limited sensitivity, active methods are normally only applied for shallow soil or ground water investigations.

Finally, it is possible to apply some passive collectors in the saturated zone or directly in monitoring wells to help reduce the cost of long term monitoring programs. The flexibility of passive systems is the result of research & development aimed at addressing the needs of environmental professionals and filling the gaps left by conventional soil gas methods.

Developing and producing an effective passive soil gas survey requires an experienced multi-disciplinary team. Understanding the limitation as well as the strengths of passive soil technologies leads to appropriate and successful applications and can avoid misinterpretation and a misunderstanding of the results.

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FAX: 410/506-4780

GORE-SORBER® EXPLORATION SURVEY
GORE-SORBER® SCREENING SURVEY

GORE-SORBER® SCREENING SURVEY CAD MAP INSTRUCTIONS

Thank you for your recent purchase of a GORE-SORBER Screening Survey. It is our goal to make certain that you are happy with our service for this project, so please do not hesitate to contact us with any questions at (410)392-7600.

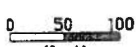
- **Currently, we ask that the CAD drawing be generated in <u>AutoCAD® Release 14</u> or earlier. If you are using another CAD program, please export and save the file in <u>DXF</u> format from your CAD system.**

- **The CAD file can be mailed to the address above, attention Jay Hodny or Ray Fenstermacher, or sent by e-mail to jhodny@wlgore.com or rfenster@wlgore.com.**

- To help insure that we deliver results on time, please comply with our specifications for the supply of a CAD map of your site to Gore:

  Upon installation of the GORE-SORBER® Screening Modules, **a CAD map showing the <u>module locations identified with the module serial number</u>** should be generated and forwarded to Gore (in advance of the return shipment of exposed modules).

  The site drawing should include:

  - A minimum number of layers with no additional hidden or frozen layers; all colored white.
  - Locational entities - such as buildings, streets, property lines, etc...; all colored white.
  - **The module locations clearly marked and labeled with the module serial number.**
  - **A graphical scale.** 

  - Be drawn in decimal ground units of the survey (i.e., feet as opposed to plot inches or architectural units); checked with the graphical scale. For example, if the graphical scale above is measured in AutoCAD, the distance will read 100, if drawn in the correct ground units (feet).
  - Exploded blocks.
  - Hard copy to be sent with diskette.
  - Include any special font or other files used to generate the drawing.

FORM 17 R.2
2/22/99

Attachment C

Equipment Checklist

EQUIPMENT CHECKLIST

General Materials

____Broom and dust pan
____Container for H_2O
____Ear plugs
____Extension cord
____First aid kit
____Flashlight
____Garbage bags
____Geologist's hammer
____Work gloves and sampling gloves
____Handiwipes
____Logbook
____Maps (site and sample location)
____Mixing bucket
____Notebook and clipboard
____Pens
____Personal protective equipment
____Pin flags or wooden stakes
____Pliers and wire snips
____Poly rope
____Quick-plug cement
____Ribbon flagging
____Engineer's scale and calculator
____Safety glasses
____Scissors
____Spray paint
____Tool box
____Trowel
____Utility bucket

Attachment D

Example GORE-SORBER® Sreening Survey

Installation and Retrieval Log

GORE-SORBER® Screening Survey Installation and Retrieval Log

SITE NAME & LOCATION
LLNL
TFC-HS

Page 1. of 1 .

LINE #	MODULE #	INSTALLATION DATE/TIME	RETRIEVAL DATE/TIME	EVIDENCE OF LIQUID HYDROCARBONS (LPH) or HYDROCARBON ODOR (Check as appropriate)			MODULE IN WATER (check one)		COMMENTS
				LPH	ODOR	NONE	YES	NO	
1. 46	493391								
2. 47	493392								
3. 48	493393								
4. 49	493394								
5. 50	493395								
6. 51	493396								
7. 52	493397								
8. 53	493398								
9. 54	493399								
10. 55	493400								
11. 56	493401								
12. 57	493402								
13. 58	493403								
14. 59	493404								
15. 60	493405								
16.	493406								
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41.									
42.									

Attachment E

Example GORE-SORBER® Screening Survey

Chain of Custody

GORE-SORBER® Screening Survey Chain of Custody

For W.L. Gore & Associates use only
Production Order # 12757430

W. L. Gore & Associates, Inc., Survey Products Group
100 Chesapeake Boulevard • Elkton, Maryland 21921 • Tel: (410) 392-7600 • Fax (410) 506-4780

Instructions: Customer must complete ALL shaded cells

Customer Name: LAWRENCE LIVERMORE	Site Name: VARIOUS SITES
Address: UNIVERSITY OF CALIF	Site Address: LLNL
PO BOX 5110	SITE 3
LIVERMORE CA 94551	Project Manager: JOHN KARACHEWSKI
Phone: (925) 424 5063	Customer Project No.:
FAX:	Customer P.O. #: B560319 Quote #:

Serial # of Modules Shipped		# of Modules for Installation 14	# of Trip Blanks 2	
# 493391 - # 493406	# - #	Total Modules Shipped: 16 Pieces		
# - #	# - #	Total Modules Received: Pieces		
# - #	# - #	Total Modules Installed: Pieces		
# - #	# - #	Serial # of Trip Blanks (*Client Decides*)		#
# - #	# - #	#	#	#
# - #	# - #	#	#	#
# - #	# - #	#	#	#
# - #	# - #	#	#	#
# - #	# - #	#	#	#
# - #	# - #.	#	#	#
Prepared By: *[signature]*		#	#	#
Verified By: *[signature]*		#	#	#

Installation Performed By: Name (*please print*): Company/Affiliation:	Installation Method(s) (*circle those that apply*): Slide Hammer Hammer Drill Auger Other:
Installation Start Date and Time: / /	: AM PM
Installation Complete Date and Time: / /	: AM PM
Retrieval Performed By: Name (*please print*): Company/Affiliation: 1	Total Modules Retrieved: Pieces Total Modules Lost in Field: Pieces Total Unused Modules Returned: Pieces
Retrieval Start Date and Time: / /	: AM PM
Retrieval Complete Date and Time: / /	: AM PM

	Date	Time		Date	Time
Relinquished By *[signature]* Affiliation: W.L. Gore & Associates, Inc.	6-6-06	11:30	Received By: Affiliation:		
Relinquished By Affiliation:			Received By: Affiliation:		
Relinquished By Affiliation			Received By: Affiliation: W.L. Gore & Associates, Inc.		

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.12: Surface Soil Sampling—Revision: 3

ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # THIS IS A RED STAMP ERD	**AUTHOR(S):** **S. Gregory** **APPROVALS:** **Date** Jesse Yow 4/9/09 **Department Manager** Ed Folks 4-8-09 **Engineering & Operations Division Leader** **CONCURRENCE:** **Date** Rebecca Goodrich 4/9/09 **QA Implementation Coordinator**

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to describe the collection of representative surface soil samples for analysis of chemical, radiological, or physical parameters.

2.0 APPLICABILITY

This procedure is applicable to the development of surface soil sampling plans and the collection of surface soil samples independent of drilling operations, although the techniques described herein are also valid within that context. SOP 1.2, "Borehole Sampling of Unconsolidated Sediments and Rock," describes soil sampling during drilling in detail. Depending on the purpose of the sampling activity, modifications to these procedures can be made on a case-by-case basis and should be documented in a sampling plan. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The

Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 LLNL Environment, Safety and Health Manual.

3.3 Site 300 Site Safety Plan (SSP).

3.4 Livermore Site Safety Plan (SSP).

3.5 U.S. Environmental Protection Agency (1987), *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

3.6 Webster-Scholten, C. P., Ed. (1994), *Final Site-Wide Remedial Investigation Report, Lawrence Livermore National Laboratory*, Livermore, CA. (UCRL-AR-108131).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Department Manager

The Department Leader's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Project Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

5.3 Engineering and Operations Division Leader (EODL)

The EODL's responsibility is to ensure that proper procedures are followed for activities (e.g., construction, facility operation and sampling).

5.4 Site Safety Officer (SSO)

The SSO's responsibility is to ensure that fieldwork is conducted safely and in compliance with applicable IWSs, Site Safety Plans, SOPs, and any other applicable safety related documentation.

5.5 Task Leader (TL)

The TL or designee is responsible for preparing a surface soil sampling plan per the requirements of this SOP, reviewing the plan with all applicable parties to ensure all roles, responsibilities, and procedures are clear, and providing the plan to DMT for archiving.

5.6 Field Personnel (FP)

The FP's responsibilities are to perform the surface soil sampling activities in accordance with approved SOPs and sampling plans. FP are responsible for packaging, handling, and shipping surface soil samples per SOP 4.2, "Sample Control and Documentation," SOP 4.3, "Sample Containers and Preservation," and SOP 4.4, "Guide to the Handling, Packaging, and Shipping of Samples." The FP are also responsible for obtaining permission to travel offroad, if sampling locations necessitates travelling more than 25 ft off pavement. Refer to SOP 4.1, "General Instruction for Field Personnel."

5.7 Data Management Team (DMT)

The DMT's responsibility is to decode the blind QC sample identification names on the analytical results, and distributing the data to appropriate personnel. DMT is responsible for archiving surface soil sampling plans and approving sample location names.

6.0 PROCEDURE

6.1 Sampling Plan Preparation

The sampling plan is prepared by the TL or designee.

6.1.1 Determine sample locations, including QC samples, and consult with DMT for approved location sample names. Include a map when possible.

6.1.2 Determine sample analyses, DMT analyses codes, container and volume requirements, and analytical laboratory. Consult with the QC Chemist for special analytical needs.

6.1.3 Provide sampling plan to DMT, QC Chemist, and FP for review. Ensure that appropriate sample IDs have been obtained from DMT.

6.2 Field Preparation

6.2.1 Review SOP 4.1, "General Instructions for Field Personnel," and perform applicable preparation activities (i.e., arranging access to sampling areas through building coordinators or Facility Point of Contacts (FPOCs), control point operators, security, or other appropriate personnel) including calibrating and decontaminating field equipment.

6.2.2 Inventory all field equipment listed in the Equipment Checklist (Attachment A) and load into field vehicle.

6.2.3 Initiate obtaining a dig permit at least 30 days prior to sampling event so all underground utilities can be located. Locate and mark all tentative sampling locations on the ground and on a site map. Marking paint can be used to mark the location, but no stakes should be driven into the ground unless a dig permit has already been issued. A copy of the map should be given to the utility locator personnel. After the dig permit has been issued, and all sampling locations have been given the “okay” by the utility locators, a stake can be driven into the location with the proposed sample ID attached to or written onto the stake. All locations identified as not suitable due to underlying utilities should be removed from the sampling plan unless the utility locator has given permission to move the location a certain distance and in a certain direction from the originally proposed location. Work must be initiated within 10 days from the issuance of the dig permit or all locations will have to be reviewed again by the utility locators. The dig permit must be kept at the site during the entire sampling event.

6.2.4 Determine the best sampling order. Sample from the potentially least contaminated area to the potentially most contaminated area whenever possible. If site historical data is unavailable, sample from the areas furthest from site operations, considered background, to areas closest to operations. Ensure that permission for offroad travel has been granted, if applicable, as described above (SOP 4.1, “General Instruction for Field Personnel”).

6.3 Surface Soil Sampling Procedure

6.3.1 Insure the dig permit has been obtained and present at the sampling locations during the entire sampling event.

6.3.2 Using a clean trowel, clear an area of vegetation large enough to supply the quantity of soil that will be needed for all analytical requirements. Usually a one ft^2 area is sufficient. Avoid removing the topsoil when scraping off the vegetation.

6.3.3 If samples are to be analyzed for volatile chemical constituents, such as those using analytical methods EPA 8021 or 8260, a sampling device which limits the exposure of the matrix to air should be used if at all possible. The following procedure should be followed:

A. Using a soil sampling device, such as a slide hammer with cup and cap assembly, insert a clean liner into the cup, and drive the cup into the soil within the cleaned area. The cup is driven at a 45° angle to ensure the sampler does not obtain any soil from depths greater that six inches. The cup needs to be driven until it is certain that there is no air space remaining inside the cup assembly. The liner may be composed of either stainless steel or brass depending on the analysis being performed.

B. Retrieve the cup from the ground and remove the liner filled with surface soil being careful not to let any of the soil fall out of the liner. Quickly inspect each end of the liner to ensure the soil extends to the end of the liner. Then place a square of Teflon tape over the end of the tube followed by a plastic end cap. Repeat this for the other end of the tube and secure caps to the liner using duct tape to prevent the caps from falling off during shipment.

C. Label the soil tube with the same identifier used to stake the location. Put sample in an air-tight bag, and place in an ice chest with loose ice to maintain samples at 4°C. Loose ice should be replaced with double bagged ice or blue ice prior to shipment or courier pick-up (SOP 4.4).

D. If it is not possible to use a slide hammer sampling device, samples may be collected by either directly driving a brass tube into the soil by hand or with a hammer, or by tightly packing soil into a glass jar. This should be performed quickly to prevent the loss of VOCs. Label and place on ice as described above.

E. For collection of QC samples, the soil core should be collected adjacent to the original sample and packaged in exactly the same manner for shipment to the analytical laboratory. Refer to SOP 4.9, "Collection of Field QC Samples" for sample ID instructions.

6.3.4 Samples being analyzed for non-volatile chemical constituents or physical characteristics may be collected without concern about the exposure to air. The following procedure should be followed:

A. Using the trowel, chop and stir up the soil within the cleared area down to about 6 inches. It should be thoroughly mixed up to ensure that a representative composite sample of the top 6 inches is obtained.

B. Fill the appropriate number of containers as determined by the analytical method or the sampling plan. A Teflon™ -lined lid or cap should be used to seal the container. If these are not available, Teflon* sheeting may be placed over the top of the container prior to sealing with a conventional cap. The cap should be taped in place to prevent it from coming off during shipment.

C. Label the container as described above. Place the sample in an air-tight bag and in an ice chest as described above to maintain samples at 4°C (SOP 4.4).

D. For collection of QC samples, insure that enough soil is composited in the area to fill the additional QC containers. As described above, the samples should be packaged in the same manner as the routine samples. Refer to SOP 4.9, "Collection of Field QC Samples" for sample ID instructions.

6.3.5 In some situations it may be necessary to composite soil samples from several locations into a single sample for analysis. The following procedure should then be followed:

A. Obtain a pre-cleaned compositing container large enough to hold soil from each of the locations to be composited, along with a pre-cleaned graduated beaker to measure the volume of soil collected from each location.

B. Using the same procedure described above (6.3.4), collect approximately the same volume of soil from each location to be composited and place into compositing container. The volume of soil collected from each location should be such that the final volume is only slightly larger than the final volume needed for the appropriate analyses. For example, if 500 mls of soil are needed for the final sample for analysis, and there are five locations to composite, collect just a little more than 100 mls from each location.

C. Thoroughly mix the soil in the container either by capping the container and vigorously shaking it, or stir the contents using a trowel until sufficiently mixed.

D. Once thoroughly mixed, transfer soil into the appropriate number of containers as determined by the analytical method or the sampling plan and follow steps B through D above.

E. Any soil left over after sample container(s) have been filled should be transferred to a waste container for appropriate disposal.

F. No equipment decontamination is necessary between sample collections when samples are being composited into a single sample. However, all equipment and compositing container do need thorough decontamination (SOP 4.5, “General Equipment Decontamination”) prior to collection of the next composite samples.

6.3.6 Record all pertinent information in the document control logbook including sample ID, location description, the number and types of samples collected (SOP 4.2).

6.3.7 Verify that the sampling location and ID has been marked on a topographic site map as accurately as possible. The locations coordinates can either be determined through surveying, a ground positioning system (GPS), or estimated by utilizing the Hot Maps application within the Gemini web tools.

6.3.8 Decontaminate all sampling equipment (SOP 4.5, “General Equipment Decontamination”) prior to moving to the next sampling location. Equipment used in background locations and those locations not containing organic contaminants can be decontaminated just by thoroughly rinsing with deionized water and drying with a clean cloth.

6.4 Post Operation

6.4.1 Perform post operation activities described in SOP 4.1.

7.0 QA RECORDS

7.1 Document Control Logbook

7.2 Chain-of-Custody Forms

8.0 ATTACHMENTS

Attachment A—Equipment Checklist

Attachment A

Equipment Checklist

Equipment Checklist

____ Air-tight plastic bags
____ Alconox (detergent)
____ Appropriate documents (e.g., Sampling Plan, SOPs, QAPP, Site Safety Plan)
____ Backpack
____ Brushes
____ Compositing container
____ De-ionized water
____ Disposable towels
____ Fluorescent marker tape
____ Gloves (leather, vinyl, and/or Nytrile)
____ Graduated beaker
____ Ice chest and ice
____ Logbook
____ Maps
____ Permanent ink markers
____ Portable 2-way radio
____ Sample containers
____ Shovel
____ Sledge hammer
____ Stakes
____ Trash bags
____ Trowel
____ Split spoon sampler and slide hammer
____ Snake chaps
____ FID or PID or other appropriate monitoring devices
____ Appropriate attire (e.g., coveralls, hat, etc.)
____ Drinking water

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.13: Operation of the AMS TR7000 Well Management System—Revision: 1

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#
ERD

AUTHOR(S):
R. Goodrich and B. Clark

APPROVALS:	Date
Jesse Yow **Department Head**	4/30/12
Livermore Program Leader	4/18/12
Leslie Ferry **Site 300 Program Leader**	4/12/12

CONCURRENCE:	Date
Rebecca Goodrich **QA Implementation Coordinator**	4/19/12

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this procedure is to provide general operating instructions for the Art's Manufacturing & Supply (AMS) TR7000 Well Management System used to perform work activities such as baseline sampling, well development, and hydraulic testing.

2.0 APPLICABILITY

This procedure is applicable to the safe and consistent operation of the AMS TR7000 Well Management System when performing baseline sampling, well development, and hydraulic testing applications. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Art's Manufacturing & Supply (AMS) Well Management System Owner's Manual.

4.0 DEFINITIONS

Not applicable.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the FPOC, based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Modeling & Subsurface Data Quality Objectives Team Leader (MSDQOTL)

The MSDQOTL is responsible for developing the Work Plan and Sampling Plan and ensuring the work is carried out safely and in accordance to the plans and the data quality objectives.

5.6 Hydraulic Test Coordinator (HTC)

The Hydraulic Test Coordinator (HTC) is responsible for ensuring that equipment is operated safely and the hydraulic tests are performed in accordance with this procedure and the Work Plan and Sampling Plan.

5.7 Field Personnel (FP)

The Field Personnel (FP) are responsible for operating equipment safely and in a manner consistent with the AMS TR7000 Well Management System operating instructions. The FP are also responsible for recording information on applicable forms such as the Ground Water Sampling Data Sheets.

5.8 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review the Work Plan and the Sampling Plan and the incoming analytical data received from the contracted analytical laboratories resulting from this work activity.

5.9 Date Management Team (DMT)

The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

The AMS TR7000 Well Management System is used to perform work activities such as baseline sampling, well development, and hydraulic testing. The AMS TR7000 Well Management System consists of a sampling trailer that is used to support a hydraulically operated boom. The boom is safely positioned over a ground water well and used to lower a purging devise such as an electric submersible pump into the well to conduct sampling and pumping activities.

6.1 Preparation

6.1.1 Prior to conducting work, perform the applicable preparation activities described in SOP 4.1, "General Instructions for Field Personnel". Personnel who are new to the LLNL project will receive direct field supervision and on-the-job training (OJT) from a qualified SARA/OSHA trained supervisor for at least the first 24 hours of field activity using the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.2 Safety Considerations

6.2.1 The AMS TR7000 Well Management System consists of moving parts, some which are exposed and pose a safety concern to operators who are unfamiliar with the system. It is necessary that the operator be aware of potential dangers and must be constantly on guard when operating the equipment. General operating instructions are provided in this procedure and a list of precautionary measures that shall be reviewed prior to operating the equipment, and followed during equipment operation.

6.2.2 Work activities described by this SOP shall be performed in accordance with IWS 12545 "Operation of the AMS TR7000 Well Management System" and IWS 11577 "ERD Compliance Driven Ground Water Sampling and Water Level Monitoring" at the Livermore Site. The AMS TR7000 Well Management System is typically not used at Site 300 due to the rugged terrain.

6.3 Prior to Operating the AMS TR7000 Well Management System

Review this SOP thoroughly, paying special attention to the potential hazards associated with operating the AMS TR7000 Well Management Sampling System. The instructions provided are general instructions and are not meant to be all-inclusive. Emphasis on operating the equipment safely is the main focus of this SOP. If further information is needed prior to operating the equipment, please refer to the operator's manual or call the manufacturer. The Operator's Manual is retained on the AMS Sampling System at all times.

6.3.1 Precautionary Measures to Prevent Damage to Equipment

- Do not allow the AMS TR7000 Well Management System to operate unattended.
- When extending the boom, unwind enough hose so that the hose will not be stretched as the boom is being extended. Stretching the hose could result in damage to the hose, internal wiring or separation of the hose from its fitting.
- Leave two wraps of hose or cable on the spools when nearing the end of a hose or cable to prevent damage to the spool or loss of hose/cable and any connected apparatus.

- To prevent damage to any moveable parts, make sure the parts are not anchored or attached to other components before activating the system.

6.4 Control Panel

6.4.1 The control panel is divided into three sections. A high voltage area that contains (4) circuit breakers is located on the left side of the Control Panel. To the right of the high voltage section is the submersible pump converter and on the far right is the low voltage portion of the control panel. The low voltage end of the panel is where the majority of the controls for the TR7000 are located. A brief description of each of the components follows:

- **Main Circuit Breaker (CB1)**: must be in the on position for any of the circuity to be energized. When starting the generator, the main circuit breaker needs to be in the **OFF** position.
- **Hydraulic Pump Breaker (CB2)**: protects the hydraulic pump circuit from over current. It must be turned on to activate any components that require hydraulic power to operate.
- **Internal Outlet Breaker (CB3)**: protects the submersible pump converter from too much current and must also be turned on if the submersible pump is to be used. The breaker also protects the solenoid valve that allows pressurized water to flow to the decon box on the boom.
- **External Outlet Breaker (CB4):** must be turned on to use the convenience outlets located at the rear of the AMS TR7000.
- **Grundfos Converter Box:** controls the output of the submersible pump.
- **Decon On/Off: Push buttons** open and close the primary switch that allows water to the Decon box mounted on the boom of the AMS TR7000. Illuminated buttons, green (on) and red (off) indicates the operational status of the system. A secondary toggle switch on the Pendant must also be in the "On" position for the decon box sprayers to emit pressurized fluid.
- **Hydraulic Pump On/Off:** push buttons turn the hydraulic pump on and off which is indicated by illumination of a green (on) or red (off) button.
- **Transfer Pump On/Off:** a toggle switch turns a hydraulic driven transfer pump on (indicated by an illuminated green light) and off (indicated by an illuminated red light) which moves water from the Decon Tray to the Gray Water holding tank.
- **Hour Meter:** records the amount of hours that the TR7000 has been used.
- **12-V Switch:** turns on the power supply to the low voltage side of the control panel. It must be turned on for any of the TR7000 systems to work.
- **Oil Temperature Gauge**: monitors the oil temperature. If the temperature exceeds 150 degrees, the AMS TR7000 Well Management System should be shut down.

- **Pendant Receptacle:** is where the Pendant is plugged into the control panel. The Pendant on/off switch should be turned **OFF** before inserting the Pendant into the Control Panel.
- **Bypass:** is used when starting the hydraulic pump. The Bypass should be turned on when starting the hydraulic pump to prevent overloading of the electric motor that activates the pump.
- **Circuit Breaker**: a set of low-voltage circuit breakers that protects the low voltage components of the control panel. They are labeled to indicate which circuits they protect.
- **Pendant:** controls all the functions of the boom. All of the functions are appropriately labeled. The Pendant plugs into the Pendant Receptacle.

6.5 Operating the AMS TR7000 Well Management System

Follow the AMS TR7000 Well Management System Order of Operation (Attachment A) when operating the system.

A. **Positioning the Trailer:** The AMS Sampling System Trailer should be positioned so that the end of the boom can be located directly over the well or body of fluid to be sampled. It is recommended for most applications, that the trailer be positioned so that the well is located on the driver's side of the towing vehicle. The mast should be even with the well and the side of the trailer should be approximately five feet from the wellhead. Before raising the boom, ensure that the boom is not at an angle of less than 45 degrees or more than 70 degrees off of the horizontal. Once the trailer has been safely positioned, set the emergency brake and set up wheel chocks before operating the boom system. Connect generator ground to well grounding rod.

Begin Operation

B. **Starting the Generator:** Start the generator according to the manufacturer's instructions included in the AMS TR7000 Well Management System Manual. Once the generator is started, the control box power cord must be plugged into the 30A 125/250V outlet on the generator and the 30A 125/250V circuit breaker must be switched to the "On" position to supply power to the control panel in the control box.

C. **The Main Circuit Breaker (CB1)**, the Hydraulic Pump Breaker (CB2), the Internal Outlet Breaker (CB3), and the External outlet breaker (CB4) located on the main control panel should all be placed in the "On" position. The main control panel is located in the tool compartment on the driver's side of the AMS rig.

D. **Turn the Hydraulic Pump on** and allow it to run for a few minutes to warm-up.

E. **Switch the Hydraulic Pump Bypass switch to the "On" position.**

F. **Plug the Pendant into the Pendant Receptacle** and turn on the 12-Volt power. Using the Pendant, position the boom over the wellhead. Lower the submersible pump into the well to the desired depth. Turn Bypass off, then turn hydraulic pump off.

G. **Connect Discharge Hose** to the cam-lock fitting on the discharge located on the end of the hose spool. Direct the discharge hose to a suitable container for purging the well being sampled. Start Redi-Flow, adjust flow rate. Purge the well according to the converter instructions provided in the owner's manual. Back-off Redi-Flow to stop pump.

Ending Operation

H. **Following sample collection or hydraulic testing**; turn hydraulic pump on, then turn Bypass switch on, retrieve pump from well and properly wind the hose back onto the spool to prevent damage to the hose ensuring there is enough spool capacity for the hose. Use the Levelwind to help guide the hose onto the spool.

I. **Use the Decon System** to rinse the hose as it is wound back onto the spool. To activate the system, make sure that the Pressure Washer quick disconnect fitting is connected to the hose leading to the decon box. . When using decon capabilities of the AMS TR7000 it is necessary to transfer the gray water into the gray water storage tank. This is easily accomplished by turning the transfer pump "On."

Power Down

J. **Once the hose is wound back onto its spool,** return the boom to transport position using the pendant. Park pump in holder. Turn all of the 12-V components and power off. Turn the hydraulic pump and any remaining components off. Disconnect the Pendant and store it to prevent damage during transport.

K. **Turn the generator off** and empty the gray water tank into a proper receptacle by opening the valve located on the driver's side of the trailer.

6.6 Maintenance of the AMS Sampling System

6.6.1 The AMS Sampling System requires minimal maintenance. The following activities should be performed daily prior to using the equipment:

- Check the condition of all sheaves and replace if necessary.
- Check condition of hoses and replace as necessary.
- Check condition of all pins and set screws; replace or tighten if necessary.
- Check hydraulic oil level and fill with Conoco hydraulic oil no. 46 when needed. To check oil level, remove the cap on the hydraulic tank. The oil level should be within ½ inch from the opening**.**
- **Check the condition of the grounding cable and grounding clamp and replace if necessary.**

6.6.2 The following activities should be performed monthly prior to operation:

- Grease the fittings that are located on the top and bottom of the boom frame.

- Grease the fittings that are located on the level wind sheave bracket assembly.
- Perform any daily service as outlined above.

Maintenance of any of the components supplied by outside manufacturers such as the generator or pressure washer should be serviced according to the manufacturer's recommendations. The manufacture's maintenance recommendations are included in the AMS TR7000 Well Management System Owner's Manual.

6.7 Post Operation

6.7.1 Perform post-work activities described in SOP 4.1, Section 6.4.

6.7.2 Return the site to its original condition using best reasonable efforts.

6.7.3 Deliver all original documentation to the DMT.

7.0 QUALITY ASSURANCE RECORDS

The ERD QA records identified below are to be created, managed, and preserved in accordance with SOP 4.10: Records Management.

7.1 Document Control Logbooks

7.2 Ground Water Sampling Data Sheets

8.0 ATTACHMENTS

Attachment A—AMS TR7000 Order of Operation Checklist

Attachment A

AMS TR7000 Order of Operation Checklist

TR7000

Order of operations

Begin operations

(1) Connect ground from generator to ground rod at well.
(2) Make sure all breakers on the generator and control panel are in the off position.
(3) Plug main control box power chord into the 30A125/250V outlet on the generator.
(4) Plug pendant chord into control panel.
(5) Power up generator and set 30A 125/250V breaker to the on position.
(6) Set breakers, CB1, CB2, CB3 and CB4 to the on position.
(7) Turn on hydraulic pump.
(8) Turn bypass switch on.
(9) Turn pendant on.
(10) Lower pump to specified depth.
(11) Turn bypass off.
(12) Turn hydraulic pump off.
(13) Start Redi-Flo, slowly adjust flow to desired flow rate.

Ending Operations

(1) Back Redi-Flo dial to stop pump.
(2) Connect pressure washer to upper decon box and plug into compressor.
(3) Turn on hydraulic pump.
(4) Turn bypass switch on.
(5) Turn on decon switch (control panel).
(6) Turn on decon switch (pendant).
(7) Retrieve pump from well, using level wind to disperse hose properly.
(8) Park pump in holder.
(9) Turn off decon switch (pendant and control panel).

Power Down

(1) Turn bypass off.
(2) Turn hydraulic pump off.
(3) Turn pendant off.
(4) Turn all breakers off.
(5) Turn generator off.

LLNL Environmental Restoration Division (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.14: Final Well Development/Specific Capacity Tests at LLNL Livermore Site and Site 300—Revision: 2

AUTHOR(S):
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ENVIRONMENTAL RESTORATION DIVISION
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ERD

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[signature] Hydrogeology & Decision Support Group Leader	8/15/06

CONCURRENCE:	Date
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*Weiss Associates

1.0 PURPOSE

The purpose of this SOP is to document field activities for final well development and specific capacity tests. Final well development and specific capacity tests are performed after the drill rig has completed its initial development. The AMS-TR7000 is used at the Livermore Site to conduct well development following SOP 1.13: Operation of the AMS TR7000 Well Management System. At Site 300, well development is performed after a pump has been installed in a newly completed well. Well development involves overpumping and intermittent pumping of the well in order to clear residual drilling mud and remaining fines (silt and clay) from the sand pack and well. During the well development process data is obtained for estimating the specific capacity, maximum flow rate, and optimum flow rate for subsequent hydraulic testing. This final well development takes place prior to hydraulic testing and collection of the baseline ground water samples. Baseline samples are collected for an expanded list of analyses following procedures specified in SOP 2.1: Pre-sample Purging of Wells.

2.0 APPLICABILITY

The purpose of final well development and specific capacity tests is to obtain representative samples of turbid-free ground water, collect accurate water-level data, and determine maximum and optimum flow rates. These factors will ensure:

1. Selection of a purging device appropriate for the hydraulic characteristics of a well.
2. The purging device is not damaged by fine-grained sediments during subsequent sampling or hydraulic testing.

ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Gass, Tyler E., "Monitor Well Development," *Water Well J.*, January 1986, pp. 52–55.

3.2 Barcelona, M. J., Gibb, J. P., Helfrich, J. A., and Garske, E. E., *Practical Guide to Ground Water Sampling*, U.S. Government Printing Office, EPA 600/2-85-104, 1985.

3.3 Driscoll, F. G., Groundwater and Wells, Second Edition, Johnson Division, St. Paul, MN, 1089 pp, 1986.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Division Leader (DL)

The DL's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely, comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Project Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an IWS, and there is sufficient funding to initiate the work.

5.3 Hydrogeology & Decision Support Group Leader (HDSGL)

The HDSGL's responsibility is to ensure that proper procedures are followed for activities (e.g., drilling, borehole logging and sampling, well installation and development).

5.4 Hydrogeologist (HG)

The HG is responsible for determining borehole locations and well design, hydrostratigraphic unit (HSU) analysis, and planning/evaluation of hydraulic tests.

5.5 Site Safety Officer (SSO)

The SSO is responsible for ensuring the safety of ERD's ongoing operations, fieldwork, and facilities and that the work being performed is covered by an authorized IWS.

5.6 Field Personnel (FP)

The FP's responsibilities are to properly develop wells to obtain the maximum yield and the highest quality ground water samples in compliance with all established operational and safety procedures, and to inform the HDSGL when the procedures are inappropriate. Field personnel are also responsible for (1) communicating the performance of development activities to the Hydrogeologist (HG) and recommending modifications of field methods to improve well yield, and (2) notifying the sampling coordinator that final well development is completed.

5.7 Data Management Team (DMT)

Once well development is complete, DMT will add the well to the Routine Ground Water Sampling Schedule for baseline sampling. The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

6.1 Preparation

6.1.1. Prior to conducting work, perform the applicable preparation activities described in SOP 4.1, "General Instructions for Field Personnel." Personnel who are new to the LLNL project will receive direct field supervision and on-the-job training (OJT) from a Subject Matter Expert (SME) for at least the first 24 hours of field activity using the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.1.2 The FP should check with the HG to obtain information on well design and estimated flow rate in order to determine the appropriate number of portable tanks or collection drums. The FP coordinates the use of portable tanks and associated equipment and reviews the equipment checklist (Attachment A) to obtain necessary supplies.

6.1.2 The FP reviews the ground water sampling requirements with the HG before the final well development is complete.

6.2 Safety Considerations

6.2.1 The procedures described in the following sections will be conducted in accordance with LLNL IWS 12545 "Operation of the AMS TR7000 Well Management System," IWS 11577 "Compliance Driven Ground Water Sampling and Water Level Measurements," and IWS 11343 "IWS-621 ERD-0004 Routine Ground Water Sampling and Water Level Monitoring."

6.3 Procedures

6.3.1 Wells with Electric Submersible Pumps

A. Connect a discharge line from pump to flow meter.

B. Check to make sure the extension cord's on/off switch box is "off." Plug extension cord with Ground-Fault Interrupter (GFI) from generator into well control box.

C. Obtain the depth-to-water (DTW) measurement. Record corresponding time.

D. Turn on generator, followed by the pump. Record time (t) on the well development field sheet (Attachment B) and baseline sampling data sheet (Attachment C).

E. Measure flow rate (Q) with a 5-gal bucket by reading the flow meter totalizer and determining the time it takes for 10 gallons to flow into the portable tank or collection drum(s).

F. Note color, odor, amount, and type of sediment (e.g., clay, silt, sand) in the water. Note changes in these parameters as pumping proceeds.

G. Obtain Q and DTW measurements every 5–10 min for the first 30 min.

H. After 30 min record DTW. Determine "specific capacity" = $Q/\Delta s$ at $t = 30$, where Q = flow rate and Δs = (DTW at $t = 30$) minus (DTW at $t = 0$).

I. Shut off pump, note and record time, and allow the water level to recover. Periodically, record DTW and times as recovery is occurring. The frequency of measurements will depend on the rate of water level recovery in the well. For wells with flow rates greater than 1 gpm, measure the depth to water every couple of minutes for the first 15 minutes and then every 10 minutes thereafter until the water level recovers to approximately 90% of the original reading. For wells with flow rates less than 1 gpm, measure the depth to water every five minutes for the first half hour and then every two hours.

J. Estimate optimum Q for a subsequent 1-hr drawdown test, i.e., the Q that will maximize drawdown, but not daylight a pressure transducer after 60 minutes of continuous pumping.

Note: It is more desirable to pump at a lower Q and obtain a steady-state pumping level in 45–60 min, than to have the water level continue to draw down after 45–60 min. The former procedure produces a better data curve when the drawdown test data points are plotted.

K. Pump well intermittently for at least 2 hr. Maximize drawdown but do not daylight pump intake.

Example:

Pump on—30 min

Pump off—5 min

Pump on—15 min

Pump off—5 min, etc.

The suggested periods for a high yielding well (high flow rates) are listed in the above example. For low-yielding wells, shorten the pumping period from 30 to 10 minutes, allow water levels to recover, and attempt to remove at least 3 casing volumes of water. If the well is pumped dry, allow the water levels to recover overnight before repeating these steps. The purpose is to surge the well and over pump it to remove fine sediment and stabilize the well's sand pack.

Note: Always record the time and DTW when the pump is turned on or off.

L. Final development is complete when:

1. Water is clear and free of sediment.
2. For a high-yielding well, calculate Δs for three or more flow rates. In contrast, for a low-yielding well calculate Δs for two flow rates, if possible.

M. Collect ground water sample per SOP 2.6, "Sampling for Volatile Organic Compounds." When sampling low-yielding monitor wells, follow procedures outlined in SOP 2.7, "Pre-sample Purging and Sampling of Low-Yielding Monitor Wells."

6.3.2 Wells with Bladder Pumps

A. Connect bladder pump air line to the Well Wizard controller pump supply line. Connect Well Wizard air compressor supply line to Well Wizard controller air pressure inlet. All necessary hoses are stored in Well Wizard controller case.

B. Place discharge line in portable tank or collection drum(s).

C. Record DTW and time.

D. Start the Well Wizard's air compressor and pump. Record time (t).

E. Measure and record flow rate (Q) with a 5-gal bucket.

F. Note the color, odor, type, and amount of sediment in water. Record any changes in these parameters as pumping proceeds.

G. Record Q and DTW measurements as often as practical.

H. At t = 30 (30 min. after "pump on") record DTW. Determine "specific capacity" (see Section 6.3.1, Step H).

Note: Because flow is not constant, specific capacity is not as accurate but can be useful.

I. Pump well intermittently for at least 2 hr until water is clear. Continue recording Q and DTW.

Note: Because most wells with bladder pumps have a sustainable yield <1 gpm, a slug test may be necessary to determine hydraulic properties (see SOP 3.3 Hydraulic Testing [Slug/Bail]).

J. Collect ground water samples per SOP 2.6 or SOP 2.7 when sampling a low-yielding monitor well.

6.3.3 Important Information Recorded After Final Well Development

- Specific capacity.
- Total pumping time (i.e., excluding recovery periods).
- Total gallons pumped.
- Optimum sustainable Q for drawdown tests.
- Maximum Q.
- Water clarity, odor, flow rate, etc.

Important: When final well development is completed, inform the Sampling Coordinator and provide them with an optimum Q for sampling.

6.4 Post Operation

6.4.1 Perform post operation activities as described in SOP 4.1, "General Instructions for Field Personnel."

6.4.2 Decontaminate all equipment per SOP 4.5, "General Equipment Decontamination."

6.4.3 Prior to disposal, store containers of water produced during development in a secure area until water is treated.

6.4.4 After review, give the original Ground Water Sampling Data sheets to the DMT. The final well development data is being electronically stored by the HDSG.

7.0 QUALITY ASSURANCE RECORDS

7.1 Final Well Development Field Sheet

7.2 LLNL Ground Water Sampling Data Sheet

8.0 ATTACHMENTS

Attachment A—Equipment Checklist

Attachment B—Final Well Development Field Sheet

Attachment C—LLNL Baseline Sampling Data Sheet

Attachment A

Equipment Checklist

Equipment Checklist

All wells:

____ Water-level probe/engineer's tape graduated in hundreths of a ft
____ 5-gal bucket
____ Watch with stopwatch capabilities
____ Calculator, clipboard, pencil
____ Well development forms

Wells with electric submersible pumps:

____ 230-volt generator
____ Black extension cord with GFI and on/off switch box. Note: different generators require extension cords—make sure the cord and generator are compatible
____ Pump control box (must match voltage and horsepower of pump)
____ PVC fittings (elbows, unions, etc.)
____ Hoses
____ Tool box (with wrenches, hose fittings, Teflon tape)

Wells with bladder (Well Wizard) pumps:

____ Well Wizard control box with air compressor

Attachment B

Final Well Development Field Sheet

FINAL WELL DEVELOPMENT FIELD SHEET

Site	❑ Livermore Site ❑ Site 300	Page of	By: Billy Clark
Well ID		Location/Area	
Date			
Development Method(s): Multiple pumping/over pumping events with variable rate.			
Screened Interval (ft bgs):		Well Diameter (in):	
Depth to Water Before Development (ft bmp):		Sounded Depth (ft bmp):	
Development Equipment (AMS, Pump, Bail):		Pump Intake Depth (ft bmp):	

Clock Time	Depth to Water (ft)	Gallons Pumped	Flow Rate (gpm)	Comments (method, pump on/off, water clarity, odor, sounded depth)

Well Development Summary						
Total Number of Pumping Events and Rates:						
Specific Capacity (Q/Δh) for each Event:						
Total Pumping Time (min):		Total Volume Extracted (gals):				
Total Volume of Water Injected (gals):						
Estimated Sustainable Yield (gpm):						
Qualitative Description of Well Yield (Poor <1 gpm, Fair 1-5 gpm, Good 5-15 gpm, High >15 gpm):						

bgs - below ground surface

bmp - below measurement point

Attachment B. Final Well Development Field Sheet.

Attachment C

LLNL Baseline Sampling Data Sheet

LLNL Baseline Sampling Data **2001**

Monitor Well: ________ Well ID: ____________

Date: ____________ Extraction Well: ________

CoC #: ____________

Purging Device: *AMS/ ES / RF / BP / PB / OTHER

Dedicated / Portable

Casing Diameter/gal./ft

2"	3.5"	4.5"	5"	6"	8"
.163	.5	.826	1.02	1.47	2.61

Depth of Casing: ________ P.O.M = ________

Depth to Water: ________ S.I.: ________ Casing Volume (gal.): ________

Water Column (ft) ________ Intake: ________ Initial Flow Rate (gpm): ________

Time Pump On: ________ Measured by: graduated cylinder /flow meter/other

Time Pump Off: ________ Treatment Facility: ________

Min.	Time	GPM	Gal.	Volumes	pH	Temp C	SC	OG	Depth to Water
	Well Sustains: gpm								

Meter	Serial #	Calibrated
pH		yes/no
S.C.		yes/no
H_2O		yes/no
Other		

Project:	Livermore Site - LGIV
Analytical Lab (1)	
Analytical Lab (2)	
Samplers Initials/Employer:	

Sample ID.: ____________________ Time: ________

QC Sample ID: ____________________ Time: ________

Requested Analyses

VOCs, Metals, Etc.

- O E602/ __ x 40 ml VOAs/0 preservatives (pres.)
- O E624/ __ x 40 mL VOAs/0 pres.
- O GENMIN/2 x 1 L, plastic
- O NPDESMETALS/1 x 1 L plastic
- O E218.4B/1 x 500 ml, plastic
- O Other: ____________

Rad

- O E906/ 4 x 40 ml glass/0 pres.
- O E900/2 x 1 L plastic
- O E903+904/2 x 1 L plastic
- O E913.0/ __ x 250 ml glass
- O AS:UISO/ __ x 1 L plastic
- O Other: ____________

*EP = EasyPump, ES = electric submersible, RF = RediFlo, BP = bladder pump, PB = Poly bailer

Attachment C. LLNL Baseline Sampling Data Sheet.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.15: Well Site Core Handling—Revision: 3

ENVIRONMENTAL RESTORATION DEPARTMENT
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#
ERD

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CONCURRENCE:	Date
Rebecca Goodrich QA Implementation Coordinator	4/19/12

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous**

*Weiss Associates

1.0 PURPOSE

The purpose of this SOP procedure is to describe a method for collecting, handling, labeling, and storing cores of sediment or rock obtained during drilling activities.

2.0 APPLICABILITY

This SOP applies to all Lawrence Livermore National Laboratory (LLNL) and contractor personnel assigned to handle core obtained during drilling of boreholes in support of the Environmental Restoration Department (ERD) projects. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Dibley, V. (1999), *Quality Assurance Project Plan LLNL Ground Water Project* (UCRL-AR-103160 Rev. 2).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.6 Drilling Coordinator (DC)

The DC provides the interface between the DGS, HG, and the field personnel and is responsible for coordinating the drilling activities with the DG. The DC provides core boxes to the DG that are of the appropriate size and construction for the core that is to be generated.

5.7 Drilling Geologist Supervisor (DGS)

The DGS coordinates the geologist schedules and related activities, equipment needs, and the progress of daily activities. The DGS ensures that the Drilling Geologist (DG) uses the appropriate procedures for handling, describing, and boxing core samples.

5.8 Hydrogeologist (HG)

The HG is responsible for determining borehole locations and well design, hydrostratigraphic unit (HSU) analysis, and the planning/evaluation of hydraulic tests.

5.9 Drilling Geologist (DG)

The DG is responsible for overseeing drilling activities and for conducting borehole logging per established operational and safety procedures and to inform the DC and HG of any nonconformances. The DG observes core collection, prepares detailed descriptions of any soil or rock recovered, and places the recovered material into an appropriately labeled core box according to the instructions provided by this SOP.

5.10 Core Librarian (CL)

The CL is responsible for ensuring that the core boxes are stored and maintained properly at the storage facility and that the core database is regularly updated to include new material.

6.0 PROCEDURES

6.1 Safety Considerations

To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with LLNL Integration Work Sheet (IWS) 12614 “Examination of Geologic Materials Archived in Core Library”.

6.2 General

The HG determines the borehole location, drilling procedures, total depth, sample intervals, and prepares or reviews the Drilling Plan and Sampling Plan prior to the start of field activities. The Drilling Plan and Sampling Plan may be prepared for each borehole or a single plan may be prepared for a group of similar boreholes.

The DG must be present at the drill rig while coring is in progress. The DG observes all handling of the core by the drill crew, prepares a lithology log, documents sampling and analysis information, and oversees well site activities. As specified by the Drilling Plan and Sampling Plan, the DG collects core samples at specific intervals for purposes of chemical analyses and/or physical testing, and makes lithologic core descriptions, as well as estimates of hydrogeologic properties.

6.3 Supplies

Attachment A shows the boxes (top and bottom) and dividers required at the well site for proper core handling and storage. The DG should keep track of supplies and field forms and replenish them as necessary according to the Drilling Geologist Equipment Checklist in SOP 1.1: “Field Borehole Logging”.

6.4 Core Transfer

After each core run, the drill crew retrieves the core barrel or split-barrel sampling tube from the borehole. The core barrel or split-barrel sampling tube is disassembled so the core can be examined.

6.4.1 The DG must observe the core as it is being removed from the core tube or split inner barrel. The core should be extruded in continuous motion from the core barrel or split-inner barrel into a polyvinyl chloride (PVC) tray, unless otherwise instructed per Drilling Work Plan and/or Sampling Plan or the HG.

6.4.2 The DG is responsible for ensuring that the core remains in the correct stratigraphic position.

6.5 Core Handling

The DG should measure the length of core recovered in the PVC tray prior to further transport or handling. Next, the DG should collect the samples specified in the Drilling Plan and/or Sampling Plan. The DG then transfers the core from the PVC tray to core boxes. Care must be taken to maintain the proper stratigraphic position of the core pieces. If the core is larger in diameter than the core box, then the core may be split along the vertical axis and placed in the core box. The uppermost piece of core is put at the top left corner of the core box, and the remaining core box sections are filled from left to right with core, working downhole, as in reading across a page of text (Attachment A).

6.6 Core Measurement and Labeling

Core measurements are made to the nearest 0.1 ft. Depths should be verified with the driller. Conventionally, all core and/or sample loss is assumed to be from the end of the run. If the DG determines that the next run contains material dropped from the preceding run, it may be credited to the preceding run and the amount of recovery and the Rock Quality Designation (RQD) properties must be adjusted as required.

6.6.1 Core runs

The DG is responsible for writing the following information on the side dividers on the inside of each core box:

- At the start of each run, indicate the depth on the divider.
- Indicate at least two depths per divider.
- Indicate depth intervals where samples were collected for analysis.
- At the end of each run, indicate the depth.

6.6.2 Spacers

The DG is responsible for marking the dividers to identify intervals with little or no core recovery, or intervals where core has been removed for chemical analyses and/or physical testing. In addition, the use of spacers, such as plastic end caps, is recommended to physically mark the missing core intervals.

If the ends of the core sample are angled, the depth is measured from approximately the middle of the angled extension. The sample depth interval is also recorded on a spacer placed in the core box and on the divider at the appropriate location.

Note: A black permanent marker must be used for writing on core boxes and dividers.

6.7 Final Preparation of Core Box

Final preparation includes filling the core box and checking the labels for accuracy.

6.7.1 Core from one or more core runs from the same borehole may be placed in a box. Ensure that the start and stop depths of each core run, intervals of no recovery, and sample depths are recorded on the inside dividers.

6.7.2 Label information is written on both ends of the core box with a black permanent marker. The label records the borehole designation and the depths of the upper and lower core ends in the box. If waxed cardboard boxes are used, this information is added directly to the end of the box lid. In addition, ensure that the borehole ID is written inside the box lid and on the box.

6.7.3 As core boxes are filled and labeled, stack them in a convenient area at the drill site.

6.7.4 When the borehole is finished, a marker block is placed at the end of the last run that is marked with the drill hole designation, the total depth of the hole, and the letters “TD”.

6.7.5 The DG is responsible for transporting the core to the designated storage facility and covering the material to protect it from the elements.

6.8 Drilling and Sampling Plan

The Drilling and/or Sampling Plan specifies the intervals from which core is to be collected. This document also lists any special requirements for sample collection, preservation, or analysis.

6.9 Other Duties

Other well site duties may be assigned to the DG, depending on the needs of the HG. These may include collecting additional samples or core tests, photographing the core, completing additional forms or daily communication with project personnel. These duties, if assigned, will be described in the Drilling Plan and Sampling Plan. These procedures are described in the drilling and sampling SOPs.

6.10 On-the-Job-Training (OJT)

Newly hired personnel will receive On the Job Training (OJT) under the supervision of a qualified LLNL technical supervisor or his/her designee. The period spent in OJT shall include core labeling, handling, and storage procedures as well as requirements for preparing lithologic logs and other LLNL documentation and forms.

6.11 Communication

The DG is responsible for communicating with the driller's helper to ensure the core remains in its original stratigraphic position.

7.0 QUALITY ASSURANCE RECORDS

7.1 Logbooks

7.2 Field forms

7.3 CoCs

8.0 ATTACHMENTS

Attachment A—Storing Core and Labeling a Core Box

Attachment A

Storing Core and Labeling a Core Box

METHOD OF STORING CORE IN CORE BOX

INSIDE OF CORE BOX TOP

(print inside box top)	*Project #____________* *Borehole #____________* *Depths ______to______*	

INSIDE OF CORE BOX BOTTOM

(record run depth inside box) ---------->

Top ------> *(fill across)*	------>	------>	*(mark depth of each spot where core run ends)*	*(mark depth of each spot where core run begins)*	----->
------>	*(mark depth of each spot where samples taken)*	------>	------>	------>	------>
------>	------>	------>	------>	------>	------>
------>	------>	*(mark depth of each spot where samples taken)*	------>	------>	------>
------>	------>	------>	------>	------>	**Bottom** *(end here)*

<---*(record run depth inside box)*

Attachment A. Storing Core and Labeling a Core Box.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.16: Four Wheel All Terrain Vehicle (ATV) Operation—Revision: 2

AUTHOR(S):
V. Madrid

APPROVALS:	Date
Department Head	4/30/12
Livermore Program Leader	4/18/12
Site 300 Program Leader	4/12/12

CONCURRENCE:	Date
QA Implementation Coordinator	4/19/12

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

As a general guide this SOP will cover the basics of safety, startup, and operation of the HONDA FOURTRAX 400 four wheel drive all terrain vehicle (ATV). The ATV can be used for a variety of applications including hauling light equipment and performing off-road water-level measurements, but is primarily used as a support vehicle for seismic data acquisition, which includes transporting seismic equipment and personnel to and from the field and during field operations.

2.0 APPLICABILITY

The ATV is uniquely appropriate for transporting off-road use and maneuvering light equipment used in the acquisition of seismic data. The ATV must be transported from site to site on a trailer or truck and cannot be operated on public roads. At the site, the ATV can be used to transport equipment and personnel to, from, and during assigned work. All site speed limits and offroad restrictions apply. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 HONDA, Owners Manual (1996), TRX 400 FW FOURTRAX Foreman 400.

3.2 Special Vehicle Institute of America (1991), "Tips and Practice Guide for the ATV Rider," ATV Safety Institute.

3.3 Business Services Department, Fleet Management Group (1996), *Honda ATV*, Letter from Sal Ruiz to Robert Bainer, Environmental Restoration Division, Lawrence Livermore National Laboratory, Livermore, Calif., dated July 26, 1996.

4.0 DEFINITIONS

4.1 Equipment

- ATV – HONDA FOURTRAX 400
- Elasic Wave Generator – EWG
- Helmet - LLNL supplied motorcycle helmet.
- Tool kit - emergency maintenance tools located in rear compartment of ATV.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Custodian

The ERD custodian is responsible for on-the-job (OJT) training, operation, maintenance, and proper storage of the ATV.

5.6 ATV Operator

The ATV operator's responsibilities are to complete the required OJT and be approved by the custodian to operate the ATV.

6.0 PROCEDURES

6.1 General

Protective gear (hard hat, safety glasses, hearing protection, and safety shoes) must be worn when operating with the EWG. Prior to conducting work, perform the applicable preparation activities described in SOP 4.1, "General Instructions for Field Personnel". Personnel who are new to the LLNL project will receive direct field supervision and on-the-job training (OJT) from a Subject Matter Expert (SME) for at least the first 24 hours of field activity using the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.2 Office Preparation

A. Review the HONDA owner's manual, tips, and practice guide.

B. Locate protective gear (helmet, safety glasses, hard hat, hearing protection, and safety shoes).

C. Obtain ignition key from custodian.

6.3 Safety Considerations

6.3.1 Serious injury can result from improper use of ATVs, but with preparation and practice, you can safely develop and expand your riding skills. ATVs handle differently from other vehicles, such as motorcycles and cars. A collision or rollover can occur quickly. Proper instruction and practice are important.

6.3.2 The procedures described in the following sections will be conducted in accordance with LLNL Integration Work Sheet (IWS) 12021 "Seismic Reflection Survey" when the ATV is used as a support vehicle for seismic data acquisition activities.

6.4 Pre-Ride Inspection

A. Set PARKING BRAKE. The parking brake is engaged by pulling the left hand grip and pushing the lever marked Parking Brake.

B. Check that the transmission is in NEUTRAL.

C. Brakes. The left hand grip and the right foot pedal are the rear wheel brakes. The right hand grip is the front wheel brake. Check operation. Make sure there is no brake fluid leakage.

D. Fuel. Fill the fuel tank with unleaded gas when necessary. Check for leaks.

E. Tires and wheels. Check condition and pressure.

F. Controls. Check for proper function.

G. Lights and switches. Check for proper function.

H. Drive shaft and chassis. Check for damage or leaking fluids.

I. Steering. Check that the wheels turn properly as you turn the handlebars.

J. Cargo. Check that all cargo is properly secured.

K. Headlight and headlight dimmer switches. Check for proper function.

L. Engine stop switch has three positions. When the switch is in the Run position, the engine will operate. When the switch is in either OFF position, the engine will not operate.

M. Engine oil level. Check the oil level and add oil if required. Check for leaks.

N. Throttle. Check for smooth opening and closing in all steering positions.

O. Nuts, bolts, and fasteners. Check the wheels to see that the axle nuts are tightened. Check the security of all other nuts, bolts, and fasteners.

P. Underbody and exhaust system. Check for, and remove, any dirt, vegetation, or other debris that could be a fire hazard or interfere with the proper operation of the vehicle.

Q. Air cleaner housing drain tube. Check for deposits in the drain tube. If necessary, clean the tube and check the air cleaner housing.

R. Check tool kit.

6.5 Field Procedures

6.5.1 Starting the Engine

A. Lock the parking brake and make sure the transmission is in neutral. Note: Starter will not operate unless the transmission is in neutral.

B. Turn the fuel valve and the ignition switch ON.

C. Turn the engine stop switch to RUN.

D. Move the choke level all the way to the ON position. Keep the throttle fully closed.

E. Press the starter button. After starting motor turn off choke.

6.5.2 Shifting Gears

A. To prevent injury, always keep your feet on the footrests while riding.

B. Be sure that the engine is sufficiently warmed up before you begin riding.

C. With the transmission in neutral, release the parking brake, but continue squeezing the front brake lever.

D. With the throttle released, raised the gearshift pedal one full stroke to shift into SL (super low) gear.

E. Release the rear brake lever and increase engine speed by gradually opening the throttle.

F. When speed increases, release the throttle and shift to first gear by raising the gearshift pedal one full stroke.

G. Repeat this sequence to progressively shift to second, third, and fourth (top) gear.

H. To downshift, reverse this sequence. Remember to release the throttle each time you shift to the next lower gear.

6.5.3 Riding in Reverse

A. First, bring the vehicle to a complete stop and make sure the transmission is in neutral.

B. While pushing the reverse selector knob (located on the left handlebar) in, squeeze the left brake lever, then depress the gearshift pedal.

C. Release the left brake lever.

D. Open the throttle gradually and ride slowly. Do not open the throttle suddenly or make abrupt turns.

E. To stop, release the throttle and gradually apply both the front and rear brakes. Do not abruptly apply the rear brake by itself.

F. To shift from reverse to neutral, raise the gearshift pedal one stroke.

6.5.4 Transporting Equipment

Note: Never transport additional personnel on the ATV.

A. The EWG and other trailer-mounted light equipment may be hauled by the ATV at a work site.

B. Attach trailer hitch to ball jack and secure.

C. Ensure that equipment does not exceed the recommended weight towage capacity as described in owner's manual.

D. Follow all posted traffic rules and wear the helmet.

E. When off road, take extreme care to avoid uneven terrain, and operate at a safe speed.

6.6 Field Post Operation

A. Lock the parking brake and make sure the transmission is in neutral.

B. Turn the fuel valve and the ignition switch off.

C. Turn the engine stop switch to OFF.

D. Turn all auxiliary switches off.

E. Check for damages and leaks.

6.7 Office Post Operation

A. Return protective gear to proper storage.

B. Return ATV to designated storage area.

C. Return ignition key to custodian, and report any damages or malfunctions that may have occurred during use.

7.0 QUALITY ASSURANCE RECORDS

7.1 Documentation of completed OJT.

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD) Standard Operating Procedure (SOP)	
ERD SOP 1.17: Soil Vapor Monitoring and Sampling **Revision: 4**	
ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # ERD	**AUTHOR(S):** **S. Gregory**
	APPROVALS: Date Jesse Yow 4/30/12 Department Head 4/13/12 Livermore Program Leader Leslie Ferry 4/12/12 Site 300 Program Leader
	CONCURRENCE: Date Rebecca Goodrich 4/19/12 QA Implementation Coordinator
Type of Procedure (per ES&H Manual, Document 3.4) ☒ Informational Use ☐ General Use ☐ Continuous Use	

1.0 PURPOSE

This SOP describes the procedures that will ensure the collection of accurate soil vapor treatment facility operating parameters (flow rates, applied vacuums, vapor temperatures, etc.), representative soil vapor samples, and accurate analytical measurements of volatile organic compound (VOC) concentrations in soil vapor.

2.0 APPLICABILITY

This procedure is applicable to the monitoring and sampling at Environmental Restoration Department (ERD) soil vapor treatment facilities, which includes monitoring and sampling of active extraction wells, as well as soil vapor sample collection from non-active extraction wells and monitor wells. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Thermo Environmental Instruments Inc. MODEL TVA-1000 (Instruction Manual).

3.2 Foxborough Model OVA 128 Century Organic Analyzer (Instruction Manual).

3.3 ERD Standard Operating Procedure 4.8, "Calibration/Verification and Maintenance of Measuring and Test Equipment (M&TE)."

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Treatment Facility Compliance Manager (TFCM)

The TFCM is responsible for reviewing facility data for compliance with all applicable permits for Site 300. The TFCM prepares treatment facility sampling plans and specifies procedures for facility data collection and soil vapor sample collection, with input from Hydrogeology personnel. The TFCM also reviews, and accepts or rejects all facility Self Monitoring Reports (SMRs), and requests revisions to reports as needed. The TFCM is responsible for shutting down the ERD Site 300 treatment facilities due to non-compliance, and requests treatment media change-out when needed. At the Livermore Site, the aforementioned responsibilities are performed by hydrogeologists and engineers.

5.6 Treatment Facility Operator (TFO)

The TFO is responsible for properly operating treatment facilities, recording treatment facility operating parameters as specified, and collecting soil vapor samples and field measurements per the ERD SOPs, IWS(s), and facility sampling plan.

5.7 Data Management Team (DMT)

The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURE

In order to comply with applicable permits, to ensure facility discharges remain within compliance, to be able to adequately calculate VOC mass removal, and to assess subsurface contaminant concentrations, several critical pieces of information are necessary. The following will be addressed in this SOP: 1) soil vapor flow measurements at treatment systems, 2) field measurements of VOCs at treatment facilities to ensure compliance, and 3) the collection of soil vapor samples from active extraction wells, non-active extraction wells, and monitoring wells for analysis by a contract analytical laboratory (CAL). Section 6.3 includes procedures for the measurement of soil vapor flow rates under various conditions. Several methods are utilized for flow rate measurements as described below. Concentrations of VOCs in soil vapor may be determined in the field as described in Section 6.4 for facility compliance monitoring, or the vapors can be collected and sent to a CAL for analysis as described in Section 6.5. This is the usual method used for mass removal calculations and to ascertain vadose zone VOC concentrations. Samples should be collected and analyzed as designated by the facility startup plan and/or sampling plan.

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities per SOP 4.1 "General Instructions for Field Personnel" including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015). Direct field supervision and on-the-job-training (OJT) will be provided using ERD's Treatment Facility Operations Lesson Plan (course number EP7033-016). Successful completion of the OJT will be required prior to performing treatment facility vapor monitoring and sampling independently. When applicable and recommended by the ERD management, an employee may be granted an exception from training by completing the Exception from Training (LL6499) form. ERD management must approve the form and forward to the Training Coordinator to obtain final authorization. The employee will be given course credit once the process is completed.

6.2 Safety Considerations

6.2.1 Work is to be performed in accordance with the LLNL Site Safety Plans, the Quality Assurance Project Plan (QAPP), applicable ERD SOPs, facility sampling plans, and ERD Integration Work Sheets (IWS). Work activities described by this SOP shall be performed in accordance with IWS 11534 "Treatability Testing and Related Activities" at the Livermore Site and IWS 11341 "Ground Water and Soil Vapor Treatment Facility Operations at Site 300."

6.3 Soil Vapor Flow Measurements

6.3.1 Documentation

Soil vapor flow measurement data, or raw data that is used to calculate flow rates, shall be recorded in the Document Control Logbook, and in the weekly or monthly SMRs. SOP 4.2, "Sample Control and Documentation" describes the information that is required to be documented in the Document Control Logbook.

6.3.2 Measuring and Testing Equipment (M&TE)

- Soil vapor flow rates are determined using a variety of equipment. For single extraction well treatment systems, or for multiple well extraction systems that do not have individual well flow meters, equipment used is typically an electronic total mass flow meter. These meters automatically measure the applied vacuum, differential pressure, barometric pressure, vapor temperature, etc., and then calculate and display the instantaneous soil vapor flow rate in standard cubic feet per minute (SCFM) as well as the total flow to-date through the system (SCF). In this case, the ending totalizer reading for the reporting period is entered into the SMR for a calculation of total vapor volume extracted. The total hours of operations, or the ending hours on the running facility clock, is entered on the SMR, but is not used to calculate the total volume extracted. SMRs only need to be completed monthly for systems that have totalizing flow meters.

For the multiple soil vapor extraction well systems that have individual flow meters, there are multiple methods that can be used for vapor flow calculations. For Site 300, two methods are currently utilized which provide instantaneous flow rates. The first method includes the use of a Venturi flow meter, differential pressure gauge, vacuum gauge, and a temperature gauge. Barometric pressures are also necessary for the flow rate calculations, but these are collected from the Site 300 Meteorology tower and converted to pressures at the location of the measurement. The raw data, differential pressure, applied vacuum, and vapor temperature, are entered into the SMR for conversion to SCFM. In addition, the number of hours of operation, or the ending hours on the running facility clock, is also entered to calculate the total volume of soil vapor extracted. The second method used is a VFC Visa-Float flow meter, which gives direct readings in SCFM. However, the observed flow rate is based on standard pressures and temperatures and needs to be converted using actual pressures and temperatures. The formula for the conversion is:

$Q2 = Q1 \times \mathrm{sqrt}((P1 \times T2)/(P2 \times T1))$

where,

Q1 = Actual or observed flow meter reading

Q2 = Standard flow corrected for pressure and temperature

P1 = Actual pressure (14.7 psia + gauge pressure)

P2 = Standard pressure (14.7 psia, which is 0 psig)

T1 = Actual temp (460 R + temp °F)

T2 = Standard temp (530 R, which is 70°F)

This formula is contained within the SMR, and upon entering the observed flow rate, the actual flow rate is automatically calculated. The number of hours of operation, or the ending hours on the running facility clock, is also entered to calculate the total volume of soil vapor extracted. For both of these methods that only have instantaneous flow data, SMRs are completed weekly to catch flow rate variability during the month.

At the Livermore Site, most of the multi-well extraction systems have an individual total mass flow meter installed on each extraction well. The ending totalizer reading for each well during the reporting period is then entered into the SMR for a calculation of total vapor volume extracted. Similar to single well systems, the total hours of operations, or the ending hours on the running facility clock, is entered on the SMR, but is not used to calculate the total volume extracted. For these systems, the SMRs are only completed monthly.

- For multi-well soil vapor extraction systems that do not have individual well total mass flow meters, instantaneous flow rates are determined by the use of a Venturi flow meter, differential pressure gauge, vacuum gauge, and a temperature gauge. Barometric pressures are also necessary for the flow rate calculations, but these are collected from the Livermore Site and converted to pressures at the location of the measurement. The raw data, differential pressure, applied vacuum, and vapor temperature, are entered into the SMR for conversion to SCFM. In addition, the number of hours of operation, or the ending hours on the running facility clock, is also entered to calculate the total volume of soil vapor extracted. For these types of facilities, SMRs are completed weekly to catch flow rate variability during the month.
- Select a critical piece of M&TE listed on the ERD M&TE list (see SOP 4.8, "Calibration/Verification and Maintenance of Measuring and Test Equipment [M&TE]").
- Before using one of the listed soil vapor flow meters or components, ensure that they comply and are being maintained in accordance with the critical M&TE requirements described in SOP 4.8.
- Consult the instrument manual for operating instructions.

6.3.3 Flow Measurements at Influent to Treatment Systems

Influent treatment system flow rates are normally collected for systems where there is only a single extraction well, or where multiple extraction wells are in use but are not outfitted with individual flow meters. In these cases, the flow meters are normally total mass flow meters. As stated above, these meters display the instantaneous flow rate (SCFM) as well as the total vapor mass to-date (SCF). The total flow and the instantaneous flow rate, along with the soil vapor temperature are recorded in the Document Control Logbook, on a field data sheet (if used), and also entered on the SMR. The SMRs are completed monthly for treatment systems with influent totalizing flow meters and no individual well flow meters.

Note: It should be noted that for either single well or multiple well extraction systems where the well(s) are also used for ground water extraction using a pneumatic pump, the air vented from the extraction pump during each pump cycle will be totalized along with the extracted soil vapor.

6.3.4 Flow Measurements from Individually Outfitted Single-Phase Extraction Wells

For soil vapor extraction systems where each well is outfitted with individual flow meters, but no ground water extraction is taking place, no special action is needed other than recording the raw flow rate data, pre-calculated flow rates, or total mass meter readings. These data are recorded in the Document Control Logbook, on a field data sheet (if used), and also entered on the SMR. However, if it is suspected or known that substantial condensate has built up within the flow meter, the condensate should be drained from the extraction line prior to recording the flow rate and vacuum. For Venturi/differential pressure (dp) methods, a wildly fluctuating dp can indicate excess moisture within the Venturi. Also, gurgling noises coming from the pipeline is an obvious sign of excessive condensate buildup. After draining of excess condensate, allow sufficient time for vacuum and flow rate to stabilize prior to recording data.

6.3.5 Flow Measurements from Dual-Phase Extraction Wells

For soil vapor extraction systems where each well is outfitted with individual flow meters, but ground water extraction is also taking place using pneumatic pumps, some extra actions are needed prior to recording instantaneous flow rate data. Pneumatic pumps are often installed where they vent air into the well casing each time they cycle. This vented air adds to the volume of vapor being extracted from the well. Prior to recording instantaneous flow rate data, the air supply valve to the pump should be closed and the water line valve to the facility should also be closed. This will prevent the pump from cycling while flow rate data are being recorded. Both valves need to be re-opened upon completion of data recording. If an electronic totalizing flow meter is being used, and the total volume of vapor is what is being recorded on the SMR, it should be noted that this total would include the air being vented from the pump. This could introduce a moderate to relatively small error in total flow depending on the pneumatic conductivity of the well, the frequency of the pump cycles, and the size of the pump being used.

6.4 Field Measurement of VOC Concentrations

6.4.1 Documentation

Field measurements of VOC concentrations in vapor shall be recorded in the Document Control Logbook, as well as on the facility field data sheet if being used. SOP 4.2, “Sample Control and Documentation” describes the information that is required to be documented in the Log Book. These field measurements are used to track VOC breakthrough between the granular activated carbon (GAC) canisters used to adsorb VOCs in soil vapor and to demonstrate compliance with the air permit issued by the particular county.

6.4.2 Measuring and Testing Equipment (M&TE)

- A Toxic Vapor Analyzer/Flame Ionization Detector (TVA/FID), or an equivalent instrument, such as the Organic Vapor Analyzer/Flame Ionization Detector (OVA/FID) may be used. For the remainder of this SOP, the term TVA will be utilized.
- Select a critical piece of M&TE listed on the ERD M&TE list (see SOP 4.8, “Calibration/Verification and Maintenance of Measuring and Test Equipment [M&TE]”).
- Before using the TVA, ensure that it complies and is being maintained in accordance with the critical M&TE requirements described in SOP 4.8.
- Consult the instrument manual for operating instructions.

- Record the calibration verification information on the calibration log sheet for the particular TVA unit being used.

6.4.3 VOC Measurements under Vacuum Conditions

When measuring VOC concentrations from a location that is under vacuum, a vacuum pump is typically utilized. A single clean piece of transparent tubing is used to connect the pump to the sample port. A second tubing assembly incorporating standard tee fittings is used to connect the vacuum pump to the TVA, allowing excess vapor flow to be routed through an exhaust line. After the vacuum pump has been activated, allow the pump and TVA to run for several minutes while drawing in atmospheric air to get a background VOC reading. Once a stable value is displayed, record value in logbook. The vacuum pump can then be attached to the sample port to collect a VOC measurement. Once a stable VOC concentration has been achieved, the value may be recorded. Consult the M&TE manual for measurement instructions.

Notes: It is always recommended to use a tee-style assembly with transparent tubing when using the vacuum pump along with the TVA. Transparent tubing should be used to protect the TVA from drawing excess moisture into the instrument.

Excess moisture can douse the flame and possibly damage the instrument. The transparent tubing allows the user to see if water is being drawn into the tubing.

When possible, sample ports from the lowest expected concentration to the highest expected concentration. For example, the final effluent sample port should be sampled first, followed by moving upstream in the treatment process.

6.4.4 VOC Measurements Under Positive Pressures and Ambient Conditions

When measuring VOC concentrations from a sample location under positive pressure conditions, it is not necessary to use the vacuum pump to deliver the sample to the TVA. Collect a background VOC measurement as described above. Connect the tee-style tubing assembly to the sample port and to the TVA. If there is low enough pressure, the TVA may be connected directly to the sample port with a single piece of transparent tubing, or the sample tip of the TVA may be inserted directly into the sample port. When measuring VOC concentrations from a sample location under ambient pressure conditions, the need for using a vacuum pump depends on the ability of the internal TVA pump to draw the sample. If flow is insufficient to keep the internal flame ignited, a vacuum pump may be necessary.

Notes: When collecting measurements by inserting the sample tip of the TVA directly into the sample port, ensure that the tip is inserted completely, to prevent ambient air from being drawn into the TVA.

When possible, sample ports from the lowest expected concentration to the highest expected concentration.

6.5 Analytical Laboratory Measurements

Vapor samples are collected following the steps below and sent to an analytical laboratory for VOC analysis. This is done when accurate analyses are needed for mass removal calculations from vapor extraction wells or the influent to the treatment system, and to ascertain vadose zone VOC concentrations. This is also useful for evaluating mass loading of VOCs on the GAC. Samples needed for these purposes are always collected using a vacuum box sampler. Vacuum box samplers are designed to collect a bag sample (select the appropriate requested analyses code to denote the type of vapor bag used to collect the sample) of the soil vapor directly from the source without the vapor traveling through a pumping devise that can introduce atmospheric air and dilute the sample. In addition to collection of samples from active extraction wells, samples can also be collected from non-active extraction wells and monitor wells. Some extraction wells are outfitted with a dedicated vapor line stinger that is attached to the wellhead sample port and extends down to the screen section of the well. Monitor wells require substantial pre-purging to ensure a representative sample is collected, while only minor purging is needed for active extraction wells with stingers. When possible, sample wells from the lowest expected concentration to the highest expected concentration. The maximum safe vacuum that can be applied to the vacuum box is 15“ Hg (see below for collection of samples under high vacuum situations). An abbreviated version of the procedures listed below is included in Attachment A.

6.5.1 Sampling of Active Vapor Extraction Wells without Dedicated Stingers:

- This procedure is applicable for collecting soil vapor samples from a location that is under a vacuum, such as an active extraction well or a sample port within the treatment system, and where no pre-purging is required. A vacuum box sampler should be utilized for the collection of all vapor samples. Where possible, the extraction well or treatment system should be left on-line during sample collection. If sampling a dual phase extraction well outfitted with a pneumatic pump, close off the air supply to the pump and close the water discharge line from the pump, so the pump will not cycle during sample collection. When attempting to collect a vapor sample under extremely high vacuum situations (> 15 “ Hg), the well or sample port can be partially or completely isolated from the vacuum source prior to sample collection following the procedures below. For specific operating instructions, refer to Attachment A, Abbreviated Sampling Procedures and Attachment B, Vacuum Box diagram.
- Make sure the wellhead is sealed and there are no leaks to the atmosphere or to the pipeline connected to the treatment system. Connect a sampling tube from the upper inlet line on the vacuum box to the wellhead sampling port. Ensure the sample port valve and the main vacuum box inlet valve are both closed. Attach a vapor bag (e.g., Tedlar®) to sample hose inside vacuum box with fill valve in closed position.

- Open the sample port valve and the main vacuum box inlet valve and evacuate the entire sample line for ~30 seconds using the applied vacuum at the wellhead.
- Close the main vacuum box valve, open the fill valve on the bag, and close the lid securely.
- Activate vacuum box pump and slowly open main vacuum box valve. Immediately adjust the fill rate using the flow meter adjustment knob to the lowest flow rate possible where the bag is still filling. It should take 30 to 60 seconds for the bag to fill. Don't overfill bag, as this can lead to leakage.
- As soon as the bag appears to be sufficiently full, close the main vacuum box valve, followed by turning off the vacuum pump and then closing the sample port valve.
- Release vacuum from box using bleed valve, open vacuum box and immediately close vapor bag fill valve prior to detaching the sample line from the bag.
- Record all data such as sample date and time, purge volume, flow rates, applied vacuums, etc. on the Vapor Sampling Field Sheet (Attachment B). Samples should be sent to the CAL and analyzed as soon as possible due to short hold times. The samples should be transported in a cooler without ice and exposure to sunlight should be avoided. Inspect vapor bag samples prior to shipment for leakage. Any samples suspected of leaking should be discarded and the location re-sampled. Follow ERD SOP 4.2 for proper sample control and documentation and SOP 4.4, "Guide to the Handling, Packaging, and Shipping of Samples" for shipping and handling procedures.
- Replace all tubing at the end of each quarter or if it becomes discolored.

6.5.2 Sampling of Active Vapor Extraction wells with Stingers, Non-Active Vapor Extraction Wells, and Monitor Wells:

- This procedure applies to the collection of soil vapor samples from active extraction wells with dedicated stingers, non-active extraction wells and monitor wells. A vacuum box is still employed for the sample collection, but pre-purging of the well is required prior to sample collection using a vacuum pump. In cases where a non-active extraction well can be pre-purged by using the vacuum applied by the treatment system, the external vacuum pump is not necessary. In this case, after the prescribed volume has been purged, the procedures above in section 6.5.1 can be followed. When attempting to collect a vapor sample under extremely high vacuum situations (> 15 " Hg), the well or sample port can be partially or completely isolated from the vacuum source prior to sample collection following the procedures below. For specific operating instructions, refer to Attachment A, Abbreviated Sampling Procedures and Attachment B, Vacuum Box diagram.
- Make sure the wellhead is sealed and there are no leaks to the atmosphere or to the pipeline connected to the treatment system. Connect a sampling tube

from the upper inlet line on the vacuum box to the wellhead sampling port. Ensure that the valve on the wellhead sampling port is closed

- Connect a second sample tube from the lower inlet port on the vacuum box to an external vacuum pump.
- Attach vapor bag to sample hose inside vacuum box with fill valve in closed position.
- Open main vacuum box valve and close the valve at the wellhead sample port. Turn on external vacuum pump and run for approximately one minute at > 1 L/min to evacuate all sample lines.
- Close main vacuum box valve and open wellhead sample port valve. Purge the well for the specified time or volume. If the well is an active extraction well equipped with a vapor line stinger that extends down to the screen section of the well, very minor purging is required prior to sample collection. The volume within the stinger is fairly negligible. A 50 ft stinger contains approximately 0.02 cu ft or ~ .6 liters of air.
- Once the required purge volume is reached, open the vapor bag, fill valve and securely close the box lid, close the valve on the lower inlet line, and shut off the external vacuum pump.
- Activate vacuum box pump and slowly open main vacuum box valve. Immediately adjust the fill rate using the flow meter adjustment knob to the lowest flow rate possible where the bag is still filling. It should take 30 to 60 seconds for the bag to fill. Don't overfill bag, as this can lead to leakage.
- As soon as the bag is sufficiently full, close the main vacuum box valve and shut off the vacuum box pump, and close the sample port valve.
- Release the vacuum within the box using the bleed valve, open box lid, and close the vapor bag, fill valve prior to removing the bag from the sample hose inside box.
- Record all data such as sample date and time, purge volume, flow rates, applied vacuums, etc. on the Soil Vapor Sampling Field Sheet (Attachment C). Samples should be sent to the CAL and analyzed as soon as possible due to short hold times. The samples should be transported in a cooler without ice and exposure to sunlight should be avoided. Inspect vapor bag samples prior to shipment for leakage. Any samples suspected of leaking should be discarded and the location re-sampled. Follow ERD SOP 4.2 for proper sample control and documentation and SOP 4.4, "Guide to the Handling, Packaging, and Shipping of Samples" for shipping and handling procedures.
- Replace all tubing at the end of each quarter or if it becomes discolored.

7.0 QA RECORDS

7.1 Facility Logbooks

7.2 M&TE Calibration and Maintenance Log Books

7.3 Analytical Results

7.4 CoCs (Chain of Custodies)

7.5 Self-Monitoring Report

8.0 ATTACHMENTS

Attachment A—Abbreviated Sampling Procedures

Attachment B—Vacuum Box

Attachment C– Soil Vapor Sampling Field Sheet

Attachment A

Abbreviated Sampling Procedures

Vacuum Box Procedures with Pre-Purging

Procedure for active extraction wells with stingers, non-active extraction wells, or monitor wells.

1) Attach sample line from well-head sample port to the upper inlet line (V2) on vacuum box.
2) Attach additional tubing from lower inlet line on the vacuum box to an external vacuum pump. Insure all valves are closed.
3) Attach vapor bag to sample hose inside vacuum box with fill valve in closed position (lid can remain open)
4) Open sample port valve on well-head, open V2 and turn on external vacuum pump. Purge the for the specified time period or volume. For active wells with stingers, a purge time of 30 seconds is adequate.
5) While purging, open main inlet valve (V1) for a short period (30 sec to 1 min) to evacuate entire line to Tedlar bag. Close V1 when done.
6) When purging is complete, turn off external vacuum pump.
7) Open vapor bag fill valve and securely close lid on box.
8) Open V1 and V2 and activate internal vacuum pump. Immediately adjust the flow rate using adjustment knob to the lowest flow rate possible where you still see the bag filling. It should take at least a minute for the bag to fill.
9) The maximum safe vacuum to apply to the box is 15 in Hg. For operating systems with vacuums in excess of this, partially close vacuum line from well until the applied vacuum is below 15 in Hg.
10) Close V1 and V2 when full (don't overinflate bag), turn off internal vacuum pump, and close sample port valve.
11) Release vacuum from box by opening the vacuum release valve (V3).
12) Open box, close vapor bag fill valve, disconnect bag from hose, and remove.

Vacuum Box Procedures without Pre-Purging

Procedure for active extraction wells without dedicated stingers.

1) Cap off lower inlet line. The upper inlet line (V2) will be utilized only.
2) Attach vapor bag to sample hose inside vacuum box with fill valve in closed position (lid can remain open).
3) Attach sample line from well-head sample port to upper inlet line (V2) on vacuum box.
4) Open well-head sample port valve, the main inlet valve (V1) and V2 for a short period (~30 sec) to evacuate entire line to vapor bag. Close V1 when done.
5) Open vapor bag fill valve and securely close lid on box.
6) Open V1 and activate internal vacuum pump. Immediately adjust the flow rate using adjustment knob to the lowest flow rate possible where you still see the bag filling. It should take at least a minute for the bag to fill.
7) The maximum safe vacuum to apply to the box is 15 in Hg. For operating systems with vacuums in excess of this, partially close vacuum line from well until the applied vacuum is below 15 in Hg.
8) Close V1 and V2 when bag is full (don't overinflate), turn off internal vacuum pump, and close sample port valve.
9) Release vacuum from box by opening the vacuum release valve (V3).
10) Open box, close vapor bag fill valve, disconnect bag from hose, and remove.

Attachment B

Vacuum Box


V3
V1
V2
To external pump
l/min AIR

Attachment C

Soil Vapor Sampling Field Sheet

Soil Vapor Sampling Field Sheet

Site	Livermore ( ) S-300 ( )	Page __ of __	By:
	Purge pump/ Ser no.		
	Vacuum box/ Ser no.		
Comments/conditions:			

Date	Time	Sample ID	Sample depth / sample port	Purge flow rate/ vacuum pressure	Purge duration (min)	Vacuum Box flow rate / box pressure

LLNL Environmental Restoration Department (ERD) Standard Operating Procedure (SOP)	
ERD SOP 1.18: Site 300 Treatment Media Acceptance Testing and Usage Tracking Process **Revision: 0**	
ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # ERD	**AUTHOR(S):** S. Gregory
	APPROVALS: Date Jesse Yow 12/21/15 Department Head Leslie Ferry 12/15/15 Site 300 Program Leader
	CONCURRENCE: Date Rebecca Goodrich 1/7/16 QA Implementation Coordinator

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this procedure is to implement a process to ensure newly received shipments of treatment media meet the acceptance criteria defined in the purchase agreement prior to utilizing the material at the treatment facilities. The process also tracks the type of media, the quantity, facility where it is being utilized, and outlines a sample collection process.

2.0 APPLICABILITY

This procedure is applicable to the ERD treatment facilities at Site 300, where treatment media is utilized in the ground water treatment process. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

Purchase Agreement Contract.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Treatment Facility Compliance Manager (TFCM)

The TFCM is responsible for implementing the treatment media acceptance testing and usage tracking process as defined by this procedure. The TFCM is responsible for ordering all treatment media and performing, or overseeing, the associated acceptance testing to ensure all material meets the acceptance criteria set forth in the purchase order agreement. The TFCM also directs the treatment facility technicians (TFTs) to perform media change-outs, and tracks the usage of all treatment media. The TFCM provides chemical waste classification data for disposal of all spent treatment media through RHWM.

5.6 Treatment Facility Technician (TFT)

The TFT is responsible for properly operating treatment facilities, recording treatment facility operating parameters as specified, and collecting soil vapor samples and field measurements per the ERD SOPs, IWS(s), and facility sampling plan. In accordance with this procedure, the TFT is also responsible for inspecting, documenting, sampling, and tracking the treatment media as described.

5.7 Data Management Team (DMT)

The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP. The DMT is also responsible for creating a document control logbook specific to the treatment media tracking process.

6.0 PROCEDURE

A tracking process has been developed to ensure that newly received shipments of treatment media meet the conditions specified in the purchase agreement prior to utilizing the material at the treatment facilities.

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities per SOP 4.1 "General Instructions for Field Personnel" including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015). Direct field supervision and on-the-job-training (OJT) will be provided using ERD's Treatment Facility Operations Lesson Plan (course number EP7033-016). Successful completion of the OJT will be required prior to performing treatment facility vapor monitoring and sampling independently. When applicable and recommended by the ERD management, an employee may be granted an exception from training by completing the Exception from Training (LL6499) form. ERD management must approve the form and forward to the Training Coordinator to obtain final authorization. The employee will be given course credit once the process is completed.

6.2 Safety Considerations

6.2.1 Work is to be performed in accordance with the LLNL Site Safety Plans, the Quality Assurance Project Plan (QAPP), applicable ERD SOPs, facility sampling plans, and ERD Integration Work Sheets (IWS). Work activities described by this

SOP shall be performed in accordance with IWS 11341 "Ground Water and Soil Vapor Treatment Facility Operations at Site 300," IWS 11314 "ERD Site 300 Ion Exchange Resin Replacement" and IWS 11346 "ERD Site 300 Removal Replacement of Spent Aqueous and Vapor-Phase Granular Activated Carbon (GAC).

6.3 Treatment Media Inspection, Labeling, and Testing

All treatment media, both ion-exchange resin and granular activated carbon (GAC), needs to be inspected, labeled, sampled, and tested to ensure it meets acceptance criteria immediately upon receipt.

6.3.1 Inspection and Labeling of Treatment Media

1) Upon receipt of new treatment media, perform the following tasks: Inspect each container for integrity and ensure that the custody seal (if applied) is intact. If a container in the shipment of treatment media is damaged, or if the custody seal is broken, immediately notify the TFCM to facilitate replacement of the container(s). This initial inspection should be done while the shipment is still at LLNL Receiving if at all possible.

2) Inspect each container to ensure that each item in the order is from the same lot number. If there are containers in the same order with different lot numbers, then segregate items by their lot numbers, and notify the TFCM.

3) After segregating containers by media type, and lot numbers, place the appropriate media label on each container. Specific colored labels for each type of media are to be utilized (Attachment A). Yellow labels are for perchlorate specific resin, blue for nitrate specific resin, orange for uranium specific resin, and white labels for Granular activated carbon (GAC). The labels should be filled out with the product name (e.g., SIR-110-HP), received date, lot number, and the next available package number. The next available package number can be obtained from the media logbook. The "approved for use" line will not be filled in until the media has been acceptance tested and released for use. Place a red dot on each package to show it has not yet been approved for use.

4) This information then needs to be recorded in the Treatment Media Logbook. Record the following:

   - Received date
   - Product Name (i.e. SIR-110-HP)
   - Lot Number
   - Volume Received (i.e. 10 @ 1 cu ft boxes)

5) Note whether the media packages have been marked with Chem Trac labels indicating they have been through the LLNL Chemical Tracking process. If they have not, notify the TFCM.

6.3.2 Testing of Treatment Media

Samples of all media types will be collected for acceptance testing and saved for future evaluations if necessary. The number of samples collected is based on the lot numbers and the volume of media within each lot number. A minimum of one sample should be collected for each lot number. For shipments of a new type of ion-exchange resin, or a resin or GAC from a new vendor that has not been previously tested, a minimum of two containers should be selected for testing regardless of the volume in the shipment. For larger orders of ion-exchange resins, those of 20 or more cubic feet, two containers should be randomly selected for testing.

1) Collect a sample from one of the containers for acceptance testing:

   a. Cut or break custody seal (if applied) on the package.

   b. Obtain a clean 8 oz. Quorpak jar from the B833 sampling supply shed. Label the jar with the date, media type (e.g., Resin Tech SIR-110-HP), lot number, received date, and container number.

   c. Don Nitrile gloves, open container, and using a clean sample scoop fill sample jar with treatment media.

   d. For larger orders, orders containing more than one lot number, or for a new media variety, collect additional samples as described above.

   e. Tightly seal all jars and place labeled samples in media sample refrigerator.

   f. Reseal all media packages opened for sampling.

   g. Notify TFCM that a sample(s) has been collected and is ready for acceptance testing. Document sample collection details in the appropriate logbook.

2) A leachate test (soak test) is then conducted on the ion exchange resin samples collected. These prepared soak samples (as described below) are then submitted to a contract analytical laboratory, where the water portion of the sample is analyzed by EPA method 624. The results from these analytical tests are then compared to the acceptable VOC concentrations in leachate testing specified in the Acceptance Criteria in the Purchase Order Agreement.

   a. Obtain three new volatile organic analysis (VOA) vials from a sealed case of vials obtained from one of LLNL's contract analytical laboratories.

   b. Obtain analyte free water (blank water) from one of LLNL's contract analytical laboratories. This water should be accompanied by analytical results demonstrating it does not contain any VOCs above their respective reporting limits (also defined in the "Find Analysis Suites" in The Environmental Information Management System (TEIMS) database).

   c. Obtain a clean/narrow sampling tool for transferring resin from the package to the sampling containers (VOA vials).

   d. Obtain resin samples already collected in step 1 above, and using the sampling tool, fill all three VOA vials approximately one third full with resin. Ensure each vial has about the same amount of resin.

   e. Using the analyte-free water, fill each vial with the water and cap. Ensure no head-space (air bubbles) is present in the vials.

   f. Invert each vial several times to mix resin with the water. If any head-space (bubbles) is observed, un-cap vile, add additional water, re-cap, and repeat above.

g. Place vials in sealed Ziplock® style bags and tape closed with custody tape.

h. Store vials for three to four days in a clean location and at room temperatures to mimic field conditions where compound leaching could occur.

i. Submit samples to contract analytical laboratory for analysis of the water within the vials by EPA Method 624. A rush turn-around-time (TAT) should be requested to expedite analytical review by the TFCM.

j. If one resin shipment contains multiple lots, a separate sample should be tested for each lot.

k. Once notified by the TFCM that the resin soak test has met the acceptance testing, place a green dot on each container in the shipment indicating it is approved for use. Also add a "Y" to sample label indicating it is approved for use.

3) Samples of the GAC are tested to ensure they meet acceptable pH ranges. Since the discharge limit for treated ground water from the Site 300 treatment facilities falls within a pH of 6.5 to 8.5, the pH of the GAC must also fall within this range. Non-pH adjusted GAC will initially have a basic pH in the 10 to 12 range. For this reason, acid rinsed GAC is normally procured, which should fall within a pH range of 7 to 8.

a. Obtain GAC sample(s) retained from step 1 above.

b. Using either pH paper or a pH meter, measure and record the pH of the water that will be used to test the GAC.

c. Using a separate clean sample container, fill container about half way with the new GAC and then add the testing water slowly. A slight exothermic reaction will occur between the water and the GAC causing the release of heat and gas bubbles. Add water until there is enough water above the GAC to submerge the pH test strip or pH probe (about an inch).

d. Cap the container and gently invert several times to mix GAC and water and quickly loosen container top to release gas. Repeat until gas is no longer being produced.

e. Allow water and GAC to sit for approximately 10 to 15 minutes and then measure the pH of the water in the testing container. Wait an additional 5 minutes and measure the pH again. Record the resulting pHs in the media logbook and report values to the TFCM. A measured pH outside the acceptable range will require the shipment of GAC to be sent back to the vendor for replacement.

6.3.3 Documentation of Treatment Media

A logbook dedicated for recording treatment media information will be maintained at Building 835 where treatment media is stored and change-outs are performed. Upon receipt of the new treatment media, record the following information in the dedicated logbook:

1) Date of Receipt

2) Type of media (e.g., perchlorate resin/SIR-110-HP; GAC/aqueous phase virgin coconut, etc.).
3) Vendor (e.g., Baker Filtration)
4) Volume of media received
5) Lot Numbers
6) Chem-Track Label numbers (if supplied)
7) Volume received (e.g., 5 boxes at 1 cu ft. each; 1,000 lbs. bulk in bags, etc.)
8) Condition of shipment (Custody seal intact (Y/N))
9) Date of acceptance testing; documentation of approved for use

6.3.4 Usage of Treatment Media

At the time of removal of treatment media from storage for media change-out, record the following information in the assigned logbook:

1) Date of Change-out
2) Type of media (e.g., perchlorate resin/SIR-110-HP; GAC/aqueous phase virgin coconut, etc.)
3) Treatment media vessel ID being filled (note: the treatment vessel logbook tracks where each vessel is being utilized)
4) Volume of media removed (e.g., used 3cu ft. of resin; used 250 lbs. of GAC, etc.)
5) Container numbers used (e.g., used approximately two-thirds of Drum #2; used approximately 1 cu ft. remaining from Drum #1 and the rest from Drum #2, etc.)

Once one container (drum, box, etc.) is empty, if at all possible, store the container until the treatment media from the container(s) has been fully evaluated and has been determined to meet LLNL's acceptance criteria.

6.4 Post Operation

6.4.1 Review logbooks and field forms for completeness and accuracy per SOP 4.2,"Sample Control and Documentation".

7.0 QA RECORDS

7.1 Treatment Media Logbook

7.2 Facility Logbooks

8.0 ATTACHMENT

Attachment A — Media Label

Attachment A

Media Label

Perchlorate Ion-Exchange Resin

Product Name
(e.g., SIR-110-HP): ____________
Received Date: ____________
Lot #: ____________
Package # ____________
Approved for use (Y/N)

Adhesive sticker

Green Sticker means ready for use

Nitrate Ion-Exchange Resin

Product Name
(e.g., SIR-100-HP): ____________
Received Date: ____________
Lot #: ____________
Package # ____________
Approved for use (Y/N)

Adhesive sticker

Red Sticker means not ready for use

Uranium Ion-Exchange Resin

Product Name
(e.g., A-284): ____________
Received Date: ____________
Lot #: ____________
Package # ____________
Approved for use (Y/N)

Adhesive sticker

Granular Activated Carbon (GAC)

Product Name
(e.g., VCAW8X30): ____________
Received Date: ____________
Lot #: ____________
Package # ____________
Approved for use (Y/N)

can be adhesive sticker we attach to a plate

Attachment A. Media Label.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.19: Conditioning Treatment for Ion Exchange Resins—Revision: 0

AUTHOR(S):
S. Kawaguchi

APPROVALS:	**Date**
Department Head	12/21/15
Livermore Site Program Leader	12/17/15

CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	1/7/16

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

This SOP describes the conditioning process for new ion exchange resin prior to installing and utilizing it at the ERD Livermore site ground water treatment facilities. The ion exchange resins are utilized as a treatment media to remove hexavalent chromium from ground water at the Livermore site in order to meet the discharge limit of 22 μg/L. The discharge limit is specified in the Explanation of Significant Differences for Metals Discharge Limits at the Lawrence Livermore National Laboratory Livermore Site for the Wet season (December 1 through March 31).

2.0 APPLICABILITY

This procedure provides guidelines for conditioning new resin prior to utilizing the resin at ERD Livermore site treatment facilities. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 City of Livermore (LWRP) Groundwater Discharge Permit No. 1510g.

3.2 Explanation of Significant Differences for Metals Discharge Limits at the Lawrence Livermore National Laboratory Livermore Site, L.L Berg, et al., April 1997, UCRL-AR-125927.

3.3 Handbook of Separation Techniques for Chemical Engineers, Philip A. Schweitzer, 1979, McGraw-Hill, Inc.

3.4 Removing Hexavalent Chromium from Subsurface Waters with Anion-Exchange Resin, Richard A. Torres, June 1995, UCRL-ID-114369.

3.5 Safety Data Sheet for LANXESS Sybron, Lewatit ASB 2, Material Number: 56788054.

3.6 Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Treatment Facility Technician (TFT)

The TFT is responsible for properly operating treatment facilities, recording treatment facility operating parameters as specified, and for the safe completion of resin conditioning and documentation of the activity according to guidelines in this procedure.

5.7 Technical Release Representative (TRR)

The TRR is responsible for the acquisition and administration of blanket contract releases for the procurement of goods and services. The TRR has the authority to obligate LLNS for payment of goods and services, delegated by the LLNS Business Manager through the Procurement Department.

5.8 Data Management Team (DMT)

The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

This procedure provides guidelines for TFTs to condition new ion exchange resin in the fiberglass-wound columns using a type 2 anion resin (ASB-2). During the resin conditioning process, the pH of the effluent decreases as the bicarbonate ions are exchanged for chloride ions. Because the surface discharge pH limit specified in the Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin is between 6.5 and 8.5, this procedure ensures that the appropriate discharge parameters are met in addition to proper resin conditioning.

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities per SOP 4.1 "General Instructions for Field Personnel" including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015). Direct field supervision and on-the-job-training (OJT) will be provided using ERD's Treatment Facility Operations Lesson Plan (course number EP7033-016). Successful completion of the OJT will be required prior to performing treatment facility vapor monitoring and sampling independently. When applicable and recommended by the ERD management, an employee may be granted an exception from training by completing the Exception from Training (LL6499) form. ERD management must approve the form and forward to the Training Coordinator to obtain final authorization. The employee will be given course credit once the process is completed.

6.2 Safety Considerations

6.2.1 Work is to be performed in accordance with the applicable ERD SOPs, facility sampling plans, and ERD Integration Work Sheets (IWS). Work activities described by this SOP shall be performed in accordance with IWS 11534 "Treatability Testing and Related Activities at Livermore" and IWS 12794 "Ion Exchange Resin Change-out and Conditioning at ERD Facilities in Livermore" at the Livermore Site.

6.3 Receiving Resin

6.3.1 Reconcile the packing list to the requisition to ensure the correct quantity and type of resin was received.

6.3.2 Verify that the container label reads: Lewatit ASB 2 56788054.

6.3.4 Record the lot number. If the resin is more than two years old, do not sign the invoice or open the containers. Arrange to return the shipment to the manufacturer.

6.3.5 Inspect the drums for signs of physical or chemical damage.

6.3.6 Safety Data Sheets (SDS) are available in the O&M, Volume 1, Appendix C. If unfamiliar with the chemical properties of resin, please review before continuing. To ensure current chemical safety information is being reviewed, it is advisable to retrieve the applicable MSDS from the Chemtrack website using the following link: http://chemtrack.llnl.gov

6.3.7 Open the drum and inspect the resin. The resin should arrive in a sealed plastic bag within the cardboard drum. It should be moist, but not saturated. Inspect the resin for areas of discoloration or note any unusual odors. If anything unusual is noticed, inform the Technical Release Representative (TRR).

6.3.8 If the resin passes inspection, sign the invoice and notify the TRR that the resin has arrived.

6.4 Resin Conditioning

6.4.1 Secure necessary materials and equipment for the conditioning, including a 2,500 gal storage tank, 2 in hoses, 55-gallon drum vacuum, resin column filling attachment, flow meter, and pH meter or paper.

6.4.2 Follow IWS 12794 "Ion Exchange Resin Change-out and Conditioning at ERD Facilities in Livermore".

6.4.3 If starting with a new canister perform a pressure test by filling empty columns with clear TFC effluent water and let stand overnight.

6.4.4 Remove the upper manifold to allow the resin to be added. Ensure that there is enough sand in the bottom of the column to cover the lower diffusers. Place the square plate of the resin column filling attachment on the open top of the resin column with the rubber side down and attach the hose with the metal adapter to the suction port of the vacuum head.

6.4.5 Add 7 ft^3 (1 drum) of ASB-2 resin to the column by turning on the vacuum and transferring the contents of the cardboard drum into the resin column. The resin will fill approximately 3/4 of the column.

6.4.6 Replace the upper manifold on the resin column before conditioning. The conditioning process takes approximately 3.5 hours for 3 columns (not including the soaking process in step 6.4.8).

6.4.7 Connect the hoses and flow meter in an upflow configuration. Flowpath is from TFC effluent line to bottom of resin column, top of resin column to bag filter, and from bag filter to a 2,500 gallon holding tank.

6.4.8 Add water from the bottom of the column to completely fill the column at a flow rate of approximately 5 gallons per minute and allow the resin beads to swell for at least one hour but for no more than 24 hours. Important: the resin will expand as it completely hydrates. Secure flow.

6.4.9 Perform a slow rinse (upflow) at a rate of 4-10 gpm for 60 minutes with clean effluent water (360 gallons). Collect the rinsate into a 2,500 gallon storage tank.

6.4.10 Stop the flow and allow the resin to settle for 5 minutes while reconfiguring the hoses to a down flow mode.

6.4.11 Pack the resin bed using a fast rinse (down flow) at a rate of 30 gpm for 10 min (300 gals). Flow path is from TFC effluent line to top of resin column, bottom of resin column to bag filter, and from bag filter to 2,500 gallon tank.

6.4.12 The manufacturer recommends a total conditioning requirement of 50 gal/ ft^3 (about 350 gals). The entire conditioning procedure will produce approximately

900 gals of rinsate per column. Verify that the pH of the rinsate is between 6.5 and 8.5. Reintroduce the collected rinsate into the treatment facility (TFC).

6.4.13 The resin must remain wet at all times and be stored in a manner that inhibits bacterial growth. Do not store resin in a drained column, not even overnight. Resin may be stored temporarily, less than 24 hours, in columns filled with clean facility water. Longer storage in ground water will oxidize the resin with the adsorbed hexavalent chromium.

6.4.14 In order to maximize the useful life of the resin, split the facility influent flow through the columns so that a proportion of the water bypasses the columns. An engineer can calculate a bypass ratio to keep the facility in compliance. A typical water flow rate through the columns is between 20-30 gpm with a maximum flow rate of 60 gpm per resin capacity specification.

Following column activation, each column will have a laminated tag attached to it with the following information:

Resin Column #: ____________________________

Resin Manufacturer: LANXESS Sybron, Lewatit ASB 2, Material

Number: 56788054

Resin Lot #____

Resin Quantity in Column: 7 ft^3

Date of New Resin Addition:______________________________

Date of Regeneration:______________________________

7.0 QA RECORDS

7.1 Facility Logbooks

7.2 Ion exchange resin logbook

8.0 ATTACHMENTS

Attachment A—Checklist for Resin Conditioning

Attachment A

Checklist for Resin Conditioning

Checklist for Resin Conditioning

☐ **1.** Verify the container label reads: **Lewatit ASB 2 56788054**. Record the lot number.

☐ 2. Secure necessary materials and equipment for the conditioning including the MSDS, storage tank, hoses, 55 gal drum vacuum, resin column filling attachment, flow meter and pH meter or paper.

☐ 3. Remove the upper manifold to allow resin to be added to the column.

☐ 4. Fill column with about 30 gallons of facility effluent water then add 7 ft^3 (one drum) of resin to the column with the 55-gal drum vacuum and the resin column filling attachment.

☐ 5. Connect the hoses in an up flow configuration.

☐ 6. Add water from the bottom of the column to completely fill the column and allow to swell for 1 hour, no longer than 24 hours.

☐ 7. Perform a slow rinse (upflow) at a rate of **4-10** gpm for 60 min with clean effluent water (360 gals). Collect the rinsate into a 2,500 gallon storage tank.

☐ 8. Stop the flow and allow the resin to settle for 5 minutes while reconfiguring the hoses to a downflow mode.

☐ 9. Pack the resin bed using a fast rinse (downflow) at a rate of **30** gpm for 10 min (300 gals).

☐ 10. Condition resin with 50 gal/ft^3 (about 350 gals) as recommended by the manufacturer, which will produce approximately 900 gals of rinsate per column.

☐ 11. Verify that the pH of the rinsate is between 6.5 and 8.5. Reintroduce the collected rinsate into the treatment facility.

Note: In order to maximize the useful life of the resin, split the facility influent flow through the columns. A typical water flow rate through the columns is between 20-30 gpm with a maximum flow rate of 60 gpm.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.20: Carbon Canister Removal and Carbon Conditioning — Revision: 0

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#
ERD

AUTHOR(S):
S. Kawaguchi

APPROVALS:	Date
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[signature] Livermore Site Program Leader	12/17/15

CONCURRENCE:	Date
Rebecca Goodrich QA Implementation Coordinator	1/7/16

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this procedure is to describe the process of removing spent carbon canisters from treatment facilities, evacuating spent carbon from the canisters, and activating new carbon canisters for use at the Livermore Site with ground water treatment facilities. The carbon will ensure the removal of volatile organic compounds (VOCs) from the ground water in order to meet the discharge limit of 5 parts per billion (ppb).

2.0 APPLICABILITY

This procedure provides guidelines for field personnel to remove and dispose of spent carbon and condition new activated carbon in fiberglass-wound canisters. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Bay Area Air Quality Management District (BAAQMD) Permit, current version.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Treatment Facility Technician (TFT)

The TFT is responsible for properly operating treatment facilities, recording treatment facility operating parameters as specified, and for the safe completion of carbon removal, conditioning, and documentation of the activity according to the guidelines in this procedure.

5.6 Data Management Team (DMT)

The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

5.0 PROCEDURE

When chemical breakthrough of a carbon canister occurs, it becomes necessary to remove the spent carbon from the canister(s) and activate the new carbon canister(s) for usage at the ground water treatment facilities. The canister(s) is refilled with carbon by an outside vendor and is not the responsibility of the treatment facility technician.

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities per SOP 4.1 "General Instructions for Field Personnel" including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015). Direct field supervision and on-the-job-training (OJT) will be provided using ERD's Treatment Facility Operations Lesson Plan (course number EP7033-016). Successful completion of the OJT will be required prior to performing treatment facility vapor monitoring and sampling independently. When applicable and recommended by the ERD management, an employee may be granted an exception from training by completing the Exception from Training (LL6499) form. ERD management must approve the form and forward to the Training Coordinator to obtain final authorization. The employee will be given course credit once the process is completed.

6.2 Safety Considerations

6.2.1 Work is to be performed in accordance with the LLNL Site Safety Plans, the Quality Assurance Project Plan (QAPP), applicable ERD SOPs, facility sampling plans, and ERD Integration Work Sheets (IWS). Work activities described by this SOP shall be performed in accordance with IWS 11534 "Treatability Testing and Related Activities at Livermore" and IWS 15331 "Recycling "Carbon Removal and Conditioning" at the Livermore Site.

6.3 Removal of Spent Canisters

6.3.1 When chemical breakthrough of a carbon canister(s) occurs, remove hoses and fittings from canisters to be removed. It may be only one canister, or it may be all three, depending on sample analysis data.

6.3.2 Remove spent canisters. When using fork truck, use 6' nylon or polyester lifting straps on top of canister and 5' nylon or polyester lifting straps on bottom of canister. Wear appropriate PPE, i.e., hardhat, safety shoes, vest, and gloves. Use nylon or polyester lifting straps to sling individual canisters. Lift and remove canisters using an approved fork truck.

6.4 Evacuating Spent Carbon

6.4.1 Drain water from carbon canister(s). Use an air compressor attached to the influent port to force water out of the effluent port. Pressurize canister to 10-15 psi (canisters are rated at 75 psi). Pressurize canisters several times, waiting a few minutes between each cycle. This will help ensure as much water as possible has been evacuated.

6.4.2 Collect and/or dispose of water blown down from carbon canisters. If the water is blown down at the facility, connect the canister effluent line to the facility influent line. If this step occurs at a remote location, collect water in an appropriate container, i.e., collection drums or tanks. Once water has been collected, dispose of by emptying into TFB purge water tanks or running water back through an operating facility.

6.4.3 Remove spent carbon from dewatered canisters. Using a drum vacuum with a stinger to reach the bottom of canisters, vacuum carbon into unlined 55-gallon drums. About 1½ drums are required to empty one canister. This step may be done at the facility or remote location.

6.4.4 Dispose of spent carbon. Once 55-gallon drums have been filled with spent carbon, secure the lid and tighten the lid ring. Label drums with the appropriate waste label and contact the ERD hazardous waste technician. All drums will be handled and disposed of following hazardous waste management guidelines.

6.5 Conditioning New Carbon

6.5.1 Canisters are filled with carbon by an outside vendor. Their work is covered with a Procured Work Sheet (PWS). This procedure does not cover the filling of empty canisters.

6.5.2 Place newly filled carbon canisters on skid of treatment facility. Always use two people to move and locate canisters.

6.5.3 Install new tops onto canisters and tighten. Fill canister number one with water. It takes approximately 30 to 40 gallons to fill each canister.

6.5.4 Once canister number one is filled, flow through canister number one to fill canister number two.

6.5.5 Once canister number two is filled, flow through canister number two to fill canister number three.

6.5.6 Allow all GAC canisters to condition/soak for at least six hours.

6.5.7 Re-plumb all new canisters.

6.6 Post Operation

6.6.1 Record all information in facility logbook, i.e., date, time, and total canisters removed or used in conditioning process.

7.0 QA RECORDS

7.1 Facility Logbooks

8.0 ATTACHMENTS

Not applicable.

PLLNL Environmental Restoration Department (ERD) Standard Operating Procedure (SOP)	
ERD SOP 2.1: Pre-sample Purging of Wells—Revision: 9	
	AUTHOR(S): **R. Goodrich and E. Walter**
ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # ERD	**APPROVALS:** Date Jesse Yow 12/17/15 Department Head 11/16/15 Livermore Site Program Leader Leslie Ferry 12/15/15 Site 300 Program Leader
	CONCURRENCE: Date Rebecca Goodrich 12/17/15 QA Implementation Coordinator
Type of Procedure (per ES&H Manual, Document 3.4) ☒ Informational Use ☐ General Use ☐ Continuous Use	

1.0 PURPOSE

The purpose of this SOP is to identify well purging (evacuation) procedures that will ensure enough stagnant water in the well is replaced by ground water so a representative sample of the aquifer can be collected. It is possible to obtain a representative sample from the aquifer without prior purging, therefore, when feasible, low-volume purging techniques are employed as described in SOP 2.7.

2.0 APPLICABILITY

This procedure provides guidelines for Field Personnel to purge wells adequately and appropriately by using sampling devices, such as a bailer, electric submersible pump, or a specific-depth grab sampling device prior to sample collection. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Barcelona, M.J., J.P. Gibb, J.A. Helfrich, and E.E. Garske (1985), *Practical Guide for Ground Water Sampling*, U.S. Government Printing Office, Washington, D.C. (EPA/600/2-85/104).

3.2 Korte, N. and P. Kearl (1984), *Procedures For The Collection and Preservation of Ground Water and Surface Water Samples and for the Installation of Monitoring Wells*, U.S. Department of Energy, Grand Junction, Colo.

3.3 Morrison, R.D. (1983), *Ground Water Monitoring Technology, Procedures, Equipment and Applications*, TIMCO Manufacturing, Inc., 85-90.

3.4 Morse, S.I. (1997), San Francisco Bay Regional Water Quality Control Board, Toxics Cleanup Division; letter to Interested Parties. Subject: *Utilization of Non-Purge Approach for Sampling of Monitoring Wells Impacted by Petroleum Hydrocarbons, BTEX, and MTBE,* File: 1123.64, January 31, 1997.

3.5 Robbins, G.A. and J.M. Martin-Hayden (1991), Mass Balance Evaluation of Monitoring Well Purging: Part 1. Theoretical Models and Implications for Representative Sampling," *J. Contam. Hydrol.* 8, 203–224.

3.6 Schilling, K.E. (1995), Low-Flow Purging Reduces Management of Contaminated Groundwater, *Environmental Protection*, December 1995.

3.7 U.S. EPA (1992), *RCRA Ground-Water Monitoring: Draft Technical Guidance*, Washington, D.C. (EPA/530-R-93-001).

3.8 U.S. EPA (1996), Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, *Ground Water Issue*, EPA/540/S-95/504.

3.9 U.S. EPA (1995), Use of Low-Flow Methods for Ground Water Purging and Sampling: An Overview, *Quick Reference Advisory* (December 1995).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sampling Coordinator (SC)

The SC's responsibility is to supply a routine quarterly Sampling Plan to the Field Personnel, track sample collection throughout the quarter to ensure completion of the sampling plan within the specified sampling quarter, and ensure fieldwork is conducted in compliance with applicable SOPs.

5.6 Field Personnel (FP)

The FP are responsible for the safe completion of evacuation and collection of purge water, when necessary from monitor wells according to guidelines set forth by this procedure, as well as other associated SOPs. The wells to be purged and sampled on a frequent basis are listed in the routine quarterly Sampling Plan provided by the SC. The FP are also responsible for performing work in accordance with the requirements of the IWSs listed in Section 6.4.

5.7 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review the routine quarterly sampling plan distributed by the DMT.

5.8 Data Management Team (DMT)

The DMT is responsible for generating routine quarterly sampling plans and distributing to the SC to supply to FP. DMT is also responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

6.1 Procedure Exception

Tritium is considered a conservative contaminant (i.e., it will not volatilize preferentially [fractionate] or change activity appreciably upon minimal contact with the atmosphere) therefore, pre-sample purging is not necessary. SOP 2.9, "Sampling for Tritium in Ground Water," discusses tritium sampling in more detail. Also, pre-sample purging of low-yielding monitor wells is covered under SOP 2.7, "Pre-sample Purging and Sampling of Low-Yielding Monitor Wells.

6.2 Dedicated Sampling Devices

6.2.1 In some cases, monitor wells are not equipped with a dedicated sampling device. If the well is not fitted with a dedicated sampling device, the procedure and/or temporary equipment required for well evacuation is determined by the SC and appropriate personnel.

6.2.2 Frequently sampled monitor wells have dedicated sampling pumps and associated equipment necessary to purge and sample the well. Discharge and sampling tees are dedicated and are stored inside the steel protective casing. At Site 300, control boxes for electric submersible pumps up to 2.0 horsepower (hp) are also dedicated and are locked inside the protective casing. (Using portable control boxes maintained on the sampling vehicle in lieu of having dedicated control boxes stored at the wellhead is in process at Site 300.) At Livermore Site, portable control boxes are to be used on all pumps. In wells where a specific-depth grab sampling device is used, the dedicated equipment (due to its compact nature) may be stored either in the locked stovepipe or at a remote location. Installation of dedicated pumps is described in SOP 2.8, "Installation of Dedicated Sampling Devices."

6.3 Preparation

6.3.1 Prior to commencement of field activities, perform preparation activities described in SOP 4.1, "General Instructions for Field Personnel," including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.3.2 Review all pertinent sampling information, such as the quarterly Sampling Plan and Ground Water Sampling Data Sheets. The plan and/or sampling data sheets contain the following information:

- Locations to be sampled.
- Proposed sampling methods (See Attachment A, Methodology Sampling Codes).
- Requested analyses.
- Method specific sample collection instructions e.g., E300.0:PERC (EPA Method 314).
- Contract analytical laboratory (CAL) to which samples are to be sent for analyses.
- Estimated amount of purge water to be collected.
- Current technical information for each well.

6.3.3 Obtain appropriate data collection forms e.g., Chain-of-Custody (CoC) forms, Ground Water Sampling Data Sheets (Attachment B), assigned Document Control Logbook, labels, and any necessary shipping forms. Instructions for completing the logbook entries and field forms are provided in SOP 4.2, "Sample Control and Documentation". Consult with the SC for the appropriate sampling method to apply to the site if it is not indicated on the sampling plan.

6.3.4 Contaminant information is provided in the quarterly Sampling Plan or by the SC and should be reviewed prior to sampling. The SC also provides contaminant information for newly completed installations that may not appear on the plan provided baseline sample data has already been collected.

6.3.5 Obtain appropriate materials to conduct fieldwork according to Attachment C, Equipment Checklist.

6.3.6 The number and type of sample containers needed for the sampling event should be obtained from the sample bottle inventory. Field Personnel should keep a sufficient stock of sample containers on hand and also maintain an inventory of supplies (e.g., trip blanks, field blank water ordered from the CAL) to ensure adequate sampling supplies are available at all times.

6.4 Safety Considerations

6.4.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.4.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.5 Purge Water Collection

At Site 300, the FP must ensure there are sufficient collection drums, carboys, or the appropriate portable tank available for purge water containment (SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids"). The quantity of purge water to be collected for each well is calculated by the field personnel based on the prescribed sample method. At some wells, purge water is collected in a portable tank and then transported by FP to a designated treatment facility for treatment.

The Livermore Site Field Personnel will tow a collection tanker with the sampling vehicle when necessary. Tankers and drums filled with purge water may not be left at the well location and will be logged and disposed of daily, when possible according to SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids."

6.6 Operation

6.6.1 A Well Entry Logbook is kept in each well. Whenever a well is entered for any reason, record the date, the purpose, name of the operator, and any water level obtained in the logbook. Replace the logbook in the well when operations are complete. A logbook should be replaced when damaged. The damaged logbook should be given to the DMT for archival.

6.6.2 Calculate and record the amount of water in the well (casing volume) as described in steps A through E (see Attachment B, "Ground Water Sampling Data Sheet"):

A. Record the well ID, date, and Document Control Logbook number on the Ground Water Sampling Data Sheet.

B. Unlock the steel protective casing and obtain depth to water (in tenths of feet) in accordance with procedures specified in SOP 3.1, "Water-Level Measurements." Record this information on the Ground Water Sampling Data Sheet and the Well Entry Logbook as discussed previously.

C. Subtract the depth to water from the depth of casing (in tenths of feet). Make sure both measurements are referenced to the same point of measurement (POM). Record this result as water in casing (feet) on the Ground Water Sampling Data Sheet. Note: All well specification data are provided on the electronically generated Ground Water Sampling Data Sheets.

D. The casing diameter for each well can be found on the Ground Water Sampling Data Sheets.

Casing/Discharge line Diameter	Volume Factor
1.0 in.	0.041
1.5 in.	0.092
2 in.	0.163
3 in.	0.37
3.5 in.	0.50
4 in.	0.65
4.25 in.	0.74
4.5 in.	0.83
5 in.	1.00
6 in.	1.47
8 in.	2.61
10 in.	4.08

Note: For a discharge-line diameter not listed, consult the SC.

E. Multiply the feet of water in casing by the volume factor for each casing diameter. The result represents the amount of water in a single casing volume and should be recorded as Gallons/Casing Vol. on the Ground Water Sampling Data Sheet.

F. When conducting low-volume sampling assume that the discharge line is filled with water. Use the casing depth and multiply by the appropriate volume factor to determine the amount of purge water to evacuate.

6.6.3 Field parameter measurements (pH, specific conductance, oxidation/reduction potential (ORP), and temperature), flow rate (Q), depth to water and any visual observations such as outgassing, etc. are collected at specific intervals during the purging of a monitor well or at sample collection time based on the sampling methodology being used (See Attachment A, Methodology Sampling Codes).

A. 3-volume sampling event: field parameter measurements (pH, specific conductance, ORP, and temperature), flow rate (Q), depth to water and any visual observations such as outgassing, etc. recorded at the end of each casing volume.

B. 90% of one casing volume: 90% of one volume divided by three equal measurements (beginning and middle of purge, and at sample collection time).

C. Low volume: If purging a maximum of 2 to 3 discharge lines prior to sampling, field parameter measurements should be collected at sample collection time, when possible.

D. Specific-Depth Grab Samples: Consult the SC and Hydrogeologist for purging requirements. Field parameter measurements should be collected at sample collection time, when possible.

E. Domestic Well Grab Samples: Consult the SC and Hydrogeologist for purging requirements. Field parameter measurements should be collected at sample collection time, when possible.

6.6.4 Bailer Operation

Where approved by the SC, it is acceptable to use a ®Teflon, stainless steel, polyethylene, or polyvinyl chloride (PVC) bailer. Attachment D is a schematic of a typical bailer. Collection of an equipment blank sample may be necessary when using a non-dedicated bailer, consult SOP 4.9, "Collection of Field QC Samples" for this determination.

A. The retrieval rope should be securely attached to the bailer. A new rope should be used at each well, unless the bailer is dedicated. Dedicated bailers should be checked for cracks and breaks and replaced when necessary.

B. Lower the bailer gently into the well and begin water removal. Avoid unnecessary agitation of the water. Collect or dispose of purged water in acceptable containers as specified in SOP 4.7A (Livermore Site) or SOP 4.7B (Site 300).

C. Field measurements of pH, specific conductance, ORP, and temperature should be taken at least once per casing volume purged, as described in SOP 2.2, "Field Measurements on Surface and Ground Waters." Depth to water and visual observations, such as clarity and outgassing should also be made and recorded at each volume interval. If it is suspected that the well may go dry prior to the removal of three casing volumes, at least two sets of field measurements should be taken during the removal of the first casing volume.

D. When applicable, purge a minimum of three casing volumes, or until the pH, temperature, and specific conductance of the discharge water stabilize. Stabilization is reached when no upward or downward trends are apparent (pH is within 0.1 pH unit, temperature is within 0.5°C, and specific conductance is within plus or minus 3%). When sampling wells under RCRA (Resource Conservation and Recovery Act) guidelines, an additional set of field measurements should be taken at 2-minute to 3-minute intervals at the end of the third well casing volume and prior to sample collection. RCRA wells are identified in the quarterly sampling plan. As mentioned previously in this SOP under section 1.0 "Purpose", it is not always necessary to purge multiple casing volumes prior to sample collection. In instances where the SC has indicated that a grab sample is adequate, a specific-depth grab sample or bailed grab sample may be substituted for the 3 casing volume pre-sample purge, or other low-volume techniques.

E. If the well does not produce three casing volumes of water, SOP 2.7, "Pre-sample Purging and Sampling of Low-Yielding Monitor Wells" should be consulted.

6.6.5 Electric Submersible Pump Operation

The dedicated pump assembly and sealed electric drive motor are submersed in the well. The pump is suspended by the discharge pipe, safety cable, and electric lead wires which are held in place by the sanitary seal. A portable generator provides power for the pump. On the sanitary seal of the wellhead, a capped discharge pipe and a capped sounding tube should be visible. The electrical cable to the pump is also fitted through the sanitary seal. The cable either has a dedicated control box or is completed with an outlet for a portable control box. The pump intake is typically placed in the middle of the screened interval for Livermore Site installations, but due to low-yielding aquifers is placed near the bottom of the screened interval at Site 300 locations. See Attachment E for wellhead completion details.

A. Place the generator downwind from the well. According to the manufacturer's recommendation the well should be purged at a discharge rate of no less than 1.2 gpm when using an electric submersible pump. Water levels should be monitored frequently to ensure the water level does not drop below the top of the screened interval, when possible. Attach the dedicated sample-tee (found inside the protective steel casing) to the discharge pipe. Plug the control box into the generator and start generator. Adjust the discharge rate so that the well will yield water without exposing the screen by partially closing the ball valve on the sample-tee. If using a rheostat equipped pump, the discharge rate is controlled by the pump speed on the controller unit. Collect or dispose of purged water in acceptable containers as specified in SOP 4.7A or 4.7B. Electrical equipment shall not be used in the rain.

B. Take field measurements of pH, specific conductance, ORP, and temperature, flow rate (Q), depth to water and any visual observations such as outgassing, etc., at frequencies listed above in Section 6.6.3, and as described in SOP 2.2 (for exceptions to this frequency list, consult the SC). If it is suspected that water discharge will cease, due to the well going dry, at least two sets of field measurements should be taken during the removal of the first casing volume.

C. When applicable, purge a minimum of three casing volumes, or until the pH, temperature, and specific conductance of the discharge water stabilize. Stabilization is reached when no upward or downward trends are apparent (pH is within 0.1 pH unit, temperature is within 0.5°C, and specific conductance is within plus or minus 3%). When sampling wells under RCRA (Resource Conservation and Recovery Act) guidelines, an additional set of field measurements should be taken at 2-minute to 3-minute intervals at the end of the third well casing volume and prior to sample collection. As mentioned previously in this SOP under Section 1.0 "Purpose", it is not always necessary to purge multiple casing volumes prior to sample collection.

D. If water discharge ceases prior to the removal of three casing volumes, SOP 2.7, should be consulted.

6.6.6 Specific-Depth Grab Sampling Device Operation

A well with a dedicated specific-depth grab sampling device (Attachment F) will include (at the surface) a spool with a pre-measured length of motor lead, attached to a low-voltage pump. There will be a quick disconnect low-voltage female plug adapter attached to the spool. The pump, motor lead and spool will be stored within the stovepipe. For portable usage, the Field Personnel will attach a disposable sample capture chamber (modified double check-valve bailer) to the pump intake and affix the spool to a portable reel assembly. The device is lowered to a pre-determined depth specified by the SC and/or appropriate personnel, usually the mid-point of the screened interval. A low-voltage control box/power supply is then attached. The SC will have advised full or low-flow setting. These flow rates vary from 250 milliliters per minute at low flow to 8 liters per minute. The desired flow rate is set and the Field Personnel will activate the pump for a duration sufficient to "purge" or triple rinse the interior of the sample capture portion. The pump is deactivated, isolating the sample by means of dual check valves. The device is retrieved and the sample is obtained (refer to SOP 2.4, Section 6.5.6).

6.6.7 Portable Pump Assemblies

Electric submersible pumps and specific-depth grab sampling devices are available as portable units. Portable pumps should be thoroughly decontaminated prior to use according to SOP 4.5, "General Equipment Decontamination." Collection of an equipment blank sample may be necessary when using a portable purging device. Consult SOP 4.9, "Collection of Field QC Samples" for this determination.

A. Slowly lower the pump assembly down until the pump is at the middle of the screened interval. On low-yielding aquifers, the pump should be placed just above the bottom of the well so that it can be completely evacuated. Check with the SC on placement of the pump intake.

B. For electric submersible pumps, plug the control box to the appropriately rated generator. Ensure that the generator is downwind from the well.

C. Purge the well and follow operating instructions as described above in Section 6.6.5 B, C, and D.

D. Collect or dispose of purged water in acceptable containers as specified in SOP 4.7A or 4.7B.

E. When using a specific-depth grab sampling device, lower to middle of screened interval whenever possible and follow operating instructions in Section 6.6.6.

6.7 Post Operation

6.7.1 Perform post operation activities as described in SOP 4.1.

6.7.2 Make copies of the Document Control Logbook pages (upon request) and Ground Water Sampling Data Sheets. Deliver copies to the SC.

6.7.3 The SC will deliver the original Ground Water Sampling Data Sheets to the DMT for archive. The SC will provide copies to the Environmental Functional Area (EFA) Analyst, as necessary.

7.0 QA RECORDS

7.1. Ground Water Sampling Data Sheets

7.2. Document Control Logbooks

7.3. Well Entry Logbooks

8.0 ATTACHMENTS

Attachment A—Methodology Sampling Codes

Attachment B—Ground Water Sampling Data Sheet

Attachment C—Equipment Checklist

Attachment D—Schematic of a Typical Bailer

Attachment E—Wellhead Completion and Possible Pump Placement for Electric Submersible Pumps

Attachment F—Well with Specific-Depth Grab Sampling Device

Attachment A

Methodology Sampling Codes

Methodology Sampling Codes

3VBA: 3 casing volume purge using a Bailer

3VES: 3 casing volume purge using an Electric Submersible pump

3VVS: 3 casing volume purge using a variable speed pump

Note: Purging 3 casing volumes prior to sampling may be necessary at specific monitoring locations. Guard wells (wells used to monitor the leading edge of a plume) are sampled using this method, when possible.

90BA: 90% of 1 casing volume using a Bailer

90ES: 90% of 1 casing volume using an Electric Submersible

90VS: 90% of 1 casing volume using a variable speed pump

Note: Purging 90% of 1 well volume prior to sampling is the method used at locations where there is insufficient yield to produce 3 well volumes prior to the well going dry.

LVES: Low-Volume purge using an Electrical Submersible pump

LVVS: Low-Volume purge using a variable speed pump

LVAP: Low-Volume purge using an air driver piston pump

Note: Purging 2-3 discharge lines is a low-volume purging method applied to locations that will not sustain sufficient flow to perform a 90% purge or where waste minimization is a key factor in determining the sampling method.

GRBA: Grab sample using a Bailer

GRES: Grab sample using an Electrical Submersible

GROT: Grab sample using Other method (no purge device, i.e., spring sampling or offsite surveillance)

GRVS: Grab sample using a variable speed pump

GRAP: Grab sample using an air driver piston pump

GRWL: Grab sample using a Water Level Indicator (specifically for Tritium sampling)

Note: Purging prior to sampling is not performed due to water column being insufficient to apply preceding methods or when performing tritium sampling.

DOBA: Dry-out using a Bailer

DOES: Dry-out using an Electrical Submersible

90VS: Grab sample using a variable speed pump

Note: Drying out a well is a methodology applied when there is insufficient yield to produce 3 well volumes and when deemed necessary by the hydrogeologist.

OTSM: Other sampling methodology

SDGS: Specific Depth using a device to collect sample from a specific depth without purging

Note: Sampling methodologies applied in any location specified by the SC.

Attachment A. Methodology sampling codes.

Attachment B

Ground Water Sampling Data Sheet

ALL GROUND WATER SAMPLING DATA

Target Sample Date: 01-Apr-2001 Month: 5 Norm Qtr: 2 Norm Year: 2001

Date ______________ LOG# ______________ Well ID: NC7-69

LAB_LOC_ID: NC7-69-3VES Doc. Control Num.: ______________

PURGING METHOD: GF Sample Status: 3VES CONTAMINANT PRESENT: ND

SCREENED INTERVAL: 128.400 – 148.400 PUMP INTAKE DEPTH: 146.30

DEPTH OF CASING: 148.800 CASING DIAMETER: 4.50

DEPTH TO WATER ______________ VOLUME FACTOR: 0.826

WATER IN CASING (ft): ______________ CASING VOL (Gal/Time): ______________

TIME PUMP ON: ______________ INITIAL FLOW RATE (Q=GPM): ______________

TIME PUMP OFF: ______________ MEASURED BY: GRAD. CYL. /BUCKET /FLOW METER & OTHER

TIME	Q	GAL PURGED	WELL VOLUMES	PH	TEMP C	SC	MV	OG	DTW

METER		SERIAL #		CALIBRATED
pH	______	8908079	______	YES/NO
SC	______	8908079	______	YES/NO
ORP	______	8908079	______	YES/NO

SAMPLERS INITIAL/EMPLOYER ______________

PROJECT: 3EMG

SAMPLE ID: (VERIFY) ______________ TIME COLLECTED: ______________

ANALYTICAL LAB	REQUESTED ANALYSES	QUANTITY	TYPE OF CONTAINERS
CALTEST	E200.7:K	1 × 1L	PLASTIC
CALTEST	E300.0:NO3	1 250 × mLs	PLASTIC
CALTEST	E601	6 40 × mls	VOA VIAL
CALTEST	E8330:R+H	1 × 1L	NM AMBER GLASS
CALTEST	WGMGMET3	1 × 1L	PLASTIC
TNURICH	AS:UISO	2 × 1L	PLASTIC
TNURICH	E900	2 × 1L	PLASTIC
TNURICH	E200.7	4 × 40 mls	VOA

Note:

Shaded items indicate data retrieved from database.

Attachment B. Ground Water Sampling Data Sheet.

Attachment C

Equipment Checklist

Equipment Checklist

The purpose of the list presented below is to aid Field Personnel in identifying those supplies necessary to conduct a particular field operation. It is not intended to be inclusive. It is the responsibility of Field Personnel to determine and obtain the supplies required for successful performance of assigned tasks.

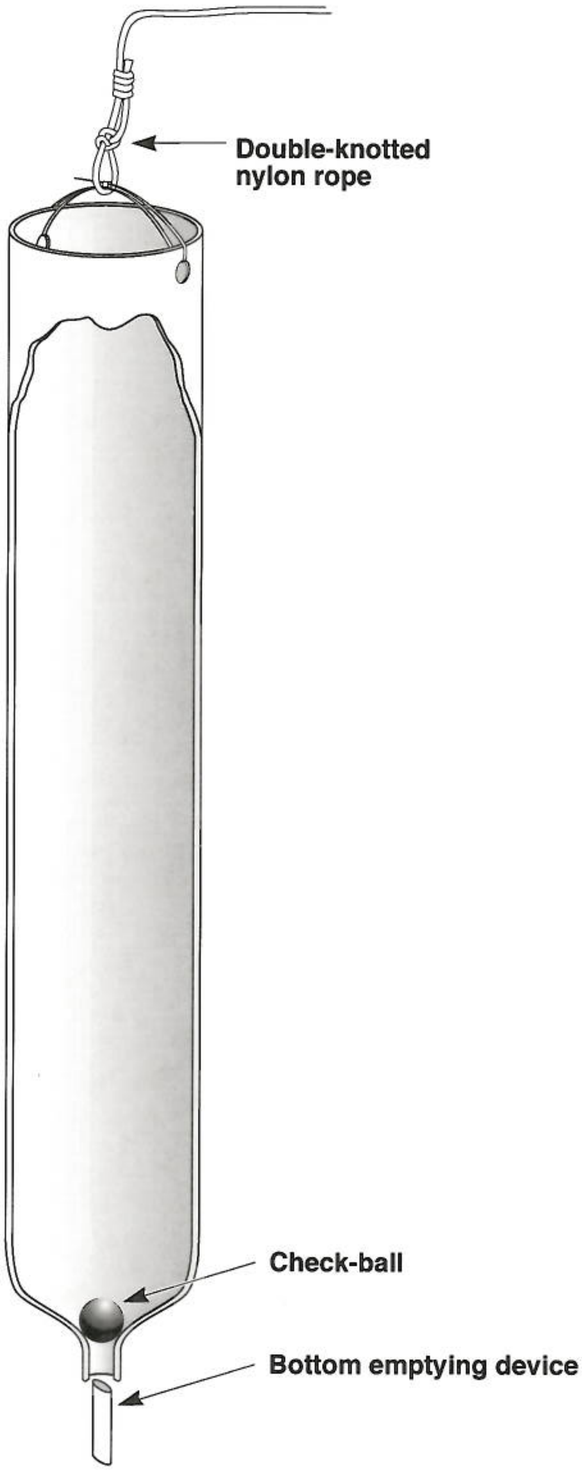
____ Alconox (detergent)
____ All applicable documents (e.g., Sampling Plan, SOPs
____ Air tight plastic bags
____ Appropriate sample containers
____ Appropriate shipping documents
____ Bagged cubed or blue ice
____ Bailer and cotton or nylon bailing rope
____ Barricades/traffic cones/traffic vest
____ Beakers
____ Bound logbook
____ Bubble wrap or necessary packaging
____ Calculator
____ Chain-of-Custody (CoC) forms
____ Clipboard
____ Cold weather gear/rain suit (if necessary)
____ Coolers
____ Distilled (organic-free) water
____ Drinking water
____ Duct tape
____ Ear plugs
____ Field forms
____ First aid kit
____ Fittings
____ Generator
____ Graduated cylinder/bucket
____ Hat and work gloves
____ Pens, pencils, permanent markers
____ pH, specific conductance, temperature meters and flow cell (ASTM approved)
____ Personal protective equipment
____ Preprinted labels
____ Radio, cell phone
____ Safety shoes/boots
____ Sample-tee
____ Snake guards
____ Stop watch
____ Sun screen
____ Tape measure (tenths)
____ Temperature blank
____ Teflon tape

Equipment Checklist (cont.)

____ Tool box
____ Trip blanks/field blanks
____ Volume conversion chart
____ Water level indicator

Attachment D

Schematic of a Typical Bailer

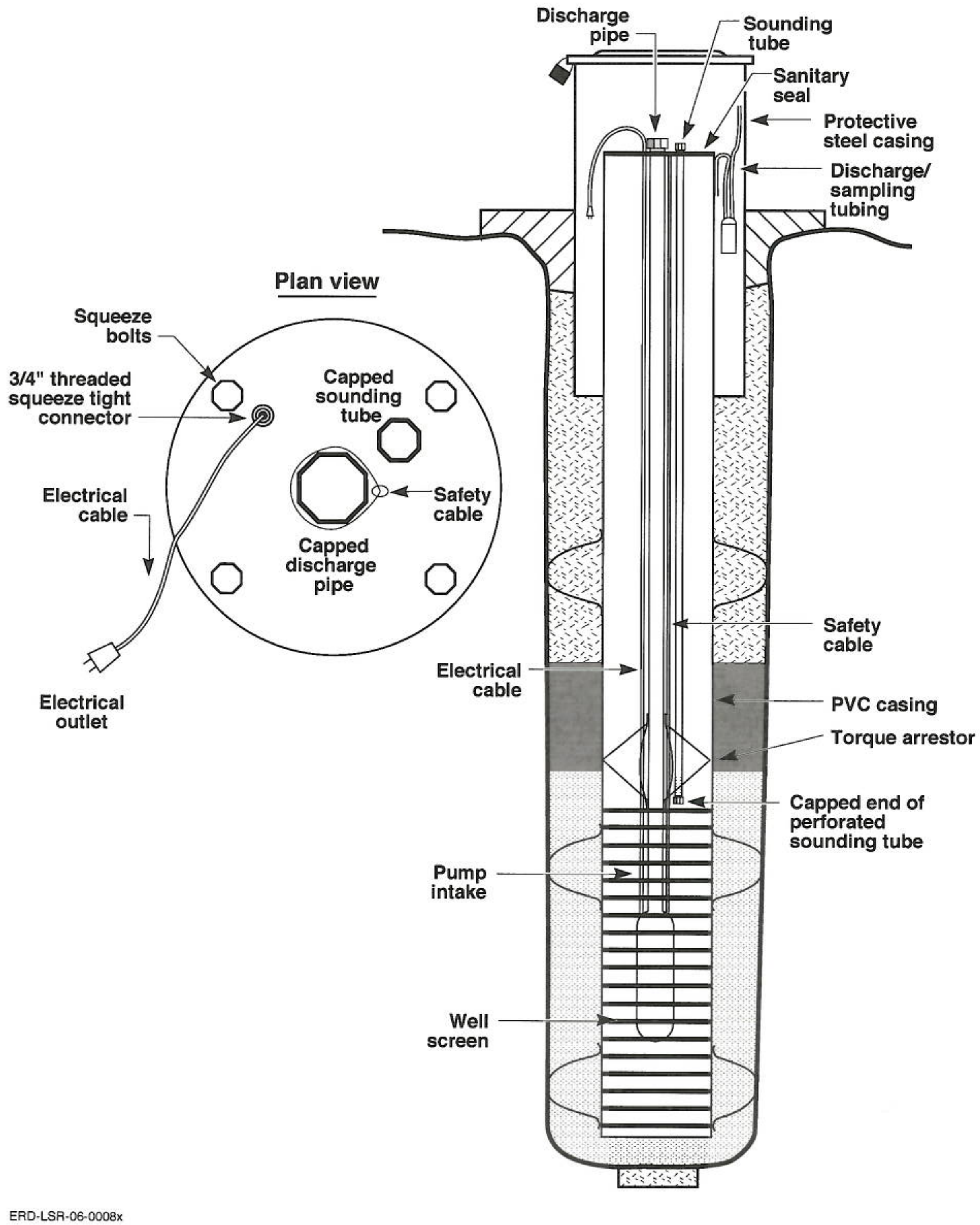


ERD-LSR-07-0064x

Attachment D. Schematic of a Typical Bailer.

Attachment E

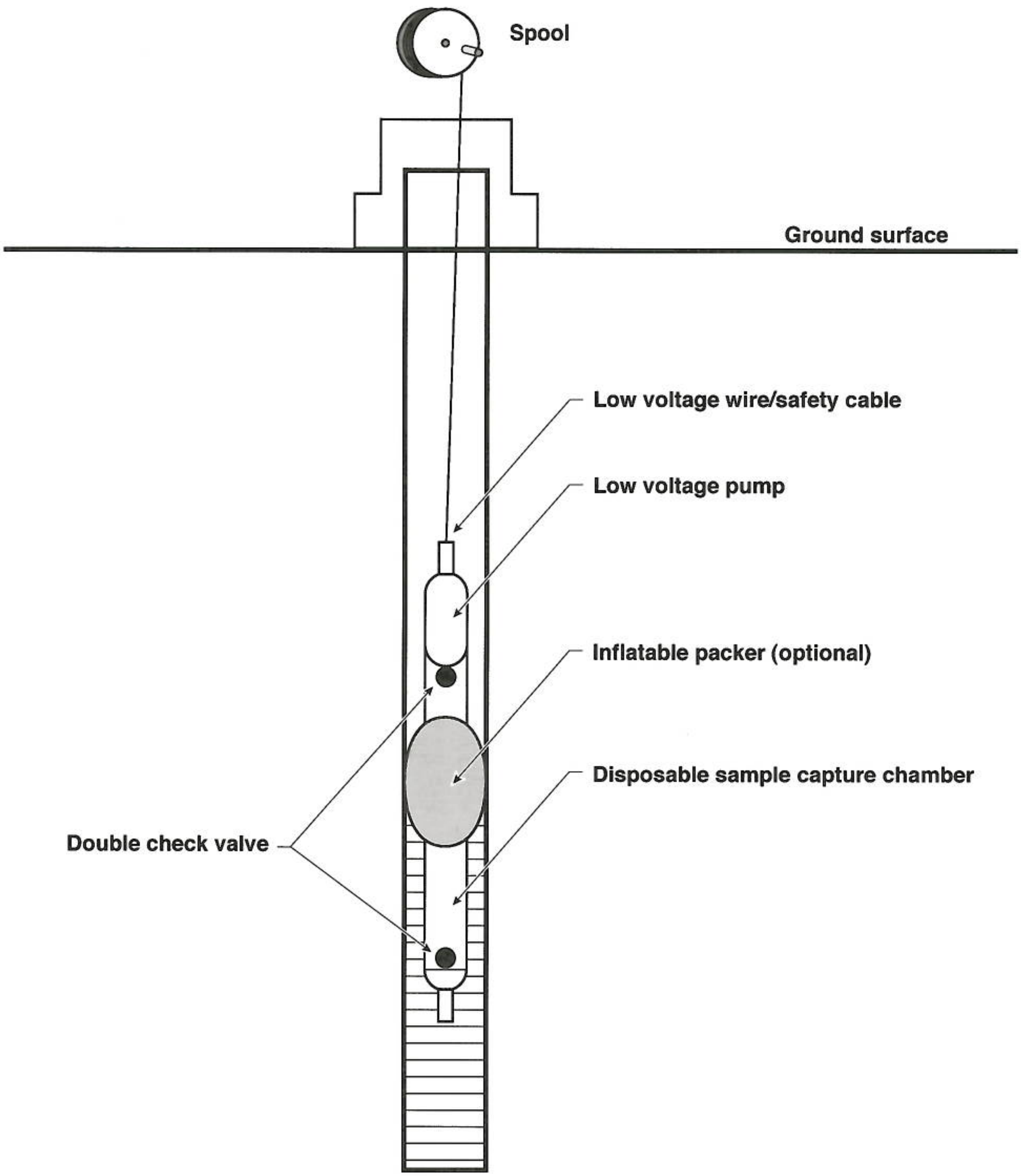
Wellhead Completion and Possible Pump Placement for Electric Submersible Pumps



Attachment E. Wellhead completion and possible pump placement for electric submersible pumps.

Attachment F

Well with Specific-Depth Grab Sampling Device



ERD-LSR-06-0009x

Attachment F. Well with specific-depth grab sampling device.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 2.2: Field Measurements on Surface and Ground Waters—Revision: 6

ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY #______ ERD	**AUTHOR(S):** **R. Goodrich** **S. Gregory, and E. Walter**	
	APPROVALS:	**Date**
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	[signature] **Livermore Site Program Leader**	11/16/15
	Leslie Ferry **Site 300 Program Leader**	12/15/15
	CONCURRENCE:	**Date**
	Rebecca Goodrich **QA Implementation Coordinator**	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this procedure is to ensure that water chemistry measurements (pH, temperature, specific conductance, oxidation/reduction potential) on surface and ground water, and water-level measurement are properly performed and documented.

2.0 APPLICABILITY

This procedure is applicable when measuring water quality parameters during ground water monitoring, treatment facility sampling, and special studies. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Korte, N. and P. Kearl (1984), *Procedures For The Collection and Preservation of Ground Water and Surface Water Samples and for the Installation of Monitoring Wells*, U.S. Department of Energy, Grand Junction, Colo.

3.2 U.S. EPA (1983), *Methods for Chemical Analysis of Water and Wastes*, Washington, D.C. (EPA-600/4-79-020).

3.3 U.S. EPA (1992), *RCRA Ground-Water Monitoring: Draft Technical Guidance*, Washington, D.C. (EPA/530-R-93-001).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sample Coordinator (SC)

The SC's responsibilities are to review the incoming LLNL Ground Water Sampling Data Sheets and ensure fieldwork is conducted in compliance with applicable SOPs.

5.6 Field Personnel (FP)

The FP are responsible for collecting and measuring water quality parameters during sampling activities according to the guidelines herein.

5.7 Data Management Team (DMT)

The DMT is responsible for generating routine quarterly sampling plans and distributing to the SC to supply to FP. DMT is also responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

6.1 When to Collect Field Measurements

6.1.1 Quarterly Ground Water Sampling. The quarterly sampling plan provided by the SC to the Field Personnel for routine ground water sampling lists the wells for which field chemistry measurements need to be obtained, as well as other purging and sampling information.

6.1.2 Treatment Facility Sampling. The quarterly sampling plan for treatment facilities determined by waste discharge permits or Substantive Requirements and/or the Site 300 Compliance Monitoring Plan list the locations for which field chemistry measurements need to be taken.

6.1.3 Special Studies. During special studies, field measurements may be collected per the work and or sampling plan.

6.2 Preparation

6.2.1 Prior to commencement of field activities, perform preparation activities described in SOP 4.1, "General Instructions for Field Personnel," including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015).

6.3 Safety Considerations

6.3.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.3.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.4 Field Instrument Calibration/Maintenance

6.4.1 Assemble the appropriate water sampling equipment and field chemistry instrumentation according to Attachment A. Check to ensure that equipment and instruments are properly working.

6.4.2 Perform required maintenance according to SOP 4.8, "Calibration/Verification and Maintenance of Field Instruments Used in Measuring Parameters of Surface Water, Ground Water, and Soils.

6.4.3 Calibrate or verify the calibration of field chemistry instrumentation according to SOP 4.8. Use calibrated instruments only.

6.5 Field Measurements

6.5.1 Field Measurement Documentation. Initiate the proper sample documentation as described in SOP 4.2, "Sample Control and Documentation." The following data fields should be filled in on the Ground Water Sampling Data Sheet and/or in the appropriate field logbook when collecting water chemistry measurements using the following instruments:

A. Specific Conductance Meter ID. Identification, model, or serial number of specific conductivity meter being used.

B. pH Meter ID. Identification, model, or serial number of pH meter being used.

6.5.2 Collecting Field Measurements

A. pH Measurements

Take pH measurements per instrument operating instructions. pH paper may be used when applicable.

B. Temperature

Temperature readings are usually obtained from the temperature probe used to compensate the pH measurements and can be read directly off the pH meter. A separate temperature probe may be used and should read to the 0.1°C.

C. Specific Conductivity (SC)

Measure conductivity in a clean container that has been rinsed with the liquid to be sampled or using a flow-through cell per operator instructions.

D. Dissolved Oxygen (DO)

Measure dissolved oxygen per instrument operating instructions.

E. Oxidation/Reduction Potential (ORP)

Measure oxidation/reduction potential per instrument operating instructions.

F. Depth to Water

Measure depth to water per SOP 3.1, "Water-Level Measurements."

6.5.4 Decontaminate instrument as described in SOP 4.5, "General Equipment Decontamination."

6.5.5 Inventory sampling equipment and supplies. Repair or replace all expendable, broken or damaged equipment and return to storage area.

7.0 QA RECORDS

7.1 Document Control Logbooks

7.2 Ground Water Sampling Data Sheets

8.0 ATTACHMENT

Attachment A—Equipment Checklist

Attachment A

Equipment Checklist

Equipment Checklist

The purpose of the list presented below is to aid Field Personnel in identifying those supplies necessary to conduct a particular field operation. It is not intended to be all-inclusive. It is the responsibility of Field Personnel to determine and obtain the supplies required for successful performance of assigned tasks.

_____ Beakers
_____ Buffer solution
_____ Distilled water
_____ DO meter
_____ ORP meter
_____ SC meter
_____ Gloves
_____ KCL solution
_____ pH meter or paper
_____ Squirt bottle
_____ Thermometer
_____ Tissues
_____ Water-level indicator

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 2.3: Sampling Monitor Wells with Electric Submersible Pumps and Specific-Depth Grab Sampling Devices—Revision: 7

AUTHOR(S):
R. Goodrich and E. Walter

ENVIRONMENTAL RESTORATION DEPARTMENT
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#
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CONCURRENCE:	Date
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Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to describe the procedure for sampling wells with electric submersible pumps and specific-depth grab sampling devices, and to ensure that ground water samples are obtained in a credible, uniform, and well-documented manner when using these devices. It assumes the well has been properly purged according to SOP 2.1, "Pre-sample Purging of Wells." A brief description of sampling devices, and the installation thereof, is given in SOP 2.8, "Installation of Dedicated Sampling Devices."

2.0 APPLICABILITY

This SOP applies to all Field Personnel involved in operating dedicated and/or portable electric submersible pumps, or specific-depth grab sampling devices, used during ground water sampling events. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 deVera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm (1980.), *Samplers and Sampling Procedures for Hazardous Waste Streams*, U.S. EPA, Washington, D.C. (EPA-600/2-80-018).

3.2 Ford, P.J., P.J. Tarina, and D.E. Seely (1984), *Characterization of Hazardous Waste Sites—A Methods Manual, 302. Vol. II Available Sampling Methods,* 2nd ed., U.S. EPA, Washington, D.C. (EPA-600/4-84/076).

3.3 Korte, N. and D. Ealey (1983), *Procedures for Field Chemical Analyses of Water Samples,* U.S. Department of Energy, GJ/TMC-07, Technical Measurements Center, Grand Junction Project Office, Grand Junction, Colo.

3.4 Korte, N. and P. Kearl (1985), *Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells,* Second Edition, U.S. Department of Energy, GJ/TMC-08, Technical Measurements Center, Grand Junction Projects Office, Grand Junction, Colo.

3.5 Morse, S.I. (1997), San Francisco Bay Regional Water Quality Control Board, Toxics Cleanup Division; letter to Interested Parties. Subject: *Utilization of Non-Purge Approach for Sampling of Monitoring Wells Impacted by Petroleum Hydrocarbons, BTEX, and MTBE,* File: 1123.64, January 31, 1997.

3.6 Robbins, G.A. and J.M. Martin-Hayden (1991), Mass Balance Evaluation of Monitoring Well Purging: Part 1. Theoretical Models and Implications for Representative Sampling, *J. Contam. Hydrol.* 8, 203–224.

3.7 Schilling K.E. (1995), Low-Flow Purging Reduces Management of Contaminated Groundwater, *Environmental Protection*, December 1995.

3.8 U.S. Department of the Interior (n.d.), *National Handbook of Recommended Methods for Water-Data Acquisition*, Washington, D.C.

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3.12 U.S. EPA (1992) *RCRA Groundwater Monitoring: Draft Technical Guidance*, Washington, D.C. (EPA/530-R-93-001).

3.13 U.S. EPA (1994), *Test Methods for Evaluation of Solid Waste,* Third Edition, Washington, D.C. (EPA-SW-846).

3.14 U.S. Environmental Protection Agency (EPA) (1996), Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, *Ground Water Issue*, EPA/540/S-95/504.

3.15 U.S. Environmental Protection Agency (EPA) (1995), *Use of Low-Flow Methods for Ground Water Purging and Sampling: An Overview*, Quick Reference Advisory (December 1995).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sampling Coordinator (SC)

The SC's responsibility is to supply a routine quarterly Sampling Plan to the Field Personnel, track sample collection throughout the quarter to ensure completion of the sampling plan within the specified sampling quarter, and ensure fieldwork is conducted in compliance with applicable SOPs.

5.6 Field Personnel (FP)

The FP are responsible for the safe completion of evacuating and sampling ground water monitor wells according to guidelines set forth by this procedure and associated SOPs.

5.7 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review the routine quarterly sampling plan distributed by the DMT.

5.8 Data Management Team (DMT)

The DMT is responsible for generating routine quarterly sampling plans and distributing to the SC to supply to FP. DMT is also responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities described in SOP 4.1, "General Instructions for Field Personnel," including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015).

6.1.2 Review all pertinent sampling information such as the quarterly Sampling Plan and electronically generated Ground Water Sampling Data Sheets (SOP 2.1, Attachment B). The plan and/or data sheets contains the following information:

- Locations to be sampled.
- Proposed sampling methods (See SOP 2.1, Attachment A, Methodology Sampling Codes).
- Requested analyses.
- Method specific sample collection instructions e.g., E300.0:PERC (EPA Method 314).
- Contract analytical laboratory (CAL) to which samples are to be sent for analyses.
- Estimated amount of purge water to be collected.
- Current technical information for each well.

6.1.3 Obtain appropriate data collection forms e.g., Chain-of-Custody (CoC) forms, Ground Water Sampling Data Sheets (SOP 2.1, Attachment B), assigned Document Control Logbook, labels, and any necessary shipping forms. Instructions for completing the logbook entries and field forms are provided in SOP 4.2, "Sampling Control and Documentation."

6.1.4 Compile all necessary equipment and instrumentation for sampling according to Attachment C, Equipment Checklist in SOP 2.1.

6.1.5 The appropriate number and type of sample containers needed for the sampling event should be obtained from the sample bottle inventory. The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirement. See SOP 4.3, "Sample Containers and Preservation."

6.1.6 The appropriate personnel should keep a sufficient stock of sample containers and maintain an inventory of supplies, e.g., trip blanks, field blank water ordered from the contract analytical laboratory (CAL), plastic bags, etc., to ensure adequate sampling supplies are available at all times.

6.1.7 If needed, the Administrative Escort Services must be given a 24-hour notice before work is scheduled in restricted areas. If appropriate, arrange access to sampling areas through the Facility Point of Contact (FPOC), the Functional Area Supervisor (FAS) or the control point Operator per SOP 4.1, "General Instructions for Field Personnel."

6.1.8 Routine maintenance of ground water monitor wells and equipment such as generators be performed on a quarterly basis, when possible. Prior to usage in the field, assigned sampling personnel should check equipment for cleanliness, proper operation, and ensure that the batteries are charged and the fittings are secure. Use gloves when handling compressors and generators, and dispose of them immediately to avoid possible sample contamination.

6.1.9 Fill out initial information on the Ground Water Sampling Data Sheet and Document Control Logbook per instructions in SOP 4.2.

6.1.10 Organize sampling route.

The SC may specify the order in which the wells are to be sampled. Complete an entire treatment facility or study area before beginning the next, when possible.

Sample wells working from the least contaminated to the most contaminated, when it is practical to do so. When it is not practical to do so, be sure and follow proper decontamination procedures before moving on to the next sample location.

6.2. Safety Considerations

6.2.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.2.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level

Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.3 Purge Water Collection

6.3.1 At Site 300, the FP must ensure there are sufficient collection drums, carboys, or the appropriate portable tank available for purge water containment (SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids"). The quantity of purge water to be collected for each well is calculated by the field personnel based on the prescribed sample method. At some wells, purge water is collected in a portable tank and then transported to a designated treatment facility for treatment.

6.3.2 The Livermore Site field personnel will tow a collection tanker with the sampling vehicle when necessary. Tankers and drums filled with purge water may not be left at the well location and will be logged and disposed of daily, when possible according to SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids."

6.4 Operation

6.4.1 Once pre-sample purging is complete according to SOP 2.1, sampling may begin. Wear new disposable gloves during sampling. According to SOP 2.2, "Field Measurements on Surface and Ground Waters," temperature, pH, ORP, and specific conductance should be measured immediately prior to sampling. Instruments should be calibrated according to SOP 4.8, "Calibration and Maintenance of Field Instruments Used in Measuring Parameters of Surface and Ground Water and Soils."

6.4.2 Refer to the operators manual for additional instructions on operating specific types of equipment.

6.4.3 Monitor wells are sampled from the discharge tubing immediately after the final field measurements are taken (after presample purging, if applicable). Samples requiring filtration will be performed by the analytical lab upon receipt of the samples when requested (Refer to SOP 2.4, Section 6.6.8) on the CoC.

6.4.4 Collect samples directly in containers as specified in SOP 4.3, "Sample Containers and Preservation." If sampling for volatile organic compounds (VOCs), refer to SOP 2.6, "Sampling for Volatile Organic Compounds." Fill the appropriate sample containers by allowing discharge to flow gently down the side of the bottle with minimal entry turbulence. The flow should not be excessive, but the sample should be obtained in a timely manner (SOP 2.6). Do not allow the discharge tube to come in contact with the sample container.

6.4.5 Samples should be obtained in order of volatility; VOCs collected first, followed by semi-VOCs, inorganics, and radiologicals. The SC will specify if samples should be collected in a different sequence other than order of volatility. All samples should be placed in airtight plastic bags. The samples requiring preservation of $\leq 6°C$ should be cooled by using blue ice packs in airtight plastic bags or bagged ice cubes. Loose ice may be used when samples need to be rapidly cooled, but should be replaced with blue ice before shipping.

6.5 Post Operation

6.5.1 Perform post operation activities per SOP 4.1.

6.5.2 Before leaving the sampling location, verify that the appropriate samples have been collected according to the samples scheduled on the Ground Water Sampling Data Sheets.

6.5.3 Prior to sampling another site and to prevent cross contamination of equipment between locations, thoroughly decontaminate all equipment that is not dedicated according to SOP 4.5, "General Equipment Decontamination."

6.5.4 Complete the appropriate Ground Water Sampling Data Sheet and record sampling information in the assigned Document Control Logbook (SOPs 2.1 and 4.2).

6.5.5 Verify that the CoC is appropriately completed per SOP 4.2. Indicate any special instructions in the Remarks Section of the CoC. Such instructions may include a request for the laboratory to filter and preserve the sample upon receipt or to analyze trip blank only if hits are detected in associated sample(s).

6.5.6 Deliver Ground Water Sampling Data Sheets and CoC forms to the SC daily.

6.5.7 The SC will retain a copy of the original forms (CoC, Ground Water Sampling Data Sheets), and provide the originals to the Data Management Team (DMT) for final archive. The SC will provide copies to the Environmental Functional Area (EFA) Analyst, as necessary.

6.5.8 Leave samples and proper documentation in the environmental sample lock-box for the CAL. Field Personnel will ship samples and/or distribute to the appropriate laboratories. Ensure that the samples requiring refrigeration remain at $\leq 6°C$, but do not allow them to freeze. Always ensure that proper chain of custody is maintained.

7.0 QA RECORDS

7.1 Ground Water Sampling Data Sheets

7.2 Document Control Logbooks

7.3 Chain-of-Custody Forms

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 2.4: Sampling Monitor Wells with a Bailer—Revision: 8

ENVIRONMENTAL RESTORATION DEPARTMENT
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ERD

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to provide guidance on collecting a representative ground water sample using a bailer.

2.0 APPLICABILITY

This procedure applies to all Field Personnel using a bailer to purge and collect ground water samples from a monitoring well. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management

System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 deVera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm (1980), *Samplers and Sampling Procedures for Hazardous Waste Streams*, U.S. EPA, Washington, D.C. (EPA-600/2-80-018).

3.2 Ford, P.J., P.J. Tarina, and D.E. Seely (1984), *Characterization of Hazardous Waste Sites—A Methods Manual, 302. Vol. II Available Sampling Methods*, Second Edition, U.S. EPA, Washington, D.C. (EPA-600/4-84/076).

3.3 Korte, N. and D. Ealey (1983), *Procedures for Field Chemical Analyses of Water Samples*, U.S. Department of Energy, GJ/TMC-07, Technical Measurements Center, Grand Junction Project Office, Grand Junction, Colo.

3.4 Korte, N. and P. Kearl (1985), *Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells*, Second Edition, U.S. Department of Energy, GJ/TMC-08, Technical Measurements Center, Grand Junction Projects Office, Grand Junction, Colo.

3.5 National Council of the Paper Industry for Air and Stream Improvement, Inc. (1982), A Guide to Groundwater Sampling, National Council for the Paper Industry Technical Bulletin No. 362.

3.6 U.S. Department of the Interior Publication, (n.d.), *National Handbook of Recommended Methods for Water-Data Acquisition*, Washington, D.C.

3.7 U.S. EPA (1983), *Methods for Chemical Analysis of Water and Wastes*, Washington, D.C. (EPA-600/4-79-020).

3.8 U.S. EPA (1994), *Test Methods for Evaluation of Solid Waste*, Third Edition, Washington, D.C. (EPA-SW-846).

3.9 U.S. EPA (1985), *Practical Guide for Groundwater Sampling*, Washington, D.C. (EPA-600/2-85/104).

3.10 U.S. EPA (1986), *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*, Washington, D.C. (OSWER-9950.1).

3.11 U.S. EPA (1992) *RCRA Groundwater Monitoring: Draft Technical Guidance*, Washington, D.C. (EPA/530-R-93-001).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sampling Coordinator (SC)

The SC's responsibility is to supply a quarterly Sampling Plan to the Field Personnel, track sample collection throughout the quarter to ensure completion of the sampling plan within the specified sampling quarter, and ensure fieldwork is conducted in compliance with applicable SOPs.

5.6 Field Personnel (FP)

The FP are responsible for the safe completion of evacuating and sampling ground water monitor wells according to guidelines set forth by this procedure and associated SOPs.

6.0 PROCEDURES

6.1 Bailer Construction

Where approved by the SC, it is acceptable to use a ®Teflon, stainless steel, polyethylene, or polyvinyl chloride (PVC) bailer. SOP 2.1: "Presample Purging of Wells," Attachment D is a schematic of a typical bailer. Collection of an equipment blank sample may be necessary when using a non-dedicated bailer, consult SOP 4.9 "Collection of Field QC Samples" for this determination.

6.2 Discussion

Bailers are useful tools for the collection of grab samples when low flow sampling methods are not feasible. Excessive agitation of the ground water should be avoided since this action results in aeration of the ground water sample. Unnecessary agitation of the ground water can be minimized by gently lowering the bailer into the well (not dropping it), and by using a bailer that can be fitted with a bottom-emptying device. Attachment D in SOP 2.1 contains a schematic of a typical bailer and a bottom-emptying device that slips into the bottom opening.

6.3 Preparation

6.3.1 Prior to commencement of field activities, perform preparation activities described in SOP 4.1, "General Instructions for Field Personnel," including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015).

6.3.2 Review all sampling information, such as the quarterly sampling plan and electronically generated ground water sampling data sheets. The plan and/or data sheets contains the following information:

- Locations to be sampled.
- Proposed sampling methods (See SOP 2.1, Attachment A, Methodology Sampling Codes).
- Requested analyses.
- Method specific sample collection instructions e.g., E300.0:PERC (EPA Method 314).
- Contract analytical laboratory (CAL) to which samples are to be sent for analyses.
- Estimated amount of purge water to be collected.
- Current technical information for each well.

6.3.3 Obtain appropriate data collection forms, e.g., Chain-of-Custody [CoC] forms, Ground Water Sampling Data Sheets (SOP 2.1, Attachment B), assigned Document Control Logbook, labels, and any necessary shipping forms. Instructions for completing the logbook entries and field forms are provided in SOP 4.2, "Sampling Control and Documentation." Consult with the SC for the appropriate sampling method to apply to the site if it is not indicated on the sampling plan.

6.3.4 The appropriate number and type of sample containers needed for the sampling event should be obtained from the sample bottle inventory. The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirement. See SOP 4.3, "Sample Containers and Preservation."

6.3.5 The appropriate personnel should keep a sufficient stock of sample containers and maintain an inventory of supplies, e.g., trip blanks, field blank water ordered from the contract analytical laboratory (CAL), plastic bags, etc., to ensure adequate sampling supplies are available at all times.

6.3.6 Obtain the line (nylon, polypropylene, cotton) or measured tape on a spool to be used when lowering the bailer into the well. The line used for bailing should be new or dedicated to the monitor well to be sampled.

6.3.7 The analytical labs should be notified when collecting samples with short holding times (e.g., hexavalent chromium, fecal and total coliform) or samples that must be analyzed on a rush turn-around-time, e.g., 24h, 10d, etc. to ensure analysis can be performed.

6.3.8 Organize sampling route. The SC may specify the order in which the wells are to be sampled. Complete an entire treatment facility or study area before beginning the next, when possible.

Sample wells working from the least contaminated to the most contaminated, when it is practical to do so. When it is not practical to do so, be sure and follow proper decontamination procedures before moving on to the next sample location.

6.3.9 If needed, the Administrative Escort Services must be given a 24-hour notice (at a minimum) before work is scheduled in restricted areas.

6.3.10 Decontaminate non-dedicated bailers according to SOP 4.5, "General Equipment Decontamination." Bailers should be checked for cracks and breaks that could cause sample and/or bailer loss. Ensure that new, clean line is used and is cut to the appropriate length according to the casing depth of the well.

6.3.11 Record the required information on the Ground Water Sampling Data Sheet and Water Sampling Logbook per the instructions in SOP 4.2, "Sample Control and Documentation."

6.4. Safety Considerations

6.4.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.4.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.5 Purge Water Collection

6.5.1 At Site 300, the FP must ensure there are sufficient collection drums, carboys, or the appropriate portable tank available for purge water containment (SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids"). The quantity of purge water to be collected for each well is calculated by the field personnel based on the prescribed sample method. At some wells, purge water is collected in a portable tank for transport to a designated treatment facility for treatment.

6.5.2 The Livermore Site field personnel will tow a collection tanker with the sampling vehicle when necessary. Tankers and drums filled with purge water may not be left at the well location and will be logged and disposed of daily, when possible according to SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids."

6.6 Operation

6.6.1 Once pre-sample purging is complete according to SOP 2.1, sampling may begin. Wear new disposable gloves during sampling. Collect measurements according to SOP 2.2, "Field Measurements on Surface and Ground Waters," e.g., temperature, pH, oxidation/reduction potential (ORP), and temperature, depth to water, and any visual observations such as outgassing, etc. Instruments should be calibrated according to SOP 4.8, "Calibration and Maintenance of Field Instruments Used in Measuring Parameters of Surface and Ground Water and Soils."

6.6.2 The retrieval line should be carefully measured to ensure that the influent portion of the bailer is at the targeted sample depth, and securely attached to the bailer.

6.6.3 The free end of the retrieval line should be securely fastened to the protective casing or to the sampler to avoid losing the bailer in the well.

6.6.4 Lower the bailer gently into the well until the bailer is within the screened section of the well. Avoid unnecessary agitation of the water.

6.6.5 Remove the bailer and attach the bottom-emptying device.

6.6.6 Fill the appropriate sample bottles (SOP 4.3, "Sample Containers and Preservation") using the bottom-emptying device. Allow water to flow gently down the side of the bottle with minimal entry turbulence (SOP 2.6, "Sampling for Volatile Organic Compounds") when collecting samples to be analyzed for VOCs. If a bottom-emptying device is not available, obtain the sample by gently pouring from the top of the bailer, avoiding excessive agitation.

6.6.7 Samples should be obtained in order of volatility; VOCs collected first, followed by semi VOCs, inorganics, and radiologicals, or otherwise specified by the SC.

All samples should be placed in sealable-type bags. The samples requiring preservation of ≤ 6°C should be cooled down by using blue ice packs in sealable-type bags or bagged ice cubes. Loose ice may be used when samples need to be rapidly cooled, but should be replaced with blue ice before shipping.

6.6.8 If filtering and/or preservation is required, include the "FILTER" requested analysis and a notation on the CoC instructing the CAL to filter and/or preserve samples upon receipt.

6.7 Post Operation

6.7.1 Perform post operation activities described in SOP 4.1.

6.7.2 Before leaving the sampling location, verify that the appropriate samples have been collected according to the samples scheduled on the Ground Water Sampling Data Sheets.

6.7.3 Prior to sampling another site and to prevent cross contamination of equipment between locations, thoroughly decontaminate all equipment that is not dedicated according to SOP 4.5, "General Equipment Decontamination."

6.7.4 Complete the appropriate Ground Water Sampling Data Sheets and record sampling information in the designated Water Sampling Logbook (SOP 2.1 and SOP 4.2).

6.7.5 Verify that the CoC is appropriately completed per SOP 4.2. Indicate any special instructions in the Remarks Section of the CoC. Such instructions may include a request for the laboratory to filter and preserve the sample upon receipt or to analyze trip blank only when there are hits in associated samples.

6.7.6 Deliver Ground Water Sampling Data Sheets and CoC forms to the SC daily.

6.7.7 The SC will retain a copy of the original forms (CoC, ground water sampling data sheets), and provide the originals to the Data Management Team (DMT) for final archive. The SC will provide copies of the forms to the appropriate Analyst, as necessary.

6.7.8 Leave samples and proper documentation in the environmental sample lock-box for the CAL. Field Personnel will ship samples and/or distribute to the appropriate laboratories. Ensure that the samples requiring refrigeration remain at ≤ 6°C, but do not allow them to freeze. Always ensure that proper chain of custody is maintained.

7.0 QA RECORDS

7.1 LLNL Ground Water Sampling Data Sheets

7.2 Logbooks

7.3 Chain-of-Custody forms

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD) Standard Operating Procedure (SOP)	
ERD SOP 2.5: Surface Water Sampling—Revision: 4	
ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY #________ ERD	**AUTHOR(S):** S. Gregory and E. Walter
	APPROVALS: **Date** Jesse Yow 12/17/15 Department Head [signature] 11/16/15 Livermore Site Program Leader Leslie Ferry 12/15/15 Site 300 Program Leader
	CONCURRENCE: **Date** Rebecca Goodrich 12/17/15 QA Implementation Coordinator
Type of Procedure (per ES&H Manual, Document 3.4) ☒ Informational Use ☐ General Use ☐ Continuous Use	

1.0 PURPOSE

The purpose of this SOP is to establish surface water collection techniques that ensure collection of representative samples.

2.0 APPLICABILITY

This procedure is applicable to the sampling of surface water at Site 300 and the Livermore Site. Surface water may include rainwater runoff, springs, and building discharges. Building discharges may include cooling tower discharges and/or effluent from septic systems. ERD work activities are conducted within the framework of the institutional Integrated Safety

Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 deVera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm (1980), *Samplers and Sampling Procedures for Hazardous Waste Streams*, U.S. EPA, Washington, D.C. (EPA-600/2-80-018).

3.2 Ford, P.J., P.J. Tarina, and D.E. Seely (1984), *Characterization of Hazardous Waste Sites—A Methods Manual, 302. Vol. II Available Sampling Methods,* Second Edition, U.S. EPA, Washington, D.C. (EPA-600/4-84/076).

3.3 Instrument Specialties Company (1980), *Instruction Manual, Model 2100 Wastewater Sampler*.

3.4 Korte, N. and D. Ealey (1983), *Procedures for Field Chemical Analyses of Water Samples*, U.S. Department of Energy, GJ/TMC-07, Technical Measurements Center, Grand Junction Project Office, Grand Junction, Colo.

3.5 Korte, N. and P. Kearl (1985), *Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells*, Second Edition, U.S. Department of Energy, GJ/TMC-08, Technical Measurements Center, Grand Junction Projects Office, Grand Junction, Colo.

3.6 U.S. Department of the Interior Publication (n.d.), *National Handbook of Recommended Methods for Water-Data Acquisition*, Washington, D.C.

3.7 U.S. EPA (1982), *Handbook for Sampling and Sample Preservation of Water and Wastewater*, Washington D.C. (EPA-600/4-82-029).

3.8 U.S. EPA (1983), *Methods for Chemical Analysis of Water and Wastes*, Washington, D.C. (EPA-600/4-79-020).

3.9 U.S. EPA (1984), *Test Methods for Evaluation of Solid Waste*, Second Edition, Washington, D.C. (EPA-SW-846).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sampling Coordinator (SC)

The SC's responsibilities are to ensure that the Field Personnel have been properly trained; they comply with all applicable regulations and procedures, and generate all applicable field sheets.

5.6 Field Personnel (FP)

The FP are responsible for properly performing Surface Water Sampling in compliance with all applicable regulations and procedures to ensure the samples and data provided are representative of actual conditions.

6.0 PROCEDURES

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities described in SOP 4.1, "General Instructions for Field Personnel," including

participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015).

6.1.2 Review all pertinent sampling information, such as the quarterly Sampling Plan and electronically generated Ground Water Sampling Data Sheets. The plan and/or data sheets contains the following information:

- Locations to be sampled.
- Proposed sampling methods (See SOP 2.1, "Pre-sample Purging of Wells," Attachment A, Methodology Sampling Codes).
- Requested analyses.
- Method specific sample collection instructions e.g., E300.0:PERC (EPA Method 314).
- Contract analytical laboratory (CAL) to which samples are to be sent for analyses.
- Estimated amount of purge water to be collected.
- Current technical information for each well.

6.1.3 Obtain appropriate data collection forms, e.g., Chain-of-Custody (CoC) forms, Ground Water Sampling Data Sheets (SOP 2.1, Attachment B), assigned Document Control Logbook, labels, and any necessary shipping forms. Instructions for completing the logbook entries and field forms are provided in SOP 4.2, "Sample Control and Documentation." Consult with the SC for the appropriate sampling method to apply to the site if it is not indicated on the sampling plan.

6.1.4 Compile all necessary equipment and instrumentation for sampling according to Attachment C, Equipment Checklist in SOP 2.1.

6.1.5 The appropriate number and type of sample containers needed for the sampling event should be obtained from the sample bottle inventory. The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirement. See SOP 4.3, "Sample Containers and Preservation."

6.1.6 The appropriate personnel should keep a sufficient stock of sample containers and maintain an inventory of supplies, e.g., trip blanks, field blank water ordered from the contract analytical laboratory (CAL), plastic bags, etc., to ensure adequate sampling supplies are available at all times.

6.1.7 Organize sampling route.

The SC may specify the order in which the locations are to be sampled. Complete an entire treatment facility or study area before beginning the next, when possible.

Sample locations working from the least contaminated to the most contaminated, when it is practical to do so. When it is not practical to do so, be sure and follow proper decontamination procedures before moving on to the next sample location.

6.1.8 If needed, the Administrative Escort Services must be given a 24-hour notice before work is scheduled in restricted areas. If appropriate, arrange access to sampling areas through the Facility Point of Contact (FPOC), the Functional Area

Supervisor (FAS) or the control point Operator per SOP 4.1, "General Instructions for Field Personnel."

6.1.9 Prior to usage in the field, assigned sampling personnel should check equipment for cleanliness, proper operation, and ensure that the batteries are charged and the fittings are secure. Use gloves when handling compressors and generators, and dispose of them immediately to avoid possible sample contamination.

6.1.10 Fill out initial information on the Ground Water Sampling Data Sheet and Document Control Logbook per instructions in SOP 4.2.

6.2. Safety Considerations

6.2.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.2.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.3 Field Preparation

6.3.1 Assemble all appropriate sampling equipment (Attachment A) and load into field vehicle. Make sure that all sampling equipment is decontaminated according to SOP 4.5, "General Equipment Decontamination."

6.3.2 Locate surface waters to be sampled and determine the best sampling order. Ensure that permission for offroad travel has been granted, if applicable, as described in SOP 4.1, "General Instruction for Field Personnel".

6.3.3 Fill-out any initial information in the Document Control Logbook (SOP 4.2) describing the surface water sampling location.

6.3 Operation

6.3.1 Sampling Location

Pick a sample location as close to the source as possible. In the case of building discharges (i.e., if the water is coming from a pipe or culvert), the samples should be collected directly from the pipe to reduce volatilization. In some cases (springs and some discharge locations), samples have to be collected directly from ground depressions.

6.3.2 Low Water-Yielding Springs

A. Manually dig a small depression in the saturated soil with a clean trowel or shovel.

B. Collect samples to be analyzed for VOCs as soon as sufficient water has filled the depression. Collect samples to be analyzed for other compounds as soon as sufficient water has filled the depression to fill remaining containers.

C. Continue sample collection by following steps in Section 6.3.3 A through D.

6.3.3 High Water-Yielding Springs

If plenty of water is available, the procedures are as follows:

A. Collect samples in order of volatility, with samples to be analyzed for VOCs first. For small surface water bodies, collect samples directly into the container that will be sent to the laboratory. There can be no head space within the container when collecting samples to be analyzed for VOCs as described in SOP 2.6, "Sampling for Volatile Organic Compounds".

B. Collect samples for other analyses directly into their appropriate container, or samples can be collected using a portable peristaltic pump. The use of a clean glass, stainless steel or Teflon vessel can also be utilized to transfer water into a specific sample container. Such vessels should be used to collect samples from near the center of the water body. A collection vessel should also be used if the sample container already contains any necessary preservative.

C. Secure caps tightly and attach an identification label to all containers. Instructions for filling out the identification label are in SOP 4.2. Fill in all Ground Water Sampling Data Sheets and Document Control Logbook and any additional information, as required.

D. Place samples into chilled cooler to maintain samples at ≤ 6°C (SOP 4.4).

6.4 Post Operation

6.4.1 Before leaving the sampling location, verify that the appropriate samples have been collected according to the samples scheduled on the Ground Water Sampling Data Sheets.

6.4.2 Prior to sampling another site and to prevent cross contamination of equipment between locations, thoroughly decontaminate all equipment that is not dedicated according to SOP 4.5, "General Equipment Decontamination."

6.4.3 Complete the appropriate Ground Water Sampling Data Sheet and record sampling information in the assigned Document Control Logbook (SOPs 2.1 and 4.2).

6.4.4 Verify that the CoC is appropriately completed per SOP 4.2. Indicate any special instructions in the Remarks Section of the CoC. Such instructions may include a request for the laboratory to filter and preserve the sample upon receipt or to analyze trip blank only when there are hits in associated samples.

6.4.5 For newly discovered locations, mark the sampling location and ID on a copy of a site map. Mark the field location with fluorescent marker tape adjacent to where the samples were collected. This reference point should be subsequently surveyed.

6.5 Post Operation

6.5.1 Perform post operation activities per SOP 4.1.

6.5.2 Inventory sampling equipment and supplies. Repair or replace all broken or damaged equipment.

6.5.3 Replace expendable items.

6.5.4 Deliver Ground Water Sampling Data Sheets and CoC forms to the SC daily.

6.5.5 The SC will retain a copy of the original forms (CoC, Ground Water Sampling Data Sheets), and provide the originals to the Data Management Team (DMT) for final archive. The SC will provide copies of the forms to the appropriate Analyst, as necessary.

6.5.6 Leave routine samples and proper documentation in the environmental sample lock-box for the CAL. Field Personnel will ship samples and/or distribute to the appropriate laboratories. Ensure that the samples requiring refrigeration remain at ≤ 6°C, but do not allow them to freeze. Always ensure that proper chain of custody is maintained.

7.0 QA RECORDS

7.1 Ground Water Sampling Data Sheets

7.2 Document Control Logbooks

7.3 Chain-of-Custody Forms

8.0 ATTACHMENT

Attachment A—Equipment Checklist

Attachment A

Equipment Checklist

Equipment Checklist

____ Air tight plastic bags
____ Alconox (detergent)
____ Appropriate SOPs, Site Safety Plans, Sampling Plans
____ Brushes
____ Deionized water
____ Disposable towels
____ Fluorescent marker tape
____ Glass beaker (if necessary)
____ Gloves
____ Ice chest with bagged ice or Blue Ice
____ Logbook
____ Maps
____ Packing material
____ Paper towels
____ Permanent ink markers
____ Portable electric pump and disposable tubing
____ Sample containers and appropriate preservative when necessary
____ Shovel
____ Snake Chaps
____ Trash bags
____ Trowel

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 2.6: Sampling for Volatile Organic Compounds—Revision: 7

AUTHOR(S):
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ERD

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to provide guidance on the collection of a ground water sample to be analyzed for volatile organic compounds (VOCs). The objective is to provide the laboratory with a sample that is representative of its original environment.

2.0 APPLICABILITY

This procedure applies to the collection of ground water samples to be analyzed for VOCs. Due to the volatility of such compounds as trichloroethylene, extra care should be taken during sample collection to ensure sample integrity. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Morse, S.I. (1997), San Francisco Bay Regional Water Quality Control Board, Toxics Cleanup Division; letter to Interested Parties. Subject: *Utilization of Non-Purge Approach for Sampling of Monitoring Wells Impacted by Petroleum Hydrocarbons, BTEX, and MTBE,* File: 1123.64, January 31, 1997.

3.2 Robbins, G.A. and J.M. Martin-Hayden (1991), Mass Balance Evaluation of Monitoring Well Purging: Part 1. Theoretical Models and Implications for Representative Sampling," *J. Contam. Hydrol*. 8, 203–224.

3.3 Schilling K.E. (1995), Low-Flow Purging Reduces Management of Contaminated Groundwater, *Environmental Protection*, December 1995.

3.4 U.S. EPA (1985), *Practical Guide for Groundwater Sampling*, Washington, D.C. (EPA/600/2-85/104).

3.5 U.S. EPA (1986), *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*, Washington, D.C. (OSWER-9959.1).

3.6 U.S. Environmental Protection Agency (EPA) (1996), Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, *Ground Water Issue*, EPA/540/S-95/504.

3.7 U.S. Environmental Protection Agency (EPA) (1995), *Use of Low-Flow Methods for Ground Water Purging and Sampling: An Overview*, Quick Reference Advisory (December 1995).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sampling Coordinator (SC)

The SC's responsibility is to supply a quarterly Sampling Plan to the Field Personnel, track sample collection throughout the quarter to ensure completion of the sampling plan within the specified sampling quarter, and ensure fieldwork is conducted in compliance with applicable SOPs.

5.6 Field Personnel (FP)

The FP are responsible for the safe completion of evacuating and sampling ground water monitor wells according to guidelines set forth by this procedure and associated SOPs.

6.0 PROCEDURES

Because laboratory methods are extremely sensitive, well controlled, and quality assured, sample collection should also be performed following comparable procedures. The proper collection of a sample to be analyzed for dissolved VOCs requires minimal disturbance to the sample in order to limit volatilization, and produce a representative sample.

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities described in SOP 4.1, "General Instructions for Field Personnel," including

participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015).

6.1.2 Review all pertinent sampling information, such as the quarterly Sampling Plan and electronically generated Ground Water Sampling Data Sheets. The plan and/or data sheets contains the following information:

- Locations to be sampled.
- Proposed sampling methods (See SOP 2.1 Attachment A, Methodology Sampling Codes).
- Requested analyses.
- Method specific sample collection instructions e.g., E300.0:PERC (EPA Method 314).
- Contract analytical laboratory (CAL) to which samples are to be sent for analyses.
- Estimated amount of purge water to be collected.
- Current technical information for each well.

6.1.3 Obtain appropriate data collection forms, e.g., Chain-of-Custody (CoC) forms, Ground Water Sampling Data Sheets (SOP 2.1, Attachment B), assigned Document Control Logbook, labels, and any necessary shipping forms. Instructions for completing the logbook entries and field forms are provided in SOP 4.2, "Sample Control and Documentation. Consult with the SC for the appropriate sampling method to apply to the site if it is not indicated on the sampling plan.

6.1.4 Contaminant information is provided in the quarterly Sampling Plan or by the SC and should be reviewed prior to sampling. The SC also provides contaminant information for newly completed installations that may not appear on the plan provided baseline sampling has been performed.

6.1.5 Obtain appropriate materials to conduct field work according to Attachment C, Equipment Checklist in SOP 2.1.

6.1.6 The number and type of sample containers needed for the sampling event should be obtained from the sample bottle inventory. The appropriate personnel should keep a sufficient stock of sample containers on hand. Field personnel should also maintain an inventory of supplies, e.g., trip blanks, field blank water ordered from the CAL, plastic bags, etc., to ensure adequate sampling supplies are available at all times.

6.1.7 Organize sampling route.

The SC may specify the order in which the wells are to be sampled. Complete an entire treatment facility or study area before beginning the next, when possible.

Sample wells working from the least contaminated to the most contaminated, when it is practical to do so. When it is not practical to do so, be sure and follow proper decontamination procedures before moving on to the next sample location.

6.1.8 If needed, the Administrative Escort Services must be given a 24-hour notice (at a minimum) before work is scheduled in restricted areas. If appropriate, arrange access to sampling areas through the Facility Point of Contact (FPOC), the Functional Area Supervisor (FAS) or the control point Operator per SOP 4.1, "General Instructions for Field Personnel."

6.1.9 The analytical lab should be notified when collecting samples with short holding times or samples that must be analyzed on a rush turn-around-time, e.g., 24h, 10d, etc. to ensure the analysis can be performed within the specified time frame.

6.1.10 Record the required information on the Ground Water Sampling Data Sheet and Document Control Logbook per the instructions in SOP 4.2, "Sample Control and Documentation."

6.2. Safety Considerations

6.2.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.2.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.3. Purge Water Collection

6.3.1 At Site 300, the FP must ensure there are sufficient collection drums, carboys, or the appropriate portable tank available for purge water containment (SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids"). The quantity of purge water to be collected for each well is calculated by the field personnel based on the prescribed sample method. At some wells, purge water is collected in a portable tank for transport to a designated treatment facility for treatment.

6.3.2 The Livermore Site field personnel will tow a collection tanker with the sampling vehicle when necessary. Tankers and drums filled with purge water may not be left at the well location and will be logged and disposed of daily, when possible according to SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids."

6.4 Operation

6.4.1 Purge well prior to sampling as specified in SOP 2.1. Obtain water quality parameters in accordance with SOP 2.2, "Field Measurements on Surface and Ground Waters."

6.4.2 Sample retrieval systems suitable for the valid collection of volatile organic samples include gear-driven submersible pumps, specific-depth grab sampling devices, and bailers. Field conditions and other constraints will limit the choice of appropriate systems. A sample subjected to the least amount of turbulence possible remains as the objective in collecting a representative sample for analysis.

A. Sample Retrieval—Submersible Pump

Electric submersible pumps are used to quickly and efficiently purge large quantities of water. The flow rate is controlled at the surface by an in-line ball valve attached to a sample tee or controlled by the use of a rheostat. Samples are collected from a small diameter ®Teflon tube. Care must be exercised when sampling for VOCs to avoid possible splashing and aeration.

1. Place the generator downwind from the well whenever possible.
2. Attach the dedicated sample tee (found inside the protective steel casing) to the discharge pipe. Start the generator. Adjust the discharge rate by partially closing the ball valve on the sample tee so that the well will yield water without exposing the screen when possible. When using a rheostat equipped pump, the discharge rate is controlled by the pump speed on the controller unit.
3. Water levels should be monitored at the frequency determined by the sampling method described in SOP 2.1, "Pre-sample Purging of Wells" to ensure the water level does not drop below the pump intake or screened interval when possible.
4. Label vials with appropriate sample information. Open vials and set caps in an upright position in a clean place. Collect one volatile organic analysis (VOA) vial at a time to avoid spillage and possible breakage. Reduce the discharge rate using the sample tee or rheostat to minimize volatilization of the sample. Sample should be collected over a collection vessel such as a tray, bucket or collection drum to avoid spillage to ground when contaminants are present in the ground water. Contamination information is included on the Sampling Plan and on the electronically generated Ground Water Sampling Data Sheets.
5. Hold the edge of the sample discharge line at the top edge of the sample vial and allow the water to run down the inside into the vial. Do not allow the discharge tube to touch the sample vial or the water to drop or fall into the vial; avoid splashing. The proper collection of a sample for dissolved VOCs requires minimal disturbance of the sample to limit volatilization and, therefore, a loss of VOCs from the sample.
6. Do not rinse or excessively overflow the vials but fill the vial completely until a convex meniscus forms at the top. Visually inspect the caps to ensure the caps did not get contaminated before capping the vials.
7. Invert the vials and tap gently. No entrapped air should be left in the sample vial. In some instances, a well can have natural off-gassing which can produce gas bubbles in the sample. In these cases of natural off-gassing, the sample should sit open briefly to allow the gas to coalesce, then top off the sample until a convex meniscus forms and gas bubbles disappear. Cap sample vials immediately.

8. Place the samples in airtight plastic bags in a cooler containing bagged ice, loose cubes, or bagged blue ice. Loose ice should be replaced with bagged ice or bagged blue ice before shipping. Samples should be maintained at ≤ 6°C. When submitting samples to be analyzed for VOCs, a trip blank should be included in the cooler for analysis. A note regarding the trip blank analysis should be provided to the CAL in the remarks section of the CoC (e.g., analyze trip blank only if there are VOCs detected in associated samples).

B. Sample Retrieval—Bailers

Where approved by the SC, it is acceptable to use a ®Teflon, stainless steel, polyethylene, or polyvinyl chloride (PVC) bailer. SOP 2.1, "Pre-sample Purging of Wells," Attachment E is a schematic of a typical bailer. Collection of an equipment blank sample may be necessary when using a non-dedicated bailer, consult SOP 4.9, "Collection of Field QC Samples" for this determination.

1. The retrieval rope should be securely attached to the bailer. A new rope should be used at each well, unless the bailer is dedicated. Dedicated bailers should be checked for cracks and breaks and replaced when necessary.
2. The free end of the retrieval rope should be fastened to the protective casing or secured by the sampler to avoid losing the bailer in the well.
3. Lower the bailer gently into the well and begin water removal. Avoid unnecessary agitation of the water. Collect or dispose of purged water in acceptable containers as specified in SOP 4.7A or SOP 4.7B.
4. To collect a sample from the bailer, an emptying device is inserted into the bottom of the bailer which expels the water. Again, use caution when filling sample VOA vial (SOP 2.4, "Sampling Monitoring Wells with a Bailer").
5. Follow steps in Section 6.4.2A steps 4 through 8.

C. Sample Retrieval—Specific-Depth Grab Sample Device

These devices obtain samples at a specific depth within the water column. The procedure is to lower the device to the depth specified by the SC and or appropriate personnel (usually the mid-point of the screened interval). The device is then activated and two or more sample chamber volumes are drawn through the bailer. The sample is isolated from the water column by shutting off the pump (ensure that a minimum of 30 seconds has elapsed before shutting off the pump). This closes the double-check valves and allows the sample to be retrieved. The device is retrieved and the sample is transferred to sample vessels as outlined in Section 6.4.2A steps 4 through 8.

6.5 Post Operation

6.5.1 Perform post operation activities per SOP 4.1.

6.5.2 Before leaving the sampling location, verify that the appropriate samples have been collected according to the samples scheduled on the Ground Water Sampling Data Sheets.

6.5.3 Prior to sampling another site and to prevent cross contamination of equipment between locations, thoroughly decontaminate all equipment that is not dedicated according to SOP 4.5, "General Equipment Decontamination."

6.5.4 Complete the appropriate Ground Water Sampling Data Sheet and record sampling information in the assigned Document Control Logbook (SOPs 2.1 and 4.2).

6.5.5 Verify that the CoC is appropriately completed per SOP 4.2. Indicate any special instructions in the Remarks Section of the CoC. Such instructions may include a request for the laboratory to filter and preserve the sample upon receipt or to analyze trip blanks only if hits are detected in associated samples.

6.5.6 Deliver Ground Water Sampling Data Sheets and CoC forms to the SC daily.

6.5.7 The SC will retain a copy of the original forms (CoC, Ground Water Sampling Data Sheets), and provide the originals to the Data Management Team (DMT) for final archive. The SC will provide copies of the forms to the appropriate Analyst, as necessary.

6.5.8 Leave routine samples and proper documentation in the environmental sample lock-box for the CAL. Field personnel will ship samples and/or distribute to the appropriate laboratories. Ensure that the samples requiring refrigeration remain at $\leq 6°C$, but do not allow them to freeze. Always ensure that proper chain of custody is maintained.

7.0 QA RECORDS

7.1 Ground Water Sampling Data Sheets

7.2 Document Control Logbooks

7.3 Chain-of-Custody Forms

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 2.7: Pre-sample Purging and Sampling of Low-Yielding Monitor Wells—Revision: 7

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ERD

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Rebecca Goodrich QA Implementation Coordinator	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to provide well purging (evacuation) and sampling techniques that will obtain representative samples from wells that yield less than three well-casing volumes of water.

2.0 APPLICABILITY

This procedure applies to sampling ground water monitor wells that are completed in low-yielding aquifers, which produce less than three well casing volumes prior to sampling. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Barcelona, M.J., J.P. Gibb, J.A. Helfrich, and E.E. Garske (1985), *Practical Guide for Ground Water Sampling*, U.S. EPA, Washington, D.C. (EPA-600/2-85/104).

3.2 U.S. EPA (1986), *RCRA Ground Water Monitoring Technical Enforcement Guidance Document*, Washington, D.C. (OSWER-9950.1).

3.3 Kearl, P.M., N.E. Korte, M. Stites, and J. Baker (Fall 1994), GWMR, *Field Comparisons of Micropurging vs. Traditional Ground Water Sampling*.

3.4 Howard, G.W. and G. Kumamoto (1994), *Cost Effectiveness and Waste Minimization through Low Volume, Pre-Sample Purging Using Historic Sustainable Yield, While Utilizing Existing Sampling Equipment*, TIE Conference.

3.5 U.S. EPA (1992), *RCRA Ground-Water Monitoring: Draft Technical Guidance*, Washington, D.C. (EPA/530-R-93-001).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sampling Coordinator (SC)

The SC's responsibility is to supply a quarterly Sampling Plan to the Field Personnel and track sample collection throughout the quarter to ensure completion of the sampling plan within the specified sampling quarter, and ensure fieldwork is conducted in compliance with applicable SOPs.

5.6 Field Personnel (FP)

The FP are responsible for ensuring safe completion of evacuating and sampling ground water monitor wells according to guidelines set forth by this procedure, as well as other associated SOPs. The wells to be purged frequently are listed in the quarterly sampling plan provided by the Sampling Coordinator (SC).

6.0 PROCEDURES

This SOP describes procedures to minimize problems inherent in sampling low-yielding wells, and it provides consistency in sampling such wells. Low-yielding wells are typically sampled using grab sampling, 90% of 1 casing volume, or dry-out method. Pre-sample purging and sampling should be performed without lowering the water level in the well below the screened interval, to prevent water from cascading down the screen, possibly volatilizing constituents of interest. However, the sustainable flow rate of some wells at Site 300 and the Livermore Site is low (<0.5 gpm), making it impossible to avoid drawing the water level into the screened interval and/or drying out the well.

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities described in SOP 4.1, "General Instructions for Field Personnel," including

participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-015).

6.1.2 Review all pertinent sampling information, such as the quarterly Sampling Plan and electronically generated Ground Water Sampling Data Sheets. The plan and/or data sheets contains the following information:

- Locations to be sampled.
- Proposed sampling methods (See SOP 2.1, Attachment A, Methodology Sampling Codes).
- Requested analyses.
- Method specific sample collection instructions e.g., E300.0:PERC (EPA Method 314).
- Contract analytical laboratory (CAL) to which samples are to be sent for analyses.
- Estimated amount of purge water to be collected.
- Current technical information for each well.

6.1.3 Obtain appropriate data collection forms i.e., Chain-of-Custody (CoC) forms, Ground Water Sampling Data Sheets (SOP 2.1, Attachment B), assigned Document Control Logbook, labels, and any necessary shipping forms. Instructions for completing the logbook entries and field forms are provided in SOP 4.2, "Sample Control and Documentation. Consult with the SC for the appropriate sampling method to apply to the site if it is not indicated on the sampling plan.

6.1.4 Contaminant information is provided in the quarterly Sampling Plan or by the SC and should be reviewed prior to sampling. The SC also provides contaminant information for newly completed installations that may not appear on the plan.

6.1.5 Obtain appropriate materials to conduct field work according to SOP 2.1, Attachment C, Equipment Checklist.

6.1.6 The number and type of sample containers needed for the sampling event should be obtained from the sample bottle inventory. The appropriate personnel should keep a sufficient stock of sample containers on hand. Field Personnel should also maintain an inventory of supplies, e.g., trip blanks, field blank water ordered from the CAL, plastic bags, etc., to ensure adequate sampling supplies are available at all times.

6.1.7 Organize sampling route:

The SC may specify the order in which the wells are to be sampled. Complete an entire treatment facility or study area before beginning the next, when possible.

Sample wells working from the least contaminated to the most contaminated, when it is practical to do so. When it is not practical to do so, be sure and follow proper decontamination procedures before moving on to the next sample location.

6.1.8 The Administrative Escort Services must be given a 24-hour notice (at a minimum) before work is scheduled in restricted areas.

6.1.9 Record the required information on the Ground Water Sampling Data Sheets and Document Control Logbook per the instructions in SOP 4.2, "Sample Control and Documentation."

6.2. Safety Considerations

6.2.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.2.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.3 Purge Water Collection

6.3.1 At Site 300, the FP must ensure there are sufficient collection drums, carboys, or the appropriate portable tank available for purge water containment (SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids"). The quantity of purge water to be collected for each well is calculated by the field personnel based on the prescribed sample method. At some wells, purge water is collected in a portable tank for transport to a designated treatment facility for treatment.

6.3.2 The Livermore Site field personnel will tow a collection tanker with the sampling vehicle when necessary. Tankers and drums filled with purge water may not be left at the well location and will be logged and disposed of daily, when possible according to SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids."

6.4 Operation

6.4.1 Purging Techniques:

1. Begin purging the well using the appropriate technique as described in SOP 2.1.
2. Initial field measurements should be taken from the first available water as soon as purging begins. Obtain water quality parameters in accordance with SOP 2.2, "Field Measurements on Surface and Ground Waters." Once the initial field parameters have been measured a discharge rate should be calculated. According to the manufacturer's recommendation, the well should be purged at a discharge rate of no less than 1.2 gpm when using an electric submersible pump. Regardless of the type of purging device used, the intent is to cause the least disturbance possible to the aquifer during the purging process.
3. Additional field parameter measurements should be collected at the frequency determined by the sampling method as described in SOP 2.1.

4. Purging a well to dryness is acceptable when specified by the SC. Follow procedures below beginning with Section 6.4.2.
5. One method of sampling wells that fit the "low-yielding monitor well" criteria is to purge a minimal amount of water prior to sampling using low-volume purge techniques. The Ground Water Sampling Data Sheet will specify the method chosen by the appropriate personnel.
6. Exposing the screened interval and/or the pump intake is to be avoided. The pump intake placement should be mid-screened interval for Livermore Site installations and near the bottom of the screened interval for Site 300 installations, unless otherwise requested by the SC and or appropriate personnel (e.g., Hydrogeologist).
7. The pumps discharge rate should be reduced to permit the recording of parameter measurements prior to sampling.
8. Alert the SC if the pumps discharge rate is not easily reduced to allow sampling prior to the well drying out.

6.4.2 If a well is purged to dryness, determine the amount of water purged from the well after discharge from the pump has ceased. This volume of water is recorded on the Ground Water Sampling Data Sheets, SOP 2.1, Attachment C.

6.4.3 Once the well has been purged dry, well recovery should be monitored by measuring the water level and calculating the volume of water remaining in the well casing. In order to sample the well, a sufficient amount of water must be available to purge the pump and discharge lines. This amount will vary depending upon pump type, well depth, and number and types of samples required. When a well goes dry prior to sample collection, field parameters should be measured before collecting the sample.

6.4.4 Sampling procedures in SOPs 2.2 through 2.6 should be followed as closely as possible. Ideally, all samples for the analysis of volatile compounds should be obtained within 2 hours of purging the well dry. It is acceptable to obtain these samples within 2 hours, allowing additional well recovery for any remaining samples for nonvolatile analysis. If sampling is split between recovery periods, field measurements should be obtained after each recovery period.

6.4.5 If insufficient water is available to obtain the samples for volatile analysis, the well should be monitored approximately every 2 hours until sufficient water is available for sampling. If sufficient water is still not available for sampling at the end of the work day, samples should be obtained immediately the next morning, providing water is available. If there is still insufficient water available for sampling, the 2-hour monitoring schedule should be resumed until enough water is available for sampling.

6.4.6 All purging rates, number of times purged, field measurements, and well recovery monitoring should be recorded on the Ground Water Sampling Data Sheets.

6.5 Post Operation

6.5.1 Perform post operation activities per SOP 4.1.

6.5.2 Complete and deliver documentation as described in all water sampling procedures SOPs 2.1 through 2.6.

7.0 QA RECORDS

7.1 Ground Water Sampling Data Sheets

72. Document Control Logbooks

7.3 Chain-of-Custody Forms

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Division (ERD)
Standard Operating Procedure (SOP)

ERD SOP 2.8: Installation of Dedicated Sampling Devices—Revision: 5

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ERD

AUTHOR(S):
R. Goodrich and G. Howard

APPROVALS:	**Date**
Albert L Lamarre **Division Leader**	9/5/03
[signature] **Environmental Chemistry and Biology Group Leader**	9/3/03

CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator (Acting)**	8/25/03

1.0 PURPOSE

The purpose of this SOP is to describe selection criteria and installation techniques for dedicated sampling pumps in ground water monitor wells to ensure installation is completed in a sound, consistent, and reliable manner.

2.0 APPLICABILITY

This SOP is applicable for use in the selection and installation of well purging and/or sampling devices. All personnel performing such tasks should review this procedure prior to commencement of related activities.

3.0 REFERENCES

3.1 Barcelona, M. J., J. A. Helfrich, E. E. Garske, and J. P. Gibb (1984), "A Laboratory Evaluation of Ground Water Sampling Mechanisms," *Ground Water Monitoring Review*, Spring, pp. 32-41.

3.2 Morse, S. I. (1997), San Francisco Bay Regional Water Quality Control Board, Toxics Cleanup Division; letter to Interested Parties. Subject: *Utilization of Non-Purge Approach* *for Sampling of Monitoring Wells Impacted by Petroleum Hydrocarbons, BTEX, and MTBE,* File: 1123.64, January 31, 1997.

3.3 Nielsen, D. M. and G. L. Yeates (1985), "A Comparison of Sampling Mechanisms Available for Small Diameter Ground Water Monitoring Wells," *Ground Water Monitoring Review*, Spring, pp. 83-99.

3.4 Robbins, G. A., and J. M. Martin-Hayden (1991), Mass Balance Evaluation of Monitoring Well Purging: Part 1. Theoretical Models and Implications for Representative Sampling," *J. Contam. Hydrol.* 8, 203–224.

3.5 Schilling K. E. (1995), Low-Flow Purging Reduces Management of Contaminated Groundwater, *Environmental Protection*, December 1995.

3.6 U.S. EPA (1992), *RCRA Ground-Water Monitoring: Draft Technical Guidance*, Washington, D.C. (EPA/530-R-93-001).

3.7 U.S. Environmental Protection Agency (EPA) (1995), Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, *Ground Water Issue*, EPA/540/S-95/504.

3.8 U.S. Environmental Protection Agency (EPA) (1995), *Use of Low-Flow Methods for Ground Water Purging and Sampling: An Overview*, Quick Reference Advisory (December 1995).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Division Leader

The Division Leader's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Field Coordinator (FC)

The FC in consultation with the Drilling Geologist (DG), Subproject Leader (SL), and the Sampling Coordinator (SC) selects the appropriate monitor well pump. The FC is solely responsible for ordering and ensuring proper installation of the pump once it has been selected.

5.3 Subproject Leader (SL)

The SL is responsible for the overall investigation, planning, and assessment and remediation within a study or treatment facility area.

5.4 Field Support Personnel

The field support personnel are responsible for providing necessary equipment, collection devices, and general field support, which enables sampling personnel to perform field activities in a timely and efficient manner.

6.0 PROCEDURE

6.1 Choosing the Placement of the Appropriate Sampling Device

6.1.1 In order to ensure timely sampling of LLNL wells and prevent cross-contamination caused by moving pumps from well to well, wells are usually fitted with dedicated sampling pumps, unless otherwise specified by the SL.

6.1.2 The choice of pump type largely depends on the sampling methodology that best matches the Data Quality Objective (DQO), the type of constituents being sampled for, and specifications such as well depth and yield. Completed wells are initially sampled (baseline sampling) by high volume purge techniques when possible. Hydrogeologic data is used in conjunction with DQOS to decide the sampling device type and depth of sampling device intake. Pumps are generally installed at the bottom of the screened interval in monitor wells at Site 300 due to the large number of low-yielding wells. Pumps at the Livermore Site are installed at mid-screened interval, at the discretion of the SL and/or FC. As appropriate, the SL, SC, or FC determines the type and placement of all dedicated pumps.

6.2 Preparation

6.2.1 Perform preparation activities per SOP 4.1, "General Instructions for Field Personnel."

6.2.2 Identify wells requiring installation of dedicated sampling device.

6.2.3 Review any available chemical analyses. The Site Safety Officer should be consulted as to the appropriate safety precautions and/or protective gear required.

6.2.4 The SC in consultation with the SL, should review the available chemical analyses, drilling logs, well development, and hydraulic testing records to determine the appropriate pump type and placement for each monitor well.

6.2.5 Order any necessary equipment (i.e., pumps, discharge tubing, control boxes, sounding tubes, sanitary seals, etc.).

6.2.6 Procure the appropriate pieces of equipment according to Attachment A, Equipment Checklist.

6.2.7 Ensure that the pump installation truck containing a winch and an operational power supply is available.

6.2.8 Ensure that all equipment and materials to be installed in the well have been adequately decontaminated as described in SOP 4.5, "General Equipment Decontamination."

6.2.9 Locate monitor wells that require dedicated pumps.

6.3 Operation

6.3.1 Bladder Pumps

A. Measure the appropriate lengths of discharge line, gas line, sounding tube (when necessary), so the pump intake will be at the specified depth. Ensure that the safety cable is slightly shorter than the gas line and discharge line so it will support the pump when installed.

B. Fasten the tubing to the pump and the top cap using threaded compression fittings, as specified by the pump manufacturer.

C. Feed the tubing through the appropriate port in the sanitary seal (when necessary).

D. Lower the complete assembly down the well by hand.

E. Install wellhead seal of appropriate size for below-grade wellheads.

F. Secure the cap assembly on top of the well casing. Place a cap on the sounding port (when necessary). Attachment B is a diagram of a well with a dedicated bladder pump.

6.3.2 Electric Submersible Pumps

A. Center the pump hoist over the well.

B. Splice the pump wiring harness to the electrical cable using watertight solderless connectors.

C. Secure safety cable to pump.

D. Thread a hoisting plug into the discharge line and hoist it to a vertical position.

E. Connect torque-arrestor at the bottom of the discharge pipe, and adjust so that it fits snugly into the well casing.

F. Thread the first 20-ft section of discharge line into the pump.

G. Using a plastic clamp (i.e., tie-wrap), bundle the discharge line, electrical cable, safety cable, and sounding tube at 5- to 10-ft intervals.

H. Carefully lower the assembly into the well using the pump hoist.

I. After lowering the assembly to the first pipe coupling, place a holding device under the coupling and lower onto device. Add additional lengths of discharge pipe and sounding tube while repeating steps F-H until the pump intake reaches the next coupling, and repeat to the last section of pipe.

J. Place the sanitary seal on the final piece of discharge pipe (precut to the appropriate length), thread the final pipe onto the discharge line, and connect the safety cable to the seal.

K. Field support personnel will splice about 4-ft of 12-gauge, four-strand, sheathed electrical cord to the end of the 10-gauge electrical cable using solderless connectors. Feed the cord through the appropriate port and fitting on the sanitary seal.

L. Connect the power cord in the following way:

1. Finish the cord with a 115- or 230-volt AC plug (male end) as specified by the pump manufacturer. Attachment C is a diagram of a below-grade wellhead completion.

M. Place threaded plugs in the discharge line and sounding tube. Attachment D is a diagram of a well with a dedicated electric submersible pump.

6.3.3 Specific-Depth Grab Sampling Devices (e.g., EasyPump)

A. A device, such as the EasyPump (see SOP 2.1, Attachment F) will have a power supply/safety cable cut to the correct length for the well and wound on a spool with power-supply plug fittings. A 12-volt submersible pump is attached to the power cord by means of these fittings. Due to the compact size of this sampling device, the spool, power cord, and pump may be left secured in the stovepipe, or removed and stored remotely for future use. The power supply/controller is hand carried to the site.

1. To install, attach disposable sample capture portion to the base of 12v pump. Hand lower to desired depth. The sample capture portion is disposable, and upon completion of the sampling event, may be discarded.

6.4 Post Operation

6.4.1 Perform post operation activities described in SOP 4.1, as applicable.

6.4.2 Use the Well Specification Form to record the date of installation, the pump type, and actual pump intake depth as recorded in the Well Entry Logbook and Pump Installation Logbook. The point-of-measurement (POM) for the pump intake depth should always be measured from the top of the concrete pad and recorded as such. Test the pump to make sure it is operational.

6.4.3 Secure the protective casing with its lock.

6.4.4 Transfer a copy of all recorded information to the SC and the Data Management Team (DMT).

7.0 QA RECORDS

7.1 Well Entry Logbooks

7.2 Pump Installation Logbook

7.3 Well Specifications Form

8.0 ATTACHMENTS

Attachment A—Equipment Checklist

Attachment B—Well Completion and Pump Placement for Bladder Pumps

Attachment C—Below Grade Wellhead Completions

Attachment D—Wellhead Completion and Pump Placement for Electrical Submersible Pumps

Attachment A

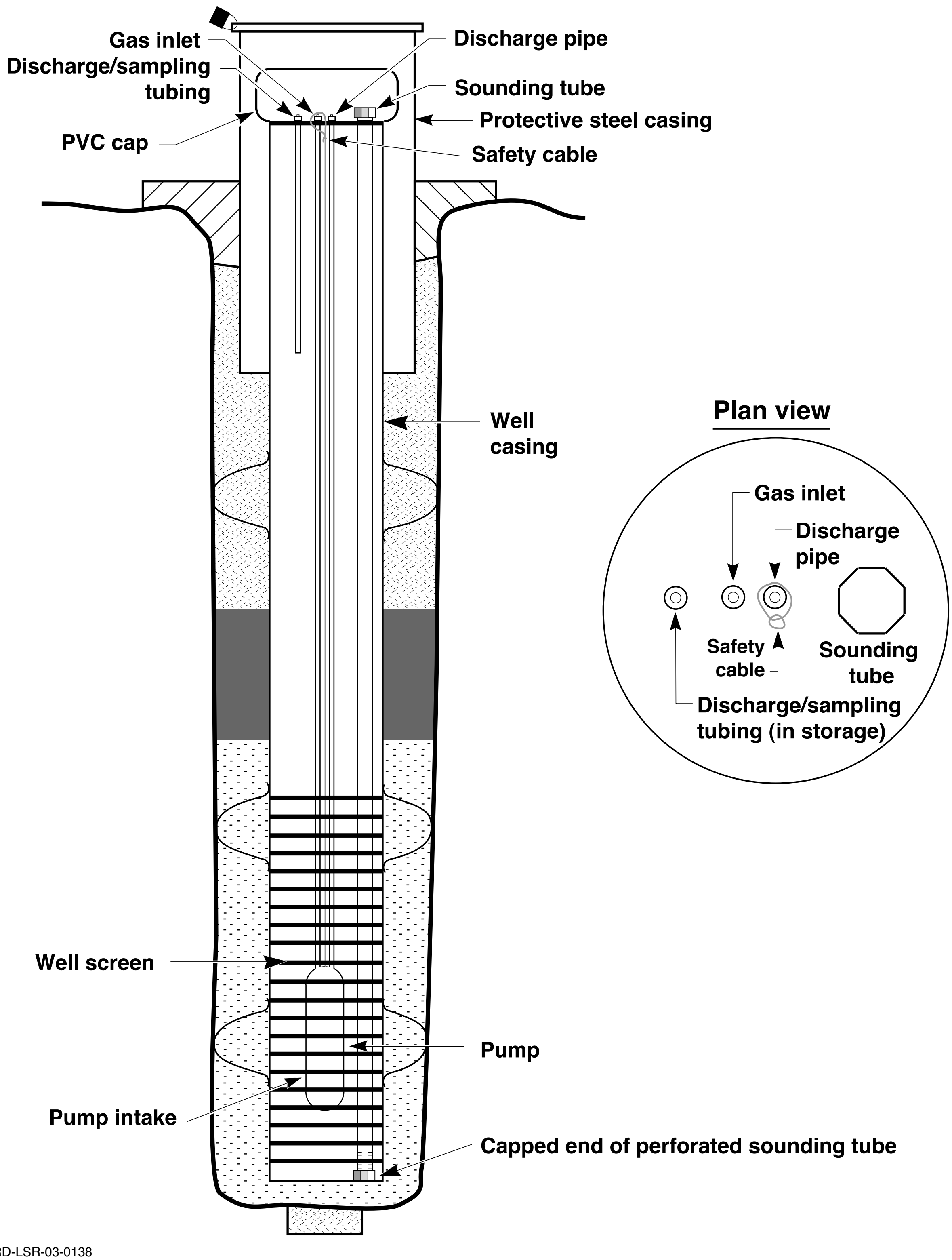
Equipment Checklist

Equipment Checklist

_____ Appropriate wellhead sanitary seals matched to well diameter
_____ Bladder pumps, electric submersible pumps, specific-depth grab sampling devices and bailer
_____ Deep well wire water tight connectors (electrical sub.)
_____ Electrical cable (10- and 12-gauge, 4-wire), power plugs for electric submersible pumps, cable connectors (water tight)
_____ Fittings and valves for sampling tee's
_____ Schedule 80 polyvinyl chloride (PVC) pipe (1 to 2 in. depending on pump size) for discharge tubes on electric submersible pumps, sch. 80 pipe couplers (threaded)
_____ Schedule 120-40 PVC pipe (1 in.) to be used as sounding tubes for water level measurements
_____ Slip to slip well casing couplers
_____ Slip to thread couplers for sounding tubes
_____ Stainless steel safety cable (1/8 in.) to span the distance from pump to top of the well casing
_____ Discharge tubes for bladder pumps and Quick-connect fittings for tubing
_____ Threaded plugs for discharge and sounding pipes (electrical sub.)
_____ Tool kit
_____ Torque arrestor

Attachment B

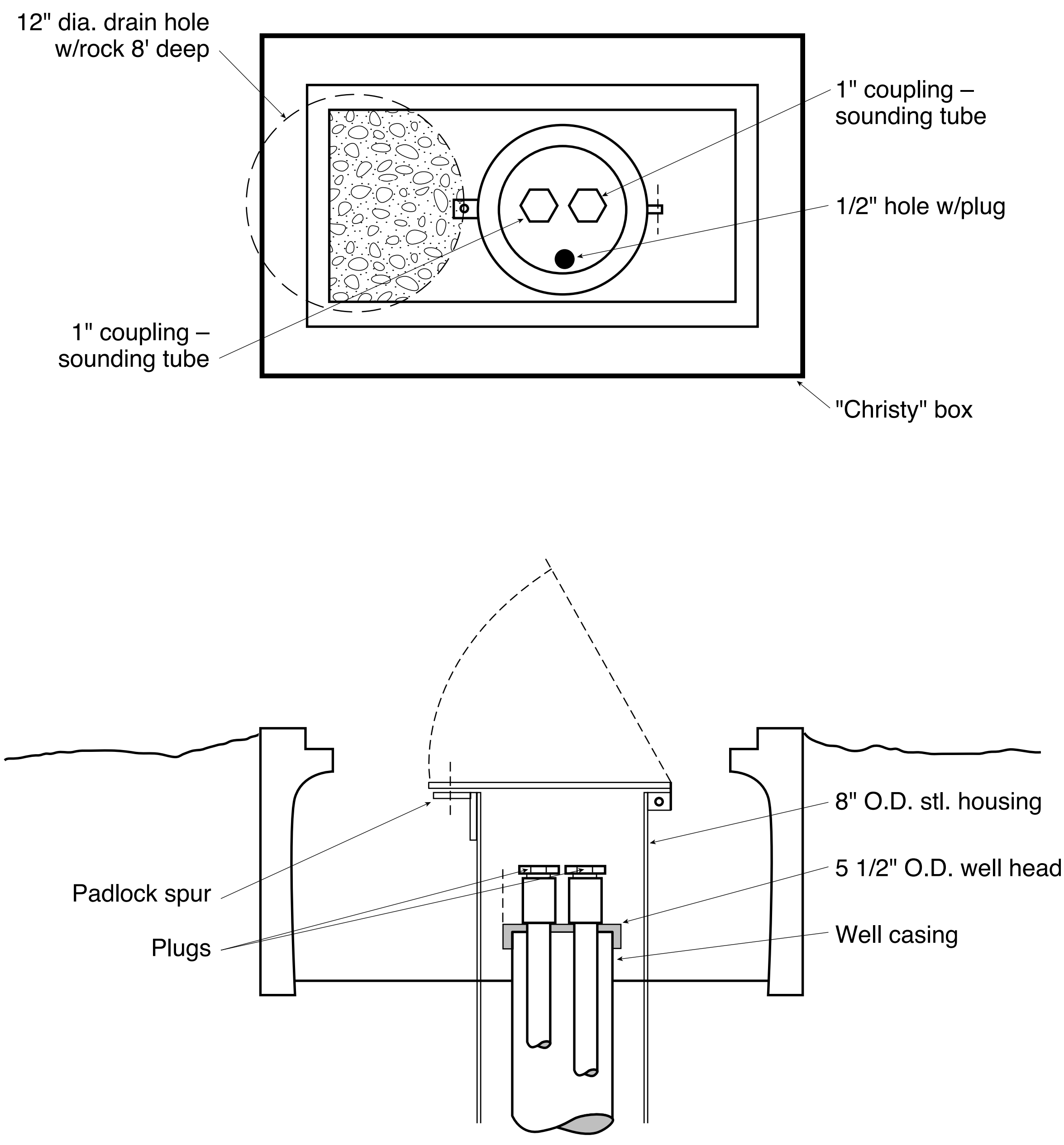
Well Completion and Pump Placement for Bladder Pumps



Attachment B. Wellhead completion and pump placement for bladder pumps.

Attachment C

Below Grade Wellhead Completions



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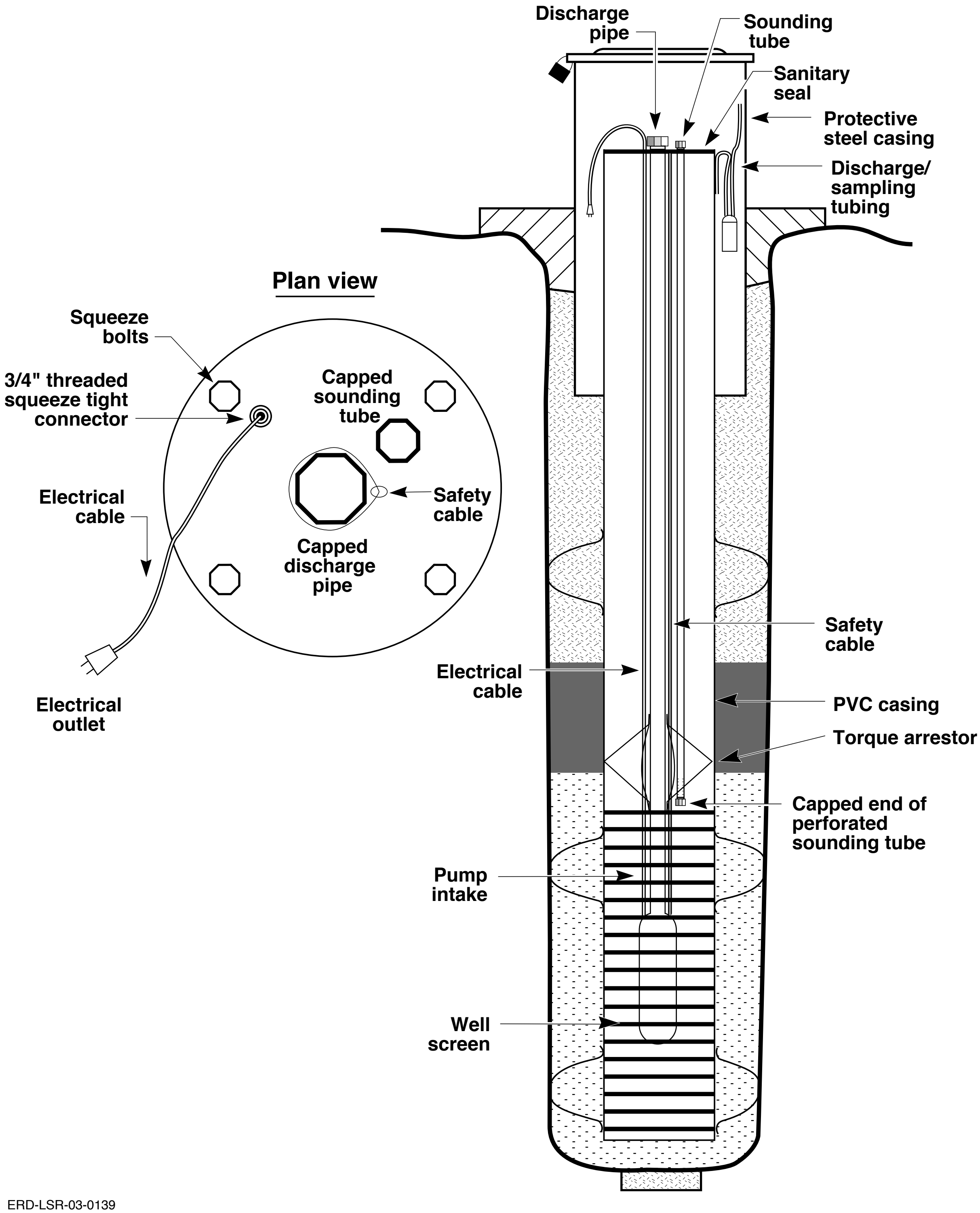
Attachment C. Below grade wellhead completions.

Attachment D

Wellhead Completion and Pump Placement for Electric Submersible Pumps



Attachment D. Wellhead completion (at the Livermore Site) and pump placement for electric submersible pumps.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 2.9: Sampling for Tritium in Ground Water—Revision: 8

AUTHOR(S):
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APPROVALS:	**Date**
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Leslie Ferry — Site 300 Program Leader	12/15/15

CONCURRENCE:	**Date**
Rebecca Goodrich — QA Implementation Coordinator	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to define the procedures for the collection of ground water samples for tritium analysis that are representative of the aquifer of interest.

2.0 APPLICATIONS

This procedure applies to the collection of water samples to be analyzed for tritium. ERD work activities are conducted within the framework of the institutional Integrated Safety Management

System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Morse, S.I. (1997), San Francisco Bay Regional Water Quality Control Board, Toxics Cleanup Division; letter to Interested Parties. Subject: *Utilization of Non-Purge Approach for Sampling of Monitoring Wells Impacted by Petroleum Hydrocarbons, BTEX, and MTBE,* File: 1123.64, January 31, 1997.

3.2 Robbins, G.A. and J.M. Martin-Hayden (1991), Mass Balance Evaluation of Monitoring Well Purging: Part 1. Theoretical Models and Implications for Representative Sampling, *J. Contam. Hydrol.* 8, 203–224.

3.3 Schilling K.E. (1995), Low-Flow Purging Reduces Management of Contaminated Groundwater, *Environmental Protection*, December 1995.

3.4 Taffet, M., J.A. Oberdorfer, T.M. Carlsen, W.R. Dugan, and R.S. Mateik (1990), *Remedial Investigation of the Building 850/East Firing Area, Lawrence Livermore National Laboratory Site 300,* Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-ID-104335).

3.5 U.S. Environmental Protection Agency (EPA) (1996), Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, *Ground Water Issue*, EPA/540/S-95/504.

3.6 U.S. Environmental Protection Agency (EPA) (1995), *Use of Low-Flow Methods for Ground Water Purging and Sampling: An Overview*, Quick Reference Advisory (December 1995).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the

Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sampling Coordinator (SC)

The SC's responsibility is to supply a quarterly Sampling Plan to the Field Personnel and track sample collection throughout the quarter to ensure completion of the sampling plan within the specified sampling quarter.

5.6 Field Personnel (FP)

The FP are responsible for properly performing ground water tritium sampling in compliance with all applicable regulations and procedures.

6.0 PROCEDURES

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities described in SOP 4.1, "General Instructions for Field Personnel," including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.1.2 Review all pertinent sampling information, such as the quarterly Sampling Plan and electronically generated Ground Water Sampling Data Sheets. The plan and/or contains the following information:

- Locations to be sampled.
- Proposed sampling methods (See SOP 2.1, "Pre-sample Purging of Wells," Attachment A, Methodology Sampling Codes).

- Requested analyses.
- Method specific sample collection instructions e.g., E300.0:PERC (EPA Method 314).
- Contract analytical laboratory (CAL) to which samples are to be sent for analyses.
- Estimated amount of purge water to be collected.
- Current technical information for each well.

6.1.3 Obtain appropriate data collection forms i.e., Chain-of-Custody (CoC) forms, Ground Water Sampling Data Sheets (SOP 2.1, Attachment B), assigned Document Control Logbook, labels, and any necessary shipping forms. Instructions for completing the logbook entries and field forms are provided in SOP 4.2, "Sampling Control and Documentation."

6.1.4 The appropriate number and type of sample containers needed for the sampling event should be obtained from the sample bottle inventory. The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirement. See SOP 4.3, "Sample Containers and Preservation."

6.1.5 The appropriate personnel should keep a sufficient stock of sample containers and maintain an inventory of supplies (e.g., trip blanks, field blank water ordered from the contract analytical laboratory [CAL], plastic bags, etc.) to ensure adequate sampling supplies are available at all times.

6.2. Safety Considerations

6.2.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.2.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.3 Purge Water Collection

At Site 300, the FP must ensure there are sufficient collection drums, carboys, or the appropriate portable tank available for purge water containment (SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids"). The quantity of purge water to be collected for each well is calculated by the field personnel based on the prescribed sample method. At some wells, purge water is collected in a portable tank for transport to a designated treatment facility for treatment.

The Livermore Site Field Personnel will tow a collection tanker with the sampling vehicle when necessary. Tankers and drums filled with purge water may not be left at the well location and will be logged and disposed of daily, when possible according to

SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids."

6.4 Field Preparation

6.4.1 Check with the Facility point of Contact (FPOC) or the Functional Area Supervisor (FAS) for area access and insure that permission for offroad travel has been granted, if applicable per SOP 4.1, "General Instruction for Field Personnel". The Administrative Escort Services must be given a 24-hour notification before work is scheduled in restricted areas at Site 300.

6.4.2 Assemble all necessary supplies, packing materials, and appropriate sampling equipment. Load into the field sampling vehicle. Refer to Equipment Checklist (Attachment A).

6.4.3 Decontaminate any nondedicated equipment that will be used per SOP 4.5, "General Equipment Decontamination."

6.4.4 Locate monitor wells to be sampled and choose most efficient sampling order. Sample from areas with the lowest tritium activity to the areas with the highest activity, if possible.

6.4.5 Fill-out any initial information in the Document Control Logbook per instructions in SOP 4.2.

6.5 Operation

If the well contains an electric submersible pump, only enough presample purging is done to remove all stagnant water residing in the discharge line of the pump. However, many of the monitor wells do not have dedicated purging/sampling equipment. For these wells, samples are collected using a bailer or by attaching a sample container to the probe of an electric water level indicator.

6.5.1 Sample Collection with Electric Submersible Pump

The collection of tritium samples using this type of device is consistent with that described in SOP 2.3, "Sampling Monitor Wells with Electric Submersible Pumps." When using the electric submersible pump, purge the required volume of water prior to sample collection to remove stagnant water from the discharge line. Collect and treat water per SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids," or SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids."

6.5.2 Sample Collection with Bailer

Bailing is described in SOP 2.4, "Sampling Monitor Wells with a Bailer." This procedure is generally followed in sampling for tritium in ground water, except that no presample well purging is necessary.

6.5.3 Sample Collection with Water Level Indicator

Attaching a 40 mL volatile organic analysis (VOA) vial to the probe of an electric water level indicator with a polyethylene cable tie is a simple means of sampling for tritium.

A. Uncap and attach a clean sample container to the probe of the water level indicator using a polyethylene cable tie. The container should be attached about 3 to 4 in. from the tip of the probe if a water level measurement is to be obtained during sample collection (Refer to SOP 3.1, "Water-Level Measurements").

B. Slowly lower the probe and sample container into the monitor well. Lower the container so it will fill completely, and then slowly reel the probe and container back to the surface.

C. Detach the container from the water level probe and cap container. Clean the water level indicator as discussed in SOP 3.1.

D. Immediately label the sample container, place into a air tight plastic bag, and store in a cooler (refer to SOP 4.3).

E. Record all sampling information (e.g., well ID, method of collection, and date) per SOP 4.2, in the Document Control Logbook and Ground Water Sampling Data Sheet (SOP 2.1, Attachment B).

6.5.4 Tritium Sample Collection With a Specific-Depth Sampling Device

No pre-sample purge is required when using this device. The sample is taken from a specific portion of the screened interval (refer to SOP 2.6, 6.4.2 D, "Sample Retrieval—Specific-Depth Grab Sample Device").

6.6 Post Field Operation

6.6.1 Perform post operation activities per SOP 4.1.

6.6.2 Before leaving the sampling location, verify that the appropriate samples have been collected according to the samples scheduled on the Ground Water Sampling Data Sheets.

6.6.3 Prior to sampling another site and to prevent cross contamination of equipment between locations, thoroughly decontaminate all equipment that is not dedicated according to SOP 4.5.6.6.4 Complete the appropriate Ground Water Sampling Data Sheet and record sampling information in the assigned Document Control Logbook (SOPs 2.1 and 4.2).

6.6.5 Verify that the CoC is appropriately completed per SOP 4.2. Indicate any special instructions in the Remarks Section of the CoC. Such instructions may include a request for the laboratory to filter and preserve the sample upon receipt or to analyze trip blanks only if hits are detected in associated samples.

6.6.6 Deliver Ground Water Sampling Data Sheets and CoC forms to the SC daily.

6.6.7 The SC will retain a copy of the original forms (CoC, Ground Water Sampling Data Sheets), and provide the originals to the Data Management Team (DMT) for final archive. The SC will provide copies of the forms to the Environmental Functional Area (EFA) Analyst, as necessary.

6.6.8 Leave routine samples and proper documentation in the environmental sample drop-off shed for the CAL. Field Personnel will ship samples and/or distribute to the appropriate laboratories. Ensure that the samples requiring refrigeration remain at ≤ 6°C, but do not allow them to freeze. Always ensure that proper chain of custody is maintained.

7.0 QA RECORDS

7.1 Document Control Logbooks

7.2 Ground Water Sampling Data Sheets

7.3 Chain-of-Custody form

8.0 ATTACHMENT

Attachment A—Equipment Checklist

Attachment A

Equipment Checklist

Equipment Checklist

____ Generator
____ Two-way radio
____ Water-level indicator
____ Indicator refence bar
____ Polyethylene cable ties
____ Ziploc-type bags
____ 40 mL VOA vials or other appropriate glass sample containers
____ Coolers
____ Deionized water
____ Document control logbook
____ Tool kit
____ Disposable latex gloves
____ Snake chaps (if necessary)
____ Squirt bottle
____ Detergent soap
____ Pencils, pens
____ Sample labels
____ Paper towels
____ Bailer/rope

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 2.10: Well Disinfection and Coliform Bacteria Sampling—Revision: 5

ENVIRONMENTAL RESTORATION DEPARTMENT
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ERD

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APPROVALS:	**Date**
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CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to describe a chlorination procedure to disinfect monitor wells prior to collecting ground water samples that will be analyzed for coliform bacteria as recommended in Appendix C of the manual, *"Water Well Standards: State of California."*

2.0 APPLICABILITY

This procedure is applicable to the disinfection of monitor wells prior to sampling for total and fecal coliform bacteria. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management

System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Driscoll, G.F. (1986), *Groundwater and Wells*, Second Edition, Johnson Division, St. Paul, Minn.

3.2 Lamarre, A.L. (1989), *Sampling and Analysis Plan for Coliform Bacteria in Water From Selected Site 300 Monitor Wells*, Memo, Lawrence Livermore National Laboratory, Livermore, Calif.

3.3 State of California Department of Water Resources Agency (1981), Appendix C, Manual, "Water Well Standards: State of California," Sacramento, Calif.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.4 Sampling Coordinator (SC)

The SC's responsibility is to supply a quarterly Sampling Plan to the Field Personnel, which includes the wells to be sampled for coliform bacteria. A spreadsheet indicating the amount of disinfectant to apply to each well prior to sampling for coliform bacteria is also provided by the SC. The SC ensures that scheduled sampling is completed within the specified sampling quarter and that fieldwork is conducted in compliance with applicable SOPs.

5.5 Field Personnel (FP)

The FP are responsible for disinfecting the wells, pumping, testing for residual chlorine, and sampling the wells following the instructions provided in this procedure.

6.0 PROCEDURES

At the direction of the SC, the designated wells are disinfected in preparation for total and fecal coliform bacteria sampling. The wells are disinfected to remove any bacteria within the well casing. Each well will receive a dose of chlorine solution containing at least 100 mg/L of available chlorine. A calculation will be made to determine the appropriate amount of chlorine to add based upon the volume of water in the well casing.

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities described in SOP 4.1, "General Instructions for Field Personnel," including participation in the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.1.2 The wells to be sampled for coliform bacteria will be included in the quarterly Sampling Plan provided by the SC. Prior to sample collection, all calculations will be made and appropriate chlorination performed.

6.1.3 A 5.25 % sodium hypochlorite solution (standard household bleach) is routinely used. The U.S. EPA recommends using a solution with a minimum concentration of 100 mg/L for proper sterilization. The following formula is used to calculate the quantity of sodium hypochlorite to be added to the well:

Volume hypochlorite (oz.) = (W) (128) (R/P)

where

W = water volume in well (gal),

R = required hypochlorite concentration in the well (decimal), and

P = Percent available chlorine (decimal).

6.1.4 When using the above equation, the required hypochlorite concentration and percent available chlorine should be in decimal form. For example: 100 mg/L = 100 ppm = 100/1,000,000 = 0.0001; percent available chlorine of 5.25% = 0.0525. The volume (gal) is the amount of water in the well casing (casing volume) and is calculated as per ERD SOP 2.1, "Presample Purging of Wells." These calculations should be documented on the appropriate field forms.

6.1.5 Inform the contract analytical laboratory ahead of time to allow for preparation when collecting samples on a rush turn-around time or samples having short hold times.

6.1.6 Field Personnel are to ensure that adequate containment devices are available at the wellhead for purge water collection. The quantity of purge water to be collected for each well is listed on the Sampling Plan.

6.1.7 Ensure that an adequate amount of 5.25% sodium hypochlorite (standard household bleach) is available. If 5.25% sodium hypochlorite is not available, it is acceptable to use a higher percent concentration of chlorine solution, such as 6% sodium hypochlorite (also considered standard laundry household bleach). The above calculation will be adjusted accordingly from 5.25% to 6.0%. Use a fresh supply for every sampling event.

6.1.8 Ensure the availability of a pool test kit with the appropriate solution to test for chlorine in water which measures in the ppm range.

6.2. Safety Considerations

6.2.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.2.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.3 Purge Water Collection

At Site 300, the FP must ensure there are sufficient collection drums, carboys, or the appropriate portable tank available for purge water containment (SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids"). The quantity of purge water to be collected for each well is calculated by the field personnel based on the prescribed sample method. At some wells, purge water is collected in a portable tank for transport to a designated treatment facility for treatment.

The Livermore Site Field Personnel will tow a collection tanker with the sampling vehicle when necessary. Tankers and drums filled with purge water may not be left at the well location and will be logged and disposed of daily, when possible according to SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids."

6.4 Operation

6.4.1 Add the calculated amount of 5.25% or 6.0% sodium hypochlorite to the well. Use the pump to recirculate the water to ensure thorough mixing of the disinfectant with the well water. Turn the pump on and off several times during this procedure.

6.4.2 After disinfection, the water in each well will be allowed to stand for 24 hours. After 24 hours the water should be pumped until the presence of chlorine is no longer detectable. Test for the presence of chlorine by using a pool test kit according to the manufacturer's instructions. Once the water is free of residual chlorine, a sample may be collected in a pre-sterilized polyethylene container provided by the analytical laboratory to which the sample will be submitted for analysis. Laboratory specific sample volume and container type requirements are available under "Find Analysis Suites" in The Environmental Information Management System (TEIMS) database.

6.5 Post Operation

6.5.1 Perform post operation per SOP 4.1.

6.5.2 Before leaving the sampling site, cross check sample container information to information recorded in the logbook.

6.5.3 To maintain and document sample custody, follow the procedure for completing a Chain-of-Custody (CoC) form in SOP 4.2, "Sample Control and Documentation."

6.5.4 After all samples are collected and preserved as necessary, any non-dedicated sampling equipment should be decontaminated prior to sampling another site in order to prevent cross-contamination of equipment between locations (see SOP 4.5, "General Equipment Decontamination").

6.5.5 Deliver all field logbook notes (upon request), Ground Water Sampling Data Sheets, and (CoC) forms to the SC daily.

6.5.6 The SC will retain copies of the Ground Water Sampling Data Sheets and provide the originals to the Data Management Team (DMT) for final archive. The SC will also provide copies of the forms to the appropriate Environmental Functional Area (EFA) Analyst, as necessary.

6.5.7 Submit the coliform samples to the analytical laboratory as soon as possible due to the short holding time for coliform analyses (6 hours).

7.0 QA RECORDS

7.1 Ground Water Sampling Data Sheets

7.2 Document Control Logbooks

7.3 Chain-of-Custody Forms

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Division (ERD)
Standard Operating Procedure (SOP)

ERD SOP 3.1: Water-Level Measurements—Revision: 7

AUTHOR(S):
E. Walter

APPROVALS:	**Date**
Division Leader	6/30/06
Hydrogeology & Decision Support Group Leader	4/10/06

CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	6/21/06

1.0 PURPOSE

The purpose of this SOP is to determine the depth to water from a standard point of measurement (POM) in an open borehole, cased borehole, monitor well, or piezometer.

2.0 APPLICABILITY

This SOP applies to the usage of an electronic water-level indicator to collect ground water elevation data for use during ground water sampling, as well as for use in constructing graphical displays (i.e., potentiometric surface maps and monitor well hydrographs). ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 U.S. EPA (1986), *RCRA Ground Water Monitoring Technical Enforcement Guidance Document*, Washington, D.C.

3.2 U.S. EPA (1992), *RCRA Ground Water Monitoring: Draft Technical Guidance*, Washington, D.C. (EPA/530-R-93-001).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Division Leader (DL)

The DL's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely, comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Project Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an IWS, and there is sufficient funding to initiate the work.

5.3 Field Personnel (FP)

While at the well site, any needed repairs should be recorded on the Well Maintenance form and submitted to the Field Operations Manager with a copy to the Sampling Coordinator. The field personnel are responsible for properly performing water-level measurements in compliance with all applicable SOPs, IWSs, and any other applicable safety or procedural related documents to ensure that the resulting data accurately represent the true hydrogeologic conditions.

5.4 Aquifer Testing Coordinator (ATC)

The ATC's responsibility is to verify the accuracy of the water-level measurement(s) and compare the new data to historical data and decide if it is consistent or suspect.

5.4 Data Management Team (DMT)

The DMT is responsible for the generation of all applicable Water-Level Measurement Field Sheets used to record the water level data. Upon completion of the water level monitoring, the DMT is also responsible for entering the data into the database. The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURE

6.1 Preparation

6.1.1 Prior to collecting water-level measurements, perform the applicable preparation activities described in SOP 4.1, "General Instructions for Field Personnel". Personnel who are new to the LLNL project will receive direct field supervision and on-the-job training (OJT) from a Subject Matter Expert (SME) for at least the first 24 hours of field activity using the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.1.2 If the water-level data are being collected for the entire site, the Water-Level Measurement Field Sheet, obtained from the DMT, should be used (Attachment A). If the data are being collected as part of a hydraulic test, consult SOP 3.2, "Pressure Transducer Field Calibration"; 3.3, "Hydraulic Testing (Slug/Bail)"; or

3.4, "Hydraulic Testing (Pumping)," as appropriate. If the data are being collected during ground water sampling, SOP 2.1, "Pre-sample Purging of Wells" or 2.7, "Pre-sample Purging and Sampling of Low-Yielding Monitor Wells should be followed, as appropriate.

6.1.3 Obtain a Water-Level Measurement Field Sheet that includes the previous month's water levels from the DMT.

6.1.4 The device used to measure water levels should attain an accuracy of 0.01 ft. A steel tape or an electronic water-level indicator can be used to measure water levels, but this SOP concerns only the use of an electronic water-level indicator.

6.1.5 For Site 300, electronic water-level indicators can be acquired at Building 833. When practical, the same portable water-level measurement device should be used for all measurements. However, Site 300 is divided into two areas with respect to water levels. In the northern portion of the site, also referred to as the East/West Firing Area (EWFA), tritium is the prevailing contaminant. The southern portion of the site is predominately contaminated with volatile organic compounds (VOCs). In order to prevent cross contamination between monitor wells, the electronic water-level indicators must be decontaminated according to SOP 4.5, "General Equipment Decontamination." If an indicator is dedicated to a particular section of the site, or a particular well, it will be marked accordingly.

6.1.6 For the Livermore Site, the same water-level device may be used site wide, except in areas of heavy gasoline contamination. In order to prevent cross contamination between monitor wells, the electronic water-level indicators must be decontaminated according to SOP 4.5, "General Equipment Decontamination."

6.1.7 Obtain the equipment on the Equipment Checklist (Attachment B).

6.1.8 Make sure water-level measuring equipment is in good operating condition.

6.1.9 Whenever possible, start at those wells that are the least contaminated and work towards more contaminated areas as indicated by the ATC.

6.1.10 Clean all equipment per SOP 4.5 before use.

6.2 Safety Considerations

6.2.1 The procedures described in the following sections will be conducted in accordance with LLNL Integration Work Sheet (IWS) 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 11343 "Routine Groundwater Sampling and Water Level Monitoring" at Site 300.

6.3 Water-Level Measurement Procedure

6.3.1 Unlock and open the protective casing. Remove the well casing cap.

6.3.2 Make sure there is a Well Entry Logbook inside the protective casing. Replace the old or unusable logbooks and give to the DMT for archival. Write the date, purpose of well entry, and initials in the logbook.

6.3.3 Use the top of the protective casing (stove pipe or Christy Box) as the measuring reference point. This is the POM to be used when obtaining water-level measurements. Any deviation from this measuring point must be documented on the Water-Level Measurement Field Sheet (Attachment A) and reported to DMT and the ATC.

6.3.4 Measure the distance from the water surface to the POM by placing a steel indicator reference bar (or something comparatively straight and rigid) over the top of the protective casing or Christy Box then, lower an electronic water-level indicator into the sounding port. Insertion into the pump discharge line (usually of the same diameter) will give a false reading. Using the electronic water-level indicator, a light (usually red) will shine on the reel of the water-level indicator, and an audible buzz will sound when water is encountered. Slowly move the line up and down along the side of the reference bar until the exact point at which the buzz is heard is located. Using the bottom of the reference bar as the measuring point, obtain the depth-to-water measurement by referencing the markings on the water-level indicator line to the buzzing tone red indicator light. The water level indicator may then be removed and cleaned (per SOP 4.5).

6.3.5 Compare the new measurement to last month's water level as displayed on the Water-Level Measurement Field Sheet (Attachment A) and to previous water-level measurements written in the Well Entry Logbook.

6.3.6 Record measurement, date, and any notes next to last month's water level on the Water-Level Measurement Field Sheet (Attachment A). If the water-level measurement seems suspect or if there is a 0.5 ft difference from the last reading, then re-check water-level measurement. Place a check mark next to the well ID on the Water-Level Measurement Field Sheet to indicate that the measurement was verified.

6.3.7 Record measurement in the Well Entry Logbook and replace logbook in well.

6.3.8 Replace well cap and lock the protective casing and/or replace Christy Box lid.

6.4 Post Operation

6.4.1 Follow post operation activities described in SOP 4.5, Section 6.2.3.

6.4.2 Store water-level indicator in a clean, protected area during transport to the next well and after work is completed.

6.4.3 Forward original Water-Level Measurement Field Sheet to DMT.

7.0 QA RECORDS

7.1 Well Entry Logbook

7.2 Water-Level Measurement Field Sheet

8.0 ATTACHMENTS

Attachment A—Example of Water-Level Measurement Field Sheet

Attachment B—Equipment Checklist

Attachment A

Example of Water-Level Measurement Field Sheet

WELL	New Date	New DTW	Prev DTW	Prev Date	Grndwtr Elev	Shiner Elev	POM Elev	Casing Height	PrevNote	NewNote
W-830-04A	-APR-06		43.44	27-Jan-06	580.66	621.10	624.10	3.00		
W-830-05	-APR-06		25.22	27-Jan-06	559.15	582.37	584.37	2.00		
W-830-07	-APR-06		0	27-Jan-06		631.80	634.80	3.00	DRY	
W-830-09	-APR-06		102.8	23-Jan-06	594.30	694.10	697.10	3.00		
W-830-10	-APR-06		16.07	23-Jan-06	580.63	594.12	596.70	2.58		
W-830-11	-APR-06		33.44	26-Jan-06	562.75	594.69	596.19	1.50		
W-830-12	-APR-06		99.25	23-Jan-06	593.37	692.62	692.62	0.00		
W-830-13	-APR-06		26.19	27-Jan-06	538.32	562.51	564.51	2.00		
W-830-14	-APR-06		20.1	27-Jan-06	545.40	563.50	565.50	2.00		
W-830-15	-APR-06		0.53	27-Jan-06	564.56	565.09	565.09	0.00	CB	
W-830-16	-APR-06		94.2	31-Jan-06	576.68	668.87	670.88	2.01		
W-830-17	-APR-06		109	31-Jan-06	564.22	671.75	673.22	1.47		
W-830-18	-APR-06		0	30-Jan-06		652.49	654.49	2.00	NM/DRILLING	
W-830-19	-APR-06		39.7	23-Jan-06	616.14	655.84	655.84	0.00		
W-830-20	-APR-06		13.47	26-Jan-06	583.49	594.95	596.96	2.01		
W-830-21	-APR-06		0	30-Jan-06		651.93	653.94	2.01	NM/DRILLING	
W-830-22	-APR-06		47.5	23-Jan-06	607.52	655.02	655.02	0.00	CB	
W-830-25	-APR-06		23.7	23-Jan-06	596.64	617.74	620.34	2.60		
W-830-26	-APR-06		66.3	23-Jan-06	592.23	652.53	658.53	6.00		
W-830-27	-APR-06		20.95	23-Jan-06	603.31	620.26	624.26	4.00		
W-830-28	-APR-06		32.65	23-Jan-06	589.51	619.16	622.16	3.00		
W-830-29	-APR-06		593.65	23-Jan-06	67.38	661.03	661.03	0.00	CB	
W-830-30	-APR-06		19.75	23-Jan-06	672.76	692.51	692.51	0.00		
W-830-34	-APR-06		20.4	23-Jan-06	671.95	692.35	692.35	0.00	CB	
W-830-49	-APR-06		37.9	23-Jan-06	628.54	664.44	666.44	2.00		
W-830-50	-APR-06		28.67	26-Jan-06	580.47	607.13	609.14	2.01		
W-830-51	-APR-06		0	30-Jan-06		563.76	567.27	3.51	FL	
W-830-52	-APR-06		0	30-Jan-06		569.87	573.38	3.51	FL	
W-830-53	-APR-06		0	31-Jan-06		572.56	576.07	3.51	NO FL	
W-830-54	-APR-06		52.9	31-Jan-06	550.12	601.03	603.02	1.99		
W-830-55	-APR-06		85.4	31-Jan-06	578.64	662.05	664.04	1.99		
W-830-56	-APR-06		31	27-Jan-06	545.82	574.83	576.82	1.99		
W-830-57	-APR-06		50	23-Jan-06	589.87	636.75	639.87	3.12		
W-830-58	-APR-06		23.7	23-Jan-06	609.38	630.88	633.08	2.20		
W-830-59	-APR-06		54.8	23-Jan-06	611.31	666.11	666.11	0.00		
W-830-60	-APR-06		45	27-Jan-06	592.39	635.41	637.39	1.98		
W-831-01	-APR-06		130.8	23-Jan-06	642.69	770.49	773.49	3.00		
W-830-1730	-APR-06		24.58	11-Jan-06	523.52	546.10	548.10	2.00		
W-830-1807	-APR-06		31.9	23-Jan-06	661.10	691.00	693.00	2.00		
W-830-1829	-APR-06		51.35	23-Jan-06	607.65	657.00	659.00	2.00		
W-830-1830	-APR-06		55.1	23-Jan-06	605.90	661.00	661.00	0.00		
W-830-1831	-APR-06		164.2	31-Jan-06	580.51	742.71	744.71	2.00		
W-830-1832	-APR-06		159.1	31-Jan-06	590.77	747.87	749.87	2.00		
W-832-01	-APR-06		35.7	23-Jan-06	670.36	704.06	706.06	2.00		
W-832-05	-APR-06		32.45	23-Jan-06	686.22	718.67	718.67	0.00	CB	
W-832-06	-APR-06		26.2	23-Jan-06	694.65	720.85	720.85	0.00		
W-832-09	-APR-06		72.45	23-Jan-06	634.77	705.22	707.22	2.00		
W-832-10	-APR-06		36.75	23-Jan-06	649.40	684.15	686.15	2.00		
W-832-11	-APR-06		30.35	23-Jan-06	668.30	696.65	698.65	2.00		
W-832-12	-APR-06		24.5	23-Jan-06	696.97	721.47	721.47	0.00	CB	
W-832-13	-APR-06		21.2	23-Jan-06	701.46	722.66	722.66	0.00	CB	

Attachment B

Equipment Checklist

Equipment Checklist

____ Two-way radio

____ Water-level indicator (with extra batteries)

____ Indicator reference bar

____ De-ionized water

____ Squirt bottle

____ Disposable gloves

____ Tool kit

____ Snake chaps (if necessary)

____ Appropriate maps

____ Water-Level Measurement Field Sheet

____ Paper towels

____ Pencils, pens

____ Detergent soap

____ Bucket

LLNL Environmental Restoration Division (ERD)
Standard Operating Procedure (SOP)

ERD SOP 3.2: Pressure Transducer Field Calibration—Revision: 3

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ERD</td>
<td colspan="2">AUTHOR(S):
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1.0 PURPOSE

The purpose of this SOP is to ensure accurate and consistent water-level measurements using pressure transducers.

2.0 APPLICABILITY

This procedure is applicable to field personnel who perform pressure transducer calibrations.

3.0 REFERENCES

3.1 Enviro-Labs, Inc., Operator’s Manual, Data Logger DL-120-MCP.

3.2 *In Situ*, Inc. (1984), Owner’s Manual: Hydrologic Analysis System, Model SE200.

3.3 *In Situ*, Inc. (1992), Operator's Manual, Data Logger SENTINEL LTM-3000.

3.4 *In Situ*, Inc. (1997), Operator's Manual, Pressure Transducer PXD-461.

3.5 *In Situ*, Inc. (1998), Operator's Manual, Pressure Transducer PXD-261.

3.6 *In Situ*, Inc. (1999), Operator's Manual, Data Logger HERMIT 3000.

3.7 *In Situ*, Inc. (1999), Operator's Manual, Data Logger TROLL SP4000.

3.8 *In Situ*, Inc. (2000), Operator's Manual, Data Logger MiniTROLL SSP-100.

3.9 *In Situ*, Inc. (2000), User's Guide, Data Logger Software Win-Situ 2000.

3.10 Instrument Northwest, Inc. (1992), Instruction Manual, Data Logger Aquistar DL-1A.

3.11 Instrument Northwest, Inc. (1997), Instruction Manual, Data Logger Aquistar DL-2.

3.12 Instrument Northwest, Inc. (1997), Instruction Manual, Submersible Pressure Transmitter, PS9800.

3.13 Instrument Northwest, Inc. (1997), Instruction Manual, Submersible Pressure/Temperature Transmitter, PS9805.

3.14 Instrument Northwest, Inc. (1997), Instruction Manual, Barometric/Vacuum Pressure Transmitter, BV9000.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Division Leader

The Division Leader’s responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Hydrogeology Group Leader (HGL)

The HGL is responsible for ensuring that proper procedures are implemented for field activities (i.e., drilling, borehole logging and sampling, monitor well installations and development) and to oversee the disposal of investigation derived wastes.

5.3 Subproject Leader (SL)

The SL is responsible for the overall investigation, planning, and assessment and remediation within a study or treatment facility area.

5.4 Field Personnel

Field personnel are responsible for the proper calibration and documentation of the pressure transducers according to this procedure.

6.0 PROCEDURES

6.1 Office Preparation

6.1.1 Coordinate schedules/actions with SL, as appropriate.

6.1.2 Review the operator's manual provided with the electronic data logger, if appropriate.

6.1.3 Check to be sure the electronic data logger is fully charged and that the logger and pressure transducer are operating properly. Test the electronic data logger and transducer using a container of water (e.g., sink or bucket of water). Always bring additional transducers in case of malfunctions.

6.1.4 Enter record of calibration into the Hydraulic Testing Logbook.

6.1.5 Review appropriate sections of the Site Safety Plan.

6.2 Field Preparation

6.2.1 Locate the monitor wells where the pressure transducers will be calibrated and identify the appropriate decontamination areas.

6.2.2 Assemble appropriate testing equipment.

6.2.3 Decontaminate the transducer and cable as specified in SOP 4.5, "General Equipment Decontamination."

6.2.4 Measure the initial water level for the calibration monitor well and record on Hydraulic Test Field Sheet (See SOP 3.3, "Hydraulic Testing [Slug/Bail]," Attachment C).

6.2.5 Before beginning the calibration, record and enter information into the electronic data logger. The type of information may vary depending on the model used. Consult the operator's manual for the proper data entry sequence to be used. For example, the following data is entered into the Enviro-Labs Model DL-120-MCP Data Logger:

1. Baud rate.
2. Station ID.
3. Date (YY/MM/DD).
4. Time (HH:MM:SS).
5. Scale factors for each channel.

6.3 Operation

Several precautions should be taken when using submersible pressure transducers. Silicon diaphragm transducers are fragile and should always be handled carefully to minimize shock. The transducer cable is vented so that temperature and barometric pressure will not cause variations in the transducer reading. If the vent port is plugged, inaccurate readings will result. If water enters the vent and flows downward into the transducer, the transducer may be damaged. The transducer cable is susceptible to both physical damage (e.g., abrasion on sharp well casings) and chemical degradation from solvents. Damaged cable can cause damage to transducers during submergence, and inaccurate readings may result.

6.3.1 Cover sharp edges of the well casing with duct tape to protect the transducer cables.

6.3.2 Connect the transducer cable to the recording device (e.g., Enviro-Labs Data Logger, *In Situ* Hermit, Campbell Micrologger 21X, and other recording devices).

6.3.3 Slowly lower the transducer and cable down the well to a depth below the target drawdown estimated for the test but at least 1 ft from the bottom of the well. Be sure this depth of submergence is within the design range stamped on the transducer. Mark this depth on the cable using a piece of duct tape. A temporary standpipe may be filled and used for transducer calibration if wellhead access is not available.

6.3.4 Partially withdraw the transducer and cable, and accurately measure a distance greater than 3 ft. Mark this depth on the cable using a piece of duct tape. Temporarily tape the transducer cable to a stationary object to keep the transducer at a constant depth.

6.3.5 Display the current water level on the recording device according to the manufacturer's instructions. Record the current water level on the Hydraulic Test Data Sheet.

6.3.6 Lower the transducer the distance measured in step 6.3.4. Record the new water level displayed on the recording device.

6.3.7 Calculate a transducer scale factor correction (SFC) as follows:

SFC = (L/W), where

L= distance that the transducer is lowered during calibration, measured in step 6.3.3, and

W= difference between the two water level measurements on the recording device.

6.3.8 Record the transducer scale factor correction on the Hydraulic Test Field Sheet (SOP 3.3, Attachment C). If the scale factor correction is considerably more than 0.01, then repeat steps 6.3.5 through 6.3.7. If the recalculated scale factor corrections are not similar to each other after three attempts, replace the transducer. Multiply all changes in water level measured by the calibrated transducer by the scale factor correction to obtain actual water level changes.

6.3.9 If transducers are installed for a period exceeding one day, periodically take water level measurements by hand to verify the function and accuracy of each pressure transducer. Transducers installed for one week should be verified daily; installations left for longer periods can be hand-verified less frequently, depending on the required accuracy of the data.

6.4 Post Field Operation

6.4.1 Continue the water-level measurement task (e.g., slug test or pumping test).

6.4.2 Decontaminate the transducer and cable per SOP 4.5 at the completion of the task. Do not use solvents to decontaminate the transducer cable.

6.4.3 Complete shutdown of the electronic data logger:

1. Stop the logging sequence.
2. Save memory and disconnect the battery at the end of the testing activities.

6.4.4 Replace testing equipment in storage containers.

6.5 Office Post Operation

6.5.1 Complete Hydraulic Test Field Sheet (SOP 3.3, Attachment C) and Hydraulic Test Logbook entries. Deliver copies of documentation to the Data Management Team, HGL, and SL, as appropriate.

6.5.2 Arrange for the repair of any transducers that were damaged or could not be calibrated.

7.0 QA RECORDS

7.1 Hydraulic Test Field Sheet

7.2 Logbooks

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Division (ERD) Standard Operating Procedure (SOP)	
ERD SOP 3.3: Hydraulic Testing (Slug/Bail)—Revision: 3	
ENVIRONMENTAL RESTORATION DIVISION CONTROLLED COPY # THIS IS A RED STAMP ERD	**AUTHOR(S):** **Z. Demir and B. Clark**
	APPROVALS: **Date** Albert L Lamarre 3/21/03 **Division Leader** D. Rice 3/20/03 **Environmental Chemistry and Biology Group Leader**
	CONCURRENCE: **Date** Rebecca Goodrich 3/20/03 **QA Implementation Coordinator**

1.0 PURPOSE

The purpose of this SOP is to determine saturated hydraulic conductivity of the sediments near the well screen under *in situ* conditions without pumping the well.

2.0 APPLICABILITY

This procedure is applicable for slug/bail hydraulic testing. Slug/bail tests are only recommended for wells that produce less than 1 gallon per minute.

3.0 REFERENCES

3.1 Bower, H. (1978), *Groundwater Hydrology*, McGraw-Hill, New York, N.Y.

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3.3 Cooper, Jr., H. H., J. D. Bredehoeft, and S. S. Papadopoulos (1967), "Response of a Finite-Diameter Well to an Instantaneous Charge of Water," *Water Resources Research* **13** (1).

3.4 DOI (n.d.), *Ground Water Manual*, U.S. Department of the Interior Publication.

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3.13 Todd, D. K. (1980), *Groundwater Hydrology*, 2d ed., John Wiley & Sons, New York, N.Y.

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4.0 DEFINITIONS

See SOP Glossary**.**

5.0 RESPONSIBILITIES

5.1 Division Leader

The Division Leader's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Hydrogeology Group Leader (HGL)

The HGL is responsible for ensuring that proper procedures are implemented for field activities (i.e., drilling, borehole logging and sampling, monitor well installations and development) and to oversee the disposal of investigation derived wastes.

5.3 Subproject Leader (SL)

The SL is responsible for the overall investigation, planning, and assessment and remediation within a study or treatment facility area.

5.4 Hydrogeologist (HG)

The HG is responsible for preparing the Hydraulic Test Plan (Attachment B) and assisting the field personnel in conducting his/her responsibilities.

5.5 Field Personnel

Field personnel are responsible for conducting and documenting hydraulic testing according to this procedure.

6.0 PROCEDURES

6.1 Discussion

6.1.1 During the slug test, a slug of known volume is lowered into the well displacing that same volume of water. Over time, typically a few hours, the water level returns to static. During the test, water-level measurements are recorded using a pressure transducer and a data logger. These measurements, plotted against time, produce a curve which is then compared to type-curves to determine values of T and K. For a bail test, the slug is removed from the well, and water-level measurements are collected similar to the slug test.

6.1.2 The advantages and limitations of using slug/bail tests to estimate hydraulic properties include: 1) estimates can be made *in situ*, and errors incurred in laboratory testing of disturbed samples are avoided; 2) tests can be quickly performed at a relatively low cost, because a pumping well and observation wells are not required; 3) the hydraulic conductivity of small volumes within an aquifer can be estimated; 4) no treatment, collection, or disposal of pumped water is necessary; 5) only the hydraulic properties of the material very near the well are estimated, and they may not be representative of the average hydraulic properties of the area; 6) certain assumptions are made in the analysis, and if they are inconsistent with the geologic conditions at the site, the slug/bail test results may be invalid; 7) the storage coefficient *(S)* usually cannot be determined; and 8) sufficient data for analysis may not be collected if the hydraulic conductivity of the screened material is relatively high.

6.2 Office Preparation

6.2.1 Review the Hydraulic Testing Plan (Attachment B) with the SL.

6.2.2 Review the Daily Operations Guide, associated SOPs, and appropriate sections of the Site Safety Plan. Information on depth to water, depth of well, screened interval, casing size, and pump size and type is obtained from the Data Management Team (DMT) for established wells, or from the drilling coordinator for new wells.

6.2.3 Coordinate schedules/actions with SL or project HG, as appropriate.

6.2.4 Review the operator's manual provided with the electronic data logger, if appropriate.

6.2.5 Check out and ensure the proper operation of all field equipment. Ensure that the electronic data logger is fully charged, if appropriate. Test the electronic data logger and pressure transducers using a container of water (e.g., sink or bucket of water). Always bring additional transducers in case of malfunctions.

6.2.6 Obtain the Hydraulic Test Logbook and a sufficient number of field forms to complete the field assignment.

6.3 Field Preparation

6.3.1 If the well has a Well Wizard bladder pump or a similar instrument installed, it must be removed at least one day before the test is conducted to allow the water level to return to static.

6.3.2 Locate monitor wells to be tested and appropriate decontamination areas.

6.3.3 Assemble appropriate testing equipment listed in the Equipment Checklist (Attachment A).

6.3.4 To avoid cross-contamination, bailers or measuring devices should be cleaned before and after each test. If water is added to the monitoring well, it should be from an uncontaminated source and be transported in a clean container. Decontaminate the transducer and cable as specified in SOP 4.5, "General Equipment Decontamination."

6.3.5 Calibrate all gauges and transducers before conducting slug test according to SOP 3.2, "Pressure Transducer Calibration." Document instrument calibration in the Hydraulic Test Logbook.

6.3.6 Measure initial water level in monitor well or piezometer according to SOP 3.1, "Water Level Measurement," and record on Hydraulic Test Field Sheet (Attachment C).

6.3.7 Before beginning the slug test, enter and record information in the electronic data logger. The type of information will vary depending on the model used. When using different models, consult the operator's manual for the proper data entry sequence to be used. For example, the following data is entered into the Enviro-Labs Model DL-120-MCP Data Logger:

1. Baud rate.
2. Station ID.
3. Date (YY/MM/DD).
4. Time (HH:MM:SS).
5. Scale factors for each channel.
6. Logging sequence.

6.3.8 Test wells from least contaminated to most contaminated, if possible.

6.4 Operation

The following general procedures will be used to collect and report slug/bail test data. The procedures required for a particular slug/bail test may vary slightly from those described, depending on site conditions. Modifications to the test procedures should be documented on the Hydraulic Test Field Sheet (Attachment C) and Slug Test Schematic (Attachment D).

6.4.1 When the slug/bail test is performed using an electronic data logger and pressure transducer, most of the data will be electronically stored internally or on computer diskettes or tape. The information will be transferred directly to the main computer and analyzed. A Hydraulic Test Field Sheet (Attachment B) with supplemental information and a computer printout of the data should be maintained with the DMT as documentation.

6.4.2 The time required to complete a slug test is a function of the volume of the slug, the transmissivity of the formation, and the well casing size. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. Test length may range from less than a minute to several hours.

6.4.3 Slug tests must be conducted on relatively undisturbed wells. If a test is conducted on a well that has recently been pumped, measure the water level within 0.1 ft of the static water level before sampling. At least one week should elapse between well development and the slug test.

6.4.4 The slug will have to remain completely submerged throughout the test, so the height of the static water column must be greater than the length of the slug.

6.4.5 A pressure transducer must hang below the bottom of the submerged slug so a portion of the water column must be available for the transducer.

6.4.6 The slug diameter must be small enough so that it will not disturb the transducer cable when the slug is lowered.

6.4.7 Although a larger slug is desired when possible, using a large slug that is unwieldy can result in unnecessary difficulties and/or damage to the pressure transducer.

6.4.8 Well diameter, screened interval, total depth, and most recent, depth-to-water information should be used to determine the appropriate slug size. A slug of appropriate size may need to be constructed.

Note: In general, slug size will not be restricted by the height of the water column, but double check to prevent having to redo a test.

6.4.9 The Hydraulic Test Field Sheet (Attachment B) is used to record observations and supplemental information. Complete the form as follows:

1. Site Location. Brief description of the general location of the well.
2. Well ID. Unique number assigned to each well where measurements are taken.
3. Date. The date of the test.
4. Make of logger used (Campbell or Hermit) and the make and serial number of the transducer used.

5. Slug Dimensions or Volume of Water. Dimensions of the slug or displacement object in tenths of feet.
6. Personnel. Initials of personnel performing field measurements or collecting samples.
7. Test Type. The slug device is either injected (slug) or withdrawn (bail) from the monitor well. Note the appropriate test type.
8. Comments. Appropriate observations or information for which no other blanks are provided.
9. Elapsed Time (min:sec). Cumulative time readings from beginning of test to end of test in minutes and seconds.
10. Depth to Water (ft). Depth of water recorded in tenths and hundredths of feet.

6.5 Procedure for Conducting a Slug/Bail Test.

6.5.1 Measure the static water level in the well, and record in the Hydraulic Test Logbook and on the Hydraulic Test Field Sheet (Attachment C). The point and time of measurement should be noted on the Hydraulic Test Field Sheet (Attachment C) and in the wellhead logbook.

6.5.2 Cover sharp edges of the well casing with duct tape to protect the transducer cables.

6.5.3 Connect the transducer cable to the electronic data logger.

6.5.4 Slowly lower the transducer and cable down the well to a depth below the slug submergence for the test, but at least 1 ft from the bottom of the well. Be sure this depth is within the design range stamped on the transducer. To keep the transducer at a constant depth, securely tape the transducer cable to a stationary object.

6.5.5 Firmly tie one end of the rope to the slug. From the top of the slug, measure a length slightly greater than the depth-to-water, and mark the rope with a duct tape tag. Then, measure the length needed at the duct tape tag to hang the slug a few inches above the static water level, and mark this with a second duct tape tag. Account for any possible stretching of the rope.

6.5.6 Tie the other end of the rope to an anchor so that the slug can be lowered within a few inches of the water level.

Note: Account for "stretch" of the rope by being a little conservative in estimating where the slug will hang.

6.5.7 Slowly lower the slug into the well and let it hang a few inches above the water as mentioned in Step 6. Have the data logger display the transducer readout while lowering the transducer. If the slug does contact the water, an immediate change will be seen. On the logger readout, use the lower duct tape tag as a reference point.

Note: Touching the water with the slug is not always disastrous. If the slug does touch the water, pull it back up a few inches and see if the water level returns to static in the next few minutes or so.

6.5.8 Once the slug is hung, set the data logger to log according to the hydraulic Test Plan (Attachment B).

6.5.9 To begin the test, turn the logger on 5 seconds prior to lowering the slug. It is preferable to begin logging on an even minute and to lower the slug 5 seconds after (e.g., 10:00:00 "logging on," 10:00:05 "slug lowered"). Quickly lower the slug to the second duct tape mark (see Step 5) and tie off the rope. Do not splash the water.

Note: Sometimes, it is possible to tie the rope to two different anchors so that when the rope is untied from the first position (slug just above the water), it can be dropped and the second anchor will hold it at the desired depth (see Attachment D "Before Start of Slug Test" and "After Start of Slug Test").

6.5.10 Another method is to introduce a solid cylinder of known volume to displace and raise the water level, allow the water level to restabilize, and remove the cylinder. It is important to remove or add the volumes as quickly as possible because the analysis assumes that an instantaneous change in pressure is created in the well. It is important to ensure that the slug is completely submerged if introduced.

6.5.11 Note on the logger readout, the initial rise in the water level and see if it corresponds with the calculated rise. Since the water level changes fairly rapidly at first, it may be necessary to scroll back through the logged data to determine the first (highest) point.

Note: This initial rise calculation often does not exactly correspond with the logged initial rise, but it should be relatively close.

6.5.12 At some point during the test, take at least one depth-to-water measurement with the water level probe to ensure the transducer is reading correctly.

6.5.13 When the water level has returned to static level, the bail test is then performed.

6.5.14 Reset logging mode on an even minute, then pull out the slug as quickly as possible. Note the decrease in water level.

6.5.15 At each reading, measure depth to water (to the nearest 0.01 ft) and record time when pressure change is at time zero. The number of depth-time measurements necessary to complete the test are variable. Frequent measurements should be made so that the change in water level between two consecutive measurements is <5% of the initial change. It is critical to make as many measurements as possible in the early part of the test.

6.5.16 Continue measuring and recording depth-time measurements until the water level returns to within 10% of equilibrium conditions.

6.5.17 The test is complete when the water level has returned to static level, and the log equipment can be broken down.

6.6 Post Field Operation

6.6.1 Decontaminate or dispose of equipment and rope according to SOP 4.5.

6.6.2 If using an electronic data logger:

1. Stop logging sequence.

2. Save memory.
3. Disconnect battery at the end of the testing activities.

6.6.3 Replace testing equipment in storage containers.

6.7 Office Post Operation

6.7.1 Inventory sampling equipment and supplies. Repair or replace all broken or damaged equipment.

6.7.2 Replace expendable items.

6.7.3 Return equipment to storage area and report incidents of malfunctions or damage.

6.7.4 Review Hydraulic Test Logbook and field forms for completeness.

6.7.5 Deliver original forms, logger data, and logbooks to the project HG. Deliver copies of documentation to the DMT, HGL, or SL, as appropriate.

6.7.6 Interpret slug/bail test field results with project HG, HGL, or SL. Analyze slug/bail test using appropriate software packages or graphical solutions.

6.7.7 Send data logger or pressure transducers to factory for recalibration, if needed.

7.0 QA RECORDS

7.1 Logbooks

7.2 Hydraulic Test Field Sheet

8.0 ATTACHMENTS

Attachment A—Equipment Checklist

Attachment B—Hydraulic Test Plan

Attachment C—Hydraulic Test Field Sheet

Attachment D—Slug Test Schematic

Attachment A

Equipment Checklist

Equipment Checklist

____ 12-volt battery

____ Appropriate references and calculator

____ Aquifer test sheets

____ Calculator, clip board

____ Duct tape

____ Electric water-level indicator

____ Electronic data logger (if transducer method is used)

____ Interface probe

____ Rope (should very little "stretch")

____ Semilog graph paper (if required)

____ Slug (steam cleaned prior to use)

____ Steel tape (subdivided into tenths of feet)

____ Stopwatch or watch with second hand

____ Tape measure (subdivided into tenths and hundredths of feet) or other water-level measuring device

____ Watch with a second hand

____ Water-pressure transducer (if test is anticipated to last overnight, a barometric pressure transducer should also be used)

____ Waterproof ink pen and logbook

Attachment B

Hydraulic Test Plan

HYDRAULIC TEST PLAN

GENERAL INFORMATION		By:
Location:	Livermore Site ❑ Site 300 ❑ Area:	
Test Type: (1-hour drawdown, longterm, step flow or drawdown, slug, facility startup)		
Test Well Name(s):		
Expected Start Date:		
Duration of Test:		
Treatment Unit or Method:		
Comments:		

TEST OBJECTIVE(S)	By:

TEST DESCRIPTION AND SPECIAL INSTRUCTIONS	By:

GROUND WATER CHEMISTRY IN TEST WELL(S)	By:

EXTRACTION WELL(S) DESCRIPTION			By:
Well(s)			
Screen Interval (ft-bgs/bmp)			
Pump Intake (ft-bgs/bmp)			
Depth to static water level (ft-bmp)			
Available Drawdown (ft)			
Extraction Flowrate (gpm)			
(only for step flowrate tests) Steps <Flowrate (gpm) - Duration(hrs)> 1 2 3 4 5			
Estimated Volume to be Extracted (gal)			
Pump Type and Size			
Extraction Flowrate Measurement			
Comments:			

Notes: **bgs**- below ground surface elevation, **bmp**- below measurement point elevation

SAMPLING PROTOCOL		By:
Sample Date/Time – **I**nfluent/**E**ffluent	Sample form Well(s)	Analysis (i.e. E601)
Initial >		
Final >		
Comments:		

WATER LEVEL MEASUREMENT SPECIFICATIONS		By:
Extraction Well:		
Observation Wells:	Shown on attached figure: Yes ❑ No ❑	
Wells instrumented with transducers:		
Wells to be hand-measured:		
Collection of water levels in instrumented wells using data loggers and hand measured wells:		
Log Barometric Pressure Readings	Yes ❑ No ❑	
PRIOR TO PUMPING: Log background water levels every 15 minutes for at least 24 hours prior to test.		
DURING PUMPING: Log water levels during test as indicated below: TEST WELL: Logarithmically increasing frequency ❑ or Linear at 15 minute intervals ❑ OBSERVATION WELLS: Logarithmically increasing frequency ❑ or Linear at 15 minute intervals ❑ HAND MEASURED WELLS: Linear at 60 minute intervals ❑		
DURING RECOVERY: Log water levels after pump shut-in as indicated below for at least 24 hours: TEST WELL: Logarithmically increasing frequency ❑ or Linear at 15 minute intervals ❑ OBSERVATION WELLS: Logarithmically increasing frequency ❑ or Linear at 15 minute intervals ❑ HAND MEASURED WELLS: Linear at 60 minute intervals ❑		
NEARBY EXTRACTION WELLS: Inform technicians of nearby extraction wells/facility to maintain constant flow rates in all extraction wells during the test. Inform them of potential water level changes in wells due to hydraulic testing.		
Comments:		

Note:
Verify availability of data loggers, transducers, and cable with Field Coordinator (Billy Clark).
Logging frequencies are subject to change as directed by LLNL Hydrogeologist or Field Coordinator.

GROUND WATER DISCHARGE	By:
Estimated Volume of ground water to be discharged (gals):	
Type of water storage tank and capacity: *(NOTE: see estimated volume to be extracted above to determine if adequate storage is available)*	
Discharge Location:	
Type of Discharge Permit Required ❑ NPDES: ❑ City of Livermore: ❑ None / Other (explain):	
Treatment of ground water required to comply with Discharge Permit:	Yes ❑ No ❑
Type of treatment, if necessary:	
Estimated Chemistry of ground water to be discharged:	
Comments:	

Attachment C

Hydraulic Test Field Sheet

HYDRAULIC TEST FIELD SHEET

Site	❑ Livermore Site ❑ Site 300	Page ___ of ___	By:
Test Well		Treatment Unit	
Test Type		Data Logger(s)	
Comments			
Totalizer: Start: End: > Total Gallons Extracted: (gals)			

Data Logging Start Date: / / Memory Loc.: Data Logging End Date: / / Memory Loc.:	Hydraulic Test Start Date: / / Hydraulic Test End Date: / /

channel									
well ID									
xducer (psi)									
date/time									

Attachment D

Slug Test Schematic

WEISS ASSOCIATES

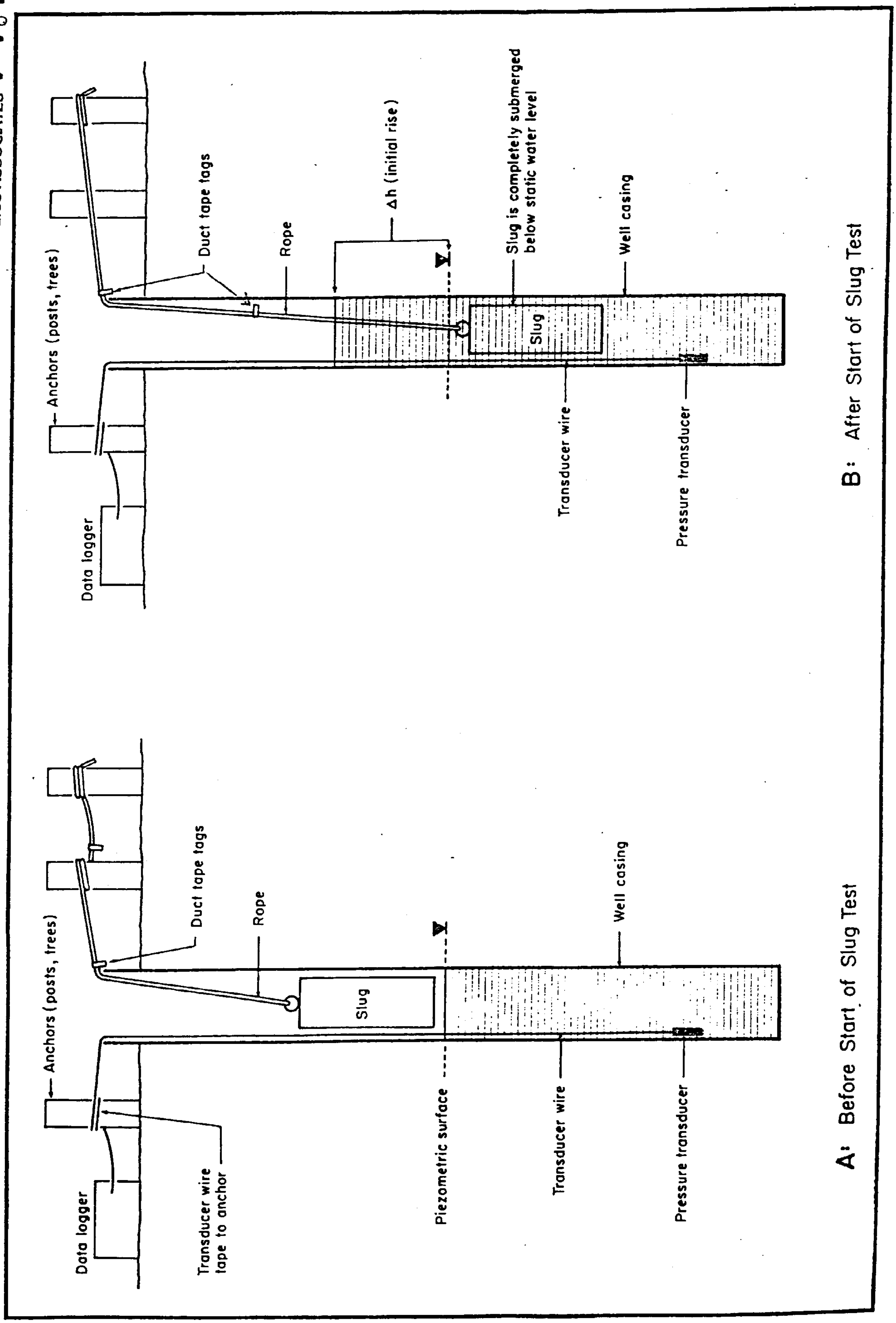

Figure 5-1 Slug Test

LLNL Environmental Restoration Division (ERD)
Standard Operating Procedure (SOP)

ERD SOP 3.4: Hydraulic Testing (Pumping)—Revision: 3

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ERD

AUTHOR(S):
Z. Demir and B. Clark

APPROVALS:	**Date**
Albert L Lamarre **Division Leader**	3/21/03
Environmental Chemistry and Biology Group Leader	3/20/03

CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	3/20/03

1.0 PURPOSE

The purpose of this SOP is to determine the hydraulic properties of water-bearing materials by controlled pumping of a well for 1–8 hours (short term) and up to 24 hours or longer (long term), and to evaluate the degree to which relatively permeable sediments are hydraulically connected vertically and horizontally.

2.0 APPLICABILITY

This procedure is applicable to hydraulic testing by pumping. Pumping tests provide results that are more representative of average aquifer characteristics than those predicted by slug tests. Pumping tests require a greater degree of activity and expense and are not always justified for all levels of investigation. For example, slug/bail tests may be acceptable at the reconnaissance level, whereas pumping tests are usually performed as part of a feasibility study in support of designs for aquifer restoration. The aquifer characteristics that can be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), specific yield (SY) for unconfined aquifers, and storage coefficient (S) for confined aquifers. Single well pumping tests of short duration, which monitor the water level in the pumping well only, can be used to determine transmissivity and hydraulic conductivity but not specific yield or storage coefficient. The test data are analyzed using graphical solutions and/or appropriate computer software packages.

3.0 REFERENCES

3.1 Boulton, N. S. (1954), "The Drawdown of the Water-Table under Non-Steady Conditions Near a Pumped Well in an Unconfined Formation," *Proc. Inst. Civil Eng.* **3**, paper 5979, p. 564.

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3.5 Bredehoeft, J. D. and S. S. Papadopoulos (1980), "A Method for Determining the Hydraulic Properties of Tight Formations," *Water Resour. Res.* **16** (1), pp. 233–238.

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3.10 Freeze, R. A. and J. A. Cherry (1979), *Groundwater*, Prentice-Hall, Englewood Cliffs, N.J.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Division Leader

The Division Leader's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Hydrogeology Group Leader (HGL)

The HGL is responsible for ensuring that proper procedures are implemented for field activities (i.e., drilling, borehole logging and sampling, monitor well installations and development) and to oversee the disposal of investigation derived wastes.

5.4.1 Subproject Leader (SL)

The SL is responsible for the overall investigation, planning, and assessment and remediation within a study or treatment facility area.

5.4.2 Hydrogeologist (HG)

The HG is responsible for preparing the Hydraulic Test Plan (Attachment B) and assisting the field personnel in conducting his/her responsibilities.

5.3 Field Personnel

Field personnel are responsible for conducting and documenting hydraulic testing according to this procedure.

6.0 PROCEDURES

6.1 Discussion

Wells are selected for extended pumping based on location relative to contaminant plume(s), expected flow rate, and proximity to observation wells. Long-term pumping tests may last from 4 days to 1 week, typically with 1 day of background monitoring, 1 day or more of actual pumping, and 1 day of recovery observations. In all phases of the long-term test, barometric pressure is monitored continuously by a barometric pressure transducer. The duration of a test is determined by the test objectives and the aquifer properties. A test duration of one to several days is desirable, followed by a similar period of monitoring water-level recovery. Partially confined aquifers and partially penetrating wells may have a shorter test duration. A knowledge of the local hydrogeology and a clear understanding of the overall objectives of the test are necessary to determine the test duration. The effect of any hydrogeologic boundaries should also be considered. Pumping or recovery monitoring can be discontinued if the water levels become constant with time. During pumping, this may indicate that a hydrogeologic recharge boundary has been intercepted and that additional testing would not yield any more useful information.

If indicated on the Hydraulic Test Plan (Attachment B) provided by the task leader/study area leader, a step-drawdown test may be performed. The general data collection procedure for this test is the same for a constant-rate test, except drawdown data only need to be collected from the pumping well (if the step test is to be followed by a constant-rate drawdown test). For this reason, it is often possible to conduct a 2 to 3 h step-drawdown test on the pumping well, while instrumenting observation wells for the constant-rate test. If done, allow sufficient time for the aquifer to recover prior to starting the constant-rate test. The objectives of a step-drawdown test are to 1) determine the magnitude of non-Thesian well losses caused by friction within the well screen and the sand pack, or 2) determine the optimum pumping rate for a constant-rate test. A step test is also useful in evaluating the progress of well development. To perform a step-drawdown test, the well should be pumped at approximately three different rates (for example, 5, 10, and 25 gallons per minute). Generally, 1 h for each step is sufficient. It is not necessary for drawdown to stabilize before proceeding to the next step.

6.2 Office Preparation

6.2.1 Review the Hydraulic Test Plan (Attachment B) with the project HG.

6.2.2 Review the Daily Operations Guide, associated SOPs, and appropriate sections of the Site Safety Plan. Information on depth to water, depth of well, screened interval, casing size, and pump size and type is obtained from the Data Management Team (DMT) for established wells, or from the drilling coordinator for new wells.

6.2.3 Coordinate schedules/actions with the SL or project HG regarding the availability of necessary pumping test equipment and the SC to coordinate hydraulic testing with the quarterly ground water sampling activities.

6.2.4 Obtain Hydraulic Test Plan (Attachment B) from the project HG or SL. This plan should include specific test details such as which wells are to be monitored, pumping rates, test duration, and other site- and task-specific variables.

6.2.5 Review the operator's manual provided with the electronic data loggers, if appropriate.

6.2.6 Obtain equipment listed in the Equipment Checklist (Attachment A) and verify it is properly operating. Make sure the electronic data logger is fully charged, if appropriate. Always bring additional transducers in case of malfunctions.

6.2.7 Obtain the Hydraulic Test Logbook. Assemble a sufficient number of field forms to complete the field assignment to include:

1. A site map of the area to be monitored with all observation wells highlighted.
2. Hydraulic Test Field Sheet (Attachment C) for each well to be monitored.
3. Schedule of water samples to be taken, and water sampling and Chain-of-Custody forms (if appropriate).
4. A list of the observation wells and their construction details, listed in the order in which water levels are to be measured.

6.2.7 Initiate steps to collect, treat, and dispose of purged water according to the appropriate version of SOP 4.7, "Treatment and Disposal of Well Development and Well Purge Fluids."

6.3 Field Preparation

6.3.1 Check equipment for proper function as follows:

1. Pumps should be submersible or turbine type. The pumping well should be properly developed at least one week before testing. Verify that the existing pump is sufficient for the estimated flow rate.
2. Verify that an orifice, weir, flow meter, container, or other type of water measuring device is available to accurately measure and monitor the discharge from the pumping well.
3. Verify that sufficient discharge hose or pipe is present to transport the discharge water from the pumping well to conform with discharge requirements.
4. Verify that an orifice valve manifold or gate valve is located on the discharge pipe to control the pumping rate.
5. Verify that a sampling port is near the wellhead for water quality sampling.

6.3.2 Calibrate all gauges, transducers, flow meters, etc., before conducting pumping tests (SOP 3.2, "Pressure Transducer Calibration"). Document instrument calibration in the Hydraulic Test Logbook and file copies of the documentation with the test data records. The calibration records should consist of laboratory measurements, and if necessary, any on-site zero adjustment or calibration. Where possible, check all flow measurement devices on site using a container of measured volume and a stopwatch.

6.3.3 Extend transducer wires to appropriate wells. Wires should be secured with duct tape where they cross walkways and other paved surfaces. To prevent disturbances, wires should be marked with flagging tape if strung across unpaved areas.

6.3.4 Decontaminate each transducer and cable as specified in the sampling plan and in SOP 4.5, "General Equipment Decontamination."

6.3.5 If the pumping duration is expected to exceed 2 h, water levels and barometric pressure at the test site should be monitored for at least one day prior to pumping. This information allows the barometric efficiency of the aquifer to be estimated, and indicates if the aquifer is experiencing changes in head due to recharge, pumping in the nearby area, or diurnal variations. Barometric pressure is recorded during the test with an on-site barograph or barometric pressure transducer in order to correct water levels for any fluctuations that may occur due to changing barometric conditions. Pretest water-level trends are projected into the pumping phase of the test. These trends and barometric changes are used to adjust water levels measured during the test to be representative of the hydraulic response of the aquifer due to test well pumping.

6.3.6 Generally, 4–8 wells are instrumented with pressure transducers and about 10–15 additional wells are monitored with an electric water-level meter. Water levels in all wells within a 500- to 1,000-ft radius of the pumping wells are measured frequently during the test. For wells with transducers, water levels are measured every 15 min during the background phase, and on a logarithmically increasing frequency ranging from 1 second to 15 minutes during the pumping and recovery phases.

6.3.7 Water-level measurements in non-instrumented wells are measured two to four times during the background phase and every one to three hours during the pumping and recovery phases of the test.

6.3.8 Water levels should be measured as specified in SOP 3.1, "Water Level Measurement." To keep measurements equally spaced in time, water levels should be taken in the same order each sampling period. Simultaneous readings at wells are not necessary. It is very important that depth-to-water readings are measured accurately and recorded at the exact time. To complete the pumping test, pressure transducers and electronic data loggers can be used to reduce the required field personnel hours. See Hydraulic Test Field Sheet, Attachment C.

6.4 Operation

6.4.1 A pumping test monitors the water levels in the pumping well and observation wells as the pumping well discharges at a constant rate.

6.4.2 Record the following data on the Hydraulic Test Field Sheet (Attachment C) at the time the test is performed.

1. Site Location. Brief description of general site location.
2. Well ID. Unique number assigned to each well.
3. Date. The date when measurements are taken.
4. Distance from pumped well (ft). Distance to the observation well from the pumping well in feet and tenths of feet.
5. Personnel. Initials of personnel performing field measurements or collecting samples.
6. Static Water Level. Depth to water, in tenths and hundredths of feet, in each observation well before pumping.
7. Test Start Date. The date when pumping began.
8. Test Start Time. Time in hours:minutes:seconds at which pumping began using 24-h clock (e.g., 08:37:00 for 8:37 a.m.; 19:12:00 for 7:12 p.m.).
9. Test End Date. The date when pumping ends.
10. Test End Time. Time in hours:minutes:seconds at which pumping ended using 24-h clock (e.g., 08:37:00 for 8:37 a.m.; 19:12:00 for 7:12 p.m.).
11. Average Pumping Rate. Time-weighted average of all entries recorded in the Pumping Rate (gal/min) column.
12. Measurement Methods. Type and serial number of instrument used to measure depth to water (this may include steel tape, electric sounding probes, Stevens recorders, or pressure transducers).
13. Comments. Appropriate observations or information for which no spaces are specifically provided.
14. Time. Record the time of water-level or flow-rate measurement in hours, minutes, and seconds, using a 24-h clock.
15. Depth to Water. Depth to water, in tenths and hundredths of feet.
16. Pumping Rate. Flow rate of pumping well measured with an orifice, weir, flow meter, container, or other device.
17. Record time pump is stopped.
18. Time. Record the time of water-level or flow-rate recovery measurements in hours, minutes, and seconds, using a 24-h clock.
19. Depth to Water. Depth to water, in tenths and hundredths of feet.

6.5 Long-Term Pumping Test Procedure

6.5.1 Day 1

1. Power up data logger(s) and synchronize clock time.
2. Lower the transducers into their respective wells. Monitor the logger channel corresponding to the well to ensure the transducer is not lowered too far below the water. Attach a transducer wire to a nearby ballard/post to prevent slippage during the test.
3. Connect barometric pressure transducer to one of the data loggers.

4. Log data at 30-minute intervals.

   Note: Set the transducers for one logger and begin logging. To allow for more background data to be collected, lower the transducers for the next logger.

5. Take one round of hand-measured water levels in all wells, including wells with transducers ("complete" round). Note the date, time, depth-to-water, and observer's initials in each well's log book. Check the data loggers.

6. After 2 hours, take a second round of water levels. However, it is not necessary to obtain hand measurements from wells with transducers ("normal" round).

   Note: To ensure logging is being completed, each round should include a check mark on the data logger and the time should be noted on each transducers readout. Look for anomalies such as sudden changes on a particular channel. If a change occurs, obtain a manual measurement of the well in question to confirm the change.

7. If time permits, take another "normal" round of water-level measurement. At least 2 rounds of water-level measurements should be collected before the end of the day.

8. When the pumping test is monitored by an electronic data logger and pressure transducers, most of the data is stored electronically or on computer diskettes or tape. The data memory location numbers from the data dump start and finish should be noted at the end of each day. This information is transferred directly to the main computer and analyzed. To document the test, test data forms are kept in files with supplemental information and a computer printout of the data in the files.

6.5.2 Day 2

1. Take a complete round of water-level measurements and check the data loggers.
2. Set up the plumbing and flow meter from the wells to water tanks, or treatment facility.
3. Take a normal round of water-level measurements and check the date loggers.
4. Start the pump test at the specified flow rate. Measure the flow rate (Q) using totalizer, or note flow on flow meter.
5. After pumping has begun, a normal round of water-level measurements must be taken approximately every 1–3 hours. Check the data logger and a measurement of Q.
6. Download the data from the data logger and review with the project HG.

6.5.3 Day 3

1. Check logger(s).
2. Continue water-level measurement rounds through the day and evening.
3. Dump Campbell logger data to the cassette tape and record the memory location numbers from start to finish.

6.5.4 Day 4

1. Check logger(s).
2. Take a complete round of water-level measurements.
3. Before turning off the pump, take a normal round of water-level measurements.
4. Set the pumping well data logger to begin fast logging intervals (also done prior to the start of pumping) and turn off the pump for 5 seconds after start of fast logging.
5. Start recovery water-level measurements approximately 1–3 hours after the pump is off. At least 2 rounds (or more) of water-level measurements must be taken before the end of the day. It is not necessary to take manual water-level measurements through the night.
6. Download the data from the data logger and review with the project HG.

6.5.5 Day 5

1. Take a complete round of water-level measurements.
2. Turn off the data loggers.
3. Download the entire data from the data logger and review with the project HG.
4. Pull the transducers from the wells and wind up the transducer wires.

6.6 Constant Rate One-Hour Drawdown Test

6.6.1 Drawdown tests are conducted on wells with electric submersible pumps to determine transmissivity (T) and hydraulic conductivity (K) of the water-bearing zone(s). The optimum pumping rate for the test (estimated during final development) is one that puts maximum stress on the aquifer for 30–45 minutes, but does not draw the water level into the well screen or pump intake. Reaching a relatively "steady state" before ending the test is also important, because the rate of drawdown at the end of the test doesn't change or is slower compared to the rate of drawdown at the beginning of the test. This provides sufficient data to form a curve that can be matched to a type-curve allowing T an K to be calculated.

6.6.2 Water levels are measured in the pumping well and some observation well by a pressure transducer and recorded by a data logger. In addition, water levels in some wells are measured manually with an electric water level probe.

6.6.3 All information collected during the test should be recorded on the Hydraulic Test Field Sheet (Attachment C).

6.6.4 Information Prior to Set Up:

1. Check with DMT to determine if purge water needs collection/treatment based on analytical data obtained from water samples collected during development.
2. Flow rate for the test (estimated during final development).
3. Make, model, voltage, and horsepower of pump is necessary to obtain the correct control box.

4. Screen interval of the well and depth of the pump intake to avoid pumping the well dry or into the screen.
5. Check with HG to determine if any surrounding wells will communicate with the test well.

6.6.5 Set Up Procedures:

1. Set up flow meter and evacuation hoses, and plumb into collection tank.
2. Plug the extension cord into the generator and into the pump control box. The extension cord on/off switch box should be "OFF."
3. Manually record depth-to-water measurements in all wells to be monitored and note the time on the Hydraulic Test Field Sheet (Attachment C).
4. Set up the data logger and lower the transducer(s) to the maximum allowable depth as specified by the transducer(s) used.
5. Firmly attach the transducer line to a nearby anchor with duct tape, such as a post or a tree (not directly to the well's stove pipe) so it will not slip. Record the static logger readout.
6. While observing the logger readout, raise the transducer 1 ft. The logger readout should decrease by 1 ft. If the logger readout change corresponds to the actual change, lower it back down. If not, the transducer is malfunctioning and needs to be repaired.
7. Prime the well discharge tube by turning the pump on long enough to bring water to the first valve. Check for leaks and then shut off the pump. If necessary, repair any leaks with Teflon tape. Allow the water level in the well to recover about one-tenth of a foot of static before starting the test.
8. After the water level has sufficiently recovered, set the data logger to log according to the Hydraulic Test Plan (Attachment B).
9. To begin the test, turn on the logger 5 seconds before starting the pump. Preferably, start logging on the "even" minute and start pumping after 5 seconds (e.g., 10:00:00 "logger on," 10:00:05 "pump on").
10. Check flow rate (Q) using a 5-gal bucket or the totalizing flow meter on the collection tank. Q should be measured at regular intervals during the test (approximately every 10 minutes), more often at the beginning (approximately every 3–5 minutes).
11. At the beginning of the test, verify that the transducer is reading correctly by taking a manual water-level measurement with the water level probe.

    Note: If the transducer is not reading correctly, stop the test. Allow the water level to return to static and restart the test using a different transducer.

12. When the water level has become relatively stable (some drawdown will be continuing very slow [i.e., 0.1 ft/1–5 minutes]), pump for a few more minutes and turn off the logger. Usually, a minimum of 30 minutes is required and tests may run up to an hour or more, depending on the well.

13. Reset logging intervals for 5 seconds before turning off the pump. Continue logging recovery until 90 percent of the water level has returned to the pre-pumping level.
14. Break down the equipment.
15. Download the data from the data logger and review with the project HG.
16. Record the tape (Campbell) of the logger used and the type and serial number of the transducers(s).

6.7 Field Post Operation

6.7.1 After pumping ceases, continue to measure recovering water levels to verify results obtained from the pumping portion of the test. The recovering water levels in the pumping well and the observation wells are measured immediately following cessation of pumping; the recovery period should be at least half the length of the pumping portion of the hydraulic test. The decision to cease monitoring of water levels should be based on aquifer recovery.

6.7.2 Decontaminate or dispose of equipment per SOP 4.5.

6.7.3 If using an electronic data logger:

1. Stop logging sequence.
2. Save memory, and disconnect the battery at the end of the testing activities.

6.7.4 Replace testing equipment in storage containers.

6.8 Office Post Operation

6.8.1 Inventory equipment and supplies. Repair or replace all broken or damaged equipment and expendable items.

6.8.2 Return equipment to storage area, and report incidents of malfunctions or damage.

6.8.3 Review field forms for completeness.

6.8.4 Deliver logger data and original forms to the project HG and copies to the DMT, HGL, or SL, as appropriate.

6.8.5 Interpret hydraulic test field results with project HG. Analyze data using an appropriate analytical solution.

6.8.6 Send data logger or pressure transducers to the factory for recalibration, if needed.

7.0 QA RECORDS

7.1 Logbooks

7.2 Hydraulic Test Field Sheet

8.0 ATTACHMENT

Attachment A—Equipment Checklist

Attachment B—Hydraulic Test Plan

Attachment C—Hydraulic Test Field Sheet

Attachment A

Equipment Checklist

Equipment Checklist

____ Appropriate references and calculator

____ Barometric pressure transducer or recording barograph (for tests conducted in confined aquifers).

____ Calculator—data logger

____ Discharge hose or pipe

____ Duct tape

____ 12-volt battery (fully charged)

____ 230-volt generator

____ Electric water-level indicator

____ Electronic data logger (if transducer method is used)

____ Extension cord and on/off switch box

____ Five-gallon bucket

____ Flow meter

____ Hoses—1 in. and 3/4 in.

____ Interface probe

____ Pump control box (must equal voltage and horsepower of pump)

____ PVC fittings (elbows, unions, etc.)

____ Semilog graph paper (if required)

____ Signet flow meter

____ Steel tape (subdivided into tenths of feet)

____ Stopwatch or watch with second hand

____ Submersible pumps or turbine type.

____ Tape measure (subdivided into tenths of feet)

____ Water-level measuring device

____ Water-measuring device (i.e., orifice, weir, flow meter, or container)

____ Water-pressure transducer(s) and cables

____ Waterproof ink pen and logbook

Attachment B

Hydraulic Test Plan

HYDRAULIC TEST PLAN

GENERAL INFORMATION		By:
Location:	Livermore Site ❑ Site 300 ❑ Area:	
Test Type: (1-hour drawdown, longterm, step flow or drawdown, slug, facility startup)		
Test Well Name(s):		
Expected Start Date:		
Duration of Test:		
Treatment Unit or Method:		
Comments:		

TEST OBJECTIVE(S)	By:

TEST DESCRIPTION AND SPECIAL INSTRUCTIONS	By:

GROUND WATER CHEMISTRY IN TEST WELL(S)	By:

"without having to fill out an on-line request form" EXTRACTION WELL(S) DESCRIPTION			By:
Well(s)			
Screen Interval (ft-bgs/bmp)			
Pump Intake (ft-bgs/bmp)			
Depth to static water level (ft-bmp)			
Available Drawdown (ft)			
Extraction Flowrate (gpm)			
(only for step flowrate tests) Steps <Flowrate (gpm) - Duration(hrs)> 1 2 3 4 5			
Estimated Volume to be Extracted (gal)			
Pump Type and Size			
Extraction Flowrate Measurement			
Comments:			

Notes: **bgs**- below ground surface elevation, **bmp**- below measurement point elevation

SAMPLING PROTOCOL		By:
Sample Date/Time – **I**nfluent/**E**ffluent	Sample form Well(s)	Analysis (i.e. E601)
Initial >		
Final >		
Comments:		

WATER LEVEL MEASUREMENT SPECIFICATIONS		By:
Extraction Well:		
Observation Wells:	Shown on attached figure: Yes ❑ No ❑	
Wells instrumented with transducers:		
Wells to be hand-measured:		
Collection of water levels in instrumented wells using data loggers and hand measured wells:		
Log Barometric Pressure Readings	Yes ❑ No ❑	
PRIOR TO PUMPING: Log background water levels every 15 minutes for at least 24 hours prior to test.		
DURING PUMPING: Log water levels during test as indicated below: TEST WELL: Logarithmically increasing frequency ❑ or Linear at 15 minute intervals ❑ OBSERVATION WELLS: Logarithmically increasing frequency ❑ or Linear at 15 minute intervals ❑ HAND MEASURED WELLS: Linear at 60 minute intervals ❑		
DURING RECOVERY: Log water levels after pump shut-in as indicated below for at least 24 hours: TEST WELL: Logarithmically increasing frequency ❑ or Linear at 15 minute intervals ❑ OBSERVATION WELLS: Logarithmically increasing frequency ❑ or Linear at 15 minute intervals ❑ HAND MEASURED WELLS: Linear at 60 minute intervals ❑		
NEARBY EXTRACTION WELLS: Inform technicians of nearby extraction wells/facility to maintain constant flow rates in all extraction wells during the test. Inform them of potential water level changes in wells due to hydraulic testing.		
Comments:		

Note:
Verify availability of data loggers, transducers, and cable with Field Coordinator (Billy Clark).
Logging frequencies are subject to change as directed by LLNL Hydrogeologist or Field Coordinator.

GROUND WATER DISCHARGE	By:
Estimated Volume of ground water to be discharged (gals):	
Type of water storage tank and capacity: *(NOTE: see estimated volume to be extracted above to determine if adequate storage is available)*	
Discharge Location:	
Type of Discharge Permit Required ❑ NPDES: ❑ City of Livermore: ❑ None / Other (explain):	
Treatment of ground water required to comply with Discharge Permit:	Yes ❑ No ❑
Type of treatment, if necessary:	
Estimated Chemistry of ground water to be discharged:	
Comments:	

Attachment C

Hydraulic Test Field Sheet

HYDRAULIC TEST FIELD SHEET

Site	❑ Livermore Site ❑ Site 300	Page ___ of ___	By:
Test Well		Treatment Unit	
Test Type		Data Logger(s)	
Comments			
Totalizer: Start: End: > Total Gallons Extracted: (gals)			

Data Logging Start Date: / / Memory Loc.: Data Logging End Date: / / Memory Loc.:					Hydraulic Test Start Date: / / Hydraulic Test End Date: / /				
channel									
well ID									
xducer (psi)									
date/time									

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.1: General Instructions for Field Personnel—Revision: 8

ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # ______ ERD	**AUTHOR(S):** **R. Goodrich**	
	APPROVALS:	**Date**
	Jesse Yow **Department Head**	4/30/12
	[signature] **Livermore Program Leader**	4/18/12
	Leslie Ferry **Site 300 Program Leader**	4/12/12
	CONCURRENCE:	**Date**
	Rebecca Goodrich **QA Implementation Coordinator**	4/19/12

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to provide general instructions to all Livermore Site and Site 300 personnel concerning activities required to be performed before, during, and after field investigations. These instructions are to ensure that field personnel understand the site, the objective and schedule of the field program, their authority, and their responsibilities.

2.0 APPLICABILITY

These instructions apply to all field personnel who conduct work at Site 300 and the Livermore Site for the ERD. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 V. Dibley (1999), *Quality Assurance Project Plan Livermore Site and Site 300 Environmental Restoration Projects* (UCRL-AR-103160 Rev. 2).

3.2 Site Safety Plan for Lawrence Livermore National Laboratory CERCLA Investigations at Livermore Site, March 2005 (UCRL-AR-21174 Rev. 5).

3.3 Site Safety Plan for Lawrence Livermore National Laboratory Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Investigations at Site 300, March 2005 (UCRL-AR-21172 Rev. 4).

3.4 ERD Operations and Maintenance (O&M) Manuals.

3.5 Integration Work Sheets (IWSs).

3.6 Lawrence Livermore National Laboratory (LLNL) Environment, Safety and Health Manual.

3.7 Lawrence Livermore National Laboratory (2002), Site 300 Field Contractor Help Guide (UCRL-ID-148438).

3.8 Lawrence Livermore National Laboratory (2008), Restricted Off-Pavement Travel at Site 300 (LLNL-MI-405430) S300MGMT-11 Rev. 3.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI) /Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sample Coordinator (SC)/Drilling Coordinator (DC)

The SC and/or DC are responsible for ensuring that the Work Plan and/or Sampling Plan is properly implemented on a daily basis, providing Field Personnel with adequate information to perform work safely and correctly, and providing the interface between the Field Personnel and ERD management.

5.6 Field Personnel (FP)

FP are responsible for the safe completion of assigned tasks as described in the ERD SOPs, Site Safety Plan (SSPs), O&M Manuals, IWSs, and appropriate LLNL ES&H Manual procedures. They are required to document the work performed and to alert their immediate supervisors of any variances from procedures established in the above documents.

6.0 PROCEDURES

ERD work activities are performed in accordance with the LLNL established institutional work planning and control process based on the Integrated Safety and Environmental Management

Systems. Inline with the work control process, the following components shall be incorporated when planning and performing work:

1) An electronic Integration worksheet with the Scope of Work broken down to the task level, identifying hazards and hazards controls specific to the task.
2) Work must be authorized, approved, and released.
3) Work is scheduled with the Work Control Center (WCC), as applicable.
4) Pre-job briefing is required to ensure workers understand the work.
5) Feedback must be collected and shared.

6.1 Training

All ERD Personnel have a training plan that is required by their administrative supervisor's completion of a training questionnaire. The LLNL system "LTRAIN" tracks the training the LLNL personnel have completed and those courses required. ERD personnel working on the CERCLA clean up require 40 hr SARA/OSHA (when determined by the PL, 24 hr SARA/OSHA training is the minimum requirement) coupled with supervised field experience, and an annual refresher. The field experience must be conducted by a qualified HAZWOPER-Supervisor who has satisfactorily completed EP0041: SARA/OSHA Supervisory Training. The SARA/OSHA supervised field experience is documented using Form EP0045-01/EP0045-02. EP0045-01 is for the 8-hr field experience required for the initial 24-hour SARA/OSHA Training and EP0045-02 is for the 24-hr field experience required for the 40-hour SARA/OSHA Training. These forms area vailable on ERD's server via the pathway: erdfilespace/departmentspace/QA_ESH/OJTs. The ERD Field Investigation Orientation Lesson Plan (EP7033-015) and Treatment Facility Operations Plan (EP7033-016) are located in the same folder. These plans are used as guidelines to conduct on-the-job training for newly hired ERD personnel.

ERD personnel performing work at Site 300 require additional site-specific training, such as HS0095-W: Site 300 Safety Orientation Training, HS0096-W: Valley Fever Awareness Training, HS2080: Explosives Safety Orientation, HS0097-W: Lightning Alert, HS4258-W: Beryllium Awareness, EP8064-003: Driving the Site 300 Fire Trails, HS5606-W: Radio Communications, and EP0028: Natural Resources Protection at Site 300.

All personnel should periodically check their LTRAIN file and ensure their training is up-to-date.

Personnel are only to perform work for which they have been trained.

6.2 Activities to be Performed Before Field Work

6.2.1 Document Review

Document review should be performed prior to commencement of field activities. At a minimum the following list of documents should be reviewed:

- Sampling or Work plan. The Sampling or Work Plan should contain sufficient detail to allow the proper completion of work. The sampling plan should include sample collection method, sample volume and container type, required sample analysis, turn around time, and analytical laboratory.
- IWSs. The RI/SSO, SC, or DC should provide Field Personnel with the safety procedures that are applicable to the work being tasked. *IWSs should be reviewed with field personnel and documented, as applicable. The "Read & Sign" function in the eIWS system shall be used by the worker to acknowledge his/her review of the document.*
- Applicable SOPs. The responsible SSO, SC, or DC shall direct Field Personnel to the SOPs that are applicable to the work being tasked. *Work shall be performed to controlled SOPs only.* This ensures that the SOPs are the most up-to-date version.
- Site Safety Plan(s).
- O&M Manual(s).
- Equipment owner/operator instructions.
- Site maps.
- Site documentation. Site 300 Management Procedure, "Restricted Off-Pavement Travel at Site 300".

6.2.2 Coordinate Work

- Scheduling. The work activity must be included in the Plan of the Week and/or Plan of the Day, as applicable. Work cannot be performed unless it has been included as part of a work plan and/or formalized work schedule. Certain work such as drilling activities must be approved by the applicable WCC.
- Sign-in board (Site 300 only). All personnel visiting Site 300 must log in and out on the sign-in board located inside Trailer 8726. Write your name, time of arrival, destination and estimated time of return on the board. Obtain a communications radio from the charger and place the magnetic tag onto the board adjacent to your name, indicating which radio will be used in the field. DO NOT leave the site without removing your name from the board and returning the radio (along with the magnetic tag) to the charger.
- Radio and/or radio identification names. A radio communications course (HS5606-W) must be completed prior to conducting work at Site 300. A communications radio must be carried by Field Personnel to contact the appropriate individuals for guidance, assistance and in case of emergencies. Make sure the radio is fully charged, as indicated by the green light on the charger. Radios must be kept on and monitored for the duration of field activities.
- Restricted travel without prior permission could result in disciplinary action including the possibility of permanent access denial to Site 300. **Prior to any**

off-road travel the work needs to be approved at the daily work control meeting for the Plan of the Week. Read through and become familiar with the regulations set forth in the latest revision of the Site 300 Management Procedure, "Restricted Off-Pavement Travel at Site 300" Before performing off-road work activities. If you do not have a copy and need one, please get in touch with the ERD Site 300 SSO or the Quality Assurance Implementation Coordinator (QAIC) and one will be provided. Personnel shall carry a copy of the procedure when conducting restricted travel and use the map provided to describe travel plans. Work that requires traveling or hiking more than 50 feet off pavement is considered restricted travel and requires approval from appropriate facility management and security before travel commences. Access approval must be obtained from the appropriate FAS prior to the proposed travel. After the FAS grants permission, then the Central Alarm Station (CAS) operator must be contacted who will ultimately approve or deny the travel request. To contact the CAS operator for restricted travel, call extension 3-5270 or call "MIKE" on the trunked radio system. Calling 3-5270 rings at the CAS unless B Division's Control Point (CP) is manned. The CAS operator is physically located in Livermore so a clear description of the travel plans must be communicated. Radio calls to Sierra 45 are answered by the CP operator (when the CP is manned) and, therefore, offer an alternate, direct means of communication to the CP. When calling the CAS Operator, you must wait for the Operator to acknowledge your call before proceeding to communicate. "MIKE" can also be contacted by phone at 3-5222 when requested to do so or if a radio becomes inoperable. Notify "MIKE" when you return to the paved road to conclude the restricted travel activity.

- <u>Coordinate escorts</u>. The Administrative Escort Services must be given a 24-hour notice when an escort is required to accompany field personnel in restricted areas.
- <u>Arrange LLNL vehicle usage</u>. Follow sign-out procedures for vehicle usage. Prior to driving the vehicle, take time to become familiar with the safety features of the vehicle, such as the location of the hazard lights, how to engage and disengage the parking break, and operate the windshield wipers, defroster, etc.
- <u>Coordinate field support.</u>

6.2.3 Assemble Materials/Equipment

- <u>Obtain the appropriate logbook and field data collection forms</u>. Refer to SOP 4.2, "Sample Control and Documentation" or the appropriate SOP or O&M.
- <u>Assemble the appropriate supplies and/or equipment</u>. Attachment A provides a general equipment checklist. Specific equipment checklists are provided in the applicable SOPs when necessary. If the sampling container and preservation requirements are not specified on the Sampling Plan, consult the SC, DC, or the Quality Assurance Implementation Coordinator (QAIC) for

sample information. Before sampling Site 300 monitor wells, it must be ensured that a sufficient number of collection drums are available at the wellhead for purge water containment.

- Don appropriate field attire. Certain work conditions, such as sampling contaminated environmental media, may require various levels of PPE depending on the potential hazard to workers. Attachment B displays the various levels of PPE as defined by OSHA. The IWSs defines the PPE required when performing each task identified for a work activity. When there is a question regarding the appropriate level of PPE, the ES&H Team will be consulted to make the final determination regarding PPE. *Do not conduct any field work if the original level of PPE is believed to be insufficient and contact the SSO.*
- Perform equipment maintenance, calibration, or calibration verification. The procedures are described in SOP 4.8, "Calibration, Verification, and Maintenance of Measuring Test Equipment (M&TE)."

6.3 Activities to be Performed During Field Work

6.3.1 Perform Work

- Perform work. Work shall not be performed unless it has been scheduled in the Plan of the Day or Plan of the Week. Work should be performed as directed by the Sampling Plan or Work Plan and according to the appropriate SOPs and IWSs. Work not defined in such plans is not to be initiated without approval of the SSO, SC, or DC. Modifications to the work plans that may be required must be approved by the appropriate SC, DC, or other appropriate personnel and documented.
- Stop work. If violations to procedures or applicable health and safety requirements are observed, the Field Personnel should *stop work immediately* and notify their direct supervisor and/or the SSO. **Anyone can stop work at anytime if they believe operations are unsafe.**

6.3.2 Monitor Work

- Monitor work environment. Visually monitor working environment continually to ensure safety. Instrumentation should be used when specified by the applicable IWS, SOP, SSP, or SSO. Field blanks shall be collected when designated by the sampling plan or if there is any reason to suspect air-borne contaminants (i.e., odors, dust, work being performed near by such as painting, fumigating, etc.). Refer to SOP 4.9, "Collection of Field QC Samples." All observations that can affect sample quality should be recorded in appropriate logbooks and/or field sheets.
- Monitor equipment. Equipment should also be monitored for contamination and decontaminated when necessary per SOP 4.5, "General Equipment Decontamination." Equipment blanks (rinsate samples) will be collected as designated by the sampling plan or if there is any reason to suspect potential

cross-contamination. Refer to SOP 4.9, "Collection of Field QC Samples." In addition, follow SOP 4.9 whenever portable purging or sampling equipment is used.

6.3.3 Document Work

- Document work. Record all pertinent information in the appropriate logbook and field form as required by SOP 4.2 and in accordance with applicable SOPs as work progresses.
- Well entries. Access to wells for any reason must be documented in the Well Entry Logbook.
- Nonconformances. Document any problems encountered during operations on a Quality Improvement Form (QIF) per the instructions provided in SOP 4.12.

6.4 Activities to be Performed After Field Work

6.4.1 Clean-up Work Site and Equipment

- Decontaminate equipment. Decontaminate equipment per SOP 4.5, "General Equipment Decontamination."
- Dispose of waste properly. Waste should be disposed of in compliance with Radioactive and Hazardous Waste Management (RHWM) requirements. Sampling and Drilling wastes should be disposed of per SOP 1.8, "Disposal of Investigation-Derived Wastes (Drill Cuttings, Core Samples, and Drilling Mud)". Consult with the appropriate RHWM representative or the Environmental Protection Department analyst when in doubt.
- Inventory sampling equipment and supplies. Repair or replace all spent, broken or damaged equipment. Return equipment to proper storage area and report incidents of malfunctions or damage to the SC or DC.
- Mark borehole or sampling location (when applicable). Durably mark borehole or sampling location with visible identification (ID) to allow survey team to locate and survey location. Place temporary cover over borehole as appropriate.

6.4.2 Review Documentation

- Check that all field data is properly recorded. Logbooks, CoCs, and field data collection forms shall be filled out as required by SOP 4.2 and applicable ERD SOPs. Cross-check samples collected with the sampling or work plan and, the information documented on the sampling containers to the information recorded on the COC form. Make corrections and or note discrepancies.
- Deliver forms and logbooks. Return logbooks to the appropriate storage location (i.e., at the facility, with the piece of equipment, to the SC or Data Management Team [DMT]). All original COCs accompany samples to the

analytical lab. Refer to SOP 4.2: Sample Control and Documentation for explicit details regarding CoCs and sample documentation procedures. File, copy, and deliver the data collection forms as appropriate. The SC should receive field data collection forms daily.

6.4.3 Dispatch Samples (when applicable)

- Notify analytical laboratory. Laboratory capacity should be checked before shipping samples that are collected before holidays and with short holding times and quick turnaround times to ensure laboratory personnel are available.
- Package and ship samples. Handle, package, and ship samples as directed in SOP 4.4, "Guide to the Handling, Packaging, and Shipping of Samples."

6.4.4 Store Core Samples (when applicable)

- Store core. Store recovered sediment and rock core per instructions described in SOP 1.15, "Well Site Core Handling."

7.0 QA RECORDS

7.1 Field Data Collection Forms

7.2 Document Control Logbooks

7.3 CoCs

8.0 ATTACHMENTS

Attachment A—Equipment Checklist

Attachment B—Personnel Protective Equipment List

Attachment A

Equipment Checklist

Equipment Checklist

The purpose of the list presented below is to aid field personnel in identifying those supplies necessary to conduct a particular field operation. It is not intended to be all inclusive. It is the responsibility of field personnel to determine and obtain the supplies required for successful performance of assigned tasks.

____ Air tight plastic bags
____ Any necessary packaging (i.e., bubble wrap)
____ CoC forms
____ Field sheets
____ Sample containers (see SOP 4.3)
____ Shipping forms
____ Site Safety Plan
____ Barricades
____ Blue ice or bagged ice
____ Calculator
____ Camera (authorized personnel only)
____ Caution tape
____ Clipboard
____ Cold weather gear
____ Coolers
____ Distilled (organic-free) water
____ Drinking water
____ Duct tape
____ Ear plugs
____ First aid kit
____ Flagging
____ Hand lens
____ Hard hat
____ Hat
____ Health and Safety Plan
____ Lath/stakes
____ Overshoes
____ Organic Vapor Analyzer (OVA) and/or photoionization detector (PID)
____ Pens, pencils, permanent markers
____ PPE, as appropriate
____ Preprinted labels
____ Protractor
____ Radio
____ Rain suit (if necessary)
____ Safety shoes/boots
____ Sampling, field, or facility logbook
____ Sampling Plan
____ Snake guards
____ SOPs
____ Sample preservative
____ Stop watch
____ Sun screen

Equipment Checklist (cont.)

____ Tape measure (tenths)
____ Tool box
____ Water-level indicator
____ Well Specification Table
____ Work gloves/sampling gloves

Attachment B

Personnel Protective Equipment

Personnel Protective Equipment[a]

Level A	Level A Protection
Should be worn when the highest level of respiratory, skin, and eye protection is needed.	Supplied-air respirator (MSHA/NIOSHA approved) Fully encapsulating chemical-resistant suit Coveralls (optional) Long cotton underwear (optional) Gloves (inner and outer), chemical resistant Boots, chemical resistant Hard hat (optional) Disposable gloves and boot covers (optional) Cooling unit (optional) Two-way radio communications (optional)
Level B	**Level B Protection**
Should be worn when the highest level of respiratory protection is needed, but a lesser level of skin protection.	Supplied-air respirator (MSHA/NIOSHA approved) Self-contained breathing apparatus Chemical resistant clothing Long cotton underwear (optional) Coveralls (optional) Gloves (inner and outer), chemical-resistant Boots (outer), chemical-resistant, steel toe and shank Boot covers (outer), chemical resistant Hard hat (face shield) (optional) Two-Way radio communications (optional)
Level C	**Level C Protection**
Should be worn when the criteria for using air-purifying respirators are met.	Air-purifying respirator, full-face, canister equipped (MSHA/NIOSHA approved) Chemical-resistant clothing Coveralls (optional) Long cotton underwear (optional) Boots (outer), chemical resistant, steel toe and shank Boot covers (outer) (optional) Hard hat (face shield) (optional) Escape mask (optional) Two-way radio communication (optional)
Level D	**Level D Protection**
Should be worn only as a work uniform and not on any site with respiratory or skin hazards. It provides no protection against chemical hazards.	Coveralls Gloves (optional) Boots/shoes, leather or chemical-resistant Safety glasses/chemical splash goggles (optional) Hard hat (face shield)

[a] ES&H Team 4 along with ERD personnel will decide which level of PPE to use for the safety of Field Personnel.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.2: Sample Control and Documentation—Revision: 8

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
______
ERD

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CONCURRENCE:	Date
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Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to describe the procedure for sample control and completion of required documentation to ensure traceable and defensible sample results.

2.0 APPLICABILITY

This SOP is applicable to ERD activities and those Environmental Functional Area activities performed by ERD that require sample control and documentation. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System

(ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

Not applicable.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sampling Coordinator (SC)/Drilling Coordinator (DC) or Facilities Operation Manager (FOM)

The SC/DC's or FOM's responsibility is to coordinate and schedule sampling activities, ensuring that all activities are accurately recorded in a Document Control Logbook and that sampling data sheets (as required) and CoCs are completed correctly.

5.6 Field Personnel (FP)

Field personnel are responsible for following this procedure when sample control and documentation are required.

5.7 Data Management Team (DMT)

The DMT is responsible for issuing logbooks and maintaining a record documenting all logbook transactions, as well as archiving completed logbooks, field logs, and Chain-of-Custody (CoC) forms. DMT responsibilities also include producing the Sampling Plan using the Sample Planning and CoC Tracking (SPACT) application.

6.0 PROCEDURE

6.1 Issuance and Archival of Logbooks

Document Control logbooks are to be bound with consecutively numbered pages. DMT assigns each logbook a unique code and issues the logbooks upon request. A list of issued logbooks and their locations is maintained by the DMT. Completed logbooks are to be returned to DMT for archival.

6.2 Sampling Document Control Logbooks

Entries in the sampling Document Control Logbooks should reflect the sampling event as accurately as possible. Collecting samples from a single monitoring well or sampling point is considered a sampling event. Examples of sample entries can be found near the front cover of each logbook and includes the following essential information:

- Date and time of sampling.
- Sample identification (ID) code.
- Method of sample collection, including preservation techniques, size or volume, description of the matrix of the sample, and any deviations or anomalies noted.
- Requested analysis and analytical lab performing the analysis.
- Condition of sampling site relevant to sample validity when applicable.
- Results of associated field measurements.
- Calibration information pertaining to field instruments used for the sampling event.
- ID of field personnel performing the work.

- ID of field equipment (model number, serial number).
- Special notes of other activities in the area that may have an impact on analytical results.

Note: Logbook entries should be made in indelible ink. Any changes/corrections made to logbook entries should have a single line thorough it with the date and initials of the personnel making the changes. DO NOT white out or remove pages from logbooks! Blank space should be lined out and initialed.

6.3 Treatment Facility Document Control Logbooks

Entries in the Treatment Facility Document Control Logbooks should reflect the activities and events that take place in and around the Treatment Facility including but not limited to the following:

- Date and time of activity or event.
- ID of personnel performing work.
- ID of equipment used to perform activities (i.e., organic vapor analyzer, thermohydrocarbon analyzer).
- Calibration information as needed per SOP 4.8, "Calibration/Verification and Maintenance of Measuring and Test Equipment (M&TE)."
- Recording of Facility Data as requested.
- Treatability Test Information.
- Analytical laboratories utilized, type of sample, etc.

Note: Logbook entries should be made in indelible ink. Any changes/corrections made to logbook entries should have a single line thorough it along with the date and initials of the personnel making the changes. DO NOT white out or remove pages from logbooks! Blank space should be lined out and initialed.

6.4 Field Data Collection Forms

6.4.1 Specific field data collection forms are used during sampling activities. Each data collection form initiated during sampling becomes a controlled document and receives a document control number. The document control number is derived from the logbook code and the Document Control Logbook page number that was used to document that sampling event. For example, a ground water sample that has sampling information recorded in logbook AH, page 23, would be assigned document control number AH023. Do not hyphenate and always use five or more places.

6.4.2 The Ground Water Sampling Data Sheet (Attachment C in SOP 2.1) is used during sampling activities. The Borehole/Well Construction Log (SOP 1.1, Attachment A) is used during drilling activities. Complete the forms as described in the appropriate SOP.

6.5 Chain-of-Custody (CoC) Record

The primary objective of using a CoC is to create an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and receipt of data. The CoC is a legal document.

6.5.1 Issuance and Archival of CoCs

- Blank CoCs are obtained from DMT.
- Electronic CoCs are produced from information in the Sampling Plan.
- Completed CoCs are archived by DMT.

6.5.2 Required Documentation

The triplicate CoC form is handwritten (Attachment A) or a CoC may be electronically produced (Attachment B) and should contain the following information:

- Assign a document control number as described in Section 6.4.1.
- Sample matrix. Sample matrix codes are listed on the Sampling Plan or in the Taurus Environmental Information Management System (TEIMS) by opening the Data Team page, then using the QBF link to access the SAMPMATRIX Table.
- Name of sampler and employer.
- Requested analysis code. The requested analysis code is listed on the Sampling Plan, if the code is not listed, contact the SC/DC for the appropriate code.
- Number and type of container(s).
- Sample ID and sample date/time. The sample ID is listed on the Sampling Plan/Work Plan. If sample ID is not known, contact DMT for the correct naming convention.
- Study area/operable unit from which sample originated.
- The analytical laboratory name. This is the laboratory where samples are to be sent as designated by the Sampling Plan.
- Individuals requiring facsimile (fax) or electronic mail (e-mail) results. DMT is automatically indicated on the CoC. Two other individuals may also be indicated.
- Requester name. This is the organization samples are being collected for.
- Additional information/instructions or remarks. The remarks section should also indicate whether field filtration and preservation has been performed, or if it is required upon receipt at the lab. If filtration or preservation needs to be performed at the laboratory, include explicit instructions to the lab on the CoC. If it is a routinely planned sampling event, filtration instructions are included on the electronically produced CoCs.

- Requested turnaround time (TAT). Standard TAT is 20 days. If a faster TAT is required, check with the QC Chemist or laboratory for available TATs. A separate CoC should be completed for each different turnaround time specified.
- LLNL Project/Task#. The appropriate Project/Task numbers are provided by TEIMS upon approval of the SC/DC.
- Critical or Clean well note. The analytical laboratory should be instructed in the remarks section of the CoC form to verify any detections in the critical or clean sampling locations as listed in the Sampling Plan and contact the appropriate ERD personnel immediately. The "Clean Well" notation is included on the electronically produced CoC.
- The appropriate relinquishing and receipt signatures. When using electronically produced CoCs, the samples are relinquished by Field Personnel and the CoC accompanies the samples to the laboratory. The Receipt copy and TRR copy is left in the Sample Pick-up Location to be picked-up by the DMT. When using the handwritten CoC form, the sampler signs the CoC to relinquish the samples. The CoC pink and yellow copies are left in the Sample Pick-up Location to be picked up by the DMT. Samples may also be shipped to an offsite lab using the LLNL Shipping Department. In this case, the CoC pink and yellow copies are retained by the Field Personnel and returned to DMT. When returning completed CoC copies to DMT, Field Personnel should stamp the completed CoC copies using the date stamp provided by DMT to signify when the samples were shipped offsite. Field Personnel should also make a photo copy for their records.

6.6 Shipping Forms

All environmental samples classified as non-hazardous must be accompanied by an LLNL ShipIt Form (see SOP 4.4, Attachment A) when going offsite for analysis. The ShipIt form shall be completed by recording the CoC number on the form and the corresponding ShipIt Form number on the CoC. The samples will not be picked-up without the required information on the CoC and ShipIt Forms. The ShipIt Form consists of the original form, which goes to the LLNL Shipping Department when complete and a copy that the courier retains to transport samples offsite. ShipIt Forms are also required for samples meeting the Department of Transportation (DOT) definition of hazardous materials and/or samples that require LLNL to pay for shipping (via Federal Express) and must go through the LLNL Shipping Department. The shipping of samples is fully described in ERD SOP 4.4.

6.7 Sample Identification Labels

Use ID labels when tagging or labeling sample containers. The sampling personnel may fill out sample container labels after collecting samples or prior to collecting samples at each location. However, extreme care must be taken to ensure that the container label corresponds to the correct location! Waterproof ink must be used on the label.

6.7.1 Issuance and archival

Sample labels may be obtained from the analytical laboratory where the samples are to be sent. The SCs/field personnel should have a small stock on-hand at all times. Labels are not archived but are destroyed with sample disposal at the laboratory.

6.7.2 Required Documentation

The Sample ID Label may be handwritten or electronically generated and must include the following information:

- Sample ID. The sample ID can be made up from the combination of various factors such as location, sample type, etc. The TEIMS Location Table contains all sample IDs previously used and is continuously updated with new sample locations. If a new location is to be sampled that is not in the Location Table or an experiment is to be conducted, the DMT must be consulted and approve all new sample IDs. The new names will then be added to the Location Table.
- Project name.
- Sample date. The date when the sample was collected.
- Sample time. Time is recorded according to the 24-h clock (e.g., 1:00 a.m. = 0100 h, 3:00 p.m. = 1500 h).
- Samplers' initials. The initials of personnel conducting the sampling.
- Preservation method. Any preservative added to the sample should be indicated.
- Comments. Any additional information.
- Requested analysis. The type of analysis to be performed on the sample. (Optional)

7.0 QA RECORDS

7.1 Chain-of-Custody forms

7.2 Document Control Logbooks

7.3 Ground Water Sampling Data Sheets

7.4 Borehole/Well Construction Logs

8.0 ATTACHMENT

Attachment A—Example Chain-of-Custody Form

Attachment B – Example of Electronic Chain-of-Custody Form

Attachment A

Example of Chain-of-Custody (Triplicate Form)

Chain of Custody

Page ____ of _____

Attn: ERD Data Management Team
Lawrence Livermore National Laboratory
P.O. Box 808 L-542
Livermore, CA 94551

Access # / COC #: H 00244/__________

Document Control #: __________

Requester / LLNL Analyst: __________

Organization / Sampler: __________

PCI Project #: __________

PCI Task #: __________

Fax / Email #1:

Analytical Lab: __________

TAT: __________

Analytical Lab Log #: __________

Project / Network: __________

Release #: __________

Fax / Email #2: __________

Additional Instructions:

Work Authorized by: __________

TRR Approver: __________

Project Info: __________

DMT additional copies: __________

Sample ID	Sampled Date / Time	Matrix	Cont. Type	Cont. Count	Study Area	Requested Analysis	Analysis Detail	Lab Instructions

Relinquished Signature	Company	Date	Time	Received Signature	Company	Date	Time
1				2			
2				3			
3				4			
4				5			

ERD COC 03Sep09

Signature Order - 1: Sampler, 2: Courier, 3: Lab, 4: Analyst, 5: DMT

Attachment B

Example of Chain-of-Custody

(Electronically Produced Form)

Chain of Custody

Attn: ERD Data Management Team
Lawrence Livermore National Laboratory
P.O. Box 808 L-542
Livermore, CA 94551

Work Authorized By: LESLIE FERRY
TRR Approver: DELLA BURRUSS
Project Info:

Access/COC #: 56002
Document Control #: AA23052
Requester/LLNL Analyst: S300
Organization / Sampler: ERD / silva90
PCI Project #: 32577
PCI Task #: 480509
Fax/Email #1: 925-422-2095
DMT Additional Copies:

Analytical Lab : ALS-PARAGN
TAT: 20d
Analytical Lab Log #: PF1203128
Project/Network: 3CMP
LLNL Acct #: 4805-09
Release #: 158308
Fax/Email #2: blake2

Additional Instructions:

Sample ID	Sampled Date/Time	Matrix	Cont. Type	Cont. Count	Study Area	Req. Analysis	Analysis Detail	Lab Instructions
CARNRW1	03/01/2012 10:01	GW	GA	1	PIT6	E906	ALL	
CARNRW2	03/01/2012 10:31	GW	GA	1	PIT6	E906	ALL	
CARNRW3	03/01/2012 09:23	GW	GA	1	PIT6	E906	ALL	
CARNRW4	03/01/2012 11:15	GW	GA	1	PIT6	E906	ALL	

Relinquished Signature	Company	Date	Time	Received Signature	Company	Date	Time
1	LLNL/ERD	4/5/2012		2			
2				3			
3				4			
4				5			

Revision Printed: 10/13/2011/11/16/10 Signature Order - 1: Sampler, 2: Courier, 3: Lab, 4: Analyst, 5: DMT

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.3: Sample Containers and Preservation
Revision: 7

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#________
ERD

AUTHOR(S):
R. Goodrich

APPROVALS:	**Date**
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[illegible] **Livermore Site Program Leader**	11/16/15
Leslie Ferry **Site 300 Program Leader**	8/26/15
CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

This procedure defines ERD's protocol regarding sample volume, container type, holding time, and preservation method requirements for water, waste, soil, rock sediment, and sludge sampling recommended by the Contract Analytical Laboratories (CALs) and the available regulatory guidance.

2.0 APPLICABILITY

This procedure provides sample container and method of preservation information for environmental samples collected by the Environmental Restoration Department (ERD). ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Mazzullo, E. T. (2003), "Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180)," letter to Henry L. Longest II, U.S. EPA, dated February 13, 2003, from E. T. Mazzullo, Director, Office of Hazardous Materials Science, U.S. Department of Transportation Research and Special Programs Administration, Washington, D.C.

3.2 U.S. EPA (1993), *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*, SW-846, 3rd edition, Washington, D.C.

3.3 U.S. EPA (2007), *40 Code of Federal Regulations,* Chapter 1, Section 136.3, Table II, Washington, D.C.

3.4 U.S. EPA (1983), *Methods for Chemical Analysis of Water and Wastes,* EPA-600/4-79-020, Washington, D.C.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Quality Control (QC) Chemist

The QC Chemist is responsible for developing and submitting a contract modification form for analyses not available via the contract but are needed by project staff. The QC Chemist will also provide sample volume, container type, and required preservation information for the newly added analysis, for limited volume samples, and for non-routine sampling events as needed.

5.6 Sample Coordinator (SC) or Drilling Coordinator (DC)

The SC's or DC's responsibility is to supply the Field Personnel with a sampling plan that contains the requested analyses, required volume, sample containers, and type of preservation.

5.7 Field Personnel (FP)

Field personnel are responsible for collecting the appropriate volume of samples necessary for analysis in the correct containers using the proper preservation technique. In addition, field personnel are responsible for considering sample hold times when collecting samples and shipping to the analytical laboratories.

5.8 Data Management Team (DMT)

The DMT is responsible for generating routine quarterly sampling plans and distributing to the SC to supply to FP. DMT is also responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

6.1 Discussion

6.1.1 Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing. Methods of preservation are intended to: retard biological action, hydrolysis of chemical compounds and complexes, and to reduce the volatility of analytes and adsorption effects.

6.1.2 Containers can introduce positive or negative errors by contributing contaminants through leaching or surface desorption, and depleting concentrations through adsorption. Therefore, containers such as Borosilicate glass, linear polyethylene, polypropylene, or Teflon should be used for collecting environmental media. If necessary, brass or stainless steel tubes, or Terra Core® Soil Samplers can be used during drilling operations. Do not use other plastic containers or lids and aluminum foil due to possible sample contamination from the phthalate esters and other hydrocarbons within the plastic and on the foil surface.

6.1.3 All sample containers should be ordered and received from the laboratory designated to perform the analysis. VOA vials should be certified clean by the vendor as well as all sample containers provided by the laboratory.

6.1.4 Due to the short holding times of some constituents, sampling of these should not be performed on Fridays or before holidays. Field personnel should alert the laboratories that short hold time samples are pending to ensure that samples can be analyzed within the required hold time.

6.2 Procedure

6.2.1 Obtain the sampling plan. A sampling plan may be obtained from the SC or DC that lists the area and well or location to be sampled, the requested analyses, container type, number of containers, the analytical laboratory the sample is to be sent, and other sampling information.

6.2.2 Determine sample container and/or preservation requirements. Using the sampling plan or the TEIMS Data Mining "Find Analysis Suite" webpage link to determine the type of bottles, preservatives, holding times, and filtering requirements. The webpage provides the number of each type of container required for the specific analysis. Gather sampling materials as listed in the appropriate sampling or drilling SOP.

6.2.3 Obtain the appropriate containers from storage. Sample containers are available from the laboratory where samples will be sent for analysis. Containers are retrieved from the sample bottle inventories maintained at the Livermore site and at Site 300. Obtain a cooler and fill with ice (either loose, bagged, or Blue). Blue ice should be bagged and used when shipping samples via Federal Express (see SOP 4.4, "Guide to the Handling, Packaging, and Shipping of Samples"). See SOP 4.9, "Collection of Field Samples" for the required QC sample requirements. Sufficient supplies of sample containers, trip blanks, temperature blanks (if required by the lab), and water for field blanks should be maintained and stored appropriately.

6.2.4 Collect samples. Samples should be collected as described in the appropriate sampling or drilling SOP.

Note: Sample containers should be filled so that the sample does not come into contact with the sampler's gloves, thus potentially causing contamination.

6.2.5 Filter samples. Samples requiring filtering (such as dissolved metals) should be filtered and preserved at the laboratory unless otherwise determined by the SC or DC. The CoC should describe any filtration the laboratory needs to perform by using the "FILTER" requested analysis code. Including "FILTER" on the COC instructs the laboratory to filter and preserve samples as necessary.

6.2.6 Preserve samples. It is ERD protocol not to preserve samples in the field, but request that the analytical laboratory perform filtration and/or preservation of the sample(s) upon receipt. In the rare case that a sample must be field preserved the following guidelines are provided.

A. If the samples are to be preserved, the sampler should:

- Consult a QC Chemist to determine the approximate volume of acid (or base) needed to preserve a sample.
- Preserve the appropriate samples using the pre-determined amount of acid (or base).

Note: Samples shipped via common carrier or U.S. Postal Service, must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR part 172), and is the responsibility of the person who prepared the material for shipment to ensure this compliance is met. For the preservation requirements of samples, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation (DOT) has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCL) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); nitric acid (HNO3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); sulfuric acid (H2SO4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and sodium hydroxide (NaOH) in water solutions at concentrations of 0.08% by weight or less (pH about 12.3 or less). The most recent guidance can be found in a Letter of Clarification on Hazardous Materials Regulations, date stamped Feb. 13, 2003, Ref. No.: 02-0093 (49 CFR parts 100-185) and is listed above under section 3.0 References.

B. If samples that require preservation at the time of collection cannot be preserved in the field or upon returning from the field, samples are to be preserved by the laboratory immediately upon receipt. In all cases, samples are to be preserved within 12 h from the time of collection, except in the instances where the samples can be analyzed within their unpreserved holding time (the time requirement automatically prints out on the COC when the "FILTER" requested analysis is used).

C. Radiological samples must be sent to the laboratory within 5 days of sample collection and sooner if at all possible to ensure proper filtration and/or preservation is performed within a timely manner. Because these samples do not have impending hold times there may be a tendency to hold samples and ship all at one time, but they should not be stockpiled for extended periods of time; In doing so, the required timeframe for filtration will be missed and the analysis may not be available when needed for regulatory reports.

6.2.7 Keep samples at the proper temperature. Samples requiring refrigeration of ≤ 6°C must be protected from getting wet. Samples must be immediately placed in an ice chest containing either Blue Ice packs (in air-tight plastic bags), or bagged or loose ice cubes. If samples are not submitted to the laboratory daily, ice chests should be checked periodically and thawed ice replaced or samples should be properly stored and segregated in a refrigerator designated for samples only.

6.2.8 Document preservation. Note sample preservation methods in sampling logbook, on sample label, and on CoC as appropriate.

6.2.9 Return unused sample containers to their appropriate place.

7.0 QA RECORDS

7.1 Completed Chain-of-Custody forms

7.2 Document Control Logbooks and field sheets

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.4: Guide to Packaging and Shipping of Samples—Revision: 7

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
____
ERD

AUTHOR(S):
R. Goodrich

APPROVALS:	Date
Jesse Yow Department Head	4/30/12
[signature] Livermore Program Leader	4/18/12
Leslie Ferry Site 300 Program Leader	4/12/12

CONCURRENCE:	Date
Rebecca Goodrich QA Implementation Coordinator	4/19/12

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to define the steps required to properly package and ship environmental samples to analytical laboratories and off-site vendors. The transportation of samples must be designed to protect the integrity of the sample, prevent any detrimental effects from the potentially hazardous nature of the samples, and comply with applicable regulations.

2.0 APPLICABILITY

This procedure is applicable to handling, packaging, and shipping samples for the ERD and Environmental Functional Area (EFA) samples handled, packaged, and shipped by ERD. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Code of Federal Regulations, 40 CFR ch. 1 (7-1-92 Edition), Part 136.3, Office of the Federal Register, National Archives and Records Administration, U.S. Govt. Printing Office, Superintendent of Documents, Mail Stop SSOP, Washington, D.C. 20402-9328.

3.2 Code of Federal Regulations, 49 CFR, Parts 171 and 172.101, Section 8, Office of the Federal Register, National Archives and Records Administration, U.S. Govt. Printing Office, Superintendent of Documents, Mail Stop SSOP, Washington, D.C. 20402-9328.

3.3 Code of Federal Regulations (CFR, 1991b) 40 Part 261.4 (d)(1), Revised July 1, 1991. Office of the Federal Register, National Archives and Records Administration, U.S. Govt. Printing Office, Superintendent of Documents, Mail Stop SSOP, Washington, D.C. 20402-9328.

3.4 Code of Federal Regulations, 40 CFR ch. 1 (10-1-04 Edition), Office of the Federal Register, National Archives and Records Administration, U.S. Govt. Printing Office, Superintendent of Documents, Mail Stop SSOP, Washington, D.C. 20402-9328.

3.5 Mazzullo, E. T. (2003), "Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180)," letter to Henry L. Longest II, U.S. EPA, dated February 13, 2003, from E. T. Mazzullo, Director, Office of Hazardous Materials Science, U.S. Department of Transportation Research and Special Programs Administration, Washington, D.C.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs, and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Sampling Coordinator (SC) or Drilling Coordinator (DC)

The SC or DC is responsible for contacting the EFA Environmental Analyst when determining whether samples are hazardous or nonhazardous.

5.6 Field Personnel (FP)

The Field Personnel are responsible for properly handling and packaging samples collected for ERD. They are also responsible for delivering samples to the sample pick-up location for lab courier pick-up, to LLNL Shipping Department to outside analytical labs, or delivery of samples to an onsite laboratory in accordance with all applicable internal and external regulations and procedures. They must also ensure that the samples delivered are representative of the original material. The FP must complete, date, and sign the appropriate sections of the Chain-of-Custody (CoC) and ERD Shipping Forms.

6.0 PROCEDURE

When samples collected at a site are classified hazardous or environmental nonhazardous, a distinction between these samples must be made to (1) determine the appropriate procedures for transporting the samples, and (2) protect the health and safety of the shipping and laboratory personnel receiving the samples. Special precautions, procedures, and secondary containment areas within the analytical laboratories will be used when hazardous samples are received.

6.1 Determining the Classification of Samples

The SC or DC determines the classification of samples based on Sections 6.1.1 through 6.1.3 and conveys this information to the sampler or other personnel responsible for handling and/or shipping of samples.

6.1.1 Hazardous Sample Identification

A hazardous substance is defined by 49 CFR, part 171, Section 8 as a material including its mixtures and solutions that meet the following criteria:

- As listed in the appendix to Section 172.101,
- Is in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) listed in the appendix to Section 172.101, and
- When a mixture or solution is in a concentration corresponding to the RQ of the material. See following table:

	Concentration by weight	
RQ pounds (kilograms)	**Percent**	**Part per million (ppm)**
5000 (2270)	10	100,000
1000 (454)	2	20,000
100 (45.4)	0.2	2,000
10 (4.54)	0.02	200
1 (0.454)	0.002	20

Note:

RQ = Reportable quantity.

The following table example lists hazardous substances and corresponding RQs from the appendix to Section 172.01:

Hazardous substance	RQs lb (kg)	Hazardous substance	RQs lb (kg)
Arsenic	1 (0.454)	1,2-Dichloroethene	1000 (454)
Benzene	10 (4.54)	Freon 11	5000 (2270)
Beryllium	10 (4.54)	Hydrochloric acid	5000 (2270)
Chloroform	10 (4.54)	Mercury	1 (0.454)
Chromium	5000 (2270)	Nickel	100 (45.4)
Copper	5000 (2270)	Nitric acid	1000 (454)
1,1-Dichloroethane	1000 (454)	Tetrachloroethene	100 (45.4)
1,2-Dichloroethane	100 (45.4)	Toluene	1000 (454)
1,1-Dichloroethene	100 (45.4)	Trichloroethene	100 (45.4)

Note:

RQ = Reportable quantity.

For example: If you had a substance weighing 1 lb that contained arsenic at 20 mg/kg (ppm), it would be considered hazardous material. Regulations for packaging, marking, labeling, and shipping hazardous material, hazardous substances, and hazardous wastes are promulgated by the U.S. Department of Transportation (DOT) and described in the Code of Federal Regulations (CFR). However, these regulations were not intended to cover the shipment of small quantities (1 kg or less for single packages) or samples collected at hazardous waste sites that are transported to laboratories for testing.

Note: For all materials identified as hazardous waste, contact the Radioactive and Hazardous Waste Management (RHWM) Programs.

6.1.2 Non-Hazardous Sample Identification

Environmental samples with an unknown history are not considered hazardous until (1) the analytical laboratory has analyzed the sample and identifies it as hazardous, (2) the personnel suspect the sample is hazardous, or (3) there is doubt of the sample classification. Once this is determined, samples are shipped accordingly.

It may be necessary to preserve samples per SOP 4.3, "Sample Containers and Preservation." Preserved environmental samples considered hazardous must go through the LLNL Shipping Department using their shipping documents, unless they meet the requirements of 40 CFR, Section 136.3, Table II, note #3. This requirement states that the Hazardous Materials Regulations do not apply to the following materials:

- Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater).

- Nitric acid (HNO3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater).
- Sulfuric acid (H2SO4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater).
- Sodium hydroxide (NaOH) in water solutions at concentrations of 0.08% by weight or less (pH about 12.30 or less).

The most recent guidance can be found in a Letter of Clarification on Hazardous Materials Regulations, date stamped Feb. 13, 2003, Ref. No.: 02-0093 (49 CFR parts 100-185). The letter confirms that when environmental samples are preserved (or even over-preserved) they are not corrosive materials subject to hazardous materials regulations (HMR). Four preservatives: Nitric acid, Sulfuric acid, Hydrochloric acid, and Sodium Hydroxide were each tested in an aqueous solution. Based on the test results, samples containing the following "upper limit" concentrations: 0.28 weight percent Nitric acid; 0.38 percent Sulfuric acid; 0.15 weight percent Hydrochloric acid, and 0.20 weight percent Sodium hydroxide, do not meet the definition of corrosive material in Sec. 173.136 and are not subject to HMR.

6.1.3 Radioactive Material

In the past, DOT defined a Class 7 (radioactive) material as any material having a specific activity greater than 70 becquerels (Bq) per gram (0.002 microcuries per gram [μCi/g] or 2000 pCi/g). On January 26, 2004 the DOT definition was rewritten. The new definition as found in 49 CFR 173.403 is as follows:

Radioactive materials means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in the table in Sec. 173.436 or values derived according to the instructions in Sec. 173.433.

Consignment means a package or group of packages or load of radioactive material offered by a person for transport in the same shipment.

Exemption value means either an exempt material activity concentration or an exempt consignment activity limit listed in the table 173.436, or determined according to the procedures described in Sec. 173.433. The values provided in table 173.436 in the regulations allow you to determine whether or not you have a Class 7 material. It is important to note in the definition that both exemption values must be exceeded in order to have a Class 7 material. The following excerpt from Table 173.436 shows exemption values and consignment values for certain radionuclides, such as tritium and uranium.

Symbol of Radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity concentration for exempt consignment (Bq)	Activity concentration for exempt consignment (Ci)
T (H-3)	Tritium (1)	$1.0x10^{6}$	$2.7x10^{-5}$	$1.0x10^{9}$	$2.7x10^{-2}$
U-230	Uranium (92))	$1.0x10^{1}$	$2.7x10^{-10}$	$1.0x10^{4}$	$2.7x10^{-7}$
U-232		$1.0x10^{1}$	$2.7x10^{-10}$	$1.0x10^{4}$	$2.7x10^{-7}$
U-233		$1.0x10^{1}$	$2.7x10^{-10}$	$1.0x10^{5}$	$2.7x10^{-6}$
U-234		$1.0x10^{1}$	$2.7x10^{-10}$	$1.0x10^{5}$	$2.7x10^{-6}$
U-235		$1.0x10^{1}$	$2.7x10^{-10}$	$1.0x10^{4}$	$2.7x10^{-7}$
U-236		$1.0x10^{1}$	$2.7x10^{-10}$	$1.0x10^{4}$	$2.7x10^{-7}$
U-238		$1.0x10^{1}$	$2.7x10^{-10}$	$1.0x10^{4}$	$2.7x10^{-7}$
U (natural)		1.0	$2.7x10^{-11}$	$1.0x10^{3}$	$2.7x10^{-8}$
U (enriched)		1.0	$2.7x10^{-11}$	$1.0x10^{3}$	$2.7x10^{-8}$
U (depleted)		1.0	$2.7x10^{-11}$	$1.0x10^{3}$	$2.7x10^{-8}$

Note: ERD groundwater and soil samples are far below the activities specified in Table 173.436 for an exempt material or an exempt consignment containing tritium and uranium. Tritium and uranium are contaminants of concern in groundwater, primarily at Site 300. To date, the highest tritium activities detected in soil or groundwater at the Livermore site or Site 300 have been detected in groundwater wells NC7-40 and NC7-51, located in the Pit 7 Operable Unit at Site 300. NC7-51 had tritium detected at 570,000 pCi/L in October 2005, which serves as a high point and from this point the activity level has continued to subside. These locations are monitored on a continuing basis and the analytic results are presented in a memo submitted periodically to the analytical labs informing them that samples submitted for analysis will not exceed these activity levels. For comparison purposes, the highest tritium detected in groundwater is well below the trigger point of $2.7x10^{-5}$ Ci/G or 27,000,000 pCi/L of tritium presented in the table below. Uranium activities are lesser in comparison than tritium activities.

6.2 Shipping Procedures

6.2.1 Hazardous Sample Shipment

To ship samples classified as hazardous or materials identified as the U.S. DOT hazardous material other than hazardous waste and radioactive materials, contact the LLNL Shipping Department, Material Distribution Division.

6.2.2 Non-hazardous Sample Shipment

Non-hazardous samples are not subject to the same packaging, labeling, and shipping requirements as hazardous wastes, but to qualify for this exemption the collector must, according to 40 CFR, Part 261.4(d):

A. Comply with DOT, U.S. Postal Service (USPS), other applicable shipping requirements, or

B. Comply with the following requirements if the sample collector determines that DOT, USPS, or other shipping requirements do not apply to the shipment of the sample:

1. Assure that the following information accompanies the sample:
   - Sample collector's name, mailing address, and phone number.
   - Laboratory's name, mailing address, and telephone number.
   - Quantity of sample.
   - Date of shipment.
   - Description of sample.

   Note: These requirements are routinely met by the inclusion of the CoC (Attachment A) documentation that accompanies samples shipped to contract analytical laboratories (see Section 6.2.4).

2. Package the sample so that it does not leak, spill, break, or vaporize.

The LLNL Shipping Department requires that an LLNL ShipIt Form (Attachment B) accompany all nonhazardous samples being hand delivered, shipped offsite or picked-up by an analytical laboratory courier for analyses at an outside contracted analytical laboratory (CAL). The ShipIt Form must be prepared in advance by the Technical Release Representative (TRR) or a person dedicated to the task of generating ShipIts. A supply of ShipIts should always be available in the sample drop-off location. Samples will not be picked-up by the lab courier unless a ShipIt form has been completed which includes the number of the CoC accompanying the samples being shipped offsite. In turn, the ShipIt number must also be included on the CoC form. The original ShipIt form and a copy of the form are signed by the courier. The original form remains at the sample drop-off location for LLNL record retention. The courier keeps the ShipIt copy to accompany the samples offsite. The ShipIt copy does not need to be retained by the courier once the samples have been transported offsite.

6.2.3 Radioactive Material Shipment

Samples considered as radioactive materials must be shipped through the LLNL Materials Management Section.

6.2.4 General Packaging and Shipping Instructions

A. Review sample labels. Once the sampling event is completed, verify that all sample bottles have been correctly identified and labeled appropriately (i.e., location, time, date, etc.). Sample containers must have a completed sample identification tag as described in SOP 4.2, "Sample Control and Documentation."

B. Complete a CoC. A CoC form must accompany all sample packages sent to the laboratories on and off site. Record samples on the CoC form. The instructions to complete this form are presented in SOP 4.2. As in other activities used to support litigation, regulatory agencies must be able to provide the chain of possession and custody of any samples which are offered for evidence, or which form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed. The primary objective of these procedures is to create an accurate written record which can be used to trace the possession and handling of the sample from the moment of its collection through analysis and its introduction as evidence.

A. A sample is in someone's custody if:

1. It is in one's actual possession, or
2. It is in one's view, after being in one's physical possession, or
3. It is in one's physical possession and then locked up so that no one can tamper with it, or
4. It is kept in a secured area, restricted to authorized personnel only.

When transferring the samples, the transferee must sign and record the date and time on the CoC form. The sample custodian in the field must account for each sample (or group of samples) when custody transfers are made. Individuals who take custody transfers must complete the appropriate section of the CoC form. The original CoC accompanies the samples to the CAL and the CoC copies are left in the Sample Pick-up Location to be picked-up by DMT.

Note: When shipping any samples offsite via the LLNL Shipping Department or when delivering samples to an onsite lab, retain the Receipt and TRR copies from electronically produced CoCs or the pink and yellow copies from the handwritten CoCs and provide to DMT.

B. Packaging samples. Properly identified sample containers should be placed inside Ziploc®-type storage bags and sealed, then placed in picnic cooler-type containers. Samples to be shipped must be packed with sufficient incombustible, absorbent cushioning material to minimize the possibility of sample container breakage. Samples that require refrigeration during shipping should be packed with a sufficient number of Blue Ice packs or bagged ice cubes to keep samples preserved. The CALs check and record the temperature of samples upon receipt. For this purpose, some CALs require a Temperature blank to be submitted with samples requiring temperature preservation (4°C [degrees centigrade]). The temperature blanks should consist of a 250-ml poly container or equivalent filled with water. The receiving analytical laboratory should be instructed to measure these blanks to ensure sample integrity. The blanks should be provided by the CAL and requested back from the CAL to be reused. It should be noted on CoC forms (under the "Remarks" section) that a temperature blank is enclosed in the shipment. If the blank temperature exceeds 4°C ± 2°C (upon sample receipt), the receiving analytical laboratory should notify the SC or other appropriate personnel.

C. Call ahead. The field personnel, the SC, or DC must call the analytical laboratories before shipping samples to verify that they have the capacity to analyze the samples within their hold and turnaround times. Most laboratories can better process samples when they can plan their workload and downtimes. The analytical laboratory must be notified in advance if incoming samples:

1. Require a rapid turnaround time.
2. Are considered hazardous or when high levels of contaminants are suspected.
3. Arrive with short holding times.
4. Are being shipped in large quantities.
5. Are being sent on Fridays or before holidays.

D. Complete Shipping Forms. A completed ShipIt form with the CoC number for samples being shipped or picked-up by an analytical lab courier must accompany all samples leaving LLNL for analysis by an outside analytical laboratory.

E. Deliver samples to appropriate shipping location. (Sample pick-up location or LLNL shipping as described in Sections 6.2.1 through 6.2.3). LLNL Shipping must receive samples by 2:00 p.m. if they are being dropped off at Livermore Shipping & Receiving; 11:00 a.m. if they are being dropped off at Site 300 Shipping & Receiving. Samples need to be delivered to the sample pick-up location by the analytical laboratory courier pickup time. Generally, the courier pickup times are 4:00–4:30 p.m. at the Livermore Site and 5:00 p.m. at Site 300. Call the analytical laboratory to arrange for special or later pickup when necessary. When samples are shipped on Friday, Saturday delivery must be specified on the LLNL Shipping Document. Receipt must be coordinated with the analytical laboratory.

7.0 QA RECORDS

7.1 Chain-of-Custody forms

7.2 Logbooks and field sheets

7.3 Shipping documents

8.0 ATTACHMENTS

Attachment A—Example Chain-of-Custody Form

Attachment B—LLNL ShipIt Form

Attachment A

Example Chain-of-Custody Form

Chain of Custody

Page ____ of _____

Attn: ERD Data Management Team
Lawrence Livermore National Laboratory
P.O. Box 808 L-542
Livermore, CA 94551

Work Authorized by: ______________

TRR Approver: ______________

Project Info: ______________

Access # / COC #: H 00244/ ______________

Document Control #: ______________

Requester / LLNL Analyst: ______________

Organization / Sampler: ______________

PCI Project #: ______________

PCI Task #: ______________

Fax / Email #1:

Analytical Lab: ______________

TAT: ______________

Analytical Lab Log #: ______________

Project / Network: ______________

Release #: ______________

Fax / Email #2: ______________

Additional Instructions:

DMT additional copies: ______________

Sample ID	Sampled Date / Time	Matrix	Cont. Type	Cont. Count	Study Area	Requested Analysis	Analysis Detail	Lab Instructions

Relinquished Signature	Company	Date	Time	Received Signature	Company	Date	Time
1				2			
2				3			
3				4			
4				5			

ERD COC 03Sep09

Signature Order - 1: Sampler, 2: Courier, 3: Lab, 4: Analyst, 5: DMT

Attachment B

LLNL ShipIt Form

ShipIt
SRS001R
05/27/2010 10:37:01

Lawrence Livermore National Security, LLC
LAWRENCE LIVERMORE NATIONAL LABORATORY

00136868

Request #: 00136868

Date Required
Fri 05/28/2010

Material Value
$0.00

Ship To:
General Engineering Labs (GEL)
Sample Receiving
2040 Savage Rd.
Charleston, SC, 29414
UNITED STATES

Signature Required

Suggested Shipment Method
Overnight

Pkg #	Weight	Length		Width		Height	Type
			X		X		
			X		X		
			X		X		
			X		X		
			X		X		
			X		X		
			X		X		
			X		X		
			X		X		
			X		X		

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.5: General Equipment Decontamination—Revision: 6

ENVIRONMENTAL RESTORATION DEPARTMENT
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ERD

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous

1.0 PURPOSE

The purpose of this SOP is to describe methods used for decontamination of field equipment that becomes potentially contaminated during field operations.

2.0 APPLICABILITY

This procedure applies to the decontamination of applicable equipment used for environmental sampling and monitoring activities, prior to, and/or after contact with soils, surface water, or ground water. This procedure is performed to prevent the potential of cross contamination. It also minimizes the possibility of exposure to field personnel from the handling of improperly decontaminated equipment. The equipment may include split spoon samplers, sampling pumps, bailers, trowels, shovels, drill bits, augers, drill rigs, or any other equipment used during field activities.

3.0 REFERENCES

3.1 U.S. Environmental Protection Agency (1987), *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

3.2 Grandfield, C. H. (1989), *Guidelines for Discharges to the Sanitary-Sewer System*, Lawrence Livermore National Laboratory, Livermore, California (UCAR 10235).

3.3 NIOSH, OSHA, USCG, and EPA (1985), *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Coast Guard (USCG), and U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is

adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs, and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Field Personnel (FP)

It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and to ensure that no contaminants are negligently introduced into the environment. Decontamination is performed in the same level of protective clothing as the sampling activities, unless otherwise specified.

6.0 PROCEDURE

6.1 General

6.1.1 Decontamination of field equipment should occur <u>before</u> equipment is used if the cleanliness of equipment is unknown and <u>after</u> each use.

6.1.2 Before proceeding, obtain materials listed in Equipment Checklist (Attachment A). This list provides general guidance and should be modified to site-specific needs. Restock supplies as necessary to ensure available inventory.

6.1.3 Check the sampling plan to determine if equipment blank rinsate (samples) are required. See SOP 4.9, “Collection of Field QA/QC Samples,” for the collection of equipment blanks when specified in the sampling plan.

6.2 Site 300 Decontamination Procedures

6.2.1 Decontamination of Tritium Contaminated Equipment

Any equipment or materials contaminated with tritium must be decontaminated in the area containing this particular contaminant using the appropriate method described in Sections 6.2.2 through Sections 6.2.4. The rinse and wash water must be contained in a drum and allowed to evaporate similar to the procedures used for purge fluids (see SOP 4.7B, "Site 300 Treatment and Disposal of Well Development and Well Purge Fluids").

6.2.2 Decontamination by Rinsing

This is normally performed when contaminant concentrations are negligible or are of a nature where detergents are not necessary. This method is particularly applicable for water soluble compounds or those of an inorganic nature (i.e., tritium, metals, etc.). Contaminants that will not readily adsorb onto the surfaces of equipment and are easily rinsed off the equipment fall into this category.

A. Remove any solid particles from the equipment or material.

B. Triple rinse equipment with analyte-free water.

C. When decontaminating equipment used for sampling/monitoring of dedicated monitor wells, collect rinsate water and allow to evaporate from dedicated and labeled purge water collection drum adjacent to monitor well. If no drum is present, place collected rinsate in a drum at an adjacent well that has similar ground water contaminants and concentrations.

D. When decontaminating equipment used in soil sampling, the rinse water can be allowed to fall on the ground adjacent to the sampling location.

E. If time permits, place equipment on a clean surface and allow to air dry. If equipment is needed immediately for use, ensure that the equipment has been thoroughly rinsed with analyte-free water and wiped with a chemical-free cloth or paper towel to remove excess water.

6.2.3 Decontamination by Hand Washing with Detergent

Hand washing using a detergent such as Alconox®, is performed when contamination is known or suspected to be present, and particularly when organic constituents are involved. This method applies when triple rinsing is not sufficient to remove contaminants, and steam cleaning is not necessary.

A. Acquire appropriate Personal Protective Equipment (PPE) before proceeding (i.e., gloves, safety glasses, coveralls, etc.). (See SOP 4.1, "General Instructions for Field Personnel").

B. Remove any solid particles from the equipment or material.

C. Using appropriate brush and water containing detergent, scrub equipment until contaminants have been amply broken down. Collect all rinsate.

D. Triple rinse with analyte-free water and inspect equipment. Repeat this process as many times as necessary until equipment is visually clean.

E. Allow to air dry for 15 min or wipe dry with a clean cloth or paper towel.

F. Properly dispose of all rinsate water according to SOP 4.7B, "Treatment and Disposal of Well Development and Well-Purge Fluids", or follow established procedure developed for the specific task.

Note: Rinsate containing detergents cannot be discharged to ground or storm drain!

6.2.4 Decontamination by Pressure Washing

Pressure washing is performed when equipment is too large to hand wash, or when high-pressure is necessary to remove larger amounts of stuck-on debris (mud, clay, etc.). Pressure washing can be done at Building 843 provided: (1) it is not a vehicle or drill rig, (2) the equipment has not come in contact with any oils or greases (O&G), and (3) the equipment has not been contaminated with radiological compounds. Drill rigs, vehicles, or equipment contaminated with O&G, must be steam cleaned at the Building 879 Motor Pool, and then taken to the process area at Route 3 "Stand pipe wash down area." Decontamination of Drill rigs and associated equipment is generally done at the mud pit and the pit is used to collect all rinsate.

A. Keep all equipment to be decontaminated over the troughs during cleaning.

B. To insure the proper use of the pressure washer, check with the ERD SSO (i.e., safety, operation, maintenance, cleanup, etc.).

C. Before proceeding, ensure that troughs have adequate capacity to contain the rinse water.

D. All water collected in troughs will be allowed to evaporate.

6.2.5 Decontamination of a Portable Pump

A. Rinse pump and discharge line by spraying analyte-free water on the exterior components where contact is made with contaminated well water.

B. Insert the pump into a clean vessel containing analyte-free water. Refer to the table in SOP 2.1 Section 6.6.2 D for the discharge line diameter and related volume factor. Calculate the purge volume based on the length of the discharge line and then purge at least 3-line volumes through the system.

C. Collect all rinsate and purge water and dispose of according to SOP 4.7B, or by task specific procedures.

D. Document decontamination activities in the appropriate Document Control Logbook.

6.3 Livermore Site Decontamination Procedures

The Livermore Site does not allow evaporation of any rinsate or purge water.

6.3.1 Decontamination of Field Equipment

A. Remove any solid particles from the equipment or material.

B. Rinse equipment with analyte-free water.

C. Collect rinsate water and dispose of per SOP 4.7A, "Treatment and Disposal of Well Development and Well-Purge Fluids."

6.3.2 Decontamination by Hand Washing with Detergent

Hand washing using a detergent such as Alconox®, is performed when contamination is known or suspected to be present, and particularly when organic constituents are involved. This method applies when triple rinsing is not sufficient to remove contaminants, and steam cleaning is not necessary.

A. Acquire appropriate Personal Protective Equipment (PPE) before proceeding (i.e., gloves, safety glasses, coveralls, etc.). (See SOP 4.1, "General Instructions for Field Personnel").

B. Triple rinse with analyte-free water being careful to collect rinsate.

C. Using appropriate brush and detergent, scrub equipment until contaminants have been amply broken down.

D. Triple rinse again with analyte-free water and inspect equipment. Repeat this process as many times as necessary until equipment is visually clean.

E. Allow to air dry for 15 min or wipe dry with a clean cloth or paper towel.

F. Properly dispose of all rinsate water according to SOP 4.7B, "Treatment and Disposal of Well Development and Well-Purge Fluids," after equipment blanks are collected. Wash or appropriately discard any contaminated PPE.

Note: Rinsate containing detergents cannot be discharged to ground or storm drain!

6.3.3 Decontamination by Steam Cleaning

Steam cleaning is performed when equipment is too large to hand wash, or when high-temperature, high-pressure steam is necessary. ERD has an agreement in place with the Maintenance and Utilities Services Department (MUSD), which allows steam cleaning to be performed in a designated area south of B511.

6.3.4 Decontamination of a Portable Pump

A. Rinse pump and discharge line by spraying analyte-free water on the exterior components where contact is made with contaminated well water.

B. Insert the pump into a clean vessel containing analyte-free water. Refer to the table in SOP 2.1, section 6.6.2D, for the discharge line diameter and related volume factor. Calculate the purge volume based on the length of the discharge line and then purge at least 3-line volumes through the system.

C. Collect all rinsate and purge water and dispose of according to SOP 4.7B.

D. Document decontamination activities in the appropriate Document Control Logbook.

6.4 Livermore Site and Site 300 Field Post Operation

Properly dispose of expendable items that cannot be decontaminated. Contact Radioactive and Hazardous Waste Management (RHWM) if necessary.

7.0 QA RECORDS

7.1 Document Control Logbook

8.0 ATTACHMENT

Attachment A—Equipment Checklist

Attachment A

Equipment Checklist

EQUIPMENT CHECKLIST

____ Cleaning liquids such as soap and/or detergent solutions, tap water, analyte-free water
____ Chemical-free cloth or paper towels
____ Cleaning brushes
____ Cleaning containers such as plastic buckets or galvanized steel pans
____ Waste-storage containers such as drums and plastic bags
____ Pressure Washer
____ Steam cleaner
____ SOPs

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.6: Validation and Verification of Radiological and Nonradiological Data Generated by Analytical Laboratories—Revision: 6

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

This procedure specifies the process used by the ERD QC chemists when reviewing analytical data to ensure consistent results of a known quality so that the data user may evaluate and make judgments based on the analytical results.

2.0 APPLICABILITY

This procedure applies to the radiological and chemical data generated by analytical laboratories from the analysis of ground and surface water and soil, rock, and sediment samples that are reviewed by the Environmental Restoration Department (ERD).

3.0 REFERENCES

3.1 U.S. Environmental Protection Agency (EPA) (1994), *Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review,* U.S. Environmental Protection Agency, Washington, D.C. 20460 (EPA-540/R-94-012).

3.2 EPA (2004), US EPA *CLP National Functional Guidelines for Inorganic Data Review,* U.S. Environmental Protection Agency, Washington, D.C. 20460 (EPA-540-R-04-004).

3.3 EPA (1987), *Data Quality Objectives For Remedial Response Activities*, Office of Emergency Response and Office of Waste Programs Enforcement, Washington, D.C., 20460.

3.4 LLNL Environmental Restoration Division (1999), *Livermore Site and Site 300 Quality Assurance Project Plan.*

3.5 Lawrence Livermore National Laboratory's (LLNL) Environmental Protection Department (EPD) and the Lawrence Berkeley National Laboratory's (LBNL) Analytical Statement of Work.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is

adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work. Work commonly performed by the public is categorized as a WAL A activity and does not require an IWS.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs, and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.2 Quality Control (QC) Chemists

The ERD QC Chemists are responsible for reviewing 100% of the analytical data for technical adequacy, internal consistency and quality, identifying and flagging data quality deficiencies and requesting additional information from the analytical laboratories if there are suspect data points or problematic QC results.

5.3 Functional Team Leader (FTL)

The FTL or personnel assigned by the FTL who are responsible for specific tasks, e.g., writing assigned sections of compliance monitoring reports including reviewing the analytical data for internal consistency prior to inclusion of data in reports. When data anomalies are discovered during the review process, the FTL or designated personnel should consult the QA/QC Chemist for further evaluation. Based on the evaluation outcome, the QA/QC Chemist will apply data qualifier flags if deemed necessary.

5.4 Data Management Team (DMT)

The DMT is responsible for decoding collocated sample identifications and electronically recording qualifier flags. Flags assigned by QC Chemists are hand entered and those flags that can be generated automatically (see Attachment B) are assigned by running a computer program. The DMT is also responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURE

6.1 QC Chemist Review

In order for the QC Chemist to perform data validation/verification, the analytical laboratory must provide sufficient information for the QC chemist to determine the status of the following:

A. Integrity and stability of the samples(s) analyzed.

B. Performance of the instrument(s) used for analyses.

C. Results of Internal quality control checks.

D. Identification and quantification of the analyte(s) in the sample(s) analyzed.

The information sent with the analytical results varies somewhat by laboratory. The contract analytical laboratories are contractually obligated to provide specific information as described in the ERD Quality Assurance Project Plan (QAPP) and analytical Statement of Work (SOW). The QC Chemists use this information to determine if the analytical results require qualification. Attachment A shows the typical flow of the QC Chemists review. Attachment B lists all the Data Qualifier Flags available including those automatically assigned by the electronic flagging program.

6.1.1 Integrity and Stability of Sample(s) Analyzed

A. Review signed Chain-of-Custody (CoC) form for each sample received to determine if the chain of custody has been broken. Sample results may need qualification if defensibility or traceability of samples cannot be determined (i.e., S or R flag).

B. Check date and time of both extraction and analysis of each sample to ensure the appropriate holding times (if applicable) are met. If the holding time has not been met, the associated results should be qualified with the H flag. This is performed automatically by the electronic flagging program run by DMT. If the turn around times (TAT) specified on the CoC were not met, this information is documented on the sample invoice and in the Sampling Plan and Chain-of-Custody Tracking (SPACT) application.

C. Review the condition of sample upon receipt form to determine if the samples were damaged or compromised during shipment. Samples should arrive at the laboratory at the proper preservation temperature (see SOP 4.3 for proper preservation temperatures). Sample results may need qualification based on this review (i.e., S or R flag).

6.1.2 Performance of the Instruments(s) Used for Analysis

Analytical methodology for analyzing the samples will determine the type of instrument(s) to be used by the laboratory. The following steps are performed to demonstrate the working condition of instrument(s) during analysis:

A. Compare the reporting limits to the contract required reporting limits. If the reporting limits are elevated due to sample dilutions, the dilution factor should be checked against the concentration for appropriateness. A Data Revision Request (DRR) may be necessary if inappropriate reporting limits were reported. The D flag is automatically assigned by the electronic flagging program when dilutions are performed.

B. Identification of each instrument used for analysis to determine if QC samples were analyzed on the same instrument.

6.1.3 Internal Quality Control Checks

A. At least one method blank is analyzed in every analytical batch of samples or whenever system contamination is suspected following a high level sample. If analytes are detected in the method blank and the same analyte is detected in samples, then the analytes in the associated samples are qualified with the B flag. Non-detects (NDs) are not qualified.

Note: If there are detections in the blanks, but not in the associated samples, no qualification is necessary.

B. If surrogate or tracer yield recoveries are outside method specified control limits, the associated results are qualified. QC Chemists should use professional judgement when assigning flags based on surrogate results. For example, results may not need to be qualified if surrogates are slightly outside of control limits. The following should be considered as guidelines only:

1. If surrogate or tracer yield recoveries (%RCV) are greater than the upper control limit (UCL), then any sample detections should be flagged "IJ". NDs do not require flagging.
2. If %RCVs are less than the lower control limit (LCL), but greater than 50%, then flag sample results "IJ" (both ND and positive results) for estimated sample quantitation limit. Analytes that are ND will be qualified with "IUJ" due to "U" being automatically assigned in the database to non-detected analytes.
3. If %RCVs are less than the LCL, and less than 50%, then flag positive sample results "IJ" and flag NDs "IR". In some cases, the acceptable control limit range will go lower than 50% (i.e., Semivolatiles), therefore best professional judgement should be used when %RCV is < LCL.

Note: When QC sample surrogates are outside specified control limits, all supporting information (i.e., MS/MSD accuracy and precision, LCS accuracy, and sample location historical data) should be considered to determine if the associated samples were affected.

C. Accuracy as percent recovery (%RCV) and precision as relative percent difference (RPD) should be determined with each batch of samples, when appropriate, as indicated by the analytical method. Accuracy is determined by the analysis of matrix spikes (MS). For nonradiological analyses, precision is determined by the analysis of matrix spike duplicates (MSDs) and expressed as RPD. For radiological analyses, precision is determined by the analysis of sample duplicates and expressed as RPD and/or relative error ratio (RER). Radiological laboratories are not required to perform MSDs due to waste disposal issues. When %RCVs, RPDs, and/or RERs are outside method specified control limits the data is qualified. The QC Chemist should try to determine if the %RCVs, RPDs, or RERs are outside acceptance limits due to matrix affects. If matrix effects are determined to have caused the failed QC, then the extent of the matrix effects should be determined. Instances where matrix effects have been determined to only affect the sample spiked (not the other samples in the batch), qualification should be limited to this sample alone. However, it may be determined that a laboratory is having systematic problems in the analysis of one or more analytes that affects all associated samples. The reviewer must use professional judgment to determine the need for qualification of unspiked analytes and samples. The following should be used as guidelines only:

1. If both the MS and MSD %RCV are outside specified control limits (either above the UCL or below the LCL), then flag sample results (both detections and NDs) "L". If only one %RCV is outside specified control limits, no flag is necessary unless no MSD exists, then flag "L.
2. If MS/MSD %RCV is less than 30%, use professional judgement to determine if matrix interference may affect the determination of the analyte in the samples and flag positives "J" and NDs with an "R".
3. If the RPD/RER is outside specified control limits (either above the UCL or below the LCL) for an analyte, then flag sample results (both positive and negative detections) "O". LCSs should be analyzed with every batch of samples. If the LCS %RCV is outside of control limits the associated results are qualified as described below.
4. If the LCS %RCV is greater than the UCL for an analyte, then flag positive sample results from the same batch "J". No flags are necessary for ND results.
5. If the LCS %RCV is less than the LCL for an analyte, then flag positive sample results from the same batch "J" and flag NDs with "R".

   Note: If more than half of the compounds in the LCS are not within the required recovery criteria, then all associated data should be qualified "R".

6.1.4 Identification and Quantification of the Analyte(s) in the Sample(s) Analyzed

Field quality control samples (SOP 4.9, "Collection of Field QC Samples," describes the collection of field QC samples) may be submitted for analysis to support the determination by the QC Chemist that the detected constituents have been identified correctly.

A. Detections of analytes in equipment blanks may indicate inadequate decontamination of sampling equipment potentially leading to cross-contamination of samples. Analytes detected in both the equipment blank and associated samples should be qualified with the "F" flag.

B. Detections of analytes in field blanks may indicate contamination from the sampling container and/or the environment in which the primary sample was collected. Analytes detected in both the field blank and associated samples should be qualified with the "F" flag.

C. Detections of analytes in trip blanks may indicate sample contamination through handling, preservation, and shipping. Analytes detected in the trip blank and associated samples should be qualified with the "F" flag.

Note 1: If there are detections in the blanks, but not in the associated samples, no qualification is necessary.

Note 2: When flagging detections in samples based on detections in the blanks, the blanks themselves do not require qualification.

Note 3: The QC Chemists should use professional judgement to determine whether trip, field, or equipment blanks need to be qualified when associated QC is outside acceptance limits. In many cases the blanks themselves do not require qualification. (i.e., when a MS/MSD %RCV is outside of limits).

D. The QC Chemist should compare the results of decoded intralaboratory collocated samples. If the results are not comparable, a DRR (see Section 6.2.2) should be initiated. It is important to contact the individual(s) affected by the suspect results immediately in case resampling is necessary. Based on the outcome of the DRR, sample results may need to be flagged suspect (S), estimated (J), or rejected (R).

E. The QC Chemist may compare the analytical results to historical results as time permits or when data anomalies are suspected. If the data is not consistent with the historical results, the QC Chemist may initiate a DRR (see Section 6.2.2) and request that the analytical laboratory review the supporting data or reanalyze the sample. The resolution to the DRR may result in data qualification.

F. As data are scrutinized for reporting purposes, data anomalies may be detected. Upon discovery, the QC Chemist will be requested to evaluate the data to determine whether or not the data should be qualified.

6.2 Data Validation/Verification Documentation

6.2.1 Data Qualifier Flag Form

During the QC Chemists data review, the data are qualified using the Data Qualifier Flag Form (Attachment C). The QC Chemist fills out the form, and places the qualification form with the analytical results, under the case narrative when one exists. For visibility, the form should be made on yellow paper.

6.2.2 Data Revision Request (DRR)

A DRR is initiated (via email) when a problem or a question with analytical results occur that requires resolution. The laboratory should include a copy of the DRR with the revised hard copy report. The DMT receives the revised report and stamps it as “revised”. The original report is then stamped “superceded by revision.”

6.2.3 Quality Improvement Form

The Quality Improvement Form (QIF) may be necessary if an analytical error requiring a database change or a systematic laboratory problem is discovered (see Attachment A, SOP 4.12, “Quality Improvement Forms [QIFs]”).

6.2.4 Analytical Results

The QC data follows the analytical results in the data package. The CoC should be placed at the end of the data package. The front page upper right-hand corners of the results are marked with a “V” for validated, “N” when validation cannot be performed due to missing information, or “O” if a revision is reviewed that does not change the data quality. The reviewed date should be marked under the validation status (i.e., V, N, or O) and then the reviewers' initials.

Example:

V
1/25/10
VRD

6.2.5 Sampling Plan and Chain of Custody Tracking (SPACT) Application

Once validation/verification is complete, the QC Chemist should document the review in SPACT per the following instructions:

A. Log into the SPACT application. Use the “Receive Data/QC Chemist Validation” link provided under the heading titled “COC Reception/Validation” to enter data validation information.

B. Enter the data package CoC number, document control number, or lab log number to retrieve information for data package. Once the existing information for that data package is on-screen, enter initials, validation date, validation status (Y or N), N or Y depending on whether flags are required, N or Y depending on whether the report met turnaround times, invoiced date, and any comments. If a revision is requested, then enter requestor initials, date, and reason.

6.2.6. Invoices

Invoices should accompany the reported results. The QC Chemist approves the invoice for payment by initialing the invoice, documenting whether or not the TAT was met, and the data validation date. Any discrepancies, such as missed holding or turnaround times or unusable data due to severe quality problems that are the fault of the laboratory, should be noted on the invoice so that the Technical

Release Representative may apply any necessary penalties per the current Statement of Work requirements. When reviewing data for the Environmental Protection Department (EPD), a photocopy of the invoice is included and after approving it, the QC Chemist attaches it to the end of the validated data package.

6.2.7. An electronic data qualifier flag program is executed by a DMT member to compare electronically assigned flags to flags assigned by the QC chemist. Discrepancies are investigated and reconciled by the QC Chemist.

7.0 QA RECORDS

7.1 CoC forms

7.2 Original analytical results

7.3 DRRs and QIFs

7.4 Data Qualifier Flag form

8.0 ATTACHMENTS

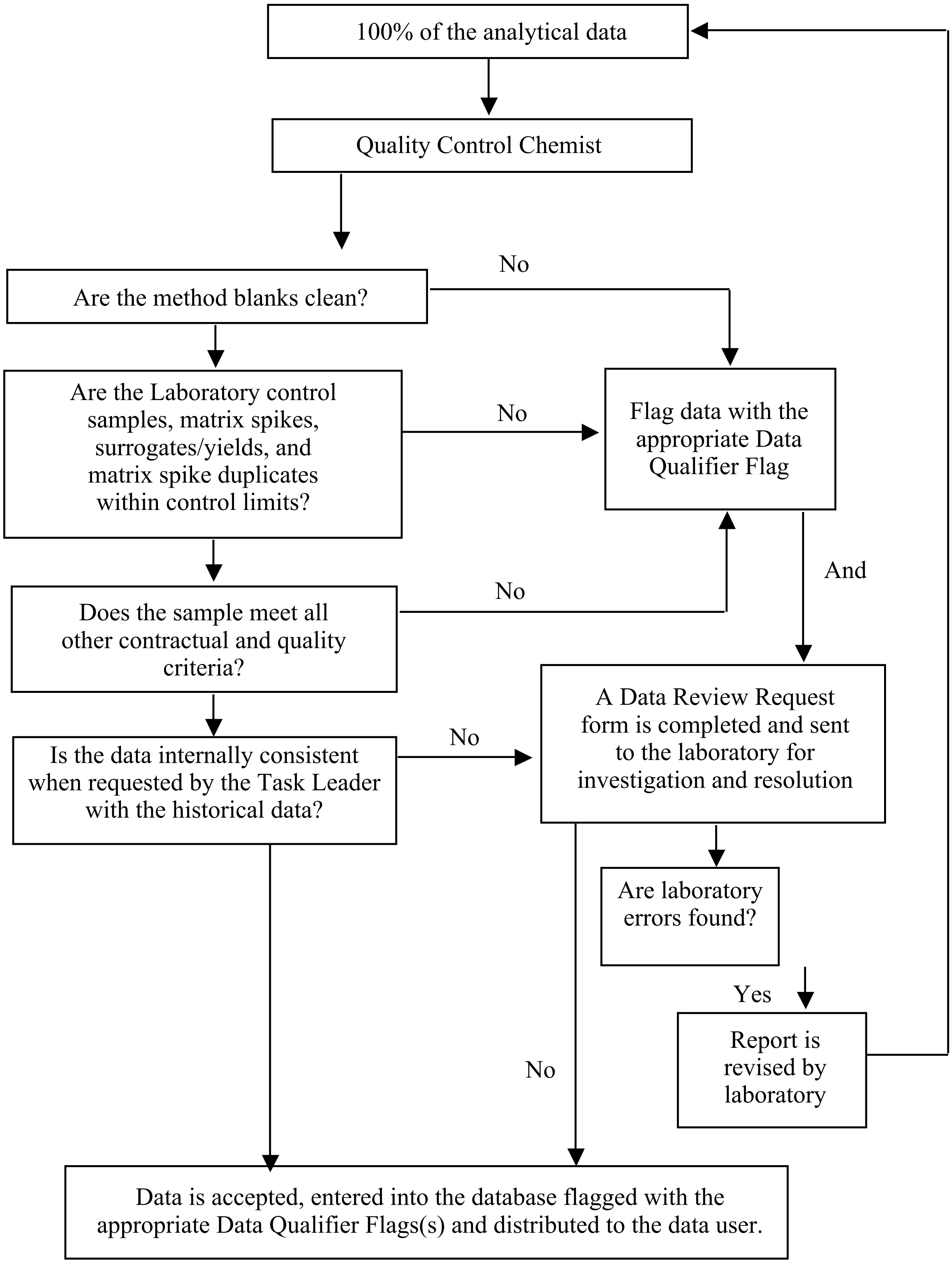
Attachment A—Flow of Analytical Data During Validation/Verification

Attachment B—Data Qualifier Flags

Attachment C—Data Qualifier Flag Form

Attachment A

Flow of Analytical Data During Validation/Verification



Attachment A. Flow of analytical data during validation/verification.

Attachment B

Data Qualifier Flags

List of Environmental Restoration Department Qualifier Flags

Flag	Definition
B	Analyte found in method blank, sample results should be evaluated.
D[a]	Analysis performed at a secondary dilution or concentration.
E[a]	The analyte was detected below the LLNL reporting limit, but above the analytical laboratory minimum detection limit or activity.
F	Analyte found in field blank, trip blank, or equipment blank, sample results should be evaluated.
G	Quantitated using fuel calibration, but does not match typical fuel fingerprint (fuel maybe gasoline, diesel, motor oil etc.).
H[a]	Sample analyzed outside of holding time, sample results should be evaluated.
I	Surrogate or tracer yield recoveries were outside of QC limits, sample results should be evaluated.
J	The analyte was positively identified; however, the associated numerical value is the approximate concentration or activity of the analyte in the sample.
L	Matrix spike recoveries not within control limits.
O	Matrix spike duplicate RPD, sample duplicate RPD, or RER not within control limits.
P	Indicates that the absence of a data qualifier flag does not mean that the data does not need qualification, but that the implementation of electronic data qualifier flags was not yet established.
R	Sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria. The presence or absence of the analyte cannot be verified.
S	The analytical results for this sample are suspect.
T[a]	Analyte is tentatively identified compound; result is approximate.
U[a]	Compound was analyzed for, but not detected above the detection limit.

[a] Automatically flagged in the database by the electronic qualifier flag program.

RPD = Relative Percent Difference.

RER = Relative Error Ratio.

Attachment C

Data Qualifier Flag Form

Today's Date:______

DATA QUALIFIER FLAG FORM

Circle the appropriate qualifier flags and fill out information below.

Flag	Definition
B	Analyte found in method blank.
F	Analyte found in field blank, trip blank, or equipment blank (circle one).
G	Quantified using fuel calibration, but does not match typical fuel fingerprint.
I	Surrogate or tracer yield recoveries were outside of QC limits (circle one).
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample. Explain circumstances below.
L	Matrix spike recoveries not within control limits.
O	Matrix spike duplicate RPD, sample duplicate RPD, or RER not within control limits. (Circle one).
R	Sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria. The presence or absence of the analyte cannot be verified. Explain circumstances below.
S	The analytical results from this sample are suspect. Explain circumstances below.

Laboratory Code: (circle one) BB, CN, TN, GE, SE, EM or other:________________________

QC Chemist Initials: RG ______Requested Analysis:__________________________________

Analyte(s)/Code:____

____

____

Explanation (check one or fill in):

[ ] Insufficient sample for spike. [ ] _______________________in method blank.

[ ] Matrix interference. [ ] LCS validates methodology.

[ ] High concentration of _____________________________________ in spiked sample.

[ ] Other/comments:____

____

____

Log Number of Affected Samples:____

____

For Data Management Use Only:

Entered: Initials_________________Date:________

Elect. Confirmed: Initials:_________Date:________

General Rules for Applying QA Qualifier Flags

Blanks:
IF analytes are found in the method blank, THEN flag positive results "B". IF analytes are found in the field, equipment, or trip blank, THEN flag positive sample results "F". Sample non-detects (ND) do not need to be flagged.

Surrogates:
IF surrogates percent recoveries (Surr %R) are > the upper control limit (UCL), THEN flag positive sample results "IJ". NDs do not require flags. If Surr %R are < the lower control limit (LCL), BUT are ≥ 50% of the LCL, THEN flag positive sample results "IJ" AND flag NDs "IUJ" for estimated sample quantification limit. IF Surr %R are < 50% of the LCL, THEN flag positive sample results "IJ" AND flag NDs "IR".

IF QC sample surrogates are out of control, all supporting information (e.g. MS/MSD accuracy and precision, LCS accuracy, and sample location historical data) should be considered to determine if the associated samples were affected. In some cases, the acceptable control limit range will go lower then 50% (e.g. Semi volatiles), therefore best professional judgment should be used when Surr %R is < the LCL.

Laboratory Control Spikes (LCS):
IF the LCS %R is > the UCL for an analyte, THEN flag positive sample results from the same batch "J. No flags are necessary for ND results. IF the LCS %R is < LCL for an analyte, THEN flag positive sample results from the same batch "J" AND flag NDs with "R". Also, if more than half of the compounds in the LCS are not within the required recovery criteria, then all associated data should be qualified with an "R".

Matrix Spikes and Matrix Spike Duplicates (MS/MSD):
The flags assigned to MS/MSD results are primarily to alert the user that something was not quite right with the QC batch. The data reviewer should first try to determine to what extent the results of the MS/MSD affect the associated data. The determination should be made with regard to the MS/MSD sample itself as well as specific analytes for all samples associated with the MS/MSD. Instances where it can be determined that the results of the MS/MSD affect only the sample spiked, then qualification should be limited to this sample alone. However, it may be determined that a lab is having systematic problems with the analysis of one or more analytes which affects all associated samples. The reviewer must use professional judgment to determine the need for qualification of unspiked analytes.

IF the MS %R is out of control (either above the UCL or below the LCL) for an analyte, BUT the MSD %R is within limits, THEN no flag is necessary, unless no MSD exists THEN flag "L". IF the MSD %R is out of control for an analyte, BUT the MS %R is within limits, THEN no flag is necessary. IF both the MS and MSD %R are out of control, THEN flag sample results (both positive and negative detections) "L".

IF MS/MSD %R < 30% use professional judgment to determine if matrix interference may have affected the determination of the analyte in the samples and flag positives "J" and NDs with an "R".

IF the %RPD is out of control (either above the UCL or below the LCL) for an analyte, THEN flag sample results (both positive and negative detections) "O".

Continuing Calibration Verification (CCV):
If the laboratory provides CCV values, use professional judgment when qualifying data based on CCVs. The following IF, THEN statements are provided as a guide only:
IF recovery is < LCL and sample result is ND, THEN flag with a "J". IF recovery is > UCL and sample result is ND, THEN no flag is needed. IF recovery is < LCL and sample result is positive, THEN flag with a "J". IF recovery is > UCL and sample result is positive, THEN flag with a "J". IF recovery is < LCL and sample result is ND and other QC failed, THEN flag with a "R".

LLNL Environmental Restoration Division (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.7A: Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids—5

AUTHOR(S):
R. Goodrich and E. Walter

APPROVALS:	Date
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[signature] Livermore Site Program Leader	11/16/15
Leslie Ferry Site 300 Program Leader	8/26/15
CONCURRENCE:	**Date**
Rebecca Goodrich QA Implementation Coordinator	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to ensure that investigation-derived ground water which is purged from monitor wells is properly treated and disposed of in a manner consistent with the protection of human health and the environment.

2.0 APPLICABILITY

This SOP was developed using the guidance provided by the U.S. Environmental Protection Agency (EPA) in *Guide to Management of Investigation-Derived Wastes* (EPA, 1992). This guidance states that "the management of investigation-derived wastes (IDW) must ensure protection of human health and the environment and comply with certain regulatory requirements that are applicable or relevant and appropriate (ARAR)." The guidance further states that "as a general rule, it will be necessary to use best professional judgment, in light of the site-specific conditions, to determine whether an option is protective of human health and the environment." The following SOP reflects LLNL Livermore Site's evaluation of applicable standards and its best professional judgment concerning the management of investigation-derived ground water. This procedure is applicable to the treatment and disposal of purged ground water produced by well development, aquifer testing, or ground water sampling activities. SOP 4.7B describes similar requirements for the LLNL Site 300.

3.0 REFERENCES

3.1 Site Safety Plan for Lawrence Livermore National Laboratory CERCLA Investigations.

3.2 U.S. Environmental Protection Agency (1987), *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

3.3 U.S. Environmental Protection Agency (1992), *Guide to Management of Investigation-Derived Wastes,* U.S. EPA, Office of Solid Waste and Emergency Response, Publication 9345.3-03FS, January 1992.

3.4 Title 26, California Code of Regulations, Section 22-66699.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Hydrogeology Team Leader (HTL)

The HTL's responsibility is to review recent analytical data to determine the appropriate sampling and purge method and to ensure the disposal of all investigation derived wastes are in accordance with this procedure

5.6 Sample Coordinator (SC)

The SC's responsibilities are to ensure that all ground water sampling is performed according to ERD SOPs and the applicable LLNL Integration Work Sheet (IWS); and to ensure the disposal of all investigation derived wastes are managed in accordance with this procedure.

5.7 Field Personnel (FP)

The FP are responsible for properly and safely following all applicable procedures and in conjunction with the SC ensure the appropriate collection vessels are available to contain purge water generated during initial or baseline sampling events.

5.8 Quality Assurance Implementation Coordinator (QAIC)

The QAIC's responsibility is to review analytical data received from the contracted analytical laboratories for samples collected during initial or baseline sampling.

5.9 Data Management Team (DMT)

The DMT is responsible for updating the Sample Planning and Chain of Custody Tracking (SPACT) application with the analytical data received from the initial or baseline sampling event. The DMT is also responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURE

6.1 Discussion

6.1.1 According to the Environmental Protection Agency (EPA, 1992) the "EPA has not established a presumption for the management of aqueous liquid IDW (e.g., ground water). It is left to site managers to determine the most appropriate disposal options on a site specific basis. Managers should consider volume of IDW, contaminants present in the ground water and in the soil, and whether the water is a drinking water supply. In addition, wastes should be managed consistent with the final site remedy."

6.1.2 Well Development Purge Water

The treatment and discharge methods for well development water will be based on information available at the time of development. This information will generally include saturated sediment chemistry from the screened interval and/or nearby boreholes, ground water chemistry from near by wells screened at similar depths, and field screening using an organic vapor analyzer (OVA). The water will also be sampled and sent to an analytical lab for testing. Based on the analytical results, the water will be collected in the appropriate container and either treated at TFB prior to discharge, or stored in the Waste Accumulation Area (WAA) and managed according to guidance provided by RHWM.

6.1.3 Routine Ground Water Sampling, Hydraulic Pump Testing, and Baseline Sampling

Routine water sampling is usually performed quarterly, semi-annually, or annually; however, hydraulic pump testing and baseline sampling is performed as needed. All purge water collected during these activities shall be emptied into the holding tanks at TFB.

6.1.5. Procedure Exceptions

In developing this SOP, every effort was made to ensure compliance with all ARARs, as required in EPA, 1992. But as recognized in EPA, 1992, it is often necessary to use best professional judgment in light of site-specific conditions. Thus, the Program Leader has the option to grant exceptions to the above purge-water handling protocol.

6.2 Safety Considerations

6.2.1 Personnel shall meet all training requirements; review the appropriate Site Safety Plan (SSP), all applicable SOPs, and Integration Work Sheets (IWSs) prior to performing work.

6.2.2 Work activities described by this SOP shall be conducted in accordance with IWS 11577 "Compliance Driven Groundwater Sampling and Water Level Measurement" at the Livermore Site and LLNL IWS 12545 "Operation of the AMS TR7000 Well Management System."

6.3 Office Preparation

6.3.1 Prior to the start of any well development, initial ground water sampling or aquifer testing, the HTL, SC, FP, and SSO shall exchange information such as the type and concentration of contaminants that may be encountered, quantity of purge water generated, as well as the level of personal protective equipment necessary for Field Personnel to safely conduct activities.

6.3.2 During the development of sampling plans and prior to the start of any routine ground water sampling activities, the HTL shall review past analytical results, with an emphasis on the most recent, to determine the proper sample and purge method. This data is then given to the DMT to be updated into the SPACT application so that the appropriate sample method, purge volume, and contaminant(s) concentrations are reflected on the sample field sheet.

Note: All purge water that is generated either onsite or offsite must be collected in a tanker trailer, carboy, or a sealable bucket (whichever is appropriate) regardless of the volume.

6.3.3 Prior to any sampling, the SC will direct the Field Personnel as to which wells need to be scheduled for sampling on that day. Any additional instructions prior to sampling will be given by the SC (or HTL) verbally during the pre-job brief, or they will be listed in the Comments/Special Instructions column of the View/Schedule Sampling Events portion of SPACT.

6.3.4 Prior to the start of any well development or aquifer testing activities, the HTL shall review the most recent analytical results, saturated sediment chemistry from the screened interval and/or nearby boreholes, ground water chemistry from near by wells screened at similar depths, and/or field screening data to estimate the contaminants likely to be present, to determine if the water needs to be contained and/or managed by RHWM. Prior to any purge water collection, the SC along with the Field Personnel shall ensure there are adequate receptacles for the collection of purge water generated.

6.4 Field Preparation

6.4.1 The Field Personnel shall place the appropriate container for the collection of purge water immediately adjacent to and downwind of all monitor wells.

6.4.2 All ground water collection containers will be labeled "NON-POTABLE WATER."

6.4.3 Ensure that all containers are sealable and have maximum fill lines clearly labeled.

6.5 Operation

6.5.1 Treatment and Disposal of the Purged Water

A. Collection water from several wells may be composited in each tanker, carboy, or bucket.

B. The Field Personnel will transport collected ground water to the Livermore Site's disposal station currently located at Treatment Facility B (TFB). The Field Personnel will evacuate the water from the tankers as to ensure the collection vessels are available for the next sampling event.

C. The treatment facility operator is notified and the tanks are discharged into the influent stream of Treatment Facility B (TFB). The water is managed to ensure compliance with Livermore Site discharge limits.

D. In the event of a change in this procedure, the SC will consult with the HTL to determine the proper means of disposal.

E. All purge water, regardless of volume, shall be collected in a sealable container or tanker trailer and disposed of at TFB. The only exception would be purge water that is determined to have contaminant concentrations in excess of TFB treatment limits, and must therefore be disposed of according to RHWM guidelines. If such an event occurs, the SC will consult with the HTL, and/or RHWM, to determine the proper means of disposal or storage for eventual disposal.

6.5.2 Disposal Criteria and Disposal Procedures for Monitor Wells that Yield Free Product.

Free product and emulsions of free product with ground water shall be handled and treated as hazardous waste and disposed of by RHWM.

6.5.3 Disposal Criteria and Disposal Procedures for Monitor Wells that Yield Compounds Not Discussed.

Ground water that contains contaminants that have not been addressed or discussed earlier should be discharged into the appropriate sealable container or tankers and stored appropriately in the WAA. Any additional disposal procedure for this water will be determined by the HLT.

6.6 Field Post Operation

6.6.1 Inventory supplies and inspect equipment. Replace or repair (if minor) all broken or damaged equipment. Report any major equipment damage to the SC at once.

6.7 Office Post Operation

6.7.1 Review field sheets, chains of custody, field logbook and pertinent forms for completeness.

6.7.2 Deliver original forms and logbook(s) to the DMT.

7.0 QA RECORDS

7.1 TFB Logbook

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.7B: Site 300 Treatment and Disposal of Well Development and Well Purge Fluids

Revision: 5

ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # ERD	**AUTHOR(S):** S. Gregory
	APPROVALS: **Date**
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	Leslie Ferry 7/12/11 **Site 300 Program Leader**
	CONCURRENCE: **Date**
	Rebecca Goodrich 7/12/11 **QA Implementation Coordinator**

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to ensure that investigation-derived ground water which is purged from wells is properly treated and disposed of in a manner consistent with the protection of human health and the environment.

2.0 APPLICABILITY

The following procedure and information is applicable to all Site 300 activities, which can generate aqueous Investigation-Derived Wastes (IDW) (i.e., purged ground water produced by well development, aquifer testing, or monitor well sampling activities). The following sections describe the handling, treatment, and disposal of aqueous IDW. SOP 4.7A, "Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids" describes similar requirements for the LLNL Livermore Site.

3.0 REFERENCES

3.1 Lawrence Livermore National Laboratory (LLNL) Environment, Safety and Health Manual.

3.2 Site Safety Plan for Lawrence Livermore National Laboratory Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Investigations at Site 300, March 2005 (UCRL-AR-21172 Rev. 4).

3.3 U.S. EPA (1991), *Guide to Management of Investigation-Derived Wastes,* U.S. EPA, Office of Solid Waste and Emergency Response, Publication 9345.3-03FS, October 1991.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Treatment Facility Compliance Manager (TFCM)

The TFCM is responsible for reviewing facility data for compliance with all applicable permits for Site 300. The TFCM prepares treatment facility sampling plans and specifies procedures for facility data collection with input from Hydrogeology personnel (HPs). The TFCM also reviews, and accepts or rejects all facility Self Monitoring Reports (SMRs), and requests revisions to reports as needed. The TFCM also ensures that the appropriate procedures are followed, and that collection and treatment criteria are set. For routine ground water sampling, the TFCM in coordination with the assigned HP periodically reviews contaminants present, contaminant concentrations, and provides updates on the purge water destination to the DMT for incorporation into the quarterly sampling plan.

5.6 Hydrogeology Personnel (HPs)

The HPs are responsible for reviewing the sampling methodologies for all monitor wells and communicating with the TFCM if the sampling methodology change effects purge water collection or the volume(s) of purge water collected.

5.7 Treatment Facility Operator (TFO)

The TFO is responsible for properly operating treatment facilities, recording treatment facility operating parameters as specified per the ERD SOPs, IWS(s), and facility sampling plan. The TFO is also responsible for pumping the contaminated purge water from the purge water transfer tanks into the specified treatment system, and to document the volume of water treated on each occasion.

5.8 Sampling Coordinator (SC)

The SC is responsible for ensuring that purge water from wells is collected and disposed of according to these SOPs and as specified in the SPACT Sampling Plan. The SC's responsibilities are also to note when the specified collection and disposal method cannot be followed and communicate this to the TFCM.

5.9 Sampling Field Personnel (SFP)

The SFP are responsible for properly and safely following all applicable procedures. The SFP are responsible for collecting and transporting the purge water to the specified treatment system, and transferring all water collected from the portable purge water tankers into the purge water transfer tanks at the specified treatment facility, according to this SOP, and notifying the TFO that purge water is ready for treatment and disposal. The sampling field personnel are also responsible for notifying the SC if purge water collection drums are not at the required location, if the drums are not tied down and/or if they are not in good condition, or if no purge water destination is included in SPACT for any particular well.

5.10 Data Management Team (DMT)

The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP. The DMT is also responsible for making changes to the purge water destinations in the SPACT Sampling Plan, or the addition of destinations for new wells at the request of the TFCM.

6.0 PROCEDURE

6.1 Discussion

6.1.1 According to the Environmental Protection Agency (EPA, 1991) the "EPA has not established a presumption for the management of aqueous liquid IDW (e.g., ground water). It is left to site managers to determine the most appropriate disposal options on a site-specific basis. Managers should consider volume of IDW, contaminants present in the ground water and in the soil, and whether the water is a drinking water supply. In addition, wastes should be managed consistent with the final site remedy." This guidance states that "the management of IDW must ensure protection of human health and the environment and comply with certain regulatory requirements that are applicable or relevant and appropriate (ARAR)." The guidance further states that "as a general rule, it will be necessary to use best professional judgment, in light of the site-specific conditions, to determine whether an option is protective of human health and the environment."

6.1.2 At Site 300, ARARs were evaluated in determining the procedure for managing purge water. Guidance was in part supplied by the State of California Regional Water Quality Control Board—Central Valley Region (RWQCB) and was documented in three LLNL "Records of Communication" (telephone conversations) dated June 28, 1988; November 29, 1989; and February 7, 1990. The disposal criteria for various contaminants and concentrations in purge water are discussed in Section 6.5.

6.1.3 In developing this SOP, every effort was made to ensure compliance with all ARARs, as required in EPA, 1991. But as recognized in EPA, 1991, it is often necessary to use best professional judgment in light of site-specific conditions.

Thus, the Site 300 Program Leader has the option to grant exceptions to the above purge-water handling protocol. All exceptions will be granted only after consultation with project geologists, and other appropriate professionals. Exceptions shall be granted only after it has been determined that such actions are still protective of human health and the environment.

6.1.4 Ground water at Site 300 may contain one to several types of contaminants. Site 300 Constituents of Concern (COCs) include volatile organic compounds (VOCs), High-Explosive (HE) compounds (predominately RDX and HMX), Radionuclides (uranium and tritium), perchlorate, and nitrate. Disposal and treatment of aqueous IDWs is dependent on the types and concentrations of these COCs as described below. There are basically three options for purge water generated as will be presented in detail below. Water void of any contaminants can be pumped directly to the ground except under special circumstances specified by the TFCM or SC. Water that does contain certain contaminants, or certain concentrations of contaminants, as described in Section 6.5 below, can be placed into 55-gallon drums adjacent to the location and be allowed to evaporate. Purge water containing contaminants, or certain concentrations of contaminants (also described in Section 6.5) need to be collected and transported to a specified treatment facility for treatment and disposal. The types of contaminants present determines which treatment facility will be utilized.

6.2 Preparation (TFCM/SC/DMT)

6.2.1 Estimate contaminants, concentrations, and quantity of purge water for planning the proper disposal method of the aqueous IDW. This is performed by Hydrogeology personnel in consultation with the TFCM for newly drilled wells undergoing final well development/hydraulic testing. For routine ground water sampling, the TFCM in coordination with the assigned Hydrogeologist periodically reviews contaminants present, contaminant concentrations, and provides input to the DMT for updating the purge water destination in the quarterly sampling plan. The disposal of Aqueous IDW generated during final well development/hydraulic testing follows the disposal criteria and is defined in the drilling plan or hydraulic testing plan. Generally, during well development, the mud pit is utilized for disposal of purge water. If the mud pit is still open during hydraulic testing, it will be utilized for disposal. If the mud pit is no longer available for disposal, the purge water generated will be dealt with as described in Section 6.5.

6.2.2 The SC will arrange to have the appropriate number of 55-gal drums, 5-gallon labeled carboys, or portable collection tankers available for all locations where purge water collection is required. Although the drums used for purge water collection will be placed directly adjacent to a well, and are to be used for that well only, the carboys and tankers are assigned to a specific treatment facility destination. They will be labeled accordingly.

6.2.3 The DMT is responsible for adding the location for disposal (destination) of purge water into the electronic Sample Planning and Collection Table (SPACT) to allow the SFPs to schedule sampling locations with similar purge water destinations. The destination of the purge water will also be included on the sampling field sheet.

6.3 Preparation (Sampling Field Personnel)

6.3.1 Where applicable, place 55-gal drums for the collection of purge water immediately adjacent to the monitor well when requested by the TFCM/SC.

6.3.2 Secure the drums to a pole or bollard, if available, with a cable or chain to prevent accidental spillage. Alternately, one or two drums may be secured by wrapping the cable or chain around the stove pipe of the monitor well. Three or more drums may be secured by attaching a cable or chain around the outside of all the drums without the use of a secured pole.

6.3.3 Label all 55-gal drums "NON-POTABLE WATER."

6.3.4. Ensure that drums are in good condition (i.e., no leaks, etc.), and portable tanks are in good working order.

6.3.5 Cover the top of all open 55-gal drums with chicken wire to prevent rodents and other animals from entering the drum to obtain water.

6.3.6. At locations where purge water is to be transported for treatment and disposal, ensure the proper labeled carboys (for low volume purging applications), or the properly labeled portable tanker is brought to the monitor well for the sampling event.

6.4 Safety Considerations

6.4.1 Work is to be performed in accordance with the LLNL Site Safety Plans, the Quality Assurance Project Plan (QAPP), applicable ERD SOPs, sampling plans, and ERD Integration Work Sheets (IWS). Work activities described by this SOP shall be performed in accordance with IWS 11343: ERD Routine Groundwater Sampling & Water Level Monitoring at Site 300.

6.5 Disposal of Aqueous IDW

Purged ground water that is suspected to contain detectable contaminant concentrations should be discharged directly to dedicated and secured 55-gal drums, labeled 5-gallon carboys, or labeled portable tankers according to the criteria in Section 6.5.1.

The proper analytical data set to use for evaluating purged ground water quality is dependent upon the type of field activity. For routine (quarterly) ground water sampling, the analytical data will be reviewed annually. The SPACT sampling plan for routine ground water monitoring will contain the purge water handling and disposal locations (destination) for each well. The specific analyses from an initial or non-routine ground water sample should be used to evaluate that particular purged ground water. Samples collected directly from the portable tanker should be used to evaluate ground water that is purged during well development and aquifer testing activities if no previous data exists for the well. For new monitor wells, the purge water should be collected in secured drums or in portable tankers until the contaminant type(s) and concentration(s) can be determined. However, during initial well development, purge water can be discharged directly into an approved mud pit if still available.

Since many of the wells at Site 300 are sampled using Low Volume Sampling methods, very little purge water is being generated. In these cases, 5-gallon carboys can be used to collect and transport purge water to the appropriate destination. When using carboys to collect purge water, carboys are to be emptied into the appropriate portable tanker at the end of each day or when full. Only during development and baseline sampling of new wells, or sampling of wells where multiple casing volume purging has been specified, is sufficient water generated to require the use of dedicated portable tankers for collection.

When the portable tankers become full, or near full, they are to be transported to the assigned treatment facility by the SFP and they will transfer the collected water into the purge water transfer tank. The SFP will then notify the TFO that water is available for treatment and disposal. The TFO will transfer the water through the treatment system, and is to record the purge water totalizer values in the Document Control Logbook every time water is treated at a treatment facility. In cases where either due to weather conditions or due to the nature of the location, making it impossible to get a portable tanker adjacent to a particular well, drums will be used to collect the generated purge water. The specific treatment and disposal criteria for purge water are described below.

6.5.1 Collection, Treatment, and Disposal Criteria for Purge Water

The treatment and/or disposal of purge water shall be conducted according to the criteria below. A purge water disposal decision flow chart is provided as Attachment A. The criteria below are referenced on the decision flow chart by the applicable letter (A-I), for reference.

For purge water with tritium activities above the 100 pCi/L background level:

A. If purged ground water contains tritium above the 100 pCi/L and no other contaminants are detected above their practical quantitation limits (PQL) [also known as reporting limits], then purge water can be collected in drums and allowed to evaporate. To prevent rainfall from potentially overfilling the drums, do not fill more than three-quarters full between October and April.

B. If purged ground water contains tritium above the 100 pCi/L, VOC concentrations are below their MCLs, and no other contaminants are detected above their respective PQLs, then purge water can be collected in drums and allowed to evaporate. To prevent rainfall from potentially overfilling the drums, do not fill more than three-quarters full between October and April.

C. If purged ground water contains tritium above the 100 pCi/L background level, VOC concentrations are above their MCLs, and any other contaminant is detected above their PQLs, the purge water must be collected and transported to the Pit 7 treatment facility for treatment and disposal.

For purge water with tritium activities below the 100 pCi/L background level and concentrations of any other contaminants above their MCL.

D. If purged ground water contains tritium below 100 pCi/L, and other contaminant concentrations are above the MCL, the purge water must be collected and transported to the specified treatment facility for treatment and disposal. A table of treatment facilities at which various contaminants and concentrations shall be treated is provided as Attachment B. **(Note: if only nitrate has been detected at concentrations above the 45 mg/L MCL, use the procedures outline in E below instead).**

E. If purged ground water contains tritium below 100 pCi/L, and only nitrate is detected at concentrations above the 45 mg/L MCL, there are two possible outcomes depending on the location:

- If the well is located in the HE process area or the Building 832 Canyon area, the water can be discharged to the ground surface in the immediate vicinity of the monitor well. Do not discharge water into any culvert, creek, wetland, or other surface water body or drainage system.

- If the well is located in any other area of Site 300, the water must be transported to a specified treatment facility for disposal. A table of treatment facilities at which various contaminants and concentrations shall be treated is provided as Attachment B.

For purge water with tritium activities below the 100 pCi/L background level and concentrations of all other contaminants are below their MCL:

F. If purged ground water contains tritium below 100 pCi/L; concentrations of HE compounds, perchlorate, and uranium are below their PQLs, and VOC concentrations are above their PQLs, then purge water can be collected in drums and allowed to evaporate. To prevent rainfall from potentially overfilling the drums, do not fill more than three-quarters full between October and April.

G. If purged ground water contains tritium below 100 pCi/L, and other contaminant concentrations are above their PQLs, the purge water must be collected and transported to the specified treatment facility for treatment and disposal. A table of treatment facilities at which various contaminants and concentrations shall be treated is provided as Attachment B.

H. If purged ground water contains tritium below 100 pCi/L, nitrate concentrations are above the PQL (but below the 45 mg/L MCL), and other contaminant concentrations are below their PQLs, then discharge purged ground water onto the ground surface in the immediate vicinity of the monitor well. Do not discharge water into any culvert, creek, wetland or other surface water body or drainage system.

I. If purged ground water contains tritium below 100 pCi/L, and concentrations of all other contaminants are below the PQL, then discharge purged ground water onto the ground surface in the immediate vicinity of the monitor well. Do not discharge water into any culvert, creek, wetland or other surface water body or drainage system.

6.5.2 Disposal Criteria and Disposal Procedures for Ground Water Potentially Containing Free Product

Free product and emulsions of free product with ground water should be handled as hazardous waste and should be transferred to RHWM for disposal.

6.6 Field Post Operation

6.5.1 Inspect all drums and portable tankers for leaks.

6.5.2 Inventory equipment and supplies. Replace or repair all broken or damaged equipment.

6.7 Office Post Operation

6.6.1 Review field logbook and forms for completeness.

6.6.2 At the end of each month, the TFO responsible for treating purge water at their treatment facility and are to record the total volume of purge water treated in their Document Control logbook and document the total volumes on the monthly SMRs.

7.0 QA RECORDS

7.1 Document Control Logbook

7.2 Chain-of-Custody Forms

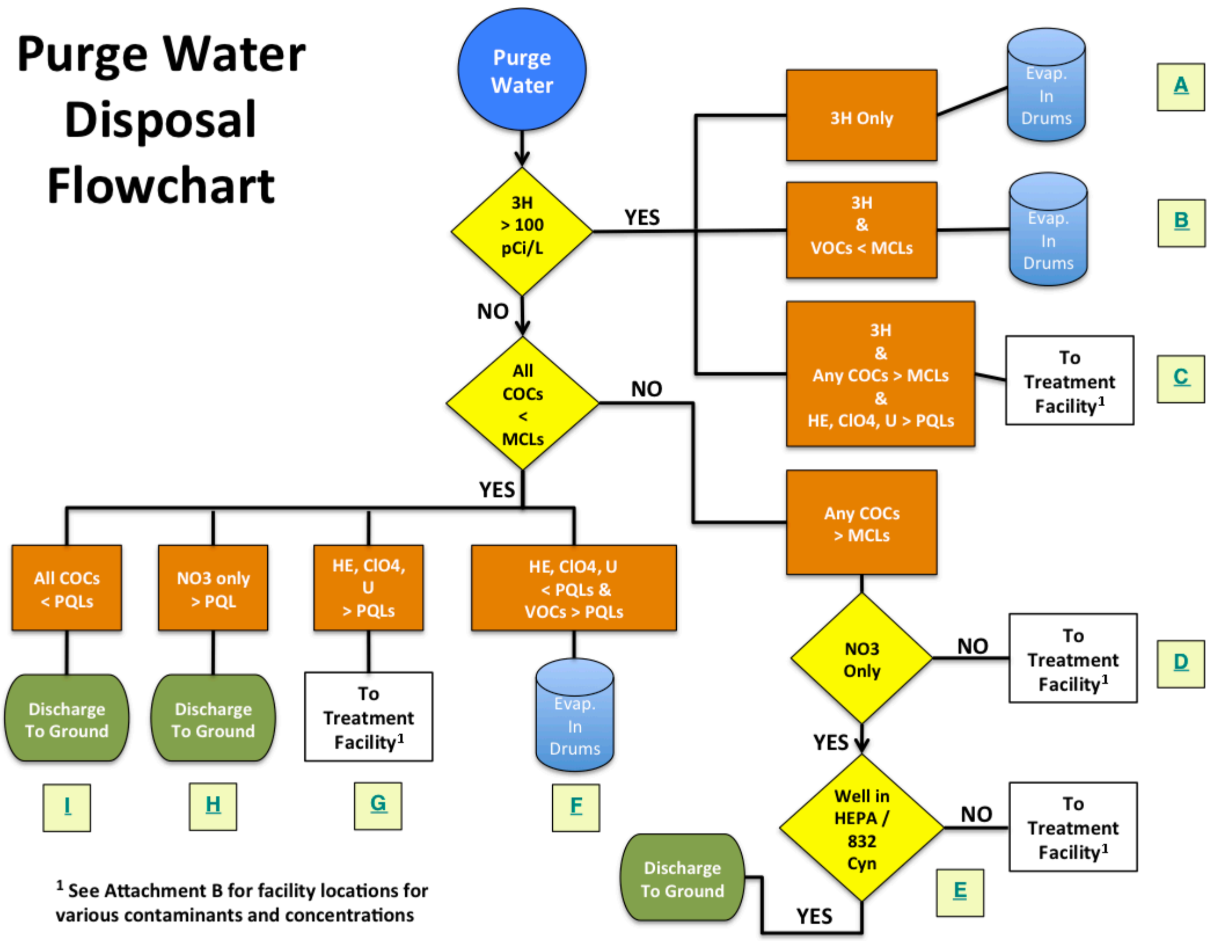
8.0 ATTACHMENTS

Attachment A—Purge Water Disposal Flowchart

Attachment B—Treatment Facility Locations for Various Contaminants and Concentrations

Attachment A

Purge Water Disposal Flowchart



Notes:

ClO_4 =	Perchlorate
COCs =	Contaminants of concern
832 Cyn =	Building 832 Canyon Operable Unit
Evap. =	Evaporate
3H =	Tritium
HE =	High explosives
HEPA =	High Explosives Process Area Operable Unit
MCLs =	Maximum Contaminant Level
NO_3 =	Nitrate (as NO_3)
pCi/L =	picoCuries per Liter
PQLs =	Practical Quantitation Limit (same as Reporting Limit)
TF =	Treatment facility
U =	Uranium
VOCs =	Volatile organic compounds
< =	Less than
> =	Greater than

Attachment A. Purge Water Disposal Flowchart.

Attachment B

Treatment Facility Locations for Various Contaminants and Concentrations

Contaminant concentrations in purge water	Treatment Facility
Tritium > 100 pCi/L and Concentration of any other COC > Maximum Contaminant Level (MCL)	Must go to PIT7-Source facility
Uranium > practical quantitation limit (PQL)	Must go to PIT7-Source facility
Tritium < 100 pCi/L, Uranium < PQL, and Any HE compound >PQL	Must go to B815-Source facility (GTU2)
Tritium < 100 pCi/L, Uranium < 20 pCi/L, and VOCs and perchlorate > PQL or Nitrate (as NO_3) > MCL	Transfer to nearest of the following treatment facilities: - PIT7-Source facility[1], or - B815-Source facility (GTU2)
Tritium < 100 pCi/L, Uranium < 20 pCi/L, All HE compounds < PQLs, Perchlorate < PQL VOCs > MCLs Nitrate > MCL	Transfer to nearest of the following treatment facilities: - B834 facility, or - B815-Source Facility (GTU2)

Notes:

[1] **If nitrates > MCL, only treat at B815-SRC unless directed by TCFM (usually if very small volume).**

Attachment B. Treatment facility locations for various contaminants and concentration.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.8: Calibration/Verification and Maintenance of Measuring and Test Equipment (M&TE)—Revision: 7

AUTHOR(S):
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ENVIRONMENTAL RESTORATION DEPARTMENT
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ERD

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this SOP is to ensure accurate and consistent field chemistry, and organic vapor measurements using measuring and test equipment (M&TE) such as (1) pH meter, (2) conductivity meter, (3) dissolved oxygen meter and probe, (4) radiation survey meter, (5) organic vapor meter, and (6) explosimeter.

2.0 APPLICABILITY

This procedure is applicable to all M&TE used by ERD for the collection of field data. This procedure was developed in compliance to Document 41.1 LLNL Program for Calibration of Critical Measuring and Test Equipment referred to as the LLNL Calibration Program. All LLNL organizations with Critical M&TE should periodically perform self-assessments to determine whether the control of their M&TE is effective. A frequency of no more than every three years is recommended. The Principal Associate Director or designee shall implement the requirement of the LLNL Calibration Program within their PD/Directorate. This procedure is applicable to M&TE used by ERD for the collection of field data.

ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Environmental, Safety, and Health, Volume IV, Part 41: Quality Assurance and Configuration Management, Document 41.1 LLNL Quality Assurance Program (2009), Lawrence Livermore National Laboratory, Livermore, CA (UCRL-AM-133867 Rev. 10).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

SOP Specific Responsibilities

5.3 Field Operations Manager (FOM)

The FOM ensures that Field Personnel have been adequately trained to operate and calibrate critical M&TE.

5.4 Quality Assurance Implementation Coordinator (QAIC)

The QAIC maintains and distributes the ERD Critical M&TE spreadsheet, which is kept current as Field Personnel provide instrument calibration data to the QAIC. As new critical M&TE are purchased, the spreadsheet is updated by the QAIC with instrument specifications provided by Field Personnel.

5.4 Field Personnel

Field personnel are responsible for the calibration, calibration verification and maintenance of the M&TE in accordance to this procedure and documented maintenance and calibration schedules. As new M&TE is purchased and as instruments are calibrated, the field personnel are responsible for informing the QAIC.

6.0 PROCEDURE

6.1 Critical and Noncritical M&TE

6.1.1 M&TE that meets one of the following criteria is defined as critical:

- M&TE whose measurement accuracy is critical to the validity of programmatic results.
- M&TE whose measurement accuracy is critical to monitoring or controlling of safe conditions or used to identify hazards to personnel or the environment.
- M&TE used for the accountability of nuclear material.
- M&TE used to determine acceptability of the physical, mechanical, electrical, radiological, and chemical characteristics of equipment credited in safety basis documentation.
- M&TE used as secondary and transfer standards to calibrate other critical M&TE.

6.1.2 Noncritical M&TE is any M&TE used to collect data that does not meet the critical M&TE definition.

6.1.3 ERD critical and non-critical M&TE are listed in Attachment A.

6.1.4 When new M&TE is purchased, the ERD QAIC must be informed so the equipment can be added as necessary to the ERD Critical M&TE spreadsheet. The new equipment's intended use must be evaluated to determine if the M&TE

is critical. An "LLNL Calibration Program" identification label must be affixed to all critical M&TE.

6.2 Preparation

To prepare for field work, perform the applicable preparation activities according to SOP 4.1: "General Instructions for Field Personnel" including participation in the ERD field investigation Orientation Lesson Plan.

6.3 Safety Considerations

6.3.1 Field personnel who are new to the project will receive direct field supervision during performance of work activities described by this SOP. Operators of the critical M&TE will be trained to properly use the instruments. The Field Operations Manager will acknowledge that personnel are qualified to operate the instruments by signing-off on a training form. The list of qualified personnel shall be maintained in each critical M&TE instrument binder.

6.3.2 The usage of critical M&TE as described in the following sections will be implemented to monitor activities conducted in accordance with the following IWSs:

- IWS 11341: "ERD Ground Water and Soil Vapor Treatment Facility Operations at Site 300".
- IWS 11534: "ERD Treatment Facility Operations, Treatability Testing, and Related Activities at Livermore".

6.4 Documentation Requirements

6.4.1 Each piece of critical M&TE should have its own calibration/maintenance logbook. The instrument and serial number should be clearly identified. The following information should be documented in the calibration/maintenance logbook:

A. Date of entry and initials of the individual recording the entry.

B. Results of the calibration or calibration verification.

C. Traceability information on the standards and method used for calibration or verification, including standard preparation details.

D. Maintenance performed.

E. Operator comments.

F. The calibration or verification status (i.e., "calibrated" or "not calibrated").

G. A copy of the current ERD Critical M&TE spreadsheet.

6.4.2 The following information should be documented in the field sampling, drilling or treatment facility logbook so that the calibration information may be referenced:

A. Calibration, verification, or maintenance activity.

B. Date of entry.

C. Instrument name.

D. Serial number.

E. Operator comments.

6.4.3 A Calibration Record label, from which the item's current calibration status can be readily determined must also be affixed to the critical M&TE. The calibration service supplier or the equipment owner is responsible for affixing the Calibration Record label. The label shall include the date of calibration, the next calibration due date, and the initials of the person performing the calibration.

6.4.4 Store the manufacturer's owner/operator manual with the M&TE.

6.4.5 Records and logs for active critical M&TE must be retained onsite and be available for inspection over the life of the equipment. According to requirements of the LLNL Records Retention Schedule (RRS), the calibration records on all critical M&TE used for purposes other than detection or monitoring of radiation shall be archived for twelve years.

6.4.6 Critical M&TE that has been determined to be "Out of Service for Critical Measurements" shall have a label affixed identifying it as such.

6.4.7 Before officially removing equipment from the Calibration Program, it should be determined whether a calibration check or formal calibration is warranted, based on the importance of the measurements made by the equipment. Calibration is recommended for each removal, but if it is determined unnecessary, the reason should be documented.

6.5 Standard Requirements

6.5.1 Standards used for critical M&TE calibration and calibration verification shall be traceable to the National Institute of Standards and Technology (NIST) or other recognized national standards whenever possible. If NIST standards do not exist, the reference standards used should be supported by certificates, reports, or data sheets. All traceability documentation should be kept with the instruments and attached in the calibration/maintenance logbook.

6.5.2 Store standards in an appropriate place so as not to compromise integrity. If the standards do not come with storage and handling guidance to maintain the required accuracy and characteristics of the standard, the QC Chemist should be consulted.

6.5.3 The standards expiration date should be clearly marked. Do not use expired standards. Dispose all expired standards properly through the LLNL Radiological and Hazardous Waste Management organization.

6.6 Calibration Nonconformances

6.6.1 Any M&TE found damaged or malfunctioning should be labeled as such and removed from service immediately. The condition shall be documented in the calibration/maintenance logbook and the appropriate steps should be taken to restore the M&TE or a back-up unit should be used.

6.6.2 If any M&TE is found to be out of calibration during the collection of measurement data, the condition shall be documented on a Quality Improvement Form (QIF). The deficiency shall be evaluated, the impact on previous output determined, and corrective action implemented. The prospective users and recipients of the associated measurement data shall be notified of the results of the QIF. Acceptance of measurements made with uncalibrated M&TE needs to be reviewed and justification for acceptance documented. Instructions for filing a QIF can be found in SOP 4.12, "Quality Improvement Forms (QIFs)."

6.7 Choosing M&TE

6.7.1 General selection criteria for choosing M&TE are given below:

A. M&TE should be capable of attaining the appropriate range, precision, and accuracy necessary of the intended measurement. (Permits may include required criteria). M&TE range, precision, and accuracy information should be obtained from the manufacturer.

B. Instruments should be made by a well-known, reputable company. Individuals (chemists, geochemists, experienced field personnel) who have used the instrument in the past should be consulted.

C. Do not use instruments that are fragile or sensitive to water, heat, or cold. Field instruments should be rugged and constructed specifically for field work.

6.8 M&TE Calibration and Verification Procedures

The Supply Chain Management Department maintains a list of approved suppliers qualified to perform critical M&TE calibration. Calibration services are to be procured only from approved suppliers. The Technical Release Representative (TRR) will help to ensure the appropriate approved vendor performs the calibration.

6.8.1 pH Meter

pH meters require on-site calibration.

At a given temperature the intensity of the acidic or basic character of a solution is indicated by pH or hydrogen ion activity. Since pH is dependent upon temperature, all meters must have a temperature measurement and compensation mode. Otherwise, the calibration should be made at the same temperature (± 2˚C) as the samples.

A. Calibration Frequency:

The pH meter is calibrated a minimum of once a day just prior to the day's first measurement using traceable, fresh buffer solutions of pH 4, 7, or 10. Buffer solutions should have expiration dates stamped on the container. Expired buffers are not to be used.

B. Calibration Procedure:

The pH meter manufacturer's instructions will be followed when calibrating the instrument.

C. Calibration Verification:

The calibration can be accepted if the measured pH of the pH verification buffer is within one tenth (e.g., pH = 7.0 ± 0.1). The verification is performed initially after the two-point calibration.

If the measured pH falls outside that range, try one or all of the following:

1. Double check the temperature of the buffer. Although small, temperature does affect the pH of the solution. The buffer is only at pH 7.0 when it is exactly 25.0˚C. An extremely hot or cold solution could make the measurement fall outside the range of acceptability. Try heating or cooling buffers to closer to 25˚ and recalibrate.
2. Look for indication that there is a problem with the meter or probe. Many meters have an indicator on the screen, which displays when there is a potential problem.
3. Consult the trouble shooting section of the equipment manual or locate a back-up unit.
4. Replace all buffers.
5. Replace probe filling solution.

6.8.2 pH Paper

A. Calibration Frequency:

None required.

B. Calibration Procedure:

None required.

C. Calibration Verification:

Each new lot of pH paper should be checked against 3 pH buffer solutions (high, low, and medium range), to check range and accuracy of the paper. The pH paper lot check should be documented in a logbook kept for this purpose. Use appropriate range of pH paper.

6.8.3 Conductivity Meter

Conductivity is a numerical expression of the ability of an aqueous solution to transmit an electrical current. This ability depends on the presence of ions, therefore, high conductivity will be observed when the pH is very high or very low. Conductivity is also temperature dependent, so all meters must have a temperature compensation mode. Otherwise, the calibration verification should be made at the same temperature (± 2˚C) as the samples.

A. Calibration Frequency:

Generally, conductivity meters are initially factory calibrated. If the meter has not been factory calibrated, it should be calibrated prior to each day's use.

B. Calibration Procedure:

Calibration will be performed at the factory or as directed by the instruments operating instructions.

C. Calibration Verification:

The calibration is verified prior to each day's use per the operating instructions.

6.8.4 Dissolved Oxygen (DO) Meter

A. Calibration Frequency:

Generally, DO meters are initially factory calibrated. If the meter has not been factory calibrated, it should be calibrated prior to each day's use.

B. Calibration Procedure:

Calibration will be performed at the factory or as directed by the instruments operating instructions.

C. Calibration Verification:

The calibration is verified prior to each day's use per the operating instructions.

6.8.5 Thermo Hydrocarbon Analyzer (THA)

THAs must be calibrated on site.

A. Calibration Frequency:

Thermo Hydrocarbon Analyzers (THAs, are to be calibrated once a day or whenever the calibration verification indicates the instrument is no longer calibrated.

B. Calibration Procedure:

Calibrate THAs using three (low, medium, and high) calibration standards that bracket the range of the instrument.

C. Calibration Verification:

Verify the day's calibration before use or when the instrument has been idle. Use a 1 mid-range calibration standard.

6.8.6 Thermo Vapor Analyzer (TVA)

A. Calibration Frequency:

The manufacturer performs calibration, instrument cleaning, and inspection annually. Submit TVA to be serviced off-site before expiration date indicated by the calibration sticker on the equipment or by the set service schedule. Do not use expired equipment.

B. Calibration Procedure:

In addition to the annual service provided by the manufacturer, TVAs should be calibrated prior to each use, or once per day. Calibrate TVAs using methane for the FID. Use an upper and lower concentration of methane gas to bracket the range of VOCs expected in the vapor stream.

C. Calibration Verification:

Verify the calibration by using a zero span gas and one methane gas standard at a concentration approximate to expected VOC concentrations of vapor stream.

6.8.7 Organic Vapor Analyzer (OVA)

A. Calibration Frequency:

Calibration frequency is every 6 months. Submit OVA for off-site calibration before expiration date indicated by the calibration sticker on the equipment. Do not use expired equipment.

B. Calibration Procedure:

OVAs are calibrated by an off-site organization.

C. Calibration Verification:

Verify the calibration before use with 1 mid-range calibration standard.

6.8.8 Explosimeters or Lower Explosive Limit (LEL) Meters

Explosimeters are used to monitor the fuel/oxygen mixture in the sampled air for LEL.

A. Calibration Frequency:

Calibration frequency is determined by the LLNL Environmental, Safety and Health (ES&H) Department. Calibration expiration date is indicated on the calibration sticker located on the instrument. Return to ES&H before expiration date. Do not use expired equipment.

B. Calibration Procedure:

Explosimeters are calibrated and maintained by the ES&H Department of LLNL.

C. Calibration Verification:

None required.

6.8.9 Flow meters

Flow meters are used for general purpose routine sampling.

A. Calibration Frequency:

Flow meters are factory calibrated.

B. Calibration Procedure:

Calibration is to be performed at the factory.

C. Calibration Verification:

Flow meters should be periodically checked against a similar flow meter for accuracy and sent to the factory for re-calibration as necessary.

6.8.10 Tritium Meter

A tritium meter issued to monitor tritium activities in air inside the Pit 7 treatment facility enclosure in the event of a leak and prior to maintenance of the transfer tank.

A. Calibration Frequency:

Calibration frequency is determined by LLNL Environmental, Safety and Health (ES&H) Team 1 or 2. The calibration expiration date is indicated on the calibration sticker located on the instrument. Return to ES&H Team 1 or 2 before the expiration date. Do not use expired equipment.

B. Calibration Procedure:

The tritium meter is calibrated and maintained by the LLNL ES&H Department.

C. Calibration Verification:
None required.

6.9 Maintenance

6.9.1 Maintenance is to be performed each day the M&TE is used. Perform maintenance as described in the equipment operating instructions. Maintenance may include refreshing the electrolyte solution in pH and DO probes, checking DO probe membranes for damage, replacing, or charging batteries as needed, checking operation of all instrument displays, etc.

6.9.2 Replace or repair M&TE as necessary.

6.9.3 Decontaminate M&TE per SOP 4.5, "General Equipment Decontamination."

6.9.4 Maintain M&TE storage area and store M&TE properly per manufacturer instructions to prevent damage to the M&TE.

7.0 QA RECORDS

7.1 M&TE Calibration and Maintenance Logbooks

7.2 Field Sampling Logbooks

7.3 Field Sampling Sheets

7.4 Treatment Facility Logbooks

7.5 Completed QIFs

7.6 QIF Logbook

7.7 Standard traceability documentation

8.0 ATTACHMENT

Attachment A—Sample ERD Critical Measuring and Test Equipment List

Attachment A

Sample ERD Critical Measuring and Test Equipment List

Item Name	DOE #	Serial # or Identifier	Model Number	Cal.Freq.	Range	Min. detec. limit	Accuracy	Responsible Individual	Owner	Location	Last Cal.Date	Next Cal. Date	Reason	Calibrator/time	Verification check
Foxborough OVA/FID Organic Vapor Analyzer	5199134	51556	OVA 128	Semi-annual	0-10,000 ppm	0.2 ppm	20%	B. Johnson	S. Kawaguchi	B438	9/2/09	3/2/10	B	Manesco	user/30 min/mo.
Foxborough OVA/FID Organic Vapor Analyzer	.	41125	OVA 128	Semi-annual	0-10,000 ppm	0.2 ppm	20%	B. Johnson	B. Kidd	B438	10/19/09	4/19/10	B	Manesco	user/30 min/mo.
Thermo Electron Toxic Vapor Analyzer/FID	8836951	0613817263	TVA-1000B	Annually	0-50,000 ppm	300 ppb for hexane	25%	B. Johnson	S. Thomas	B438	7/22/09	7/22/2010 (out for repair)	B	Thermo Electron Corporation	
Thermo Environmental Instruments Toxic Vapor Analyzer/FID	6800701	72239-370	TVA-1000B	Annually	0-50,000 ppm	300 ppb for hexane	25%	S. Orloff	T. Trammell	S300/B843	12/20/09	12/20/10	B	Thermo Env. Instruments	user/30 min/wk.
Thermo Environmental Instruments Toxic Vapor Analyzer/FID	6800718	72241-370	TVA-1000B	Annually	0-50,000 ppm	300 ppb for hexane	25%	B. Johnson	S. Thomas	B438	7/27/09	7/27/10	B	Thermo Env. Instruments	user/30 min/wk.
Thermo Environmental Instruments Toxic Vapor Analyzer/FID	6800725	72240-370	TVA-1000B	Annually	0-50,000 ppm	300 ppb for hexane	25%	S. Orloff	T. Trammell	S300/B843	5/1/09	5/1/10	B	Thermo Env. Instruments	user/30 min/wk.
Thermo Environmental Instruments Toxic Vapor Analyzer/FID	6806178	427208928	TVA-1000B	Annually	0-50,000 ppm	300 ppb for hexane	25%	S. Orloff	T. Trammell	S300/B843	6/1/09	6/1/10	B	Thermo Env. Instruments	
Tritium Sniffer	3108626	511	Overhoff - 394	Annually				S. Orloff	J. Faria	Pit 7 TF	12/1/09	12/1/10	B	ES&H Team 1	
ERD Critical M&TE (out of service)															
Gastech Inc. LEL Meter	NA	A1674	1177	Quarterly	0-100%	NA	0.5% of range	B. Johnson	B. Kidd	B438	3/30/08	6/30/08	B	HCD	user/15 min/daily
RKI Instruments Inc. Sample-Drawing Gas Detector Assemblies (LEL-H2)	NA	NA	35-3000RK	Quarterly	0-100%	1% LEL	1% LEL	B. Johnson	B. Kidd	CRD-1	3/30/08	facility inactive	B	Alarm Shop	NA
RKI Instruments Inc. Sample-Drawing Gas Detector Assemblies (LEL-H2)	NA	P9Z003-(1-4), P03030	35-3000RK	Quarterly	0-100%	1% LEL	1% LEL	B. Johnson	B. Kidd	CRD-2	3/30/08	facility inactive	B	Alarm Shop	NA
Foxbrough OVA/FID Organic Vapor Analyzer	8021616	A52245	OVA 128	Semi-annual	0-10,000 ppm	0.2 ppm	20%	B. Johnson	S. Kawaguchi	B438	calibrate prior to use	calibrate prior to use	B	Southern Cross/	not in use
Foxbrough OVA/FID Organic Vapor Analyzer	6951687	41126	OVA 128	Semi-annual	0-10,000 ppm	0.2 ppm	20%	B. Johnson	S. Kawaguchi	B438	calibrate prior to use	calibrate prior to use	B	Southern Cross/	not in use
Draeger, Pac III, Single gas monitor	NA	ERtC-0650	Pac III	Semi-annual	1-20 ppm	10ppm	10%	T. Ford	M. Verce	T4352	5/15/05	not in use	B	Semi-Annual	NA
Draeger, Pac III, Single gas monitor	NA	ERTC-0651	Pac III	Semi-annual	1-20 ppm	10ppm	10%	T. Ford	M. Verce	T4352	11/15/05	not in use	B	Semi-Annual	NA
Draeger, Pac III, Single gas monitor	NA	ERUD-0375	Pac III	Semi-annual	1-20 ppm	10ppm	10%	T. Ford	M. Verce	T4352	7/30/05	not in use	B	Semi-Annual	NA
ERD Non-critical M&TE															
Thermo Hydrocarbon Analyzer	8032858	51LT53875297	51	Prior to Use	0-10,000 ppm	0.5 ppm	0.1 ppm	B. Johnson	B. Johnson	VTF-518	NA	NA	B	user/1 hr./mo.	NA
Thermo Environmental Instruments OVM/PID Organic Vapor Monitor	NA	580U56161306	580B	Prior to Use	0-2,000 ppm	0.1 ppm	0.1 ppm	B. Johnson	B. Johnson	B438	NA	NA	B	user/15 min/week	user/5 min/daily
Thermo Environmental Instruments OVM/PID Organic Vapor Monitor	NA	580U48090279	580B	Prior to Use	0-2,000 ppm	0.1 ppm	0.1 ppm	J. Faria	S. Orloff	B843	NA	NA	B	user/15 min/week	user/5 min/daily
Thermo Environmental Instruments OVM/PID Organic Vapor Monitor	NA	580U38477258	580B	Prior to Use	0-2,000 ppm	0.1 ppm	0.1 ppm	J. Faria	S. Orloff	B843	NA	NA	B	user/15 min/week	user/5 min/daily
Thermo Environmental Instruments OVM/PID Organic Vapor Monitor	NA	580U56162306	580B	Prior to Use	0-2,000 ppm	0.1 ppm	0.1 ppm	J. Faria	S. Orloff	B843	NA	NA	B	user/15 min/week	user/5 min/daily
MiniRAE Lite (PID)	NA	590-000857	PGM-7300	Prior to Use	0.1-5,000 ppm	0.1 ppm	0.1 ppm	A. Niemand	A. VanNoy	B438	NA	NA	B		
MiniRAE Lite (PID)	NA	590-000865	PGM-7300	Prior to Use	0.1-5,000 ppm	0.1 ppm	0.1 ppm	A. Niemand	A. VanNoy	B438	NA	NA	B		

Reason for Critical M&TE Designation
A. validity for programmatic results
B. prevent hazards to personnel or environment
C. accountability of nuclear materials
D. determine applicability of characteristics of Category 1&2 SSC using graded approach
E. M&TE used to calibrate M&TE
F. other (please describe)

Notes:
Thermometers used to take temperature readings at the treatment facilities are not considered critical. The measurements taken at influent/effluent sample collection time are only relative measurements.
There are no discharge limits set for temperature of groundwater.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.9: Collection of Field QC Samples—Revision: 6

ENVIRONMENTAL RESTORATION DEPARTMENT
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#
ERD

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to obtain various types of Quality Control (QC) samples that provide quality control information necessary for interpretation of data.

2.0 APPLICABILITY

This procedure is applicable to the collection of QC samples during routine ground water monitoring, environmental investigations and remediation processes.

3.0 REFERENCES

3.1 U.S. Environmental Protection Agency (1981), *Manual of Groundwater Quality Sampling Procedures*, EPA-600/22-81-160, Washington, D.C.

3.2 U.S. Environmental Protection Agency (1982), *Handbook for Sampling and Preservation of Water and Wastewater,* EPA-600/4-82-029, Washington, D.C.

3.3 Weston Managers Designers/Consultants (1988), *Field Sampling Procedures Manual*, Prepared for Lawrence Livermore Laboratory.

3.4 U.S. EPA (1987), *Data Quality Objectives For Remedial Response Activities*, Office of Emergency Response and Office of Waste Programs Enforcement, Washington, DC, 20460.

3.5 Test Methods for Evaluating Solid Waste, SW-846, November 1986, Third Edition.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Hydrogeology Team Leader (HTL)

The HTL is responsible for determining the frequency of drilling QC samples, such as equipment blanks and collocated samples in consultation with the QC chemist. The HTL is also responsible for generating a Drilling Sampling Plan, which shall include the designated QC samples.

5.6 Modeling & Subsurface Data Quality Objectives Team Leader (MSDQOTL)

The MSDQOTL is responsible for determining the collection frequency of QC samples such as equipment blanks for hydraulic testing and baseline sampling work activities in consultation with the QC chemist.

5.7 QC Chemist

The QC chemist is responsible for determining the type(s) of analyses to be run on the various QC samples and partially responsible for determining the frequency of QC samples (i.e., field, equipment, and trip blanks).

5.8 Sampling Coordinator (SC)

The SC's responsibilities is to generate a quarterly QC sample list with input from key individuals including the QC Chemist and the Environmental Functional Area (EFA) analysts and sampling technicians, as necessary.

5.9 Field Personnel (FP)

The FP are responsible for collecting the Field QC samples as planned.

5.10 Data Management Team (DMT)

The DMT's responsibilities are to decode the blind QC sample identification names on the printed analytical results using the QC sample list provided by the SC, and properly identifying the sample type and matrix in electronic storage.

6.0 PROCEDURE

Blank water used for field QC must be determined to be analyte-free. Prior to beginning each sampling quarter, blank water is received from each analytical laboratory that ERD has scheduled to receive samples. The analytical laboratory tests the blank water prior to providing it to ERD. The blank water is provided by the analytical laboratory, along with the tests results to ensure the water is analyte-free. The SC stores these analytical tests results on ERD's server for a given sampling quarter.

6.1 Generation of the Quality Control Sampling List

6.1.1 The SC shall generate the QC sampling list by calculating the number of samples that need to be collected as collocated samples to meet the ERD Data Quality Objective (DQO) of 10% for all ground water sampling. The 10% is divided into 5% interlaboratory and 5% intralaboratory collocated samples. The SC chooses the installations to be used for collocated samples and field blanks at random within each geographic area. However, this list may be modified based upon past history, data anomalies, or logistical problems. QC samples should be collected from locations that have a history of detected analytes, so that data comparisons can be made.

6.1.2 The SC shall provide the QC Sampling List to the DMT. The DMT adds the QC sample locations to the Sampling Plan.

6.1.3 The HTL shall determine the number and location of QC samples for drilling activities. As a general rule, 10% of all soil samples will be collocated as described above.

6.2 Intralaboratory Collocated Samples

Intralaboratory collocated samples are sent to the same laboratory and have the same requested analyses.

6.2.1 ERD Routine Water Samples

A. The SC selects 5% of the well locations to be sampled as Intralaboratory collocated QC samples from those wells with a history of contamination.

B. Sample containers are filled, one right after the other, without differentiating between QC and primary samples, until labeling occurs. Samples are collected as prescribed in the appropriate sampling SOP.

C. The QC samples are assigned a fictitious well identifier (and a different collection time from the primary sample) to blind the samples' true identity to the laboratory performing the analysis, while the primary samples are labeled with a true well identifier. The fictitious well identifiers of the QC samples usually end with "Y" or represent an unused legitimate name from a sequential series (i.e., W-181). Other fictitious well identifiers are generated as needed.

6.2.2 EFA Water Samples

For EFA samples, one sampling location is randomly selected quarterly by the SC or EFA analyst in each sampling network and assigned the fictitious name as shown in Table 1 for a total of 8 "blind" intralaboratory collocated QC samples. All wells, including historically clean wells, are used for the selection.

Table 1.

Intralaboratory collocated fictitious well identifier sample	Sampling network
K1-11Y	Pit 1
K7-11Y	Pit 7
W-817-11Y	Building 817 wells (HE Process Area)
K1-21Y	Pit 2
K2-11Y	Elk Ravine (Eastern and Western Firing Area)
NC5-11Y	Off-site water-supply wells
K6-11Y	Pit 6
K8-11Y	Pit 8

6.2.3 ERD Soil Samples

Intralaboratory collocated soil samples may be assigned fictitious names as described in Section 6.2.1, or they may have "DUP" at the end of the real sample identifier. When a collocated soil sample is taken from a different depth than the original sample, the original sample's depth, as well as the collocated sample's depth, become part of the collocated sample's ID. For example, 830-23-(26.8F)-26.3FDUP, where 26.8F is the actual depth and 26.3F is the depth of the adjoining sample for which it is collocated.

6.3 Interlaboratory Collocated Water and Soil Samples

6.3.1 For routine ground water sampling, the SC selects 5% of the well locations to be sampled as interlaboratory collocated QC samples from those wells with a history of contamination. Interlaboratory collocated samples are collected one right after the other as prescribed in the appropriate sampling SOP.

6.3.2 The collection of interlaboratory collocated soil samples during drilling or other soil sampling projects are determined by the HTL in consultation with the QC chemist.

6.3.3 The samples are labeled with the true well identification and sent to two separate analytical laboratories.

6.3.4 The collocated samples are to have the same requested analyses.

6.4 Critical Wells

At Site 300, water-supply wells may be sampled as interlaboratory collocated samples in addition to the 5% interlaboratory collocated samples for QC purposes, when necessary.

6.5 Trip Blanks

6.5.1 Trip blanks are only necessary if samples are to be collected and analyzed for VOCs (volatile organic compounds). Trip blanks should be submitted for the same VOC analysis as the samples in the same ice chest. If several VOC analyses are requested, the trip blanks should be analyzed per the SC, HTL, DC, or as designated in the Sampling Plan. Trip blanks may also be submitted with soil samples.

6.5.2 Trip blanks (one 40 mL volatile organic analysis [VOA] per day) remain within the ice chest throughout the day's sampling activities and should be preserved to 4°C in the same manner as the samples. Each laboratory receiving samples requires a separate trip blank.

6.5.3 Write date of trip blank preparation on CoC as part of the Sample ID (i.e., Trip Blank 12-15-09). The sample date is the date the samples were collected.

6.5.4 Trip blanks should not be analyzed unless there are VOCs detected in the associated samples. This request should be written in the instructions to the lab on the CoC accompanying the samples or is automatically generated on electronically produced CoCs.

Note: Inspect trip blanks for air bubbles upon receipt from the contract analytical laboratory (CAL). Trip blanks containing air bubbles should be returned to the CAL and new ones requested. Also, the shelf life for the trip blanks is 30 days and any unused trip blanks should be discarded and replaced monthly.

6.6 Field Blanks

6.6.1 Collect field blanks as indicated in the Sampling Plan. Additional field blanks should be taken if there is any reason to suspect air-borne contaminants (i.e., odors, dust, work being performed nearby such as painting, fumigating, etc.). Field blanks are to be collected as described below:

A. For ERD and EFA samples, pour the analyte-free water directly into the appropriate sample container at the sampling location and submit for the appropriate requested analyses.

Note: ERD and EFA field blank water is obtained from the analytical lab.

B Label the bottle as indicated on the QC Sample list, and place in an ice chest with the samples.

C. During quarterly sampling activities, field blanks are poured at least one time per study area or sampling network at Site 300.

D. Some projects will require field blanks for all analytes listed in the sampling plan for a specific location. The sampling plan will specify the analytes the field blanks should be collected and analyzed for.

6.7 Equipment Blanks

This includes equipment used for soil and ground water sample collection, as well as pressure transducers used for hydraulic testing.

6.7.1 An equipment blank will be collected from portable pumps used for ground water purging and sampling after decontamination.

A. Decontaminate the equipment as per SOP 4.5, "General Equipment Decontamination" or by a methodology approved by the appropriate ERD personnel when a subcontractor performs decontamination.

B. Submit the equipment blanks collected for the same analyses as the well samples, or at a minimum for the constituents of concern (COCs).

C. Collect samples from the pump in the same manner as described in SOP 2.3, "Sampling Monitor Wells with Bladder and Electric Submersible Pumps," and SOP 2.6, "Sampling for Volatile Organic Compounds."

D. Label the equipment blank collected from the portable pumping system according to the type (PR for pump rinsate), pump ID, and well in which the pump was used for purging and sampling (i.e., Rinseate-S3P1-PR-W-25N-25).

6.7.2 Equipment blanks, also known as rinsate samples, are used to ensure that nondedicated equipment involved with sample collection has been adequately decontaminated. At a minimum, 1 blank/day shall be collected when using portable purging devices such as bailers.

6.7.3 Drilling equipment blanks are collected from soil sampling devices (i.e., split spoon samplers and core barrels). Auger flights will be visually inspected once they have been cleaned to verify they are free from soil particles. The frequency of these equipment blanks depends upon the past and future drilling locations, and the contaminant type and concentration in these locations. The DC and/or HGL shall determine the necessity and frequency during drilling activities. If equipment blanks are deemed necessary, follow steps A through D.

A. Decontaminate the equipment per SOP 4.5.

B. Pour enough analyte-free water (obtained from the analytical laboratory) or water approved by the DC and/or QC Chemist through or over the surface of equipment, and collect rinsate directly into appropriate containers.

C. Label the equipment blank collected from the drilling apparatus as follows:

RINSEATE-A-borehole name

RINSEATE-CB-borehole name

RINSEATE-B-borehole name

where

A = auger

CB = core barrel

B = bailer

D. Submit the equipment blanks collected for the same analyses as the soil sample.

6.8 Treatment Facility QC Samples.

Facility QC samples will be collected as specified by the Sampling Plan and/or facility permits.

6.8.1 The Central Valley RWQCB requires one field blank and one collocated sample for every 10 samples collected and analyzed. The QC samples are to be analyzed for the same parameters as the other samples collected. The collocated sample should be sent to the laboratory as the other samples (intralaboratory). Label samples as follows:

facility name - FB

facility name - dup

Other naming schemes may be used to blind the sample as approved by the DMT.

6.9 Drilling Water

Collect a sample of any water used during drilling activities and analyze for VOCs.

6.10 Drilling Mud

Collect drilling mud samples every 10 to 20 ft if high VOCs are expected.

6.11 Temperature Blanks

Some analytical labs require temperature blanks to be submitted with samples that require temperature preservation. They should consist of a 125-mL poly container, or equivalent, filled with water placed in the ice-chest at the beginning of the sampling event day. The receiving analytical laboratory should measure these blanks and notify the SC if the temperature is outside the range of 0°C - 6°C. The temperature blank should be documented in the "Remarks" section on the CoC form. Most of the analytical labs use a device to measure the temperature of the sample container itself and no longer require a temperature blank to be submitted.

6.12 Supplies

6.12.1 To meet ERD sampling requirements, 1-liter polyethylene or glass containers of analyte-free water used for field blanks and equipment blanks and VOA vials containing analyte-free water used for trip blanks, should be ordered from analytical laboratory.

6.12.2 Visually inspect ice chests used to refrigerate the samples. Use clean ice-chests only.

6.12.3 Load ice chests with enough bagged ice cubes or bagged Blue Ice to keep samples at a controlled temperature between 0°C and 6°C.

6.13 Documentation

All sampling information should be recorded as required by the appropriate sampling or drilling SOP.

6.14 Shipping and Handling

QC samples should be handled and shipped as described in SOP 4.4.

7.0 QA RECORDS

7.1 Chain-of-Custody Forms

7.2 Document Control Logbooks

7.3 Sampling and Analysis Plans

7.4 Field Sheets

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.10: Records Management—Revision: 1

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ERD

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this procedure is to identify the information considered to be records within the ERD and how those records are managed. The procedure also describes the process of how to access stored records, records retention schedule and final record disposition. In unison with the LLNL Records Management Policy definition, "a record is any recorded information, regardless of the type of media or format, generated in support of programmatic activities or to satisfy administrative or business needs of a directorate or department."

2.0 APPLICABILITY

This procedure applies to recorded information, in any format, that is created, received or needed to document ERD work activities. ERD information will be described in this procedure as records series, which is a collection of records or documents grouped together based on a commonality. The commonality may be subject matter or function, or as a result of the same activity; documenting a specific type of transaction, a particular physical form, or some other relationship arising out of their creation, receipt, maintenance, or use. Information that is created and managed electronically will be referred to as Electronic Record Sets in this procedure.

All ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Federal Facility Agreement Under CERCLA Section 120 between The United States Environmental Protection Agency and The United States Department of Energy and The California Department of Health Services and The California Regional Water Quality Control Board (1988).

3.2 Laguna, G. (2007), ERD Software Quality Assurance Plan.

3.3 LLNL Records Management Program (2008).

3.4 LLNL Site 300 Federal Facility Agreement Under CERCLA Section 120, United States Environmental Protection Agency Region 9 and California Department of Toxic Substances Control and The Central Valley Regional Water Quality Control Board and United States Department of Energy (1992).

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Department Head (DH)

The DH's responsibility is to ensure that an effective records management system is in place to adequately document operations and programmatic activities, and to ensure the information is maintained in a manner that fosters preservation, accessibility, proper maintenance, and disposition in compliance with Laboratory Records Management or other applicable regulatory policies, procedures, and record retention schedule.

5.2 Program Leader (PL)

The PL's responsibility is to ensure that employees carry out their records management responsibilities regarding the creation, use, maintenance, organization, preservation, and disposition of ERD records in accordance with this procedure and other applicable SOPs.

5.3 Data Management Team (DMT)

The DMT is responsible for the preservation, maintenance, control, and disposition of the original documents received from operations and programmatic work activities within the ERD.

5.4 Quality Assurance Implementation Coordinator (QAIC)

The ERD QAIC is responsible for maintaining a department file for QA related activities performed within the ERD, e.g., self-assessment records, quality improvement forms, and any other relevant documentation associated with the ERD QA program.

5.5 ERD Staff

It is the responsibility of every ERD staff member to generate the required documentation associated with performing certain work activities and to manage that documentation in a manner that facilitates preservation, timely retrieval, proper maintenance, and disposition.

6.0 PROCEDURES

This procedure describes the identification, creation, maintenance, retention, and disposition of records created within the ERD.

6.1. Identifying Records Series

For manageability, ERD records are grouped into "records series" which consist of like records that are grouped into categories such as CERCLA, D&D, Functional Area Management, engineering, property, finance, safety, software, and community relations information. Electronic data are managed as Electronic Data Sets and are referred to as such in this procedure.

6.1.1 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

The CERCLA requires that documents and correspondence used to form the basis for selection of a response action at a site be made available in the form of an Administrative Record. The requirement is found in the Federal Facility Agreement Under CERCLA Section 120 between the EPA, DOE, CDHS, and the CRWQCB (November 2, 1988).

All documentation created in support of the CERCLA projects shall be legally defensible and is therefore recorded and maintained in such a manner. Documented CERCLA related work activities such as drilling, sampling, and hydraulic testing events are recorded in controlled, bound logbooks in accordance with SOP 5.5: Field Logbook Control or on field data sheets designed to capture information specific to a work activity.

6.1.2 Decommissioning and Demolition (D&D)

The ERD DMT Program maintains electronic working files on the erdfilespace server.

D&D Project Management documents go to LLNL Archives after project closeout.

The historical facility information library is maintained in paper binder format by ERD DMT.

6.1.3 Engineering

Engineering drawings, facility design, and other related documentation are stored on local desktop computers and archived on the LLNL Enterprise Configuration Management System (ECMS).

Engineering and Project operation meeting notes are stored electronically on the ERD Wiki space on myconfluence.llnl.gov.

6.1.4 Property

A hard-copy file is kept for each active piece of property assigned to the ERD Property Center. Files are maintained in numerical order, according to assigned DOE identification numbers.

Additionally, hard copy records are kept on all property transferred to another Property Center; on all property sent to DUS (Donation, Utilization and Sales), aka Excess; and on retired property (i.e., lost, stolen, cannibalized, etc.)

All files and documentation are physically located in the office of the ERD Property Center Representative.

6.1.5 Finance

Financial documents pertaining to ERD are maintained and stored in electronic format by the ERD Business Manager and Financial Analyst. LLNL financial data is maintained and stored at the institutional level as directed by the CFO Department. Several database applications are available to the ERD Finance Team to retrieve and sort financial data.

6.1.6 Safety

The ERD QAIC controls the issuance and revision of safety related documents as outlined per SOP 4.18: ERD Document Control. Controlled safety documents include Site Safety Plans for both Site 200 and Site 300, and O&M manuals. Integration Work Sheets (IWSs) are managed electronically on an institutional database and global updates to the work sheets are made by the QAIC.

Subject Area Management

ERD is part of the Facilities & Infrastructure (F&I) Subject Area (SA). A Subject Matter Expert (SME) has been designated to conduct SA related work activities. SA management records are maintained on the Institutional Document Management (iDocMan) website. Records include approved Requirement Decision Records (RDRs); Subject Area Description; Gap Forms; Qualification Cards; Roles, Responsibilities, Accountabilities, and Authorities (R2A2s); and implementing mechanisms. Copies of these records are also maintained in an "evidentiary" binder.

6.1.7 Community Relations

CERCLA documents are maintained on ERD's Environmental Community Relations web page, erdfilespace, and desktop computers. The URL for the web page is http://www-envirinfo.llnl.gov.

6.1.8 Personnel

Official personnel records are maintained electronically at the institutional level. Original Performance Appraisals (PAs) are also maintained electronically in an institutional repository. ERD administrative staff tracks training requirements and completion thereof by ERD personnel through the institutionally managed Livermore Training Records and Information Network (LTRAIN) system.

6.1.9 Correspondence

Correspondence relating to CERCLA, DOE, LLNS, and other activities are appropriately created and maintained by ERD staff. The Administrative Record is updated as necessary with any correspondence that supports CERCLA based decisions.

6.2 Electronic Record Sets

6.2.1 ERD File Share Server

ERD maintains a server where ERD electronic files are stored and shared among ERD staff members. The top-level file directories on the erdfilespace server are assigned to and managed by "czars", personnel responsible for the content, organization, and privileges for the contents of the directories.

Backup Systems

The data are on raid disk arrays with hot-swappable drives and automatic recovery of data occurs when up to two drives fail

Software

ERD has developed a Software Quality Assurance Plan (SQAP) to meet the intent of the LLNL Institutional Software Quality Assurance Plan (ISQAP), and for compliance with DOE Order 414.1C and NNSA QC-1. The plan provides guidelines for the ERD in the development and modification of software, or for contract or purchase of the development or modification of software. The ERD SQA Plan identifies commercial and/or LLNL developed software and the maintenance thereof and includes: the TEIMS, Remediation Modeling Support Applications, Engineering Group Applications, Technical Release Representative tool in TEIMS, Phoenix, and other software.

Software license information is kept in a file that is read nightly by a script that automatically sends reminder emails to the "custodians" of each software package when a license nears its renewal date. The "custodians" are responsible for contacting the vendor and insuring that the license agreements are being satisfied.

6.2.2 Desktop Computers

ERD supports a variety of desktop computers – Apple/Macintosh, PC/Windows, and Linux. The computers are administered by the ERD support staff and LLNL institutional support staff.

Backup Systems

The PC and Unix boxes are backed up to tape using Legato Networker with incremental backups performed nightly and full backups performed every eight weeks. The Macintosh computers are backed up hourly using Time Machine. The users are notified by Time Machine if a backup fails.

6.3 Creating Records

6.3.1 ERD staff members are responsible for creating and properly managing the required documentation for the work activities performed.

6.3.2 Section 7.0 Quality Assurance Records of the ERD SOPs establishes a list of QA Records that are to be created as a result of performing the associated work activity.

6.4 Maintaining Records

6.4.1 ERD staff members are responsible for maintaining the required documentation for the work activities performed.

The Administrative Record and other CERCLA documentation is managed in a controlled manner by assigned ERD Staff. A designated ER Department-level Administrative person maintains the Administrative Record, which is located in B543, R1077. Only the designated person has access to the room where the Administrative Record is kept, which is controlled by a TESA key.

Drilling records and other hydrogeological records such as geophysical logging, well installation, etc. are maintained in B438, R123, which is referred to as the "Data Cave". These records are controlled by a TESA key, for which only DMT personnel have access.

Analytical data, water level field sheets, and CoCs are stored in the Data Management Records System in the same area where DMT resides. These records may be checked-out or copied by the Data Management Team for ERD staff upon request. When the materials are checked out, Data Management places orange file cards in the place of the record with the name of the ERD staff member who checked out the report and the date it was retrieved.

6.4.2 Short-term Storage

The DMT retains original records that are created in accordance with the ERD SOPs for specific work activities. These original records are stored for the short-term as part of the Data Management Records System. Copies of the original records are also maintained and disseminated as determined by the ERD SOPs.

6.4.3 Long-term

On an annual basis, ERD prepares records for storage in accordance with the guidelines set forth by the LLNL Records Management policy. Records are submitted to the Laboratory Records Center, which may be thought of as an extension to ERD's filing system. Custody of the records remains with the ERD until the retention schedule is met and then ownership and custody of records are transferred to Laboratory Archives and Research Records.

A blank transmittal form (Attachment A, Form #LL1136) is available on erdfilespace, which is used to identify records being prepared for storage. The completed form is attached to the file box and accompanies the records to the Laboratory Records Center.

Scanned copies of the completed Record Transmittal Forms are maintained in folders on erdfilespace, which provides the necessary tracking information for easy retrieval of ERD Records stored in the Laboratory Records Center in B411.

Paper copies of transmittal forms are stored in binder format in a DMT office.

6.5 Records Retention Schedule

6.5.1 In accordance with the LLNL Records Management policy, the records created within the ERD follow the requirements outlined in Schedule 10, Environmental Safety & Health. As stated in Schedule 10, these records include environmental administration, regulatory compliance, permitting & licensing, monitoring, sampling & analysis, disposal and cleanup, emergency management, and hazards control.

6.5.2 Record types include analytical data files, design review files, drilling records, environmental monitoring records, ES&H Technician Logbooks, Ground Water Sampling Records, Material Safety Data Sheets, Remediation Management and Planning Records, Standard Operating Procedures, training files, and Water Level Data Sheets.

6.7 Records Disposition

6.7.1 Disposition of records is set forth by the record type and per Schedule 10 for environmental, safety, and health. The disposition requirement differs according to the record type. For example, the Retention Instructions for SOPs is described as "Unscheduled Records: Do not destroy". Analytical Data Files are to be retained for 75 years and may be destroyed thereafter according to the Retention Schedule. Certain environmental records are considered Epidemiological (EPI) records and are governed by a moratorium. Environmental Monitoring Records fall into this category and are considered permanent records that cannot be destroyed according to the EPI moratorium.

7.0 QA RECORDS

7.1 QA records are established in each ERD SOP for the associated work activity.

Examples of ERD QA records include: All CERCLA required documentation of sampling, water level monitoring, drilling, hydraulic testing events, analytical data reports, environmental reports, standard operating procedures, and other correspondence. Information that is created, received, or otherwise acquired during the course of conducting ERD business and work activities are to be managed as records.

8.0 ATTACHMENTS

Attachment A—Records Transmittal Form (LL1136)

Attachment A

Records Transmittal Form

RECORDS TRANSMITTAL

RECORDS MANAGEMENT USE ONLY

DEPARTMENT/DIVISION	BLDG	RM.	FOLDER NO CODE	DATE
SECTION-GROUP-PROJECT	EXT.	L-CODE	DOE MANUAL REF.	FILE UNIT CODE
PERSON TO CONTACT (Individual maintaining information on stored records)	EXT.			CUBIC FEET
DEPARTMENT HEAD OR DESIGNEE (Print or Type Name)	DATE		LLNL SCHEDULE REF.	
			TRANSFERRED TO	DATE
Department Head or Designee Signature (Required)			RETENTION PERIOD	REVIEW YEAR

TITLE OF RECORDS OR FILE UNIT

THE RECORDS BELOW WERE RECEIVED AND ARE AVAILABLE FOR REFERENCE

ARRANGEMENT OF RECORDS

(Signature of Records Center Head or Designee)

Date

INCLUSIVE DATES

CLASSIFICATION

☐ UNCLASSIFIED ☐ CLASSIFIED

BRIEF DESCRIPTION OF RECORDS

BOX NO.	INCLUSIVE CONTENTS	SEAT LOCATION	BOX NO.	INCLUSIVE CONTENTS	SEAT LOCATION

To submit this form: Place completed original Records Transmittal form in Box 1 of records to be stored.
NOTE: Each group of boxes of the same "series," "type" or year requires a form. For additional information, call the Laboratory Records Center, 3-5542.

LL1136# v2.2 (2/98)

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.12: Quality Improvement Forms (QIFs)— Revision: 3

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this procedure is to describe the steps ERD personnel are to take when documenting an identified nonconforming item or process or when suggesting a cost-savings or quality improvement using a Quality Improvement Form (QIF).

2.0 APPLICABILITY

This procedure is applicable to all ERD quality affecting activities.

3.0 REFERENCES

3.1 ES&H manual, Document 41.1, LLNL Quality Assurance Program, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AM-133867-VOL-4-PT-41-2009.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Department Head (DH) or Deputy Department Head (DDH)

The DH or DDH is responsible for fostering a "no fault" attitude to encourage the identification of nonconforming items and processes. The DH or DDH is also responsible for allocating resources and resolving difficult quality issues.

5.2 Program Leader (PL)/Authorizing Individual (AI)

The PL/AI is responsible for approving the QIF and ensuring the corrective actions/preventative measures are performed.

5.3 ERD Personnel

ERD personnel are responsible for identifying nonconforming items and processes, and suggesting quality improvements. All personnel have the right and responsibility to stop work until effective corrective action is taken.

5.4 Quality Assurance Implementing Coordinator (QAIC)

The ERD QAIC is responsible for submitting QIFs, tracking QIFs, ensuring that QIFs contain the necessary information, and verifying that QIFs are satisfactorily closed.

5.5 Responsible Individual (RI)

The RI is responsible for carrying out the corrective action.

6.0 PROCEDURE

6.1 Reasons to Use a QIF

6.1.1. A QIF (Attachment A) is used for documenting and resolving identified nonconforming items or processes. A QIF may also be used to document cost savings or quality improvement suggestions. Examples of when to use a QIF:

- Changes to data in the database requiring a paper trail.
- Broken or inadequate material received from vendors.
- Sampling errors.
- Equipment malfunction.
- Treatment facility permit violations.
- Systematic analytical laboratory problems.
- Safety concerns.

- To document the implementation of ISM Function #5, "Provide Feedback for Continuous Improvement."

6.1.2 Questions related to analytical data or suspected errors are documented by the QC Chemists using a Data Review Request (DRR) (see SOP 4.6, "Validation and Verification of Nonradiological Data"). A QIF may be necessary if a change to the database is required or if a trend is identified.

6.1.3 Consult the ERD QAIC for questions regarding the appropriateness of using a QIF.

6.2 Filing a QIF

6.2.1 A QIF may be initiated by any ERD personnel that determines the necessity of a QIF. A QIF should be completed in the following manner:

Step 1. Initiator should obtain a blank QIF from the QAIC. Fill out indicating problem/condition, underlying cause, corrective action taken, responsible individual (if known), as well as preventative measures necessary.

Step 2. Forward completed form to the QAIC.

Step 3. The QAIC will log the QIF into the QIF logbook. Each QIF entry should include a brief summary of the problem, date open, and name of Responsible Manager. The QIF identifier code is assigned (ERD-YY-XXX) by the QAIC, where YY is the current year and XXX is the next available sequential number.

Step 4. The QAIC determines the affected area and forwards QIF to the PL/AI.

Step 5. The PL/AI reviews the QIF and may make changes or send it back to the initiator if more information is needed. Once the QIF is correct the PL/AI fills in the initials box and forwards it to the QAIC.

Step 6. The QAIC will print the QIF and assign a compliance code. The compliance code choices are as follows:

001 = Equipment or system failure.

002 = Defective materials or items.

003 = Calibration deficiency.

004 = Insufficient training.

005 = Procedure noncompliance.

006 = Inadequate procedure.

007 = Documentation deficiency.

008 = Lack of document or record control.

009 = Traceability and chain-of-custody.

100 = Other items not covered above.

Step 7. The QAIC places QIF in the ERD QIF binder.

Step 8. A copy of the completed QIF is stored on ERD's server and is accessible via the following pathway <departmenspace/QA_ES&H/QIFs>.

Step 9. If the QIF is complete and the corrective action is acceptable, the QAIC will verify the action and close out the form with a signature and a closed date. If the QIF cannot be closed until a corrective action takes place the QIF will remain open until verification.

7.0 QA RECORDS

7.1 Completed QIFs

7.2 QIF logbook

8.0 ATTACHMENT

Attachment A—Quality Improvement Form

Attachment A

Quality Improvement Form

Quality Improvement Form

ERD Personnel should complete Section I and forward the form to the QAIC. The form should be used to document (1) cost savings suggestions, (2) quality improvement, (3) changes to the database, (4) problem resolution, (5) broken or inadequate materials are received from vendors, (6) sampling and analysis error identification and correction, (7) broken equipment/repair, (8) treatment facility permit infractions, (9) other.

Section I

Description of the problem, condition, cost savings suggestion or quality improvement:

Underlying cause:

Corrective action needed or taken:

Preventative measures:

Responsible Individual (person to take action):____________________________

Section II

(To be completed by the Responsible Manager)

Submitted by:__________________________ **Date:**______

Responsible Manager Approval:_______________________________

Section III

(To be filled out by the QAIC)

QAIC Concurrence:__________________________

Log Number:___________________________

Compliance Code:___________________________

001 – Equipment or system failure
002 – Defective materials or items
003 – Calibration deficiency
004 – Insufficient training
005 – Procedure noncompliance
006 – Inadequate procedure
007 – Documentation deficiency
008 – Lack of document or record control
009 – Traceability and chain of custody
100 – Other items not covered above

LLNL Environmental Restoration Department (ERD) Standard Operating Procedure (SOP)	
ERD SOP 4.13: Standard Operating Procedure Process— Revision: 2	
ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # ERD	**AUTHOR(S):** **R. Goodrich**
	APPROVALS: **Date** [signature] 4/12/12 **Department Head** [signature] 4/12/12 **Facilities & Infrastructure Assurance Manager**
	CONCURRENCE: **Date** Rebecca Goodrich 4/12/12 **QA Implementation Coordinator**
Type of Procedure (per ES&H Manual, Document 3.4) ☒ Informational Use ☐ General Use ☐ Continuous Use	

1.0 PURPOSE

The purpose of this procedure is to establish the means for preparing and revising standard operating procedures (SOPs), and to ensure that they are reviewed for adequacy and approved by the appropriate personnel. Procedures are used by ERD personnel as a training tool and reference source.

2.0 APPLICABILITY

This procedure is applicable to ERD personnel that develop ERD SOPs.

3.0 REFERENCES

3.1 ES&H Manual, Document 3.4, Preparation and Use of Work Procedures, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AM-133867-VOL-1-PT-3-2009.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Department Head (DH)

The Department Head's responsibility is to ensure that all activities performed by ERD are documented in a procedure as described by this SOP. The Department Head approves all SOPs.

5.2 Program Leader (PL)/Authorizing Individual (AI)

The PL/AI approves the SOP and ensures that the SOP accurately reflects the processes in place and the requirements are implemented.

5.3 Reviewers

ERD Personnel assigned as Reviewers are responsible for reviewing newly developed or revised SOPs that directly impact their work activity and ensuring that the SOPs reflect the processes in place and any new requirements are implemented.

5.4 ERD Quality Assurance Implementation Coordinator (QAIC)

The QAIC is responsible for initiating and coordinating the SOP process for new SOPs and revisions. The QAIC concurs with all SOPs and controls their distribution.

5.5 Procedure Writer

ERD personnel assigned as Procedure Writer or Author are responsible for developing or revising SOPs in their area of expertise, per this SOP, involving all personnel that are directly impacted in the writing/reviewing and ensuring that the review is documented.

6.0 PROCEDURES

6.1 Initiation

Procedures are required to document all ERD processes to ensure that work is done correctly, consistently, and safely. When a new procedure is required, the QAIC initiates the SOP process by requesting that the PL/AI identifies the appropriate Procedure Writer and Key Reviewers.

6.2 Preparation

Procedures shall be prepared by the designated Procedure Writer per the requirements of this procedure.

6.3 Page Format

The front page of each procedure shall contain the following:

1. Procedure title, number, and revision.
2. Author(s).
3. Approval section which provides for signatures of the designated individuals and date, indicating approval of procedures.
4. Type of procedure.

6.4 Page Headings

Each subsequent page of a procedure shall have a page heading which includes the following information:

1. Procedure No.
2. Revision Number (e.g., Revision 0, Revision 1, etc.).
3. Page __ of __ (e.g., Page 1 of 10, 2 of 10, etc.).

6.5 Outline and Content

Procedures shall be divided into the following sections in the order presented:

6.5.1 Section 1.0, ***PURPOSE***

Briefly state why the procedure is being written and what activity is to be performed through the use of the procedure.

6.5.2 Section 2.0, ***APPLICABILITY***

Provide a concise description of to what or whom the procedure applies.

6.5.3 Section 3.0, ***REFERENCES***

List references. If there are no references, indicate "Not Applicable."

6.5.4 Section 4.0, ***DEFINITIONS***

Provide definitions to clarify terminology used in the procedure. Definitions will be placed in the SOP Glossary in all SOP binders.

6.5.5 Section 5.0, ***RESPONSIBILITIES***

Identify the titles and major responsibilities of the individuals or organizations responsible for implementing the requirements of the procedure.

6.5.6 Section 6.0, ***PROCEDURE***

Section 6.0 should be as concise as possible, yet with enough detail that personnel with minimal working knowledge can perform a task by following the procedure. Provide a step-by-step sequence of operations required to perform the activity in a manner that is correct, safe, and fully responsive to applicable requirements.

6.5.7 Section 7.0, ***QUALITY ASSURANCE RECORDS***

Identify the QA Records that will be generated or completed as a result of implementing the procedure.

6.5.8 Section 8.0, ***ATTACHMENTS***

Any attachments, sample forms, etc., will be labeled “Attachment” followed by an upper case alpha code. Attachments shall be listed in this section. If there are no attachments, indicate “Not applicable.”

6.6 SOP Section Headings

Where necessary, SOPs shall be divided into Sections, Subsections, Sub-Subsections, and/or Sub-Sub-Subsections. Use sequential numbering (1.1, 1.1.1, 1.1.1.1, etc.) for all Section Headings (Note: Section Headings may vary per SOP). This guide will assist authors, compositors, and editors in preparing uniform ERD SOPs and is organized by the following examples:

1.0 SECTION HEADING 1—centered

Font = Century Schoolbook, Font Type = **bold**, ALL CAPS, Font Size = 12

1.1 Subsection Heading 2 (heading only)—left justified

Font = Century Schoolbook, Font Type = **bold**, Font Size = 12

1.1 Subsection Heading 2 (heading or text)—left justified

Font = Times, Font Type = plain, Font Size = 12.

1.1.1 Sub-Subsection Heading 3 (heading or text)—indent

Font = Times, Font Type = plain, Font Size = 12

1.1.1.1 Sub-Sub-Subsection Heading 4 (heading or text)—indent

Font = Times, Font Type = plain, Font Size = 12

- For numbering indented items or lists use Bullets (•); “En” Dashes (–); 1., 2., 3.; or A., B., C.

Procedures, including revisions, shall be reviewed by ERD personnel whose work is directly related to the SOP. The Procedure Writer shall call a group meeting with those personnel to address their comments. The review shall be documented.

6.8 Approval

Procedures, subsequent revisions, or cancellations shall be approved by the Department Head and the PL/AI. SOPs that implement the requirements of the Operations and Business (O&B) QA Plan do not require PL/AI approval.

6.9 Concurrence

Procedures shall be concurred to by the ERD QAIC. When an SOP implements the requirements of the O&B QA Plan, the Facilities and Infrastructure (F&I) Assurance Manager shall also concur.

6.10 Distribution

Procedures, including revisions, shall be assigned unique numbers by the QAIC and distributed as controlled documents.

6.11 Maintenance and Revisions

6.11.1 Procedures shall be reviewed at least triennially.

6.11.2 Any changes to the procedure shall constitute a revision.

6.11.3 Revisions to procedures shall be prepared, reviewed, approved, and distributed in the same manner as the original procedures.

7.0 QA RECORD

7.1 The original approved procedure.

7.2 Revisions.

7.3 Review meeting signature sheet.

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Division (ERD) Standard Operating Procedure (SOP)	
ERD SOP 4.14: Mapping with the Trimble Pathfinder Pro XR GPS System	
REVISION: 0 ENVIRONMENTAL RESTORATION DIVISION CONTROLLED COPY # THIS IS A RED STAMP ERD	AUTHOR(S): R. Goodrich REVIEWER(S): T. Carlsen, J. Bennett*, P. Althouse
EFFECTIVE DATE: January 1999	Page 1 of 24
APPROVAL Date [signature] 4-19-99 Division Leader APPROVAL Date [signature] 4/16/99 Environmental Chemistry and Biology Group Leader	CONCURRENCE Date [signature] 4/16/99 QA Implementation Coordinator

*The Operations and Regulatory Affairs Division (ORAD)

1.0 PURPOSE

To describe general operating instructions for the usage of the Trimble Global Positioning System (GPS) Pathfinder Pro XR System. The GPS Pro XR is used to perform mapping or surveying type activities. Some uses of the system may include mapping of wildlife habitats, ecological preserves, archeological sites, and surveying of sampling locations.

2.0 APPLICABILITY

These guidelines provide general instructions for personnel conducting mapping or surveying projects using the Trimble GPS Pathfinder Pro XR and Pathfinder Office Software. A formal certified training class must be taken prior to using the Trimble Pathfinder Pro XR System and Pathfinder Office Software.

3.0 REFERENCES

3.1 Dana, H. Peter. (1998), The Geographer's Craft Project, Department of Geography, The University of Texas at Austin.

3.2 Trimble Navigation Limited Surveying and Mapping Division (1997), Pro XR System Training Manual

3.3 Trimble Navigation Limited (1997), Pathfinder Office Getting Started.

3.4 Trimble Navigation Ltd (1989), GPS A Guide to the Next Utility.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Division Leader

The Division Leader's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Environmental Chemistry and Biology Group Leader (ECBGL)

The ECBGL's responsibility is to provide biological or chemical information and expertise (i.e., biological surveys, water supplies, chemical field instruments, etc.).

5.3 Site Safety Officer

The SSO's responsibility is to ensure the safety of ERD's ongoing operations and facilities and work performed.

6.0 PROCEDURES

6.1 Discussion

When properly operated, the GPS system is superior to former navigational systems in that, the only requirement is line of sight to the sky for accurate positioning. Precise geographic coordinates can be computed by calculating the distance from a group of satellites to a GPS receiver on earth. There are three segments to the GPS system:

6.1.1 Space Segment. The space segment of the GPS is operated by the Department of Defense (DOD). It consists of 24 operational satellites (21 space vehicles (SVs) and 3 spares). The SVs orbit the earth in 12 hours. There are six orbital planes (with four SVs in each), equally spaced (60° apart), and inclined at approximately 55° relating to the equatorial plane. These SVs send radio signals from space and can be received by hand-held GPS receivers or rovers. At any given time there should be between five to eight available SVs from any point on earth.

6.1.2 Control Segment. The control segment consists of a system of monitoring stations located around the world. The main monitoring station is located at Schriever Air Force Base (formerly Falcon AFB) in Colorado. These stations measure signals from the SVs into orbital models for each satellite. These models compute precise orbital data (ephemeris) and SV clock corrections for each satellite. The corrected data is then uploaded to the SVs. The SVs then send subsets of the orbital ephemris data to GPS receivers over radio signals. This segment is referred to as the '"brain" of the GPS system.

6.1.3 User Segment. The user segment consists of GPS rovers and users. The GPS rover is used to receive signals from the SVs and are used to compute positions for multiple applications.

To compute position, the system is based on satellite trilateration or triangulation. A minimum of 4 satellites are needed to compute trilateration. Example: If the GPS rover measures the distance to the first satellite as 19,000 Km away, then your position is on the surface of a sphere within the radius of 19,000 Km from the satellite. A subsequent measurement is derived from a second SV which measures your position. Your position on earth is narrowed to the ellipse created by the intersection of the two spheres. A third measurement is the intersection of the three spheres, which narrows your position down to two points. A fourth measurement, which is based on time becomes the deciding factor between the two points which determines the GPS position.

To measure the distance to a satellite from our position on earth, we need to know how long a radio signal takes to reach us from that satellite. The GPS receiver determines when the signal left the satellite. This is accomplished by using pseudo-random code (PRC) that is generated at the same time in both the receiver and satellite. The GPS signal travels at the speed of light. The equation used to compute distance is: travel time (sec) x the speed of light (300,000 km or 186,000 mi/sec) = distance (km or mi).

The GPS signals are purposely scrambled by the government, which is referred to as selective availability. Other natural occurring phenomenon, such as atmospheric delay, multi-path error and receiver noise add inaccuracy to the computed position. Most errors can be recognized and easily corrected during the post-processing phase of the data.

6.2 Office Preparation

All personnel conducting mapping or surveying activities using the Pro XR GPS System must participate in a certified training course provided by the Trimble Navigation Surveying & Mapping Training Department prior to using the instrumentation.

6.2.1 Pre-mission Planning. Perform a field reconnaissance of the area projected for mapping. Schedule mapping sessions when satellite availability are optimal to help ensure accuracy of field data. Trimble's SatView website can be used to determine the availability of satellites at any given time of day. The website address is: http://www.trimble.com/satview/. Take note, Greenwich Mean Time (GMT) is used in SatView and must be converted to the Pacific Standard Time Zone (PST), which is 8 hours earlier to properly plan your field session.

6.2.2 GPS Hardware/Software Configuration. Become familiar with the GPS before using it during an actual mapping session. Use Attachment A "Equipment Checklist" to check for all necessary GPS components prior to use. Refer to Attachment B, "**GPS Hardware Configuration**" and Attachment C, "Introduction to Asset Surveyor Software" to familiarize yourself with the equipment.

6.2.3 Data Dictionary. Create a data dictionary using Pathfinder Office software (refer to instruction manual) for the specific project being mapped. In order to efficiently create a usable data dictionary some forethought must be given. Determine the features that you plan to map. Generate a list of point, line, and area features to be included in the data dictionary, then create a list of attributes and attribute values. Each feature should be uniquely identified, so that it can be independently labeled on the final map projection. Hint: You may want to include an 'other' attribute for every feature, since the data dictionary cannot be edited in the field. When satisfied with the data dictionary, connect the Trimble cable (see Attach A for cable number) to the PC and the GPS rover to transfer a data file. To transfer a file, you must do the following:

1. On the GPS rover select **File Transfer**, and press **Enter**.

2. Select **Utilities/Data Transfer** in Pathfinder Office.

3. In the **Data Transfer** box select **Data Dictionary** as the file type, **send** and **transfer** the dictionary to the GPS rover.

6.2.4 Configuring the Pro XR Rover Receiver. There are three types of settings when configuring the Rover: Critical, Non-Critical and Display. Critical settings must be configured prior to data capture. These are quality affective settings. Non-critical settings affect the behavior of the ASPEN software, but do not affect the usability of the GPS positions. Display settings are only used to create a more user friendly system, but are not quality effecting. Refer to Attachment D, "Configuring Rover Options" to properly configure the GPS rover receiver according to the manufacturer's instructions.

6.3 Field Preparation

6.3.1 Preparation for Data Capture. If working at Site 300 schedule access arrangements with the appropriate building coordinators before going to the field. Prior to the GPS data capture session make sure all batteries are fully charged. It is beneficial to conduct a mock mapping session before using the instrument to do your actual mapping project. This helps you to become familiar with equipment set-up and possibly trigger questions that you'll need answered before the final data capture session.

6.4 Operation

6.4.1 Data Capture. After configuring the GPS rover and proper field preparation has been made, you are ready to conduct a mapping or surveying session in the field. A file name will automatically be given to your data capture session when you create a new data file. The naming convention used is R032120A, in which the R identifies the file as a rover file, MM (Month), DD (Day), HH (Universal Coordinated Time (UTC) time by default)), x (counter-increases a, b, c, within the hr.). Before creating a new data file, verify that you have a current position fix. To do this, refer to Attachment E, “Data Capture”. If the top line reads OLD POSITION do not begin data capture. Wait until a current position is displayed. During the field mapping session, if there is a nearby location that has been surveyed, collect a GPS point at this location. This will make it easier to match data points if the GPS field data are overlaid onto other map projections.

Tip: A rover file that is over 1 week old cannot be appended to. It is important to plan your mapping project, so that it can be completed in one session, if possible. Also, rover files that are over two months old cannot be post processed. The base files are not archived past two months.

6.5 Post Field Operation

6.5.1 Post-Processing in Pathfinder Office

A formal certified training class must be taken prior to using the Trimble Pathfinder Pro XR System and Pathfinder Office Software. Please refer to the ProXR instruction manual or the Pathfinder Office, software manual for detailed operating instructions.

Pathfinder Office software is used to transfer, correct, display, edit, plot and export your data. Please refer to the instruction manual to properly configure Pathfinder Office. Once the application has been configured, field data from the GPS Rover may be transferred to Pathfinder Office. To transfer a file you must do the following:

1. Select **File Transfer** on the datalogger and press **enter**.

2. Select **Utilities/Data Transfer** in Pathfinder office.

Tip: It should only take a few seconds for Pathfinder Office to connect to the datalogger. If it takes longer, check the cable to make sure it’s properly connected to the PC and the datalogger. Once the connection has been made, continue using the Pathfinder Office menu:

3. In the **Data Type** box, select **Data.**

4. In the **Direction** field, select **receive**.

5. Select *.* as the file type.

6. In the **Available Files** box double click on the file you want to download or select a file(s) and click **Add**.

7. Click **transfer.**

7. Click **close** to exit Data Transfer.

6.5.2 Pathfinder Office Differential Correction

GPS data are captured in the field. Base data is stored at the base station. The two data sets are loaded into Pathfinder Office where corrections are processed.

1. Select **Utilities/Differential Correction.**

2. Click **browse** in the **Rover Files** box.

3. Select the rover file and click **OK**.

4. Click **Auto Select** in the **Base Files** box.

Tip: To use Auto Select, the base files must be in the C:\PFDATA\<PROJECT NAME>\BASE directory. If Pathfinder Office is not configured to use Auto Select, then download basemap data files from the Internet. The website address is ftp://ftp.trimble.com/pub/cbsfiles/. Find the basefile collected at the same time as the rover file, then download.

5. Click **OK** to run the differential correction. The **Differential Correction Completed** box highlights success or failure of the differential correction.

6. If 100% of the positions did not correct click **More Details** to find out why.

7. Select **File/Exit**.

8. Click **Close**.

6.5.3 Pathfinder Office Data Display

To view the corrected data file as a map:

1. Click **File/Open** and select a *.COR file.

2. Select **View/Map** to visually display the data.

6.5.4 Pathfinder Office Data Editing

The data editing feature provides the capability to delete unwanted GPS positions.

1. Select **Data/Query Position**.

2. In the **Map Display** click on a GPS position.

3. In the **Query Position** box click **Delete**. If a mistake is made select **Undelete**.

Unwanted features and attributes may be deleted in the same manner as unwanted GPS positions.

Data may be exported into many formats, i.e., ARC/INFO, ASCII, AutoCAD DXF, Generic Database. Please refer to the instruction manual for data export.

7.0 QUALITY ASSURANCE RECORDS

7.1 Electronic data file

7.2 Spatial data display

8.0 ATTACHMENTS

Attachment A—Equipment Checklist

Attachment B—Turning the GPS Rover On & Off

Attachment C—Introduction to Asset Surveyor Software

Attachment D—Configuring Rover Options

Attachment E—Data Capture

Attachment A

Equipment Checklist

Equipment Checklist

______ Range Poles

______ Integrated GPS/Beacon antenna

______ Antenna cable

______ Integrated GPS/Beacon receiver (8 or 12 channel)

______ TDC1 or TDC2 multiport cable

______ Datalogger, TDC1 or TDC2

______ System battery - two 12V 2.3A camcorder batteries

______ Drinking Water

______ Hat

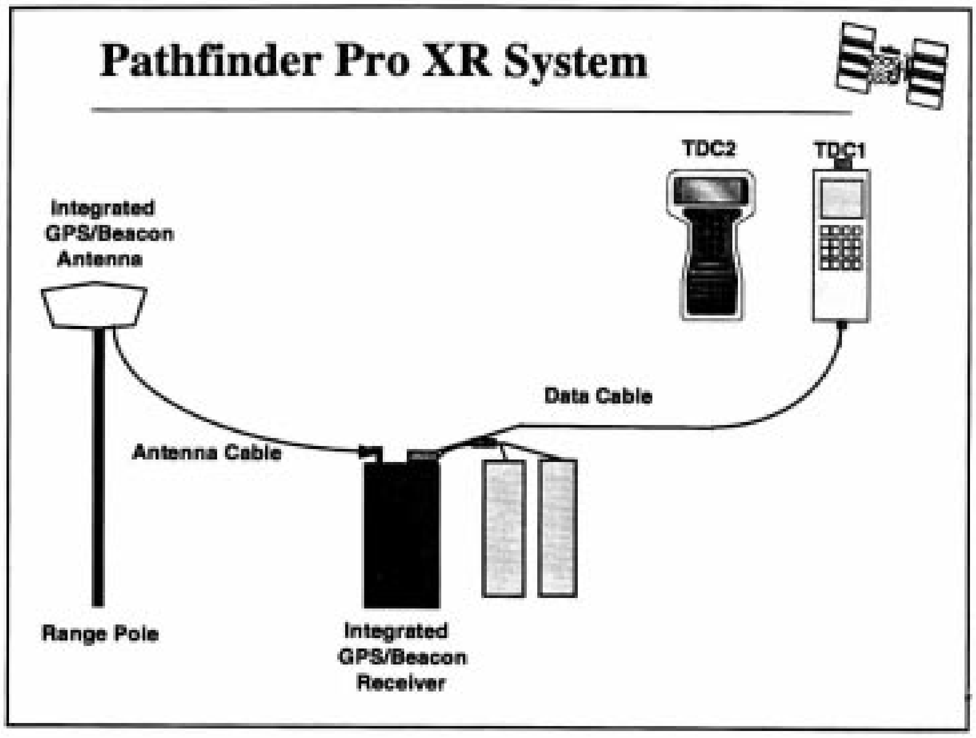
______ Snake Guards

______ Radio

______ Trimble Cable (27997 REV B, DCA 9817) for Data Transfer

Attachment B

GPS Hardware Configuration



1. Connecting the System

A. The Pro XR

Equipment needed:

- Range poles
- Integrated GPS/Beacon antenna
- Antenna cable
- Integrated GPS/Beacon receiver (8 or 12 channel)
- TDC1 or TDC2 multiport cable
- Datalogger, TDC1 or TDC2
- System battery - two 12V 2.3A camcorder batteries

TDC2 Datalogger

Func On/Off	Turn Off
GPS	GPS Operations
Func GPS	Configuration
OK	Saves/Exits
Enter	Saves a line
Func View	Review file
Func Note	Enter a note
Func B	Increase contrast
Func A	Decrease contrast

B. Features of a TDC2 Data Collector

- Full alphanumeric keyboard
- 8 line liquid crystal display screen
- 2 serial ports at top of unit
- MS-DOS (version 3.30 or later) stored in ROM
- Memory:
  - Standard: 570 kb
  - Extended: 3 mb
- Fully waterproof: stands immersion up to 1 meter (3 feet)
- Rugged: dust and shock proof, vibration resistant

Internal Power Source

- AA batteries (3):

  Considered the internal battery in the **Configuration\Hardware** menu.

- Backup Batteries:

  The TDC2 contains a trickle-charged internal battery which provides sufficient back up power to preserve the contents of the TDC2's memory for at least two weeks, if the main power source is removed.

Storing the TDC2

A serious risk with long term storage is battery leakage causing damage to the TDC2. Use only the highest quality alkaline cells for storage and ensure that they are brand new when fitted.

External Power Source

- External 12.5 volt lead acid:

  External power for receiver. Data collector can draw power from this source. These batteries do not have memory, therefore, can be left on charge at all times.

- Power adapter:

  Power adapter via cigarette lighter is also available. Do not turn vehicle off when GPS unit is on.

Attachment C

Introduction to Asset Surveyor Software

Introduction to Asset Surveyor Software

C-1 Turning On/Off Data Collector

1. To turn on, press On/Off.

2. To turn off, press **Func**, then On/Off.

C-2 Useful Key Combinations

- Enter is used to enter information on a given line.

- OK is used to validate information for an entire menu form.

- The **INFO** label on the screen (lower left corner) corresponds to the F1 key.

  - This option provides information for first-time users or for those who need a memory refresher. Scroll through the information pages. Try all the options listed.

Note—On a TDC-2 it is possible to exit the Asset Surveyor software. Exiting the program will take you to the DOS prompt. To re-enter Asset Surveyor, type ASSET at the command prompt.

C-3 Asset Surveyor Menus

Asset Surveyor contains three principle menus. They are the Main, Configuration, and GPS Operation menus.

GPS Operations–Used to view the status of receiver and satellites tracked.

Configuration–Used to configure the receiver for data capture.

Main Menu–Used to capture data, navigate, and transfer files to the PC. The menu options of the Main Menu are described in the following:

Data Capture–Used to collect rover files.

Navigation–Used to create/edit waypoints, print text reports from data collector, upgrade software, and to configure external sensors.

File Transfer–Used to communicate with your PC.

Utilities–Used to create waypoints, print text reports from the data collector, upgrade software, and to configure external sensors.

Base Station–Used to collect data in base station mode.

Info for New Users–Contains useful key combinations.

Attachment D

Configuring Rover Options

Table Attachment D-1. Configuring rover options.

Rover option	Recommended	Setting type
Point	1s[a]	critical
Line/Area	5s	critical
Not in feature	none	non-critical
Velocity	All	critical
Minimum Posn	5	non-critical
Pos. mode	Manual 3D	critical

Note:
When collecting 2D positions, you must enter the altitude.

D-1 Configuring Rover Options

- **Logging interval**–Defines the frequency at which a position is stored.
  - **Point features**–Set at *1* second.
  - **Line/Area features**–Should match the base station logging interval. Logging intervals may also depend on speed of travel:
    - If walking–*5* seconds.
    - If driving–*1* second.
- **Not in feature**–Stores a position even though you are not collecting features.
- **Logging velocity**–Velocity records can be used for attaining better post-processed accuracies in high multipath areas.
- **Minimum Posns**–Minimum number of positions collected for a given point feature. If the point feature is closed before the minimum number of positions are collected, the Asset Surveyor software will provide a warning.
- **Position Mode:**
- **Manual 3D**–Used 4 or more Svs to calculate a 3D position.
- **Elevation Mask**–Rover should be set higher then base to ensure correction (recommended value = *15*°).
- **SNR Mask**–Signal-to-Noise ration or signal strength. The stronger the signal, the better (recommended value = *6.0*).
- **PDOP Mask**–SV constellation with PDOPs greater than the specified number are not used (recommended value = *6*).
- **PDOP Switch**– Only applicable in Auto 2D/3D Mode (recommended value = 6). When PDOP rises above 6, positions are recorded in 2D.

- **Audible Click**–If activated, the data collector beeps every time a position is logged (recommended value = Yes).
- **Log DOP Data**–If activated, changes in DOP changes in DOP are recorded in the rover file (recommended value = Yes).
- **Initial Position**–Useful entry when you have a brand new unit or when you travel from one geographic location to another. Provides the receiver with a head start on where to look for Svs.
- **Dynamic Code**–Helps control initial acquisition of satellites. Land, Sea, Air.

Table Attachment D-2. RTCM configuration.

Rover option	Recommended
RTCM input mode	Auto
RTCM version	Auto
RTCM station	Any
Warning time	20 s
Log PP data	Yes
Baud rate	9600
Data bits	8
Stop bits	1
Parity	None
Mode	Auto range
Frequency	N/A

Note:

Real-time data is referred to as Radio Technical Commission for Maritime Services (RTCM). The RTCM established the format to relay GPS correction messages from one monitoring station to a field user.

D-2 RTCM Configuration

RTCM input mode:

OFF If RTCM is not being used.

ON Enables RTCM, positions will be collected, but only when RTCM is available.

AUTO When RTCM is available, positions will be corrected in the field. when RTCM is not available, positions will be stored and available for postprocessing.

RTCM version:

Auto If you are unsure which RTCM version is being transmitted by your base station.

Ver. 2 Protocol: Most Trimble receivers receive version 2 protocol only.

USCG U.S. Coast Guard protocol.

RTCM station:

Any Enables the GPS receiver to accept RTCM from any base station; however, you can enter the identification of a particular station. The receiver will use the strongest RTCM signal available, if there are multiple bases broadcasting RTCM.

Warning Time:

If no new corrections have arrived over the RTCM link, the most recent correction is considered too old to provide accurate corrected positions. When warning time expires, the GPS receiver will warn you that your RTCM link has been lost.

Log PP data:

Must be configured to "Yes" in order to post process data.

Allows you to log additional data so that GPS positions corrected in real-time can be reprocessed in the Pathfinder Office software.

A setting of **Yes** will halve the number of RTCM connected positions you can store in the datalogger.

Press F1 Beacon, to receive beacon corrections.

Mode:

Off Pro XR will disable the beacon component.

Auto Range Pro XR will automatically lock to the closest beacon.

Auto Power Pro XR will automatically lock onto the most powerful beacon.

Manual Pro XR will use only the radiobeacon frequency you specify in the **Frequency** field.

Frequency:

Lists the frequency entered that the Pro XR is to track when in Manual mode.

Table Attachment D-3. Carrier phase configuration.

Rover option	Recommended
Carrier mode	Query
Measurements	15 s
Positions	60 s
Minimum time	5 min.

D-3 Carrier Phase Configuration

Use the carrier phase mode for surveying type activities. It is necessary to remain at a location for approximately 20 minutes to obtain an accuracy of 50 cm vertical and 10 cm horizontal. If your location is > 50 km from the base station then further inaccuracy is introduced. To configure for carrier phase measurements select F2 and set the following:

Career Mode:

OFF Carrier phase mode disabled.

ON Subsequent point features will be captured in carrier phase mode. (Used if all points will be collected in carrier phase mode).

Query When you start each subsequent point feature you will be asked whether or not that feature should be captured in carrier phase mode. (Used if only some points will be collected in carrier phase mode).

Measurements–15s.

Positions–Positions are not required for carrier phase-processing. Set to *None*:

Minimum Time–The minimum time for which you should remain at a point in order to record sufficient carrier phase data to process in 5 minutes. Set to 5 minutes.

Note— An accurate antenna height is very important when operating in carrier phase.

Press F3 to change the antenna height.

Height = <user entered>

Measure = <uncorrected>

Measure from the bottom of the antenna.

Type–MB:

EC = Compact dome.

MB = Integrated GPS\MSK beacon.

Attachment E

Data Capture

E-1 Before Creating a New Data File

Verify that you have a certain position fix. There are two options:

- Check the **Status Line**; it indicates the number of Svs tracked. You need 4 to collect a 3D position.
- Press GPS/Config to access the **GPS Operations** menu.

Tip— You must be connected to a receiver to access this menu.

To view the current position, do the following:

1. Press GPS/Config to access the **GPS Operations** menu.
2. Press Enter on **Position**.
   - Press Clear to escape back to the **GPS Operations** menu.
3. Arrow down, press Enter on **Receiver Status**.

Provides valuable information regarding critical settings such as, DOP, receiver firmware versions, and external battery voltages.

- Press Clear to exit.

4. Press Enter on **Satellite Info**.

Displays PRNs, SNR values, elevation, bearing, and URA (User Range Accuracy) information for individual satellites. URA (m) is an estimate of the accuracy of the pseudorange measurement to each satellite in meters.

- Other **GPS Operations** menu options;
  - **Navigation**–used to navigate from one location to another while collecting data.
  - **Waypoints**–used to view or create waypoints while collecting data.
  - **2D Altitude**–used to enter in altitude when operation in Manual 2D or Auto 2D/3D.
  - **Disconnect**–used to terminate communication with the GPS receiver.

5. Press Clear to return to the **Main** menu.

E-2 Creating a New Data File

1. Select **Data Capture** from the **Main** menu.
2. To create a new file, select **Create rover file**.
3. Use the automatic filename or type a DOS filename in the space provided.
4. Select a data dictionary:
   - Generic (default) includes: point, like, and area generic features.

- Custom data dictionary: Created in the Pathfinder Office and transferred to the data collector.

5. Check available space in the data collector.
6. F1 softkey changes the time format from UTC to local for display purposes.
7. Press OK to validate the screen.

E-3 Other Data Capture Options

- **Reopen rover file**–Used to open existing rover files.
- **File statistics**–Lists information about the features, file size, free space, start/end times, etc.
- **Delete files**–Used to delete files.
- **Data Dictionaries**–Displays a list of data dictionaries stored in the data collector.

E-4 Recording Data

1. Open a data file with the generic data dictionary.
2. Select **Point Generic**.

Notice the rate at which GPS positions are collected. The data collector beeps every time a position is collected, and the status screen provides a numeric counter.

- Sofkeys:
- F1, **PAUSE\ RESUME**–Temporarily pauses data collection. When you press this key, the label changes to resume.
- F2, **EXT**–Activates the external sensor.
- F3, **OFFSET**–Activates a user defined current feature offset.
- ENTER–Used to enter info on a given line.
- OK–Used to validate info for an entire menu form.

3. Type a feature name for comment, press Enter. Once you have collected enough GPS positions, press OK to end the feature.
4. Select **Line Generic**.

- Softkeys:
- F1, **PAUSE\ RESUME**–Temporarily pauses data collection. When you press this key, the label changes to resume.
- F2, **NEST**–You can **only** nest a point on a line or area. No other combination is acceptable.
- F3, **SEG**–Ends the current line feature and immediately starts a new one (connects the endpoints). Change the attribute values for the new line.

- F4, **QUICK**–Quickmark activation. A list of point features to quickmark appears.
- -->, F5–Lets you access more options.
- F1, **EXT**–Activates the external sensor.
- F2, **OFFSET**–Activates a user defined current feature offset.

5. Select **Area Generic**.
   - Softkeys:
   - F1, **PAUSE\ RESUME**–Temporarily pauses data collection. When you press this key, the label changes to resume.
   - F2, **NEST**–Nesting features allows you to enter a point feature while you are collecting data for a line or area feature.
   - F3, **QUICK**–Quickmark activation. A list of point features appears.
   - F4, **EXT**–Activates the external sensor.
   - F5, **OFFSET**–Activaties a user defined current feature offset.
6. Exit **Data Capture**, press Clear and conform exit.

At any time during data capture, you can enter and exit the following Asset Surveyor menus:

- **Configuration**: To change settings.
- **GPS Operations**: To check SV status or navigate.

Warning—If you alter critical settings during data capture, you affect the quality of the GPS resulting positions.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.15: ERD Management Self-assessments, Observations, Verifications, and Inspections —Revision: 2

ENVIRONMENTAL RESTORATION DEPARTMENT
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ERD

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The LLNL Contractor Assurance Office (CAO) oversees the assessment program and coordinates all formal assessment activities at LLNL. The purpose of this procedure is to provide an overview of the LLNL Assessment Program and define the Environmental Restoration Department's role in support of that program. Self assessments are performed to improve quality and ensure compliance with all procedural, QA, and ES&H requirements and provide an opportunity for worker feedback.

2.0 APPLICABILITY

This procedure is applicable to all ERD quality-affecting activities. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System

(ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Institutional Assessment Plan, DES-0049.

3.2 Internal Independent Assessments, PRO-0050.

3.3 Issues Tracking System User Manual, current version.

3.4 LLNL Assessment Program, DES-0048.

3.5 Management Observations, Verifications and Inspections, DES-0053.

3.6 Management Self Assessments, DES-0052.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Department Head (DH) or Deputy Department Head (DDH)

The DH or DDH is responsible for ensuring that required assessments and assessment-like activities are conducted at the required frequency and that sufficient resources are allocated to correct issues identified during assessments of ERD work activities. In addition, the DH or DDH may perform assessments and assessment-like activities, write an assessment summary, and determine follow-up for those activities within the Department.

5.2 Program Leader (PL)/Authorizing Individual (AI)

The PL/AI may perform management self assessments, management observations, verifications and/or inspections; write an assessment summary, and determine follow-up for those activities within their group's purview. The PL/AI is responsible for allocating sufficient resources to correct issues identified during ERD assessments and assessment-like activities.

5.3 Quality Assurance Implementation Coordinator (QAIC)

The ERD QAIC is responsible for identifying work activities as possible management self assessments, coordinating and/or performing assessments, developing assessment checklists, writing assessment reports, tracking assessments in the Institutional Tracking System, processing management observations, verifications, and inspections and maintaining the ERD Assessment Data Spreadsheet.

5.4 ERD Facility Point of Contact (FPOC) or Responsible Individual (RI)

The FPOC/RI or designee is responsible for accompanying the self-assessment team and helping to resolve any issues or questions.

6.0 PROCEDURES

LLNL Institutional Assessment Plan (IAP)

The LLNL Assessment Program applies to all Laboratory organizations and covers assessments and assessment-like activities performed at LLNL. An annual Institutional Assessment Plan (IAP) is developed by the CAO, consisting of formal assessments that include: external assessments, internal independent assessments, internal assessments, and line and management self-assessments (MSA).

Prior to June 30th, the Departments inform their Principal Activity Directorate (PAD) of any known planned assessments and nominates specific work activities as potential MSAs. The assessment information is utilized by the CAO to prepare the annual IAP. Work activities included in the IAP become officially planned formal self assessments when scheduled using the Institutional Tracking System (ITS) database.

ERD participates in and/or performs formal assessments scheduled in the IAP, such as line and MSAs. In addition, ERD performs informal assessments of department work activities through management observations, verifications, and inspections (MOVI).

The IAP is comprised of various types of assessments as described below.

6.1 External Assessments

External assessments are performed by formal audit and oversight agencies or organizations outside of the LLNS LLC, including the Department of Energy (DOE), the National Nuclear Security Administration (NNSA), and the Livermore Site Office (LSO). These external audits and assessments are included in the IAP to the extent that they are known. In addition, Parent Organization Functional Management Reviews (POFMR) are considered external assessments and are included in the Laboratory's annual IAP.

6.2 Internal Independent Assessments

These formal assessments are authorized by the Director or Deputy Director and are conducted independently of line organizations, functional areas, programs, facilities, projects or operational activities being assessed. These assessments are referred to in DOE O 226.1A (series) as "Internal Independent Assessments," and are designed to fulfill the requirement established in DOE O 414.1C series as "Independent Assessments" and 10 CFR 830 Subpart A, Criterion 10 as "Assessment/Independent Assessments."

6.3 Internal Audits

DOE requires management and operating contractors to maintain an internal audit activity that is responsible for 1) performing operational and financial audits, and 2) assessing the adequacy of management control systems. Internal audits are performed by the Independent Audit & Oversight Department at LLNL and are included in the IAP for coordination and scheduling purposes only.

6.4 Management Self-assessments

An MSA is a tool used to evaluate organizational performance, compliance and effectiveness compared to established expectations, such as goals, requirements, procedures, instructions, or other applicable QA or safety-related documents. Line managers conduct these vertical assessments to assess performance of work by their personnel in their work areas. MSAs are included in the Laboratory's annual IAP and are scheduled using the institutional ITS.

6.4.1 With PAD approval, nominated work activities submitted by the Department become part of the annual IAP. The ERD QAIC acts as a liaison for the ERD Program Leaders and the PAD to establish a time frame in which to complete the MSA. The assessment information is entered into the ITS at the PAD-level and is scheduled as a formal self assessment. The ERD QAIC tracks the assessment to ensure it is completed within the assigned time frame or rescheduled when necessary.

6.4.2 The ERD QAIC develops a line of inquiry for use during the assessment that should include questions regarding applicable procedures, QA, safety, and management policy.

6.4.3 An assessment team including a Management representative, QAIC, and technical expert, if necessary performs the MSA. After the assessment, the QAIC writes the report and assigns the assessment a unique number using the year and sequential number of the assessment (i.e., ERD-XX-YYY). The QAIC sends the report to the other assessors and the assessed individual(s) for an accuracy review and input. Any necessary follow-up is determined and performed. A Quality Improvement Form (QIF) may be used to record, correct, and bring to closure any issues noted during the assessment.

6.4.4 A copy of the final report is sent to the DH, the DDH, the F&I Assurance Manager, and other appropriate individuals. The original report is stored in the QAIC files.

6.4.5 The MSA is recorded in the ITS and the ERD Assessment Data Spreadsheet maintained by the ERD QAIC. The ERD QAIC tracks issues identified during the assessment through to closure in the ITS database.

6.5 Management Observations, Verifications, and Inspections

Management Observations, Verifications, and Inspections (MOVI) are not formal assessments and are not part of the annually developed IAP. MOVI are not intended to take the place of MSAs. MOVI are the most frequently used, but least formal method for managers to evaluate and document compliance, overall work performance effectiveness, and improvement opportunities in the workplace.

Management Observations are meant to give the DH, DDH, or PL an opportunity to maintain familiarity with operations, personnel, the work culture, and to demonstrate their commitment to safety. Workers are observed performing work processes in their everyday work environments. Some elements to be evaluated during a management observation should include: walking the work area, observing work processes and personnel interactions, identifying possible error precursors and obstacles to work performance and situations likely to cause errors.

6.5.1 Management Observations will be randomly scheduled. The management observation will be scheduled for approximately 1 hour at the Livermore site and up to half a day at Site 300.

6.5.2 The DH, DDH, or PL determines what activity or facility will be observed. The PL's management observations are generally limited to program level activities, whereas the DH/DDH's management observations may be any Department activity or facility. A single scheduled management observation visit will generally encompass one ERD facility or field activity, or a group of co-located facilities or field activities.

6.5.3 The DH, DDH, or PL notifies the appropriate personnel of a Management Observation.

6.5.4 A Management Observation Form is utilized to record notable observations, best management practices, and areas needing improvement detected during the observation. The form is included as Attachment A and is available through the QAIC. The completed form is submitted to the QAIC for processing and then forwarded to the Directorate Site Safety Officer. The ERD QAIC records the management observation into the ERD Assessment Data spreadsheet and maintains the completed Management Observation Form in the QAIC files.

6.5.5 Any necessary follow-up is determined and performed.

MOVI also includes inspections and verifications that are performed and documented by ERD personnel. Inspections are defined as a physical examination or measurement used to verify whether an item, such as equipment or an installation, or activity meets specifications or requirements; whereas, verification, such as a walk-down is performed to validate that a plan, IWS, procedure or direction, correctly, clearly, and completely describes the work being performed.

Worker feedback is always encouraged during MOVI or any other type of assessment (formal or informal) activity and Lessons Learned may be obtained from these evaluations.

7.0 QUALITY ASSURANCE RECORDS

7.1 Self-assessment/Management Observation Forms

7.2 Self-assessment Reports

7.3 ITS Entries

8.0 ATTACHMENTS

Attachment A—Example Management Observation Form

Attachment A

Management Observation Form

Observer: *(Last, First)*	Org/Group:	Location: # Workers observed:	Date:
Activity: Management Walk About			
Work scope observed:			

In-field supervisory practices(without clipboard or form in hand); Only complete the areas that were applicable to your walk-about observation:

Work environment

- Did you notice any environmental issues or concerns at the work site? (equipment labeling, housekeeping, physical barriers, barricades, and warning signs missing, extreme environmental conditions or temperatures, etc.).

Worker evaluation

- Did you notice if the worker(s) performing the task are fit for duty? (properly trained, right frame of mind, exhibiting illness or fatigue)

Task evaluation (critical steps)

- What is the worst thing that could have happened if the work was performed incorrectly? (what part of the tasks could have had severe consequences or damage to the worker, equipment, or environment).

Worker feedback

- Do the workers have any concerns with the work tasks, work control process or paperwork, or the job site environment?

- What can we do differently to improve?

Management recognition

- Did you observe any noteworthy practices? (Team work, problem solving skills, Safety Pause – questioning attitude)

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.16: ERD Lockout/Tagout Program
Revision: 2

ENVIRONMENTAL RESTORATION DEPARTMENT
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ERD

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to satisfy the requirements of the LLNL Lockout/Tagout (LOTO) Program defined in the LLNL ES&H manual, Volume II, Document 12.6, and the Occupational Safety and Health Administration (OSHA) Control of Hazardous Energy Source, Standard 29CFR1910.147. The Program establishes minimum requirements for LOTO and testing of energy-isolating devices whenever service or maintenance is performed on equipment. Where "unexpected" energization (or startup) of the equipment or the release of stored energy could occur and possibly result in injury, these requirements shall be applied to ensure that the equipment is stopped, isolated from all potentially hazardous energy sources, and locked out and tagged before workers begin service or maintenance. The LOTO Program is implemented through LOTO procedures for shutting off and securing such equipment. LOTO procedures shall be strictly followed when it is necessary to work on any equipment that may release any form of hazardous energy, including, but not limited to, electrical, rotational, mechanical, radiation, chemical, hydraulic, or pneumatic energy sources. Construction activities also fall under the scope of this document, specifically construction equipment that poses an energy release hazard to the person who is working on it.

Electrical distribution switching activities that fall under the scope of the *High Voltage Distribution System Operation Manual* available from the Maintenance & Utilities Services Department (MUSD), and are controlled by a switching procedure are not covered by these requirements, although the switching procedure may incorporate LOTO requirements as appropriate.

The term "LOTO-authorized worker", as used in this document, refers to an LLNL worker or supplemental labor worker who is authorized to perform LOTO.

The term "work supervisor", as used in this document, refers to the person designated by management to be the day-to-day supervisor of a LOTO-authorized worker. A work supervisor may be the payroll supervisor of a LOTO-authorized worker assigned a specific, short-term duty in an area. LOTO-authorized workers assigned duties in more than one area may have more than one work supervisor. The work supervisor(s) shall ensure that the LOTO-authorized worker is trained and qualified to perform assigned tasks. Note that the term “equipment”, as used in this supplement, refers to machines, facility and research and development (R&D) equipment, and equipment components. Other terms used in this SOP can be found in the SOP Glossary.

2.0 APPLICABILITY

2.1 The LOTO Program applies to all LLNL personnel.

This procedure applies to personnel performing lockout/tagout of equipment associated with all Site 200 and Site 300 ERD treatment facility operations.

For the ERD Site 200 and Site 300 treatment facility operations, lockout/tagout of Electrical Distribution equipment over 245VAC is performed by MUSD in accordance with the LOTO program.

The LOTO Program also applies to subcontractor personnel who do not have an equivalent lockout/tagout program that satisfies the requirements of the Occupational Safety and Health Administration (OSHA).

ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

In addition, the program applies to servicing and maintenance activities (including lockout and tag) that are part of a facility or program's normal operations. These include:

- Lockout/Tagout of the equipment.
- The removal or bypass of a guard or other safety device.
- Other activities that require a person to place his/her body into an area of the equipment where work is being performed on material (point of operation) or where an associated danger zone exists during a machine-operating cycle.
- A wide variety of energy sources that may need to be locked out and tagged during servicing or maintenance of the equipment is covered under this Program. These include, but are not limited to:
- Electrical
- Hydraulic
- Pneumatic
- Mechanical
- Gravity
- Thermal
- Chemical
- Fluids and Gases
- Water under pressure
- Steam

2.2 The LOTO Program Does Not Apply to:

- Minor tool changes, adjustments, and other minor servicing activities that take place during normal operations provided that such activities are routine, repetitive, and integral to the use of the equipment and the work is performed using alternative measures that provide effective personnel protection.
- Work performed on cord and plug-connected electric equipment, if exposure to the hazards of unexpected energization or start up of the equipment is controlled by unplugging the equipment from the energy source, or if the plug is under the exclusive control of the worker performing the servicing or maintenance activity. Pneumatic tools may also fall into this category, provided that they can be completely isolated from their energy source.

3.0 REFERENCES

3.1 *Code of Federal Regulations*, Title 29, Part 1910.147, "The Control of Hazardous Energy (Lockout/Tagout);" and Part 1910, Subpart S, "Electrical."

3.2 Environment, Safety, & Health Manual, Part 12, Document 12.6, "LLNL Lockout/Tagout Program."

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Equipment Supervisors

Equipment supervisors are usually grouped into one of following three categories:

1. Equipment supervisors who are responsible for programmatic equipment (i.e., equipment owned, operated, and maintained by the program).

2. Equipment supervisors who are responsible for programmatic equipment that is maintained by Maintenance & Utilities Services Department (MUSD).
3. Equipment supervisors who are responsible for installed real property equipment that is maintained by MUSD.

5.5.1 Equipment Supervisors for Programmatic (ERD) Equipment

The equipment supervisors are listed on Attachment C of this procedure.

These equipment supervisors are responsible for:

- Notifying all affected workers that service or maintenance must be performed on the equipment and that it must be shut down, locked out, and tagged.

  Note: Existing e-mail notification lists, distribution lists, roster lists will satisfy this requirement.
- Ensuring that procedures outline the techniques to be used to lockout and tag sources of hazardous energy for equipment in their area of responsibility.
- Exchanging information about their respective lockout/tagout procedures with outside subcontractor supervisors.
- Ensuring that their personnel understand and comply with outside subcontractors' lockout/tagout procedures.
- Verifying that appropriate training has been conducted for those affected workers in the facility. (This training is the responsibility of payroll supervision.)
- Providing personal protective equipment (PPE) (including locks and tags) to authorized workers if not available from the functional supervisor.
- Providing any special chains, wedges, blank flanges, key blocks, adapter pins, self-locking fasteners, or other hardware required for isolating, securing, or blocking energy sources.

5.5.2 Equipment Supervisors for Programmatic (ERD) Equipment Maintained by MUSD

Both the programmatic equipment supervisor and MUSD equipment/functional supervisor are assigned responsibilities for these types of equipment.

Programmatic (ERD) equipment supervisors are responsible for:

- Notifying all affected workers that service or maintenance must be performed on the equipment and that it must be shut down, locked out, and tagged.

  Note: Existing e-mail notification lists, distribution lists, roster lists will satisfy this requirement.
- Ensuring that procedures outline the techniques to be used to lock out and tag sources of hazardous energy for equipment in their area of responsibility.

- Ensuring that appropriate training has been conducted for those affected workers in the facility. (This training is the responsibility of payroll supervision).
- Providing any special chains, wedges, blank flanges, key blocks, adapter pins, self-locking fasteners, or other hardware required for isolating, securing, or blocking energy sources.

MUSD equipment/functional supervisors are responsible for:

- Writing procedures (when required) that outline the techniques to be used to lock out and tag sources of hazardous energy for equipment in their area of responsibility.
- Notifying the equipment supervisor in the program that service or maintenance must be performed on the equipment and that it must be shut down, locked out and tagged.
- Exchanging information about their respective LOTO procedures with outside subcontractor supervisors hired by MUSD.
- Ensuring that their personnel understand and comply with outside subcontractors' lockout/tagout procedures.
- Providing PPE to MUSD LOTO-authorized workers. This would include locks and tags, standard lockout adapters, and other fixtures.

5.5.3 Equipment Supervisors (ERD) for Installed Real Property Equipment Maintained by MUSD

Both the equipment supervisors within the facility and MUSD work supervisors are assigned responsibilities for these types of equipment.

Equipment supervisors within the facility are responsible for:

- Notifying all affected workers that service or maintenance must be performed on the equipment and that it must be shut down, locked out, and tagged.

  Note: Existing e-mail notification lists, distribution lists, roster lists will satisfy this requirement.
- Ensuring that equipment assigned to them has a MUSD identification number and that the power sources are labeled.

MUSD work supervisors are responsible for:

- Writing procedures (when required) that outline the techniques to be used to lock out and tag sources of hazardous energy for equipment in their area of responsibility.
- Notifying the equipment supervisor in the facility that service or maintenance must be performed on the equipment and that it must be shut down, locked out, and tagged.

- Exchanging information about their respective LOTO procedures with outside subcontractor supervisors hired by MUSD.
- Ensuring that their personnel understand and comply with outside subcontractors' lockout/tagout procedures.
- Providing PPE to MUSD LOTO-authorized workers. This would include locks and tags, standard lockout adapters, and other fixtures.
- Providing any special chains, wedges, blank flanges, key blocks, adapter pins, self-locking fasteners, or other hardware required for isolating, securing, or blocking energy sources.

5.6 Work Supervisors

Work Supervisors/Responsible Individuals are indicated on the applicable IWS(s). The IWSs that cover electronic work performed for the ERD are listed in Section 6.2 "Safety Considerations" of this procedure.

Work supervisors are responsible for:

- Ensuring that personnel understand the purpose of the LOTO Program and that they have the knowledge and skills required for the safe application, usage, and removal of energy controls.
- Ensuring and certifying that periodic inspections of the lockout/tagout procedures used by authorized workers are conducted.
- Providing PPE, including locks and tags, to authorized workers.

The Lockout/Tagout board currently in ERD Field Operations building is to be under the control of the work supervisor. This is necessary to prevent unauthorized use of the locks.

- Removing lockout/tagout devices in accordance with the procedure ERD LTP-99 (Attachment A) when the LOTO-authorized worker who applied them is not available.
- Ensuring that authorized workers complete the required logs and records.

Use ERD LTP Lockout/Tagout Usage Log (Attachment B). The log is to be retained by the work supervisor for two years.

- Ensuring that personnel understand the purpose of the LOTO Program and that they have the knowledge and skills required for the safe application, usage, and removal of energy controls.
- Maintaining a current Equipment List (Attachment C) to track all equipment used in ERD that will require Lockout/Tagout procedures to service and maintain, and a current LOTO Authorized Worker List (Attachment D).

5.7 Payroll Supervisors

Payroll supervisors are responsible for ensuring that all required training is provided to authorized workers.

5.8 Workers

5.8.1 Affected Workers

Affected workers are responsible for:

- Obtaining the training specified in Section 6.1.2 of this SOP.
- Complying with all requirements of the LOTO Program. In particular, affected workers shall not attempt to operate or energize equipment or systems that are locked out and tagged.

5.8.2 LOTO-Authorized Workers

Authorized workers are responsible for:

- Performing lockout and tag procedures in accordance with the LOTO Program.
- Coordinating their activities with other authorized workers for group lockouts and for transferring lockout devices and tags when personnel and shift changes.
- Referring to the equipment supervisor's procedure to identify the type and magnitude of the energy that the machine or equipment utilizes, understanding the hazards of the energy, and knowing the methods to control the energy.
- Participating in periodic inspections of lockout/tagout procedures in use when designated by the work supervisor.
- Obtaining the training and retraining specified in Section 6.1.1 of this SOP.

5.9 Environmental, Safety, and Health (ES&H) Directorate

ES&H is responsible for providing Course HS5245-W, "Lock and Tag" and HS5245-RW, "Lock and Tag" Refresher.

6.0 PROCEDURES

6.1 Worker Training

6.1.1 LOTO-Authorized Workers

Each authorized worker shall receive training in the recognition of applicable hazardous energy sources, the types and magnitude of the energy available in the workplace, and the methods and means necessary for energy isolation and control. This training shall include a combination of web-based education (Course HS5245-W) offered by Hazards Control and on-the-job training for specific equipment. Retraining (Course HS5245-RW) is required every five years.

In addition, the functional supervisor shall ensure authorized workers understand the purpose of the LLNL LOTO Program and that they have the knowledge and skills required for the safe application, use, and removal of energy controls.

6.1.2 Affected Workers

All new workers are introduced to the LLNL LOTO Program as part of the "New Staff Safety Orientation" (Course HS0001). The equipment supervisor is responsible for ensuring that each affected worker working in the area is instructed in the purpose and use of lockout/tagout procedures, including test procedures. Although this training is the responsibility of payroll supervision, equipment supervisors shall ensure the training is completed prior to authorizing lockout/tagout procedures for their equipment.

6.1.3 Others

All other workers whose work operations are or may be in an area where energy-control procedures may be used shall be informed of the LLNL LOTO Program, and that they shall not attempt to operate equipment that is locked out and tagged.

6.1.4 Retraining

Authorized workers shall complete retraining (Course HS5245-RW) at least every five years. Whenever there is a change in job assignments, when a change in the equipment or processes presents a new hazard, or when there is a change in the energy-control procedures, additional on-the-job training may be required. Additional retraining shall be conducted whenever a periodic inspection reveals, or the supervisor has reason to believe, that authorized workers are not using the lockout/tagout procedures properly or that they lack the appropriate skills.

Retraining shall re-establish personnel proficiency and introduce new or revised control methods and procedures, as necessary.

6.1.5 On-the-job Training (OJT)

An OJT program shall be implemented to train current and new workers as to the function and hazards of ERD treatment facilities. It shall include equipment, locations, and special procedures used to service and maintain the facilities. The OJT provided to ERD personnel shall include LOTO procedures, when applicable.

Prior to commencement of field activities, perform preparation activities per SOP 4.1 "General Instructions for Field Personnel". Direct field supervision and OJT will be provided using the ERD's Treatment Facility Operations Lesson Plan (Course number EP7033-016). Successful completion of the OJT(s) will be required prior to performing treatment facility work independently.

6.1.6 Training Records

Training records shall be maintained in accordance with the individual directorate's administrative procedures. Some training records may be entered into an LLNL training record repository. Hazards Control courses are entered into the Livermore Training Records and Information Network (LTRAIN). Other training records are maintained locally (i.e., in the worker's department).

6.2 Safety Considerations

6.2.1 Procedures described in the following sections will be performed in accordance with IWS 11579 "ERD Routine Electronic Operations at Site 200" and IWS 14984 "ERD Routine Electronic Operations at Site 300". In addition, work performed at the ground water and soil vapor treatment units will be performed under IWS 11341 "ERD Ground Water and Soil Vapor Treatment Facility Operations at Site 300" and IWS 11534 " ERD Treatment Facility Operations, Treatability Testing, and Related Activities at Livermore".

6.3 Locks, Tags, and Logs

6.3.1 Controlling Lockout Locks and Tags

- The work supervisor will normally provide authorized workers the appropriate PPE, including locks and tags. However, if not provided by the work supervisor, the equipment supervisor will provide the appropriate PPE, including locks and tags.
- The MUSD functional supervisor shall provide any locks and tags to authorized MUSD electricians; heating, ventilation, and air conditioning (HVAC) mechanics; and plumbers. The MUSD Engineering shall keep their own records of locked out and tagged equipment.
- The equipment supervisor normally shall provide any special chains, wedges, key blocks, adapter pins, self-locking fasteners, or other hardware required for isolating, securing, or blocking the equipment from energy sources.

The Occupational Safety and Health Administration (OSHA) require lockout devices and associated tags to be singularly identified, durable, standardized, and substantial. To meet this requirement, only the following locks and tags shall be used at LLNL:

1. Standard Master Keyed Locks

   Per the ES&H Manual, Document 12.6, Section 3.9, the work supervisor shall provide LOTO-authorized workers with the appropriate locks or locks can be obtained from the appropriate ES&H Team. The lock shall be individually keyed, or the LOTO-authorized worker may have a set of locks that are keyed alike (e.g., for group LOTOs). Combination locks are not authorized. No other person shall have the same key unless the LOTO-authorized worker decides to give a second key to the work supervisor for use only as described in Attachment A, ERD LTP-99, Special Lock Removal Procedure. Under no circumstances shall there be more than two keys for a lock. Lock mechanisms built into equipment are acceptable, provided that (1) such mechanisms isolate energy to the unit and that (2) only the LOTO-authorized worker controls the keys.

LLNL LOTO tags shall be used for all LOTO lockouts and shall have the name of the LOTO-authorized worker who applied them. That LOTO-authorized worker shall write all other applicable information on the tag.

6.3.2 Maintaining Lockout/Tagout Logs

Lockout/tagout logs shall include the name of the authorized worker, the name of the equipment, location, the date the lock(s) and tag(s) were installed, and the date when they were removed.

The work supervisor is responsible for ensuring that authorized workers complete the required logs and records.

6.3.3 Periodic Inspections

Work supervisors shall periodically (at least annually) inspect the lockout/tagout procedures conducted by authorized workers to ensure that these procedures and the requirements of the LLNL LOTO Program are being followed. Use the form Self-Assessment Checklist (Attachment E) to conduct this inspection. Periodic inspections shall include a review of the responsibilities (as defined in the LOTO procedures being inspected) of the Authorized Workers (Attachment D) assigned to work on the equipment.

Work supervisors shall perform periodic inspections or they may designate an authorized worker (other than the worker being inspected) to perform the inspections. If another authorized worker performs the inspection, the work supervisor shall accompany him/her and observe the procedures.

The work supervisor shall certify that the inspection was performed by identifying on the Lockout/Tagout Inspection Form (Attachment F) the equipment for which the LOTO procedure was being utilized, the date of the inspection, the names of the workers included in the inspection, and that of the person who performed the inspection. Any deviations or inadequacies identified during the inspection shall be corrected before further lockouts are performed.

6.4 Other Requirements

6.4.1 Single-point Lockout

For single-point lockout/tagout equipment, a durable sign is to be placed on or next to the equipment indicating the location (e.g., electrical panel and breaker number) of the single energy-isolating device (Attachment G).

6.4.2. 480 VAC Systems and Variable Frequency Drive (VFD) and Special Lockout

For 480 VAC Systems and VFD lockout, and special procedure lockout, a durable sign is to be placed on or next to the equipment indicating the procedure number to be used to perform the lockout/tagout correctly. Attachment H is an example of a 480 VAC Systems and VFD Lockout Procedure.

6.4.3 Special Lock Removal Procedure

To comply with the exception to paragraph (e)(3) for CFR1910.147, a special procedure is required when the removal of a lock by other than the authorized worker who applied the lockout/tagout device is not available to remove it. Specific actions and responsibilities are required to cut or remove the lock. See Attachment A for Special Lock Removal Procedure.

6.4.4 Energy-Isolating Device Limitations

If the energy-isolating devices cannot be locked out,

1. Have a qualified person install a suitable lockout attachment on the energy-isolating device, then proceed with the lockout/tagout process, or

   - If approved by the equipment supervisor and facility management, locate a lockable energy-isolating device (e.g., a panel board or switch board feeding the unlockable device) that will effectively isolate the device. Properly isolate, lock, and tag the device, or

2. Have a qualified person open (or close) the energy-isolating device (i.e. circuit breaker or valve), disconnect the wiring or piping (or insert a blank flange) from the device, and tag the wiring or piping (or blank flange) and the energy-isolating device, then proceed with the lockout/tagout process.

   NOTE: Any tag used with disconnected wiring, as described above, or any tag used with a blank flange or physically disconnected piping shall indicate the point of disconnect or the location of the blank flange, or

   - Open (or close) and tag the energy-isolating device. Assign a person as a safety watch to ensure that the energy remains isolated for the duration of service or maintenance, then proceed with the lockout/tagout process. A person assigned as a safety watch shall have no other duties, nor shall he/she leave his/her station for any reason, except when formally relieved from duty or for personal safety. A lockable energy-isolating device shall be installed on equipment before personnel begin any service or maintenance task that might result in the unexpected release of hazardous energy. Non-lockable energy-isolating devices shall be designed or modified to accept a lockout device whenever equipment is replaced, new equipment is installed, or a major modification is performed. In addition, personnel must use PPE when performing these activities.

6.4.5 Deactivation and Mothballing

During deactivation or mothballing of a facility or building, it may be necessary to secure, lock, and tag electrical, compressed air, water, or other utility or programmatic services; however, no maintenance is to be performed. Locks and tags may be installed by the facility manager, building coordinator, or by an authorized worker designated by facility management. Either a "Danger" lock and tag or a "Caution" administrative lock and tag may be used, as appropriate. In this case, a lockout/tagout log is required, the keys and log shall be held by the Facility Manager.

6.4.6 Procedures List Refer to Attachment I for a list of ERD Lockout/Tagout procedures.

6.5 Administrative Lock and Tag

An Administrative lock and tag may be used to secure equipment and to prevent entry and/or operation of equipment, but is used to protect equipment only and not to protect personnel. If the operation of equipment being secured could present a hazard to personnel, then LOTO procedures shall be followed.

Administrative lock and tag is not intended to be utilized in the place of LOTO, but may be applied for programmatic purposes or when equipment security is necessary or for general safety. There is no prescribed lock and tag that must be used for administrative lock, except that LOTO locks and the LOTO "Danger" tag cannot be used. The selection of an appropriate Administrative lock can be determined based on the type of equipment being secured. A padlock may suffice. Administrative tags shall have the following information: effective date, equipment identification, secured condition desired, reason for lock and tag, and names of applying and approving individuals. Administrative tags must be able to withstand the elements and remain legible until removed, and must be fastened to the equipment to prevent unauthorized removal.

Individuals installing, completing or removing Administrative locks and tags shall be LOTO authorized individuals and shall follow the procedures prescribed in this document. An exception to the LOTO lock process is that a Group may control the Administrative lock, whereas a LOTO lock must be under the control of an individual.

6.5 Caution Tags

A Caution tag may be used without a lock on functional equipment to identify any special instruction or operational precaution prior to operation where there is no hazard to personnel. The Caution tag cannot take the place of LOTO, alternate work procedures, or corrective maintenance and cannot be attached to a LOTO lock. The decision to install a Caution tag or Administrative lock is determined by the severity of consequences if the equipment were operated.

As with the Administrative tag, the Caution tag must be fastened to equipment to prevent inadvertent or accidental removal. The tag must provide the following information: effective date, equipment identification, reason for the precaution, and names of those authorizing the installation of the tag, and must remain legible until removed.

Individuals installing, completing or removing Caution tags shall be LOTO authorized individuals and shall follow the procedures specified in this document. An exception to the LOTO lock process is a Group may control the administrative lock, whereas a LOTO lock must be under the control of an individual.

7.0 QA RECORDS

7.1 Completed Self-Assessment Checklists

7.2 Completed Lockout/Tagout Inspection Form

7.3 Completed Lockout/Tagout Usage Log

7.4 Completed Lockout/Tagout Program Procedure Forms

8.0 ATTACHMENTS

Attachment A—ERD LTP-99: Special Lock Removal Procedure

Attachment B—Lockout/Tagout Usage Log

Attachment C—Equipment List

Attachment D—Authorized Worker List

Attachment E—Self-Assessment Checklist

Attachment F—Lockout/Tagout Inspection Form

Attachment G—ERD LTP-01: General Single-Point Lockout Procedure

Attachment H—ERD LTP-03: 480 VAC systems and Variable Frequency Drive (VFD) Lockout Procedure

Attachment I—ERD Lockout/Tagout Procedures List

Attachment A

ERD LTP-99: Special Lock Removal Procedure

ERD Lockout/Tagout (LOTO) Program

Special Lock Removal Procedure

ERD LTP 99 rev. 07/14/10

This procedure is to be used when the person who installed a lock is unavailable to remove the lock. There could be a variety of reasons why the authorized person who installed the lock is not on site to remove it: These include illness, travel, vacations, unplanned leave, and after hours emergencies.

This procedure permits the Work Supervisor to authorize the removal of the lock by key or by cutting after he/she has obtained ERD Department Leader approval. The Work Supervisor must be familiar with the normal operation of the equipment and understands the consequence of restoration to normal operation. Specifically, pump, compressor, blower, power supply start-up can result in tank overflows and similar events that can occur when the equipment is restored to service.

Also, the restoration of complicated electrical systems is considered work on energized equipment and is therefore classified as a Class 3 hazard until the system is secured. As a minimum, both a LOTO-authorized worker and a co-worker shall work together when this type of work is being performed.

Details of why this procedure is being executed:

RESTORING EQUIPMENT TO SERVICE

- □ Verify that the authorized employee who installed the lock is unavailable to restore the equipment.
- □ Contact the ERD Department Leader and obtain permission to remove the lock.
- □ Notify the Equipment Supervisor and all affected employees that the equipment is to be activated.
- □ Verify the work is complete and the system is safe to re-energize.
- □ Verify the equipment and personnel are clear, remove all locks. The energy-isolating devices may now be operated to restore the energy to the equipment.
- □ Return the locks and keys to the key control rack.
- □ Sign the *Removed Date* portion of the Lockout/Tag log book.
- □ Notify the authorized employee who installed the lock that the lock has been removed and the equipment is back in service.
- □ File this form with other completed ERD LTP forms.

Restoration Executed by: ______________________________________ Date: _____________

Work Supervisor: ____

Attachment B

Example Lockout/Tagout Usage Log

ERD Lockout/Tagout Program
Lockout/Tagout Usage

Lock Number	Location Facility/Equpment	LOTO-Authorized Worker	Procedure	Installed	Removed
				Date	Date

Attachment C

Example Equipment List

ERD Lockout/Tagout Program Equipment List

Revised July 14, 2010

Facility Area	Unit	Equipment Supervisor	Equipment Type	Lockout/Tagout Procedure
TFE-East	PTU-3	Kawaguchi, S.	Furnas Motor Control Center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFE-NW	PTU-9	Anderson, P.	Furnas motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFE-HS	GTU07	Anderson, P.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFG-N	MTU-02	Anderson, P.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFG-1	GTU-01	Anderson, P.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TF406-NW	GTU-03	Anderson, P.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFA	TFA	Kawaguchi, S.	Air stripper blower motor starter	ERD LTP 01, LTP 02
			FCS enclosures	ERD LTP 01
			North pipeline motor starters	ERD LTP 01
			Variable speed drives	ERD LTP 03
			Well 415	ERD LTP 01
			West well motor starters	ERD LTP 07
TFB	TFB	Kawaguchi, S.	Air stripper motor starters	ERD LTP 01, LTP 02
			Control systems	ERD LTP 01
			Pipeline motor starters	ERD LTP 01
			Variable speed drives	ERD LTP 03
VTFD-HS	VES13	Kawaguchi, S.	Control Systems	ERD LTP 01
			Variable speed drives	ERD LTP 03
			Pipeline motor starters	ERD LTP 01
TFD-East	PTU-8	Kawaguchi, S.	Furnas Motor Control Center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFD-South	PTU-2	Anderson, P.	Furnas Motor Control Center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFD-Southshore	PTU-2	Anderson, P.	Furnas Motor Control Center	ERD LTP 01
			Well pump connections	ERD LTP 01

TF5475-1	CRD-1	Anderson, P.	Control system	ERD LTP 01, LTP 09
			Variable speed drives	ERD LTP 03
TF5475-3	CRD-2	Anderson, P.	Control system	ERD LTP 01
			Variable speed drives	ERD LTP 03
VTF5475	VESO1	Kawaguchi, S.	Variable speed drives	ERD LTP 03
TFD-SE	PTU-11	Thomas, S.	Furnas Motor Control Center	ERD LTP 01
			Well pump connections	ERD LTP 01
VTFD ETCS	VES11	Thomas, S.	Variable speed drives	ERD LTP 03
VTFE-ELM	VES-16	Thomas, S.	QED motor control system	ERD LTP 01
VTF518-PZ	VES-19	Thomas, S.	QED motor control system	ERD LTP 01
VTFE-HS	VES12	Thomas, S.	Variable speed drives	ERD LTP 03
TFC	TFC	Kawaguchi, S.	Air stripper blower motor starters	ERD LTP 01, LTP 02
			Control systems	ERD LTP 01
			Pipeline motor starters	ERD LTP 01
			Variable speed drives	ERD LTP 03
			Well 701	ERD LTP 01
TFC-SE	PTU-1	Kawaguchi, S.	Furnas Motor Control Center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFC-E	MTU-1	Van Noy, H.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFD-HPD	PTU-10	Kidd, B.	Furnas Motor Control Center	ERD LTP 01
			Generator Operation	ERD LTP 01
			Well pump connections	ERD LTP 01
VTFD-HPD	VES07	Kidd, B.	Variable speed drives	ERD LTP 03
TF5475-2	GTU09	Van Noy, H.	AC power to battery charger	ERD LTP 01
TFE-SE	MTU-04	Thomas, S.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TFA East	STU-06	Kawaguchi, S.	Low voltage DC system	ERD LTP 01
TFD-West	PTU-06	Anderson, P.	Furnas Motor Control Center	ERD LTP 01
			Well pump connections	ERD LTP 01

TFE-SW	MTU-03	Kidd, B.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TF518-N	STU-09	Kawaguchi, S.	Low voltage DC system	ERD LTP 01
			Well pump connections	ERD LTP 01
TFE-West	MTU-05	Kidd, B.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TF406	PTU-5	Anderson, P.	Furnas motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
TF518-N	STU-09	Kawaguchi, S.	AC power to battery charger	ERD LTP 01
VTF406-HS	VES08	Thomas, S.	QED motor control system	ERD LTP 01
TFE Yard	various	Project	Treatment Unit Testing	ERD LTP 01
			Variable speed drives	ERD LTP 03
B438	various	Project	Treatment Unit Testing	ERD LTP 01
			Variable speed drives	ERD LTP 03
832-SRC	VES03	Trammell, T.	Variable Speed Drives	ERD LTP 03
			Well pump connections	ERD LTP 01
830-SRC	GTU5	Trammell, T.	ERD designed motor control center	ERD LTP 01
	VES15		Well pump connections	ERD LTP 01
834-SRC	TF834	Trammell, T.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
854-SRC	STU-8	Faria, J.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
			Variable speed drives	ERD LTP 03
CGSA	PTU-7	Griffith, L.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
815-DSB	STU-4	Griffith, L.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
815-PRX	GTU-6	Griffith, L.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
815-SRC	GTU-2	Faria, J.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
817-PRX	GTU-8	Trammell, T.	ERD designed motor control center	ERD LTP 01
			Well pump connections	ERD LTP 01
PIT7-SRC	PIT7-SRC	Faria, J.	ERD designed motor control center	ERD LTP 01

Attachment D

Example LOTO Authorized Worker List

Revision Date: 10/3/2005
Print Date: 1/17/12

ERD Lockout/Tag Program Training Status List

	General Instruction			Specific Procedures	
LOTO-authorized worker	**SOP Review**	**HS5245-RW Due**	**OJT Completed**	**LTP 01** 10/26/99 Single Point	**LTP 03** 11/04/99 VFD
Soto, Gregg	11/15/10	5/7/14	9/30/05	11/15/10	11/15/10
Mills, Thomas	11/15/10	1/7/13	4/15/10	11/15/10	11/15/10
Nguyen, Van	9/15/11	6/11/12	9/30/11	9/15/11	9/15/11
Robles, Israel	11/15/10	6/14/15	6/15/10	11/15/10	11/15/10
Taylor, John W.	11/15/10	2/2/14	6/15/10	11/15/10	11/15/10

Attachment E

Example Self-Assessment Checklist

Authorized Employee Knowledge	Yes	No
Has the authorized employee received the required training?		
Can the authorized employee demonstrate knowledge about the Lockout/Tag Program?		
Can the authorized employee demonstrate knowledge about the appropriate lock and tag devices?		
Can the authorized employee demonstrate knowledge about the location of all energy-isolating devices?		
Can the authorized employee demonstrate knowledge about any (or all) secondary or residual energies?		
Can the authorized employee demonstrate knowledge about the energy-isolation verification procedures?		
Can the authorized employee demonstrate knowledge about the necessary procedures if the equipment does not have a lockable energy-isolating device?		
Can the authorized employee demonstrate knowledge about the necessary procedures used for lockouts other than single point?		
Can the authorized employee demonstrate knowledge about the log-keeping requirements?		
Lock and Tag Devices		
Is there an adequate number of locks and tags?		
Are the locks properly labeled?		
Are the LLNL danger tags the correct version?		
Is a lockout and tag log available and current?		
Are copies of the applicable energy control procedures available?		
Equipment		
Does the employee have a proper test equipment? (DVM, VoltAlert)		
Are energy-isolating devices properly labeled?		
Are energy-isolating devices lockable?		
Are energy-isolating devices (other than electrical) available for lockout and tag (e.g., valves)?		

Attachment F

Example Lockout/Tagout Inspection Form

ERD LOTO Program LOTO Inspection Form

This form shall be completed by the work supervisor (or a designated authorized worker) who inspected the authorized worker's use of LOTO procedures. The work supervisor acknowledges performance of the inspection of this form.

Date_________________________

1. List the equipment /machines on which the LOTO procedure is being used.

2. Provide the names of the authorized workers who performed the LOTO procedure for this inspection.

   Identify any discrepancies uncovered by completing the LOTO Procedure Self-Assessment Checklist. List any corrective actions.

Signature of inspector:___________________________ Date:_______________________

Signature of work supervisor:_____________________ Date:_______________________

Attachment G

Example ERD LTP-01: General Single-Point Lockout Procedure

ERD Lockout/Tag Program

General Single-Point Lockout Procedure

ERD LTP 01 rev. 11/12/10

This procedure is to be used to lockout/tagout single-point equipment used in the carious treatment facilities. This procedure requires that eh authorized employee be familiar with the normal operation of the equipment and understands the consequences of shutdown and maintenance. Specifically, drain-back, siphoning, tank overflow and similar events that can occur when equipment is removed from service.

REMOVING EQUIPMENT FROM SERVICE

- ☐ Acquire approved locks from ERD LOTO board. Enter required information in the LOTO Log book.
- ☐ PPE required: safety glasses with side shields or goggles, long sleeve cotton shirt, long pants, voltage rated gloves, test equipment and hardhat.
- ☐ Notify all affected workers that a lockout is required and the reason why.
- ☐ Operate the switches, valves, circuit breakers, or other energy-isolating devices so that the energy source is disconnected or isolated from the equipment.
- ☐ Lockout the energy-isolating devices with the assigned lock.
- ☐ Test approved voltmeter.
- ☐ Check that the equipment is indeed disconnected. Measure line to Line, line to ground and line to neutral or common.
- ☐ Test approved voltmeter.
- ☐ Fill out tags and attach to assigned lock.
- ☐ Retain possession of the key.

The equipment is now locked out.

RESTORING EQUIPMENT TO SERVICE

- ☐ Notify all affected workers that a lockout is ready to be removed.
- ☐ Verify the work is completed and the system is safe to re-energize.
- ☐ Verify the equipment and personnel are clear, remove all locks. The energy-isolating devices may now be operated to restore energy to the equipment.
- ☐ Return locks and keys to the key ERD LOTO board.
- ☐ Sign the *Removed Date* portion of the LOTO Log.

Attachment H

ERD LTP-03: 480 VAC Systems and Variable Frequency Drive (VFD) Lockout Procedure

ERD Lockout/Tag Program

480 VAC Systems and Variable Frequency Drive (VFD) Lockout Procedure ERD LTP 03 rev. 11/12/10

This procedure is to be used to lockout/tagout 480 VAC systems and all VFD used in treatment facilities. This procedure requires that the authorized LOTO worker be familiar with the normal operation of the VFD and understands the consequences of shutdown and maintenance.

LOTO on a class 3 hazard 480 VAC system must be completed by trained electricians with proper PPE or have an ERD 480 VAC Meter Box installed. The 480 VAC Meter Box demonstrates the removal of voltage into the equipment enclosure. The LOTO authorized worker shall wait 10 minutes from power removal to allow the stored energy to bleed off and then it becomes a class 2 hazard. As a minimum, both an authorized LOTO worker and a qualified safety watch shall be present to perform this procedure.

REMOVING EQUIPMENT FROM SERVICE

- ☐ Acquire approved locks from ERD LOTO board. Enter required information in the LOTO Log book.
- ☐ PPE required: safety glasses with side shields or goggles, long sleeve cotton shirt, long pants, voltage rated gloves, test equipment and hardhat.
- ☐ Notify all affected workers that a lockout is required and the reason why.
- ☐ Shutdown the equipment using normal procedures.
- ☐ Operate the switches, valves, circuit breakers, or other energy-isolating devices so that the energy source is disconnected or isolated from the equipment.
- ☐ Lockout the energy-isolating devices with the assigned locks.
- ☐ Check that the equipment is indeed disconnected from the source. All meters on the 480 VAC Meter Box should read 0 Volts.
- ☐ Be aware of the presence of stored energy in the VFD. Voltages as high as 650 VDC can be present inside the drive during normal operations. Wait 10 minutes for the stored energy to bleed off.
- ☐ Test approved voltmeter.
- ☐ Measure line to line, line to ground and line to neutral or common.
- ☐ Test approved voltmeter.
- ☐ Fill out tags and attach to assigned lock.
- ☐ Retain possession of the key.

The equipment is now locked out.

RESTORING EQUIPMENT TO SERVICE

- ☐ Notify all affected workers that a lockout is ready to be removed.
- ☐ Verify the work is completed and the system is safe to re-energize.
- ☐ Verify the equipment and personnel are clear, remove all locks. The energy-isolating devices may now be operated to restore energy to the equipment.
- ☐ Return locks and keys to the key ERD LOTO board.
- ☐ Sign the *Removed Date* portion of the LOTO Log.

Shutdown Executed by: ______________________________Date _________________

Safety Watch: ______________________________________

Date Returned to service: _____________________________

Attachment I

Example Procedures List

Procedures	Name	Current Revision
ERD LTP 99	Special Lock Removal Procedure	7/14/10
ERD LTP 01	General Single-Point Lockout Procedure	11/12/10
ERD LTP 03	Variable Frequency Drive Lockout Procedure	11/12/10

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.17: Change of Aqueous and Vapor Phase Granular Activated Carbon—Revision: 2

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
______
ERD

AUTHOR:
S. Gregory

APPROVALS:	**Date**
Jesse Yow **Department Head**	4/30/12
[signature] **Livermore Program Leader**	4/18/12
Leslie Ferry **Site 300 Program Leader**	4/12/12

CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	4/19/12

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to provide guidelines to the operators of ground water treatment and vapor extraction units, namely, granular activated carbon (GAC) Treatment Units (GTUs), Solar Treatment Units (STUs), Minature Treatment Units (MTUs), Portable Treatment Units (PTUs), Vapor Extraction Systems (VES), and fixed treatment facilities that employ GAC as to when the aqueous or vapor phase GAC canisters of the treatment units should be changed.

2.0 APPLICABILITY

This procedure is applicable to all portable treatment units (GTUs, MTUs, PTUs, STUs, and VES), and fixed treatment facilities at the LLNL sites, where three or more canisters/tanks of aqueous or vapor phase GAC canisters are employed in series, to remove primarily VOCs from extracted ground water or vapor. The same technique may be applied to other contaminants, e.g., High Explosive (HE) compounds (RDX, HMX) at Site 300. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes. This SOP should be reviewed periodically and/or in conjunction with GAC change outs. However, this document does not replace engineering and regulatory oversight by management, the facility engineer, or the facility compliance manager, for site-specific irregularities and conditions.

3.0 REFERENCES

3.1 Operations and Maintenance Manual Volume I: Treatment Facility Quality Assurance and Documentation (Common to all facilities).

3.2 Carbon Adsorption, Ground Water Treatment Technologies, Environmental Hazard Management Program, University of California Extension, Spring Quarter 1990.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process. The AI authorizes and approves an Integration Work Sheet (IWS) in concurrence with the Responsible Individual (RI), ES&H Team Leader(s) and the Facility Point of Contact (FPOC), based on the determination that the work activity is adequately described, hazards and hazard controls are identified, and there is sufficient funding to initiate the work.

5.3 Facility Point of Contact (FPOC)

The FPOC is responsible for releasing the work as described in an IWS after ensuring all hazards have been identified and adequate controls are in place. Additionally, the ERD FPOC or designee is responsible for ensuring that ERD work is scheduled with the appropriate Work Control Center (WCC) as necessary.

5.4 Responsible Individual (RI)/Site Safety Officer (SSO)

The RI or alternate RI is directly responsible for carrying out an operation, activity, or group of activities consistent with IWSs and other applicable ES&H and Work Control Process requirements. The RI directs the work of others to ensure the operation or work activity is performed safely and proceeds within the bounds of the institutional work planning and control process. In most cases, the RI and SSO are interchangeable job titles and responsibilities within the ERD, but when this is not the case, the two work closely to ensure the work is carried out in a safe manner.

SOP Specific Responsibilities

5.5 Facility Engineer (FE)

The Facility Engineer is responsible for the design, fabrication, construction, start-up, operation, optimization, and maintenance in all technical matters pertaining to the facility including directing corrective action. The FE ensures the facility meets the criteria set forth in the design specifications, building codes, and regulatory requirements. The FE is assisted by the Treatment Facility Technician and/or the Treatment Facility Compliance Manager.

5.7 Treatment Facility Compliance Manager (TFCM)

The TFCM is responsible for reviewing facility data for compliance with all applicable permits for Site 300. The TFCM prepares treatment facility sampling plans and specifies procedures for facility data collection and soil vapor sample collection, with input from Hydrogeology personnel. The TFCM also reviews, and accepts or rejects all facility Self Monitoring Reports (SMRs), and requests revisions to reports as needed. The TFCM is responsible for shutting down the ERD Site 300 treatment facilities due to non-compliance, and requests treatment media change-out when needed. At the Livermore Site, the aforementioned responsibilities are performed by hydrogeologists and engineers.

5.8 Treatment Facility Operator (TFO)

The Treatment Facility Operator is responsible for safe operations of the facility including sampling and observing QA requirements in accordance with this document and other documents in Section 3.0 References. The TFO monitors facility compliance, notifies the Facility Engineer, Hydrogeologist or the TFCM of maintenance issues, operational non-compliance or other important issues. The TFO performs corrective action as necessary.

6.0 PROCEDURES

6.1 Preparation

6.1.1 Prior to conducting work, perform the applicable preparation activities described in SOP 4.1, "General Instructions for Field Personnel". Personnel who are new to the LLNL project will receive direct field supervision and on-the-job training (OJT) from a Subject Matter Expert (SME) for at least the first 24 hours using the ERD Field Investigation Orientation Lesson Plan (course number EP7033-05).

6.2 Safety Considerations

6.2.1 To ensure safety to the workers and the environment, the procedures described in the following sections will be conducted in accordance with IWS 11893 "Recycling Spent Activated Carbon by Contractor at the Livermore Site" and IWS 11346 "Spent Aqueous and Vapor-phase Granular Activated Carbon (GAC) Replacement at Site 300". All work performed at ERD's treatment facilities shall also be conducted in accordance with IWS 11534 "ERD Treatment Facility Operations, Treatability Testing, and Related Activities at Livermore" and IWS 11341 "ERD Ground Water and Soil Vapor Treatment Facility Operations at Site 300."

6.3 Monitoring Frequency

The FE or TFCM should have an estimate as to when breakthrough of GAC will occur. For aqueous phase GAC, lbs/day can be calculated for each of the VOCs using standard isotherm models. However, actual breakthrough may vary significantly due to other factors. Therefore, the monitoring of breakthrough by sampling GAC vessel effluent shall be conducted in accordance with the procedure presented below:

6.3.1 The time interval between samples taken at the designated breakthrough monitoring point shall be calculated in the following manner:

Sampling Interval (days) = [estimated adjacent downstream GAC canister capacity (days) ÷ safety factor)] – sample turn-around time (days). The safety factor is to be "1.5".

6.3.2 Operational experience for an individual facility will replace the calculation of breakthrough, once a breakthrough pattern has been identified.

Note: When necessary, use of an on site analysis or rush analysis can increase the monitoring interval (i.e., decrease monitoring frequency).

6.3.3 For vapor phase GAC, the monitoring frequency is specified by the BAAQMD for the Livermore Site or SJVUAPCD for Site 300 operations. The vapor monitoring is conducted using an Organic Vapor Analyzer (OVA) or a Thermo Vapor Analyzer (TVA) to determine when GAC change-out is required.

6.4 Managing Spent GAC

Whenever possible, spent GAC is regenerated by a subcontracted vendor. Regeneration is preferred over disposal, but when GAC is determined to be a hazardous waste (through the profiling sampling process) it is generally disposed of through RHWM rather than being regenerated. GAC profile sampling needs to be performed at a frequency dictated by the RHWM or the GAC vendor, and should be done in advance of expected breakthrough to limit down time of the facility. Once approved by the waste regeneration facility, a GAC profile is valid for two years; profile sampling also needs to be performed prior to the profile expiration date. A sample waste profile form is included as Attachment A.

6.5 Replacement Procedure

6.5.1 Portable Aqueous Phase GAC Canisters

6.5.1.1 Upon breakthrough (>0.5 µg/L for any individual and/or total VOCs; >1 µg/L for RDX or HMX) at the influent sample port of next to the last GAC vessel, (CF2I), the upstream vessel (CF1I) should be removed and replaced. The last vessel (CF3I) should be moved to the first position and new GAC vessels placed in the remaining positions. Attachment B: Sequence of Change in GAC Canisters, presents examples of how to reconfigure GAC canisters during the change-out process. In some cases, when breakthrough is determined at the CF3I sample interval, both the CF1 and CF2 canisters are replaced. This strategy is employed to compare the efficiency of single versus double GAC change-outs.

6.5.1.2 The spent canisters from different facilities should be stored in one place. When there is at least 1,000 lb of GAC, the vendor or RHWM shall be contracted to remove the spent GAC from the site. The GAC supply vendor may re-supply new GAC at this time.

6.5.2 Portable Vapor Phase GAC Vessels

6.5.2.1 The concentration of the vapor sample taken from the influent sample port of next to the last GAC vessel (CF2I) shall indicate the initiation of the vapor phase GAC change-out procedure in accordance with air permit specifications. When the concentration at this location reaches the greater of 10% of the total inlet vapor stream concentration (ppmv), or 10 ppmv (this criteria is specified only in the Livermore BAAQMD permits; there are no change-out specifications in the Site 300 SJVUAPCD permits). At Site 300, all GAC canisters are replaced as soon as breakthrough occurs at the effluent port.

6.5.3 Fixed Vapor Phase GAC Canisters

6.5.3.1 The concentration of the vapor sample taken from the influent sample port of next to the last GAC vessel (CF2I) shall indicate the initiation of the vapor phase GAC change-out procedure in accordance with air permit specifications. When the concentration at this location reaches the greater of 10% of the total inlet vapor stream concentration (ppmv), or 10 ppmv (this criteria is specified only in the Livermore permits; there are no change-out specifications in the Site 300 permits). At such time all GAC vessels should be removed and replaced. At Site 300, typically all GAC canisters are replaced as soon as breakthrough occurs at the effluent port.

6.5.3.2 Spent GAC from the fixed vessels should follow the same replacement procedure as the portable vessels with the addition that the change-out is completed by the GAC supplier and new GAC is replaced at the same time.

6.5.3.3 The FE or TFCM may request that disposal or regeneration of GAC from the last vessel be postponed until the next change-out based on the break through concentrations, or the GAC from the vessel may be transferred to the first vessel (CF1) and new GAC placed in the remaining vessels. The precise change-out methodology may be tailored for a specific treatment facility, but this procedure describes the general process.

6.6 Documentation Requirements

6.6.1 The TFCM keeps a record of the concentration of the total VOCs (or RDX at the Site 300 High Explosives Process Area [HEPA]) at all sample ports and the date the facility was shut down in the logbook. The date when the canisters were changed and the date when the facility was restarted are also recorded. A record should also be kept if GAC waste characterization has been conducted, and a schedule set for future characterization sampling.

7.0 QA RECORDS

7.1 Treatment Facility Logbooks

A logbook issued for the facility, by the Data Management Team (DMT), shall be maintained by the TFO who shall record the dates and time of all important events, namely, shutdown, startup, date of sampling, sample port numbers, results of the chemical tests and any other important observations.

7.2 Chain-of-Custody (CoC)

The TFO shall generate sampling information on the CoC form issued by the DMT. The TFO will indicate on the CoC that the TFCM and/or FE are to receive faxed preliminary data.

8.0 ATTACHMENTS

Attachment A—Spent Carbon Profile Form

Attachment B—Sequence of Change in GAC Canisters

Attachment A

Spent Carbon Profile Form

USFilter Westates

PARKER FACILITY
2523 Mutahar Street • P O Box 3308
Parker, AZ 85344
(928) 669-5758 • FAX (928) 669-5775
EPA ID: AZD 982 441 263

RED BLUFF FACILITY
11711 Reading Road
Red Bluff, CA 96080
(530) 527-2664 • FAX (530) 527-0544
EPA ID: CAR 000 058 784

SPENT CARBON PROFILE FORM

GENERATOR INFORMATION

a) Generator: ______________________ b) Site: ______________________
Address: ______________________

Mailing Address: ______________________ ______________________
______________________ ______________________
______________________ ______________________

c) Contact Name: ______________________ d) EPA ID#: ______________________

e) Phone No: ______________________ f) Fax No: ______________________

CONSULTANT INFORMATION

2 a) Consultant: ______________________ b) Contact: ______________________

c) Phone No: ______________________ d) Fax No: ______________________

PROPERTIES AND COMPOSITION OF THE SPENT CARBON

3 Provide a specific description of the process generating the spent carbon including constituents being treated
(Please note if application is for potable water or food processing)

____
____
____
____

4. Type of Spent Carbon: ☐ Aqueous ☐ Vapor 5 Foreign Material: ☐ Yes ☐ No
(rocks, dirt, sand, etc)

6 Handling: ☐ Bulk ☐ Drum ☐ Adsorber ☐ Bulk Bag ☐ Other ______________

7 Free Liquid Range: ☐ 0 ☐ 1 – 15% 8 Liquid Flashpoint: ☐< 140°F ☐ >140°F ☐ N/A Vapor

9 pH Range: ☐ <2 ☐ 2-4 ☐ 4 1-10 5 ☐ >10 5

10 Strong Odor? ☐ Yes ☐ No If yes, please Describe______________________________

11 Is Spent Carbon Generated at a Subpart FF Facility? (Benzene NESHAP) ☐ Yes ☐ No

12 Does the waste contain benzene which is required to be managed and treated in accordance with the provisions of Subpart FF (40 CFR 61 342(f)(2)? ☐ Yes ☐ No
Note If yes, total benzene analysis is also required

13 DOES THE SPENT CARBON CONTAIN ANY OF THE FOLLOWING

A	Polychlorinated Biphenyls (PCBs)	☐ Yes	☐ No
B	Dioxins and/or Furans	☐ Yes	☐ No
C	Dibromochloropropane (DBCP)	☐ Yes	☐ No
D	Sulfide or Cyanide	☐ Yes	☐ No
E	Explosive, Pyrophoric and/or Radioactive material	☐ Yes	☐ No
F	Infectious material	☐ Yes	☐ No
G	Shock Sensitive material	☐ Yes	☐ No
H.	Oxidizer	☐ Yes	☐ No
I	Heavy Metals	☐ Yes	☐ No

GENERATOR CLASSIFICATION

14 Is the Spent Carbon a RCRA Hazardous Waste? ☐ Yes ☐ No
If yes, list waste code(s) below:
RCRA Hazardous Waste requires "11 RCRA" Analysis

______ ______ ______ ______

______ ______ ______ ______

15 Is the Spent Carbon a State Hazardous Waste? ☐ Yes ☐ No
If yes, list waste code(s) below:

______ ______ ______ ______

______ ______ ______ ______

16 Is this Waste Subject to the Land Disposal Restriction Notification? ☐ Yes ☐ No

17 Is spent carbon generated from a Superfund Site? ☐ Yes ☐ No

18 If this is a Renewal, Provide the Existing Profile Approval Number: ______

19 Estimated Annual Carbon Usage: ______

GENERATOR CERTIFICATION

I hereby certify that all information on this and all attached documents are true and that this information accurately describes the subject spent carbon. I further certify that all samples and analyses submitted are representative of the subject spent carbon in accordance with the procedures established in 40 CFR 261 Appendix I or by using an equivalent method. All relevant information regarding known or suspected hazards in the possession of the generator has been disclosed. I authorize USF/Westates to obtain a sample from any waste shipment for purposes of confirmation or further investigation. If I am a consultant signing on behalf of the generator, I have their proper approval

______ ______
Printed Name **Signature**

______ ______
Title **Date**

______

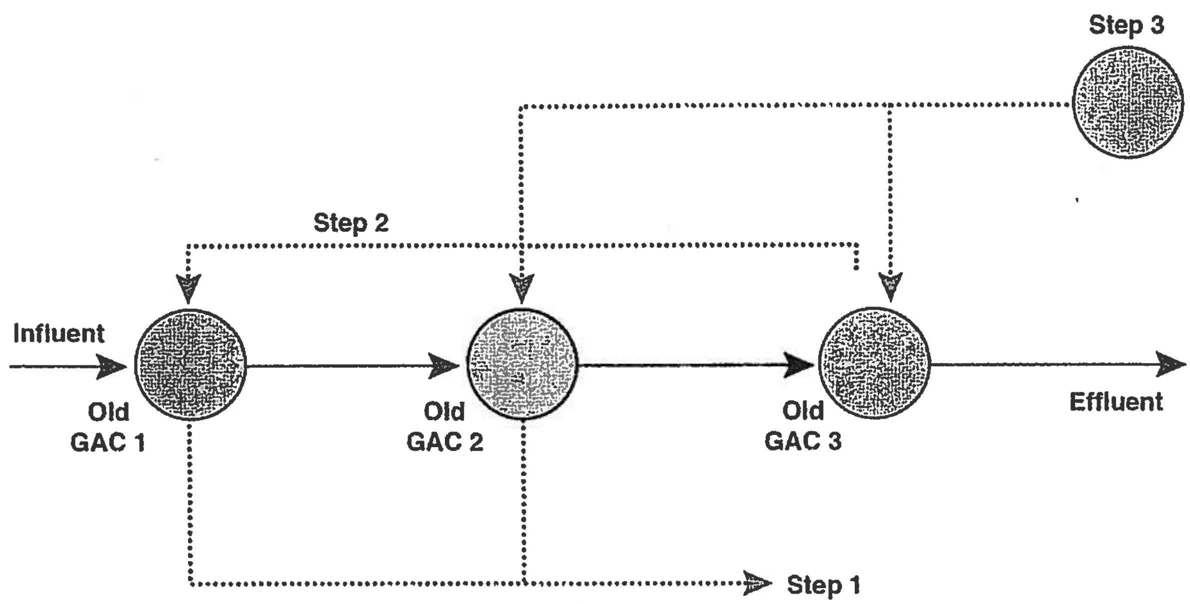
For Internal Use Only

______
Profile Approval Number

______
Valid Through

Attachment B

Sequence of Change in GAC Canisters



Step 1 – Remove old GAC 1and 2 for regeneration/disposal
Step 2 – Move old GAC 3 to old GAC 1 position
Step 3 – Move new GAC(s) to downsteam position

ERD-S3R-06-0084

Attachment B. Sequence of change in GAC canisters during double vessel change-out.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 4.18: ERD Document Control—Revision: 1

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
____
ERD

AUTHOR(S):
R. Goodrich

APPROVALS:	**Date**
Jesse Yow **Department Head**	4/12/12
K. Aley **Facilities & Infrastructure Assurance Manager**	4/12/12

CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	4/12/12

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this procedure is to describe the processes used to control ERD documents so the most current versions are available to ERD personnel.

2.0 APPLICABILITY

This procedure is applicable to ERD documents that have been identified as needing to be controlled.

3.0 REFERENCES

3.1 ES&H manual, Document 41.1 LLNL Quality Assurance Program, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AM-133867-VOL-4-PT-41-2009.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Department Head (DH)

The Department Head's responsibility is to ensure that procedures are current and readily available to activity personnel, appropriate to their use (i.e., informational versus instructional use) and that documents are controlled in a manner that is consistent with the requirements described in this procedure.

5.2 ERD Quality Assurance Implementing Coordinator (QAIC)

The QAIC is responsible for coordinating the implementation of the document control processes and for maintaining the ERD Controlled Document Distribution List.

5.3 Program Leader (PL)

The PL is responsible for providing the ERD QAIC with a list of ERD personnel that require controlled documents based on their work assignments.

5.4 ERD Personnel

ERD Personnel who are custodians of controlled documents are responsible for providing reasonable protection from damage or loss to those documents. ERD personnel are responsible for ensuring that they acquire and use the most current editions of controlled documents. In addition, ERD personnel preparing documents are responsible for consulting with the QAIC to determine control status of the document.

6.0 PROCEDURES

6.1 Identification and Tracking of Controlled Documents

6.1.1 Identification of Controlled Documents

ERD controls documents needed by personnel to perform work correctly and safely. By controlling the document, management ensures the most current version is accessible to workers.

Typically, the documents controlled by ERD are:

- Quality Assurance Project Plans
- Site Safety Plans
- Operation and Maintentance Manuals
- Standard Operating Procedures

The controlled status of documents is identified by marking the document with a red stamp indicating the staus, i.e., uncontrolled or controlled. If the red stamp is black and white the document is not controlled. If the document has no markings, or is without an assigned number, the document is uncontrolled.

6.1.2 Tracking of Controlled Documents

Within the "Controlled Copy" red stamp, a unique number is used to identify the copy holder.

The QAIC maintains the ERD Controlled Document Distribution List. This List tracks what documents are controlled, the controlled numbers and the associated copy holder names.

6.2 Document Distribution

6.2.1 Controlled Document Distribution Procedure

- The Program Leader informs the QAIC of their personnel's controlled document requirements.
- The QAIC assigns the personnel a controlled document/number and enters the information into the ERD Controlled Document Distribution List.
- Upon leaving ERD, the personnel must relinquish their controlled documents to the QAIC.
- The QAIC updates the List.

6.3 Effective Dates

ERD controlled document effective date is listed on the cover of the document (i.e., January 2010).

6.4 Disposition Control

When a controlled document is updated, the QAIC or designee manually updates each copyholder's controlled document. Personnel may update their own controlled documents under the supervision of the QAIC or designee. For controlled document copyholder's outside of ERD, the updated materials are mailed with the LLNL Environmental Restoration Department Controlled Document Receipt Acknowledgment Record (Attachment A). Obsolete or superseded documents/material are discarded/recycled, or are properly identified or marked as "Obsolete" when an older version is retained.

6.5 Electronic Copies

Electronic copies of the current QA documents are available on the ERD's server. ERD personnel can access the documents using the following pathway: erdfilespace/departmentspace/QA_ESH.

7.0 QUALITY ASSURANCE RECORDS

7.1 Controlled documents

7.2 ERD Controlled Document Distribution List

7.3 LLNL Environmental Restoration Department Controlled Document Receipt Acknowledgment Records

8.0 ATTACHMENTS

Attachment A—Example LLNL Environmental Restoration Department Controlled Document Receipt Acknowledgment Record

Attachment A

Example LLNL Environmental Restoration Department Controlled Document Receipt Acknowledgment Record

LLNL
Environmental Restoration Department
Controlled Document Receipt Acknowledgment Record

Transmittal Date:__________

From:_____________
ERD Quality Assurance Implementing Coordinator (QAIC)

To:_______________

Document Title:___________

Document Revision Number:_____________

Document Identification Number:_________

Directions

[ ] Destroy or Mark Obsolete Materials "Superseded"
[ ] Return Obsolete Materials with this Record
[ ] New Issue- No Obsolete Material

Please sign below and return this form within 30 days to:
Rebecca Goodrich
LLNL
P.O. Box 808, L-544

Signature:___________________________________ Date:_____________

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.1: Data Management Chain of Custody and Printed Analytical Result Receipt and Processing—Revision: 4

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#
ERD

AUTHOR(S):
S. Chamberlain

APPROVALS:	Date
Department Head	12/17/15
ERD Data Program Leader	11/16/15

CONCURRENCE:	Date
Rebecca Goodrich **QA Implementation Coordinator**	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this procedure is to describe the process for receiving and storing printed Chain-of-Custody (CoC) forms received from field personnel and analytical laboratories.

2.0 APPLICABILITY

This procedure includes receiving, photocopying, distributing, and storing printed analytical results and ensures complete and consistent handling of all CoC forms and printed analytical results within the ERD Data Management Team (DMT). ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

Not applicable.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 ERD Data Program Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

SOP Specific Responsibilities

5.3 ERD Data Management Team (DMT)

The DMT is responsible for receiving and processing CoC forms prior to receiving analytical results as outlined in this SOP. When DMT receives analytical results, they are also responsible for processing them according to this procedure. The DMT also communicates with the analytical laboratories regarding corrections or adjustments to CoC requests and when necessary provides clarification or additional information to ensure completeness in analytical result reports.

5.4 Quality Control (QC) Chemist

The Quality Assurance Implementation Coordinator (QAIC) functions as the QC Chemist and is the primary ERD Point of Contact (POC) responsible for communicating with the laboratories in regards to test methods, problematic QC, suspect data, sample results exceeding hold times, filtration issues, and other discrepancies noted during the data validation process.

5.5 Sampling Coordinator (SC)

The SC is a main POC for ERD in relationship to field sampling activities and is responsible for providing clarification to the laboratory when the laboratory logs discrepancies during the sample receiving and login process.

5.6 Contract Analytical Laboratories (CALs)

The CALs are responsible for performing analyses for each sample specified on the CoC form within the requested time period and taking action if necessary to clarify requests. Analytical laboratories are responsible for submitting copies of CoC forms upon sample receipt and for submitting original CoC forms with hard copy original analytical results within specified time periods to ERD's DMT. The analytical laboratories are also responsible for making corrections or revisions to hard copy original reports requested by the DMT or the QC Chemist.

6.0 PROCEDURES

6.1 Receipt of Chains-of-Custody (Attachments A and B)

CoCs are in triplicate form and are processed as follows:

1) The original CoC is signed and accompanies the samples to the analytical lab.
2) The CoC receipt copy is submitted to DMT.
3) The Technical Release Representative (TRR) copy is submitted to DMT.

6.1.1 CoC receipt copies are obtained from field personnel through lab mail, hand delivery, and/or environmental sample lock box (B653).

6.1.2 CoC receipt copies are date-stamped and categorized according to the analytical lab performing the analyses. The forms are filed according to the date and placed in the corresponding lab's inbox.

6.2 Receipt of Original Hardcopy Results

6.2.1 Obtain the analytical reports from the incoming mail or the environmental sample lock box, B653.

6.2.2 Date stamp the analytical report; specifically the CoC, the invoice, and the case narrative. Identify Environmental Functional Area (EFA) Water Monitoring Group (WMG) data with a red flag.

6.2.3 Photocopy the original CoC to accompany the analytical report. Additionally, for EFA WMG data, make a copy of the invoice to accompany the data package.

(The QC Chemist initials the invoice, subscribes a "V" and the date the package was validated indicating that tests requested on the COC were performed, analyzed, and reported. The QC Chemist attaches the photocopied invoice at the very end of the data package.)

6.2.4 Match the analytical results received to the analysis requested on the original CoC; mark each requested analysis received next to the requested analysis printed on the COC. Record the "Analytical Lab Log #" in the blank provided on the CoC, (e.g., BC Laboratory: BB0704705 ***001***). Initial the top left corner of the case narrative when you have matched and verified that all requested analyses on the COC have been received. Make appropriate notation (e.g., using post-it note) on the data package cover page and then notify the laboratory of the requested analyses that are missing from the data package.

6.2.5 Identify collocated intralaboratory (blind) duplicate samples (if any) throughout the analytical report and the location where Fields Blanks (if collected) were poured. Label results with the stamp, "This is Really ________" and fill in the actual sample location identification based on the QC sample list provided for that quarter and year.

6.2.6 Identify Field Blank samples. Label results with the stamp, "poured at: ________" and fill in the actual poured at sample location identification based on the QC sample list provided for that quarter and year.

6.2.7 Place the analytical report, with the photo copied CoC attached on top, in the "Validation In/Out Box" or deliver results to the QC Chemist for validation.

6.3 Receiving Results in Database

6.3.1 Receive data

Log into Taurus Environmental Information Management System (TEIMS) "Data Team" application and access "SPACT." Go to "View CoCs and Labels." Under "Find CoC By Number or ID," enter the CoC ID or the Log Book/Document Control #. Click "View COC List."

On the next page, identify the CoC you are going to enter (verifying one or more of the following: "Document Control Number," "CoC ID," "Labcode," "Sampler," "Field Location," or "Sampled").

For hand written COC where no electronic records are found, create a CoC per instructions provided in Section 6.4 of this procedure.

Click "Receive Data" under "CoC Action." On this page, edit the following fields:

- date_logged: the date work is logged into the system
- lab_log_no: number assigned from the analytical lab
- sample_rcvd: date the analytical lab received the sample•invoice_amount:
- invoice_rcvd_date:
- validator: QC Chemist fills in field
- validated (date): QC Chemist
- valid_status: QC Chemist
- dq_flag_form: QC Chemist

After each of the following bullets, refer to the legend at top of "Received Data for COC_id" page and complete:

- rev_status:
- rev_requestor: individual requesting a revision

- rea_status:
- rea_requestor: individual requesting a reanalysis
- log_comments: notes can be added here regarding Data Review Requests (DRRs) submitted by QC Chemist, COC discrepancies, etc.

Verify that "lab_loc_name" matches what is on the CoC. Verify that the requested analysis is correct and all samples are in the right order.

- log_no (extension only on input): enter the extension to the lab_log_no given by the analytical lab
- result_rcvd_paper: date DMT received results from the analytical lab
- result_rcvd_edd: populated when the EDD is uploaded

Repeat entering the log_no(s) as needed for all rows being received on that CoC. Once this is complete, click the "Submit" button.

Once original CoCs are returned from the lab along with the analytical results, the matching CoC receipt is discarded. File the original CoC form by analytical lab and date. Binders are maintained as a Lifetime QA Record.

6.4 Creating a Hand Entry CoC

6.4.1 If no electronic records are found, an electronic CoC must be created.

6.4.2 Select "View CoC and Labels" from the "SPACT" application. Enter Log Book/Document Control # and verify that records do not exist. If records exist, verify the access number by clicking "View/Edit." Do not create a new CoC if it is the same access number.

6.4.3 If records do not exist, click your back button, and select "Change Query." This takes you back to "Find CoCs to View/Edit/Print." Click on the link "Create Hand Entry CoC."

6.4.4 Using information from the CoC, enter appropriate "# of lines" and "driver_code." Skip "op_unit" if you are unsure of it, and verify that the default "norm_year" and "norm_qtr" are correct. Do not click the "Advanced Entry" box. Click the "Submit" button.

6.4.5 Enter/Update all of the required fields, using the hand entry CoC:

- Access #
- Analytical Lab
- Log Book/Document Control #
- Turn Around Time
- Sampler
- PCI_Project
- PCI_Task
- Release # (if applicable)

- Fax/Email #1 and #2 (if applicable)
- DMT Additional Copies (if applicable)
- Verify that Plan Code is correct from what you selected on the previous page
- Field location
- Sample ID (Lab Loc Name)
- Sampled (date)
- Matrix
- Req. Analysis
- Analysis Detail (if applicable)
- Sample Type
- Sample Method (if applicable)
- Lab Instructions (if applicable)

6.4.6 Click on "Create CoC."

6.4.7 On the next page, verify that all fields are correct and click "Create CoC." If it is not correct, click your back button and fix the error before resubmitting.

6.4.8 Process as in Section 6.3.

6.5 Processing Original Results After Validation

6.5.1 Retrieve data packages from the "Validation In/Out Box."

6.5.2 Stamp data with "Data Qualifier Flag Attached" when the QC Chemist has added a colored Data Qualifier Flag form. When the package is a revision, it needs to be stamped "Revision" and placed in the "Validation In/Out Box" for QC Chemist review.

6.5.3 Determine the packages requiring copies for the following uses:

- Individuals listed in the "DMT Additional Copies" box on the CoC.
- For EFA WMG samples, scan and send to the appropriate analyst. Make sure a photocopy of the invoice is attached to these copies.

6.5.4 Staple package together and place the originals in the appropriate lab data box for the custodian to retrieve when necessary.

7.0 QA RECORDS

7.1 Official hardcopy analytical laboratory reports

7.2 Chain-of-Custody forms

7.3 ERD Controlled Field Logbooks

8.0 ATTACHMENTS

Attachment A—ERD Electronic Chain-of-Custody forms (A-1, A-2, A-3)

Attachment B—ERD Hand Entry Chain-of-Custody form

Attachment A

ERD Electronic Chain-of-Custody Forms

A-1: Original COC

A-2: COC Receipt Copy

A-3: TRR Copy

Chain of Custody

Attn: ERD Data Management Team
Lawrence Livermore National Laboratory
P.O. Box 808 L-542
Livermore, CA 94551

Work Authorized By: LINDEE BERG
TRR Approver: SUSAN LAMBAREN
Project Info:

Access/COC #: 44231
Document Control #: WW024
Requester/LLNL Analyst: Livermore
Organization / Sampler: ERD / silva207
PCI Project #: 32572
PCI Task #: 484709
Fax/Email #1: 925-422-2095
DMT Additional Copies:

Analytical Lab : BCLABS-BAK
TAT: 20d
Analytical Lab Log #:
Project/Network: LGIV
LLNL Acct #: 4847-09
Release #: UNICARD
Fax/Email #2:

Additional Instructions:

Sample ID	Sampled Date/Time	Matrix	Cont. Type	Cont. Count	Study Area	Req. Analysis	Analysis Detail	Lab Instructions
W-1502	10/22/2008 07:28	GW	V	3	TFD	E601	ALL	
W-1804-1	10/22/2008 07:28	GW	V	3	TFD	E601	ALL	
W-1804-2	10/22/2008 07:28	GW	V	3	TFD	E601	ALL	
TRIPBLANK	10/22/2008 07:28	BW	V	1	TFD	E601	ALL	Run only if there is a hit

Relinquished Signature	Company	Date	Time	Received Signature	Company	Date	Time
1	LLNL/ERD	10/22/2008		2			
2				3			
3				4			
4				5			

Chain of Custody

Attn: ERD Data Management Team
Lawrence Livermore National Laboratory
P.O. Box 808 L-542
Livermore, CA 94551

Work Authorized By: LINDEE BERG
TRR Approver: SUSAN LAMBAREN
Project Info:

Access/COC #: 44231
Document Control #: WW024
Requester/LLNL Analyst: Livermore
Organization / Sampler: ERD / silva207
PCI Project #: 32572
PCI Task #: 484709
Fax/Email #1: 925-422-2095
DMT Additional Copies:

Analytical Lab : BCLABS-BAK
TAT: 20d
Analytical Lab Log #:
Project/Network: LGIV
LLNL Acct #: 4847-09
Release #: UNICARD
Fax/Email #2:

Additional Instructions:

Sample ID	Sampled Date/Time	Matrix	Cont. Type	Cont. Count	Study Area	Req. Analysis	Analysis Detail	Lab Instructions
W-1502	10/22/2008 07:28	GW	V	3	TFD	E601	ALL	
W-1804-1	10/22/2008 07:28	GW	V	3	TFD	E601	ALL	
W-1804-2	10/22/2008 07:28	GW	V	3	TFD	E601	ALL	
TRIPBLANK	10/22/2008 07:28	BW	V	1	TFD	E601	ALL	Run only if there is a hit

Relinquished Signature	Company	Date	Time	Received Signature	Company	Date	Time
1	LLNL/ERD	10/22/2008		2			
2				3			
3				4			
4				5			

Chain of Custody

Attn: ERD Data Management Team
Lawrence Livermore National Laboratory
P.O. Box 808 L-542
Livermore, CA 94551

Work Authorized By: LINDEE BERG
TRR Approver: SUSAN LAMBAREN
Project Info:

Access/COC #: 44231
Document Control #: WW024
Requester/LLNL Analyst: Livermore
Organization / Sampler: ERD / silva207
PCI Project #: 32572
PCI Task #: 484709
Fax/Email #1: 925-422-2095
DMT Additional Copies:

Analytical Lab : BCLABS-BAK
TAT: 20d
Analytical Lab Log #:
Project/Network: LGIV
LLNL Acct #: 4847-09
Release #: UNICARD
Fax/Email #2:

Additional Instructions:

Sample ID	Sampled Date/Time	Matrix	Cont. Type	Cont. Count	Study Area	Req. Analysis	Analysis Detail	Lab Instructions
W-1502	10/22/2008 07:28	GW	V	3	TFD	E601	ALL	
W-1804-1	10/22/2008 07:28	GW	V	3	TFD	E601	ALL	
W-1804-2	10/22/2008 07:28	GW	V	3	TFD	E601	ALL	
TRIPBLANK	10/22/2008 07:28	BW	V	1	TFD	E601	ALL	Run only if there is a hit

TRR COPY

Relinquished Signature	Company	Date	Time	Received Signature	Company	Date	Time
1	LLNL/ERD	10/22/2008		2			
2				3			
3				4			
4				5			

Revision Printed: 09/26/2008/15/53/25

Signature Order - 1: Sampler, 2: Courier, 3: Lab, 4: Analyst, 5: DMT

Attachment B

ERD Hand Entry Chain-of-Custody Form

Chain-of-Custody Record and Analytic Instructions

Page ____ of ____ AE 24886

Send all results to:
Requester:
Attn: ERD Data Management Team L-528 Lawrence Livermore National Laboratory P.O. Box 808, Livermore, CA 94551

ERD
Electronic Form

Field Log Book# (COC#) ____________ Release # ____________
LLNL Acct. # ____________ Sampling Request# ____________
Analytical Laboratory Name ____________
Analytical Laboratory Log # ____________

Analytical Lab FAX or Email copies to:
Name ____________ FAX 925-422-6950 ☐ or Email ☐
Name ____________ FAX 925-422-6950 ☐ or Email ☐

* Analytical Laboratory, when Email is requested always ccERD_DMG!

Project Name: ____________
Sampled By ____________ Sampler's Employer ____________

Sample Identification	Sample Date/Time	Matrix	Cont 3	# of Cont.	Study Area	Analysis & Turnaround Required 1							Additional Instructions to Lab / Remarks

	Signature	Company	Time	Date
Relinquished by				
Received by				
Relinquished by				
Received by				
Relinquished by				
Received by				

1. Enter the number of days or hours for TAT of the official printed report. See Requested Analysis code list for available TAT's for each type of analysis. Example: 24h = 24 hours / 20d = 20 day
2. Sample Matrix Codes: **See list on back of pink copy**
3. Container type codes: **V** = VOA Bottle, **P** = Polyethylene Bottle, **G** = Glass Bottle, **T** = Brass Tube, **B** = Bag, **S** = Stainless Steel Tube, **O** = Other (specify under remarks)

Additional Copies from Data Mngmnt
CC:

White: Laboratory return to ERD **Yellow:** Analytical Lab **Pink:** Sampler leave with ERD **Gold:** Sampler Leave with TRR
Attn. ERD Data Management Team L-528 Attn. ERD Data Management Team L-528

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.3: Data Management Electronic Analytical Result Receipt and Processing for Sample, Analysis and QC Data—Revision: 4

AUTHOR(S):
L. Graves* and S. Chamberlain

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#
ERD

APPROVALS:	**Date**
Department Head	12/17/15
ERD Data Program Leader	11/16/15

CONCURRENCE:	**Date**
Rebecca Goodrich QA Implementation Coordinator	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

*Akima

1.0 PURPOSE

The purpose of this procedure is to establish the means for receiving and storing electronic analytical results as received from Contract Analytical Laboratories (CALs). This procedure is to ensure complete and consistent handling of all electronic analytical records within the Environmental Restoration Department (ERD).

2.0 APPLICABILITY

This procedure applies to Data Management Team (DMT) personnel performing quality-affecting activities in the receipt and storage of electronic analytical results. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

Not applicable.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 ERD Data Program Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

SOP Specific Responsibilities

5.3 Quality Control (QC) Chemist

The Quality Assurance Implementation Coordinator (QAIC) performs the ERD QC Chemist functions and is responsible for reviewing 100% of the analytical data for technical adequacy, internal consistency and quality, determining and flagging data quality and requesting additional information from the analytical laboratories if there are suspect data points or problematic QC results.

5.4 Activity Leader (AL)

Personnel who are responsible for specific tasks, e.g., writing assigned sections of compliance monitoring reports and reviewing the analytical data for internal consistency prior to inclusion of data in reports.

5.5 Environmental Functional Area (EFA) Analyst

The analysts are responsible for reviewing data for internal consistency within their sampling networks.

5.6 Data Management Team (DMT)

The DMT is responsible for the disposition of the original documents received as a result of performing work activities described by this SOP.

6.0 PROCEDURES

6.1 Log-in to web application

Open a web browser

Select URL https://teims.llnl.gov

Select Data Team

6.2 Import Holding Tables to Work Tables

From Data Team home page, select Monitor. Select Import Holding Tables to Work Tables.

6.2.1 The electronic files from CALs are transmitted to the ERD LLNL. Each laboratory has its own directory. In each transmittal there are up to 5 files; Sample, analysis, qckey, qcanal, and text (optional). The files are in the analytical laboratory's directory, and are named as follows:

zzerdxyymmdd_hhmisample.xfer

zzerdxyymmdd_hhmianalysis.xfer

zzerdxyymmdd_hhmiqcanal.xfer

zzerdxyymmdd_hhmiqckey.xfer

zzerdxyymmdd_hhmitext.xfer

Where: zz = two letter code for the laboratory

x = project to which the data belongs, l for Livermore Site, s for Site 300, or w for EFA (Water Monitoring Group) (formerly WGMG).

yy = year

mm = month

dd = day

hh = hours

mi = minutes

Programming automatically moves data in these files to the holding tables in The Environmental Information Management System (TEIMS).

6.2.2 In TEIMS click through the following links: Data Team, Monitor, Import Holding Tables to Work Tables, select Lab Code

Select desired files to upload

Click on Move to Worktables button

Confirm that import is successful by viewing bottom of page

6.2.3 Run Standard Report

Select SQL under Templates link

Choose SQL file select_stdrpt.sql

Submit query

Go to bottom of screen – select Download as tsv file

Print directly or as Excel spreadsheet

6.3 Account for Hard Copies

6.3.1 Sort laboratory hard copies by log number.

Collect and compare hard copies that are part of the current electronic shipment with log_no's in wsample table.

Compare by each log number and requested analysis, if available, doing a visual scan of every page checking for unusual inclusions and exclusions.

6.4 Groom the Data

6.4.1 Click on Monitor Link

Select Verify Sample (run all)

Make corrections as needed

Re-run and print final verifications notating on verifications where error warnings are exceptable.

Repeat for: analysis, sur_analysis, tic_analysis, anal_comments, qc_analysis.

6.4.2 Click on Scan Queries on results page if numbers appear in statlimitchk, cleanwellsms, and or, cleanwells.

6.4.3. Click on corresponding link to create excel report and give to appropriate responsible person.

6.4.4 Screen print these results and put in the EDD packet.

Inform the appropriate Activity Leader(s), EFA Analyst, or their designee(s) if there are hits in the cleanwell program or statlimitchk.

6.4.5 For every treatment facility influent name that is labeled as a well name and the influent name, store in sample table by the well name. Add a record to extract1well table with the same log_no, the influent name, and sampled date. This only applies to single extraction well facilities.

6.5 Record Data Qualifier Flags

6.5.1 Review validated data returned from the QC chemist to determine whether qualifier flags have been assigned.

6.5.2 Add all assigned data qualifier flags to the appropriate wanalysis record in the wanalysis table.clp_qa_flag field.

6.5.3 Initial and date data qualifier flag form when done.

6.6 Generate Edit Reports and Check Data

6.6.1 Generate edit reports and proof electronic data.

6.6.2 Select 10% or 100% of the samples for detailed data review and comparison to laboratory reports. At least one of each requested analysis type in the electronic shipment should be represented in the 10%. For new laboratories, use 100% until 3 consecutive sends have passed completely. For hand entry use 100% proof. (refer to ERD SOP 5.3).

6.6.3 Compare every field with the printed analytical results and verify identical content. If discrepancies between electronic and hard copy data are discovered, particularly with result and lost_value, contact the analytical laboratory to confirm data.

Request revisions with any necessary changes.

Note requested revision in the receive data application.

Make applicable changes in the work tables including a remark in the sample table note field that the revision was made on a certain date, and include your initials.

6.7 Peer Review

6.7.1 Assemble a packet of:

Standard printout

Edit report

Scan Query

Verifications for all tables that are populated.

Other printouts produced by the scan (if applicable)

6.7.2 Provide packet to another DMT member for peer review for 100% proof of assembled package.

6.7.3 Make necessary changes based on the reviewer's recommendations.

6.7.4 Have the reviewer make a final recheck and place initials on data packet.

6.7.5 Initial and date packet.

6.8 Append Data to Global Tables

6.8.1 In TEIMS, Monitor use "Upload data from work tables to global tables" to append wsample, wanalysis, wtic_analysis, wsur_analysis, and wanal_comments, wqckey, wqcanal tables, from work tables to global tables.

6.8.2 In the global tables, perform random retrievals to verify the records just appended are accessible. Check that the number of rows appended from the work tables matches the number of rows added to the global tables.

6.8.3 Repeat Steps Sections 6.8.1 and 6.8.2 to append wqckey and wqcanal.

7.0 QA RECORDS

7.1 All original analytical results, reports, and copies

7.1.1 Short Term Storage of Original Analytical Results paper (3 years); stored in the same building where the DMT resides.

7.1.2 Long Term Storage of Original Analytical Results paper in Records Archives and Management Group in the Records Management Building 411 is required in accordance with ERD SOP 4.10: Records Management.

7.2 Electronically stored records

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.4: Data Management Hand Entry of Analytical Results—Revision: 3

AUTHOR:
L. Graves* and S. Chamberlain

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#________
ERD

APPROVALS:	**Date**
Jesse Yow **Department Head**	12/17/15
[signature] **ERD Data Program Leader**	11/16/15

CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

*Remtech Services Inc.

1.0 PURPOSE

The purpose of this procedure is to establish the means for storing electronically hand-entered hard copy analytical results received from analytical laboratories and to ensure complete and consistent hand entry of all hard copy analytical records [not received electronically in the standard Electronic Data Deliverable (EDD) format] within the Environmental Restoration Department (ERD) Data Management Team (DMT).

2.0 APPLICABILITY

This procedure applies to ERD DMT hand entry of analytical results not received electronically in standard EDD format. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

Not applicable.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 ERD Program Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

SOP Specific Responsibilities

5.3 ERD Data Management Team (DMT)

The ERD DMT's responsibilities are to receive analytical reports and process them as outlined in this procedure. Furthermore, the DMT's responsibility is to communicate with the QC Chemist and Contract Analytical Laboratories (CALs) regarding necessary corrections or clarifications of reported analytical results.

5.4 Quality Control (QC) Chemist

The Quality Assurance Implementation Coordinator (QAIC) functions as the QC Chemist and is responsible for following the process in which all incoming data is reviewed. When laboratories do not provide the required QC data as specified in ERD's Quality Assurance Project Plan (QAPP), the QC Chemist performs a quick review of the data package but does not validate it. The QC Chemist places an "N" for Not Validated, the date, and initials the upper right hand corner of the data package cover page.

6.0 PROCEDURES

6.1 Preparation

Use the hand entry copy of the original analytical data located in the corresponding laboratory's data box. Obtain the information needed to fill in sample and analysis spreadsheets.

6.2 Entry via Spreadsheets

6.2.1 Download the Microsoft Excel templates for the hand entry spreadsheets, by logging onto The Environmental Information Management System (TEIMS). Under Templates; click on HE. There are two templates necessary, he_analysis.xls and he_sample.xls. Download both files and begin to fill in the appropriate information.

Note: Data columns must conform to the template stated order.

6.2.2 Populate spreadsheets.

- Enter data that corresponds to the appropriate columns.
- Print and proofread the spreadsheets.

Note: There must be NO commas in the spreadsheet file.

- Do not remove the header row from the file.
- Save the files as text (tab delimited).

6.2.3 Move the files to Oracle holding tables.

- From TEIMS, select File Upload.
- Step 1: Select appropriate organization, Lab/Task=hand entry, file type.
- Step 2: Browse for desired file and press button for upload.
- Repeat for remaining file.

6.2.4 Continue process using ERD SOP 5.3 Data Management Electronic Analytical Result Receipt and Processing for Sample, Analysis, and QC Data.

7.0 QA RECORDS

Not applicable.

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.5: Data Management Revision Receipt and Processing—Revision: 3

ENVIRONMENTAL RESTORATION DEPARTMENT
CONTROLLED COPY
#__________
ERD

AUTHOR(S):
S. Chamberlain

APPROVALS:	**Date**
Department Head	12/17/15
ERD Data Program Leader	11/16/15

CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this procedure is to establish the means for receiving and processing revisions of hard copy analytical result records received from the analytical laboratories. This procedure is to ensure complete and consistent handling of revision records within the Environmental Restoration Department (ERD) Data Management Team (DMT).

2.0 APPLICABILITY

This procedure applies to personnel performing quality-affecting activities in the receipt and processing of revisions of hard copy analytical results, which constitute QA records, under the scope of the Environmental Restoration Department (ERD) Quality Assurance Project Plan (QAPP).

3.0 REFERENCES

Not applicable.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD comply with all pertinent regulations and procedures and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 ERD Data Program Leader (PL)

The PL's responsibility is to ensure that all activities performed comply with all pertinent regulations and procedures, and there is sufficient funding to initiate the work.

SOP Specific Responsibilities

5.3 Contract Analytical Laboratories (CALs)

The CALs are responsible for submitting revised analytical reports to ERD's DMT. If a Data Review Request (DRR) or other correspondence requesting a revision was sent to the CAL, the CAL should submit a copy of the request with the revised analytical report and/or provide a detailed description of the revision in the Case Narrative. A copy of the COC should also be included with the revision. Revised reports must be clearly identified as revisions.

5.4 Data Management Team (DMT)

The DMT is responsible for receiving and processing revised analytical results in accordance with this procedure. The DMT is also responsible for communicating with the CAL regarding corrections or adjustments to CoC requests. DRRs submitted by the QC Chemist are tracked by DMT to ensure the CAL responds in a timely manner. DMT also ensures the CAL sends the required information specified in this procedure.

5.5 Quality Control (QC) Chemist

The Quality Assurance Implementation Coordinator (QAIC) performs the ERD QC Chemist functions and is responsible for reviewing 100% of the analytical data for technical adequacy, internal consistency and quality, determining and flagging data quality, and submitting a DRR to the CAL when additional information or clarification is needed regarding suspect data points, problematic QC results, or other types of possible analytical and/or reporting errors.

6.0 PROCEDURE

6.1 Revision

6.1.1 Date stamp the revised original and stamp "Revision" with a red revision stamp.

6.1.2 Before recording any changes, locate the original hardcopy by checking it out using an orange check out card to match with the Revision sent by the CAL and ensure the appropriate corrections were made as requested.

6.1.3 Record revision receipt in the Taurus Environmental Information Management System (TEIMS) by selecting "SPACT", then "View COCs and Labels"; enter "Lab Log Number or COC_ID, then select "Receive Data" and complete the appropriate fields.

6.1.4 Place in the Validation In/Out Box to be reviewed and initialed by QC Chemist.

Revised reports are passed back to the QC Chemist for review and if the revised report contains original QC data then the report requires validation. Data qualifier flags may be assigned during this process. After reviewing the report, the QC Chemist indicates such by placing a "V" (for Validated), the date, and initials the upper right hand corner of the report cover page. If the revision does not impact the validation status assigned to the original report, then the QC Chemist records an "O" (for Original) instead of a "V", the date, and initials the upper right hand corner.

6.1.5 Make requested copies or scans, as necessary.

6.1.6 Place copy in the appropriate CAL data box.

6.2 Update the TEIMS sample and analysis tables.

6.2.1 Stamp "Superseded by Revision" on front page and write revision receipt date (date revision received by ERD DMT). Attach revision to original hardcopy.

6.2.2 Make necessary changes to the appropriate tables (sample, analysis, anl_comments, suranalys, qc_anal, qc_key).

6.2.3 If database changes are necessary, enter an explanation in the sample table note field with the revision date and your initials.

6.2.4 Date and sign the original revision to verify that the electronic revision was performed.

6.2.5 File original hardcopy with attached revision and remove the orange check out card.

7.0 QA RECORDS

The ERD QA records identified below are to be created, managed, and preserved in accordance with SOP 4.10: Records Management.

7.1 Electronically stored and paper copy analytical records.

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.6: Ground Water Elevation Reports—Revision: 1

ENVIRONMENTAL RESTORATION DEPARTMENT
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#
THIS IS A RED STAMP
ERD

AUTHOR(S):
S. Chamberlain and N. Blankenship*

APPROVALS:	Date
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Hydrogeology & Decision Support Division Leader	1/26/09

CONCURRENCE:	Date
Rebecca Goodrich QA Implementation Coordinator	3/9/09

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

*IAP World Services

1.0 PURPOSE

The purpose of this procedure is to establish the means for receiving, entering, and distributing ground water elevation measurements received each month for Livermore Site and Site 300.

2.0 APPLICABILITY

This procedure is to ensure complete and consistent handling of all ground water elevation measurements for both Livermore Site and Site 300 within the Environmental Restoration Department (ERD) Data Management Team (DMT). ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

Not applicable.

4.0 DEFINITIONS

Not applicable.

5.0 RESPONSIBILITIES

5.1 Department Manager (DM)

The DM's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Project Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

5.3 Hydrogeology & Decision Support Division Leader (HDSDL)

The HDSDL's responsibility is to ensure that proper procedures are followed and activities are conducted safely, consistently, and adequately.

5.4 ERD Data Management Team (DMT)

The DMT's responsibilities are to receive and process ground water measurements as outlined in this procedure.

5.5 Field Personnel (FP)

The FP are responsible for taking ground water elevation measurements by following applicable procedures, including logging measurements onto the current ground water elevation field sheet. As time permits, FP enters the elevations onto an MS Excel spreadsheet. The spreadsheet is emailed to DMT by the FP. If there isn't sufficient time for the FP to finish the data entry to the spreadsheet then it is completed by DMT. The original ground water elevation field sheet with handwritten depths-to-water is to be delivered to the DMT as soon as possible.

6.0 PROCEDURES

6.1 Ground Water Elevation Spreadsheets

Ground water elevation spreadsheets are received by email from Field Personnel.

6.2 Grooming Spreadsheet

Open the previous monthly or quarterly file and save the file using the current month in the filename. Hand enter the new depth to water measurements and dates onto the spreadsheet. Enter note codes into the report_note field (i.e., 'pump off' is in the report_note field as 'PF'). Longer notes (i.e., reasons for no measurements) should be entered in the note field. If POMs (point of measurements) are noted on the fieldsheet, enter these changes in the tcasing_ht field of the well table and recalculate the new well_msrg_pt before moving them into the database. Save the file as an Excel file and save again as a txt format file. The txt file will have an extension, 'xxxxx.txt'.

6.3 Move the files to Oracle holding tables

- From Taurus Environmental Information Management System (TEIMS), select File Upload.
- Step 1: Select appropriate organization, Lab/Task=hand entry, file type.
- Step 2: Browse for desired file and press button for upload.

6.4 Move file to work tables

From Taurus Environmental Management System (TEIMS), select Monitor.

From DMT Tools for Monitor, select Import Holding Tables to Work Tables

Select the Labcode HE (for hand entry) and then select appropriate table (i.e., heerd080924_1620gwelevation.xfer). Press the "Move to Work Tables" button to move the file.

6.5 Calculation and Update

Run gwelevupd_ora.sql from sql templates in TEIMS. This file retrieves well_msrg_pt from the well table and subtracts the depth_water measurement to calculate the elevation. Location identifier (field_loc_id), sampled date (sampled), depth-to-water (depth_water), calculated ground water elevation (elevation), sampling organization (sampling_org), note, retrieved well measuring point (well_msrg_pt), entered date (entered), and project name (project) are stored in the wgwelevation table fields. Set project to either 3GIV or LGIV.

Note: Any change to depth-to-water or POM fields will require a manual recalculation of the ground water elevation in the global table and approval by a Hydrogeologist.

6.6 Verifications

Run gwelevdeldup_ora.sql. Print hard copies.

6.7 Append to Global Ground Water Elevation Table

Append ground water data using the file gwelappend_ora.upd.

6.8 Generate Ground Water Report: Appendix C

Select report gwreport_ora.sql in TEIMS.

Enter the correct area1 (LLNL or S300)

Enter the correct project (LGIV or 3GIV)

Enter the correct date range.

Click the submit button. Download results to a tsv file and open with Excel.

Print report using font size 8, portrait orientation. Distribute report as appropriate.

6.9 Generate Ground Water Difference Report

Select gwelevdif_ora.sql report to calculate the relative difference between the present month and previous month's depths. Adjust the sql.

Put in the previous month and year on the first line. Put in the current month and year on the second line. Modify the date ranges using the current or recent dates from the work gwelevation table and the previous data range from the global gwelevation table. Put in the correct project. Click the submit button and download the results to a tsv files and open with Excel Print report using font size 8, portrait orientation. Check any measurements with a difference of 1 foot or more. Make corrections and re-run as necessary. Distribute final report as appropriate.

6.10 Generate Fieldsheets

6.10.1 Livermore Site

Run sql template LLNL_gwe_field_sheet.sql.

Save as MS Excel spreadsheet.

Email new spreadsheet to Field Personnel to use as the next fieldsheet.

6.10.2 Site 300

Run sql template either s300ewfa_ora.sql or s300 southern_ora.sql.

Save as MS Excel spreadsheet.

Email new spreadsheet to Field Personnel to use as the next fieldsheet.

7.0 QUALITY ASSURANCE RECORDS

7.1 Fieldsheets

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.8: Field Logbook Control—Revision: 4

ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY # ERD	**AUTHOR(S):** **S. Chamberlain**	
	APPROVALS:	**Date**
	Jesse Yow **Department Head**	12/17/15
	[signature] **ERD Data Program Leader**	11/16/15
	CONCURRENCE:	**Date**
	Rebecca Goodrich **QA Implementation Coordinator**	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this procedure is to establish the means for issuing and using field logbooks. This procedure is to ensure complete and consistent handling of all field logbooks within the Environmental Restoration Department (ERD) Data Management Team (DMT).

2.0 APPLICABILITY

This procedure applies to personnel performing quality-affecting activities in the issue and use of field logbooks. ERD work activities are conducted within the framework of the institutional Integrated Safety Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

3.1 Not applicable.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 ERD Data Program Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

SOP Specific Responsibilities

5.4 ERD Data Management Team (DMT)

The DMT's responsibilities are to create, issue, assign, maintain, track custody and status of the field logbooks. When logbooks are completed, the DMT is responsible for archival in accordance with this procedure.

6.0 PROCEDURES

6.1 Issuing the ERD Field Logbook

All controlled logbooks are issued by DMT.

6.1.1 Assign a document control number to the new logbook. ERD field logbooks are controlled documents and must be assigned a **unique** character code by the DMT. Check the logbook file in the appropriate server.

6.1.2 Use only a new bound logbook as kept in supply for controlled field logbooks with consecutively numbered pages, beginning with 1 (one). Place tape (blue for Livermore Site and green for Site 300) approximately one-third from the top and horizontally around the outside of the book.

6.1.3 Put the code on the front and spine of the book.

6.1.4 Write the following information inside the front cover:

- Book code.
- Technician and project name.
- Date.
- Page number for information and signature of recipient in the master logbook.

6.1.5 Apply the stamps that read:

- "If found send to: LLNL, ERD, L-542, P.O. Box 808, Livermore, CA 94551"
- "OFFICIAL LAB DOCUMENT, DO NOT DEFACE!"

6.1.6 Write the following in the document control master logbook:

{unique code} logbook assigned to **{person's name}** for **{project} {date}**

Signed Out:____________________ **{date}**

6.1.7 Have the recipient sign the master logbook upon receipt.

6.2 Completed Field Logbooks

Write the following in the document control master logbook:

6.2.1 Write the date of completion in the master logbook.

6.2.2 Archive returned logbook (see Section 6.3).

6.2.3 Issue a new logbook if work is continuing.

6.2.4 Update logbook spreadsheet on appropriate server.

6.3 Storage of Field Logbooks

Write the following in the document control master logbook:

{unique code} logbook assigned to **{person's name}** for **{project} {date}**

Signed In:____________________ **{date}**

6.3.1 After a project is complete, the field logbook must be returned to the DMT where it is archived.

6.3.2 Those needing a completed field logbook must sign it out from DMT for a specified period of time with an expected return date.

7.0 QA RECORDS

The following documents shall be maintained as ERD Quality Assurance Records:

7.1 Controlled Field Logbooks

7.2 Master Logbook

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.10: Data Management Receipt and Processing Lithology by Electronic Transfer—Revision: 4

ENVIRONMENTAL RESTORATION DEPARTMENT CONTROLLED COPY #________ ERD	**AUTHOR(S):** S. Chamberlain and N. Blankenship*	
	APPROVALS:	**Date**
	Jesse Yow **Department Head**	12/17/15
	[signature] **ERD Data Program Leader**	11/16/15
	CONCURRENCE:	**Date**
	Rebecca Goodrich **QA Implementation Coordinator**	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

*CMG Contract Services

1.0 PURPOSE

The purpose of this procedure is to establish the means for receiving and processing lithology data received by electronic transfer from the Hydrogeologists (HG) of the Environmental Restoration Department (ERD). This procedure is to ensure complete and consistent handling of electronically transferred lithology data within the ERD Data Management Team (DMT).

2.0 APPLICABILITY

This procedure applies to personnel receiving and processing electronically transferred lithology data using the Taurus Environmental Information Management System (TEIMS) database. ERD work activities are conducted within the framework of the institutional Integrated Safety

Management System (ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

Not applicable.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 ERD Program Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

SOP Specific Responsibilities

5.3 ERD Hydrogeologist (HG)

The ERD HG is responsible for reviewing lithologic data entered into the TEIMS Data Mining Tool, Borehole Logging Lithology. Once the lithologic data is in the database, the HG will proof it to confirm accuracy.

5.4 ERD Drilling Geologist (DG)

The ERD DG is responsible for entering relevant lithologic data into the TEIMS Data Mining Tool, Borehole Logging Lithology.

5.5 ERD Data Management Team (DMT)

The DMT's responsibilities are to receive lithologic data and process them as outlined in this procedure and communicate with the ERD Hydrogeologist (HG) regarding necessary corrections or clarifications of reported lithologic data.

6.0 PROCEDURES

6.1 Transfer of data

6.1.1 The DG logs onto TEIMS Data Mining.

6.1.2 Select Borehole Logging Lithology for the appropriate number of lines to be entered, less than 50 or up to 250 lines.

6.1.3 Enter the boring name. For each strata, enter depth of lower contact. Select minor constituent and major constituent from the pick lists.

6.1.4 Once all the lithologic data has been entered, click the 'Do It' button.

6.2 Upload lithologic data to work tables and process data

6.2.1 The DMT logs onto TEIMS Data Team.

6.2.2 Select File Upload.

6.2.3 Set Organization=ERD, Lab/Task=hand_entry, and File Type=LITHOLOGIC.

6.2.4 Browse to designated directory and click on file desired. Click the 'Press' button.

6.2.5 Go to Monitor application, Import Holding Tables to Work Tables, select HEERD*LITHOLOGIC file desired. Click 'Move to work tables'.

6.2.6 Go to SQL Templates and click on wlith.sql. Click submit to run.

6.2.7 Review the output and if any errors are found resolve them. Rerun wlith.sql to confirm all errors have been corrected.

6.3 Append to Global Table

6.3.1 Go to Monitor application, Append Any Table To Corresponding Global Table.

6.3.2 Select WLITHOLOGIC and click submit.

6.4 Verify Lithologic Data

6.4.1 Now that the data is in the global table, the HG can do a query on the desired boring and confirm that the data is correct.

7.0 QA RECORDS

Not applicable.

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.14: Issuing New Parameter Codes
Revision: 1

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ERD

AUTHOR(S):
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Hydrogeology & Decision Support Division Leader	1/26/09

CONCURRENCE:	Date
Rebecca Goodrich QA Implementation Coordinator	3/9/09

Type of Procedure (per ES&H Manual, Document 3.4)

☒ Informational Use ☐ General Use ☐ Continuous Use

1.0 PURPOSE

The purpose of this procedure is to set forth steps by which parameter codes are chosen and assigned for new compounds or properties that need to be stored in the database.

2.0 APPLICABILITY

This procedure applies to personnel performing quality-affecting activities in the creation of parameter codes and parameter aliases for use in the Taurus Environmental Information Management System (TEIMS).

3.0 REFERENCES

3.1 Not applicable.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Department Manager (DM)

The DM's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Project Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

5.3 Hydrogeology & Decision Support Division Leader (HDSDL)

The HDSDL's responsibility is to ensure that proper procedures are followed and activities are conducted safely, consistently, and adequately.

5.4 Contract Analytical Laboratories (CALs)

Analytical laboratories are responsible for submitting requests to ERD's Data Management Team for new parameter codes.

5.5 Parameter Code Designator (PCD)

The Parameter Code Designator (a member of the Data Management Team) is responsible for creating the needed codes for this procedure. The Parameter Code Designator also communicates the new code(s) to the analytical laboratories.

6.0 PROCEDURES

6.1 When one or more parameter codes are requested, the PCD will request or determine from the requester the name and CAS (Chemical American Society) number, if any, of the constituent(s) requiring codes. Often an analytical laboratory will need a new code in order to complete an electronic data deliverable (EDD). In such cases, the Parameter Code Designator will do the following steps as quickly as possible, hopefully within 5 to 10 minutes, while still doing a thorough job.

Note: The following steps are performed by the PCD:

6.1.1 Check the database, both parameter table and parmalias table, for the CAS number and constituent name. Note that not all constituents have a CAS number. If a matching CAS number or constituent name is found, a parameter code already exists and the following steps are not necessary. Call the requester with the existing code(s).

6.1.2 If a parameter code exists for the CAS number, but the requested name is not listed, then the requested constituent name may be a synonym. Check with a chemist, reference books, or the internet to determine if the synonym is correct. If it is a synonym, enter the name into the parmalias table. Use the same parameter code as the existing constituent which already has that CAS number and assign a sequence number appropriate for the alphabetical position in the listing. Call the requester with the existing code(s).

6.1.3 If no matching parameter code(s) are found to match the CAS given by the requester, determine whether the constituent name has a synonym by reviewing reference books, internet, and/or by consulting a chemist. If the constituent does not exist in the database under a different name, assign it a parameter code as described below.

6.1.4 Locate an unused code number from the parameter list. If possible in a timely manner, choose a number that is near where the constituent would be alphabetically. Such a selection is not always possible.

6.1.5 Select a sequence number that will place the parameter in the correct alphabetical order. If necessary, adjust nearby sequence numbers to maintain alphabetical order.

6.1.6 Enter the new information in the database.

6.1.7 Call the requester and give them the new parameter code(s) and sequence number(s), if requested.

6.2 Tentatively Identified Compounds

6.2.1 If the constituent requested is a tentatively identified compound (TIC), no new parameter code is issued, unless:

1. The TIC has been reported previously more than 10 times. Do a query on the tic analysis table to locate any records for that specific constituent. If a new code is issued, tic analyses records must be updated with the new code.
2. A scientist requests a code based on his understanding that it is a constituent of interest.

6.2.2 If a code is requested for a TIC and it has been determined that no new parameter code will be issued, explain to the requester how to use parameter codes 9800 through 9809. These codes are used for TICS and the lab_analyte and comment fields in the EDD analysis file are to contain the TIC name and retention time and CAS number, if known. Each log number can have a maximum of 10 TICS. If there are more than ten TICS per log number for which there are no existing parameter codes, consult the PCD.

7.0 QUALITY ASSURANCE RECORDS

Not applicable.

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.15 Preparation of Required Routine Groundwater and Treatment Facilities Sampling Plans—Revision: 2

ENVIRONMENTAL RESTORATION DEPARTMENT
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#__________
ERD

AUTHOR(S):
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APPROVALS:	**Date**
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[signature] **Livermore Site Program Leader**	11/16/15
Leslie Ferry **Site 300 Program Leader**	8/26/15
CONCURRENCE:	**Date**
Rebecca Goodrich **QA Implementation Coordinator**	12/17/15

Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to set forth steps by which the required Routine Groundwater and Treatment Facilities Sampling Plan for S300, S200, and the Environmental Functional Area (EFA) Water Monitoring Group (WMG) are prepared.

2.0 APPLICABILITY

This procedure applies to the development of the Livermore Site 200 and Site 300 required Routine Groundwater and Treatment Facility Sampling Plan for the Environmental Restoration Department (ERD) and the Environmental Functional Area (EFA). ERD work activities are conducted within the framework of the institutional Integrated Safety Management System

(ISMS). The Environmental Management System (EMS) is a component of the ISMS, which is also supported during the planning, performing, and evaluation of the work processes.

3.0 REFERENCES

Not applicable.

4.0 DEFINITIONS

Not applicable.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.3 Program Leader (PL)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

SOP Specific Responsibilities

5.4 Hydrogeologist (HG)

The HG reviews the plan and provides necessary revisions to ensure consistency with sampling requirements and other Program data needs.

5.5 Statistician (ST)

The ST works with the algorithm expert developing the algorithm.

5.6 Activity Leader (AL)

Personnel who are responsible for specific tasks, e.g., writing assigned sections of compliance monitoring reports and reviewing analytical data for internal consistency prior to inclusion of data in reports.

5.7 Quality Assurance Implementation Coordinator (QAIC)

The QAIC is responsible for reviewing sampling plans and for working with ERD Project Staff in determining appropriate analytical test methods to meet data quality objectives (DQOs). When needed tests are not contractually available the QAIC will request a new test by means of a Contract Modification.

5.8 Sampling Coordinator (SC)

Once well development is complete and the SC is notified, the SC will add the well to the Routine Ground Water Sampling Schedule. The SC also provides a quarterly list of locations designated to collect collocated samples and field blank samples for Quality Control (QC). The selected monitor well locations must have chemical contamination in order to compare QC results.

5.9 Field Personnel (FP)

The FP are responsible for the safe completion of evacuating and sampling ground water monitor wells per the quarterly sampling plans and the treatment facilities per the Compliance Monitoring Plan.

5.10 Data Management Team (DMT)

The DMT, in affiliation with the SC, maintains an electronic record of the sampling plan, its implementation, and the receipt of resulting analytical data The DMT provides, upon request, reports of the sampling plan, the status of particular planned or collected samples, and the status and/or content of resulting analytical data. Furthermore, the DMT supports the AL, SC, and FP by supplying clarification of sample identification and requested analysis codes used on CoC forms.

6.0 PROCEDURES

6.1 Cost Effective Sampling (CES) Algorithm Process.

The CES Algorithm process applies to the LGIV Driver Code only.

6.1.1 This Section 6.1.1 is for LGIV Driver paying account owners only:

Six weeks prior to the new quarter DMT provides the previous quarter location list to the HG or their designee. The HG reviews and updates the location list and returns it to the DMT.

The DMT updates the locgroups table to reflect changes to the location list and notifies the ST when it is completed.

The Cost Effective Sampling (CES) Algorithm is run by the ST using the updated location list. See SOP 5.20, "Cost-Effective Sampling Algorithm Preparation."

The ST notifies the HG when the Algorithm has been run.

The HG reviews the CES Algorithm recommendations. The HG overrides algorithm recommendations as necessary and sends the updated CES Algorithm back to the ST. Note: The HG can only increase the frequency recommended by the CES algorithm.

The ST reruns the algorithm and notifies the HG. The HG reviews the results of the adjusted CES algorithm recommendations for each monitor well and piezometer.

The HG then develops the routine quarterly sampling plan Excel spreadsheet and sends the sampling plan to DMT. DMT inputs the sampling plan into SPACT.

6.2 Create and Distribute Draft Sampling Plan.

For LLNL and Site 300 routine and treatment facility sampling plans, the DMT distributes the draft sampling plan to the HGs, EFA analysts, and FP as appropriate. A review period is provided for input and changes to the draft plan. The sampling plan tables are then updated according to input received.

6.2.1 Log in to TEIMS. Select "Data Team". Select "SPACT_Upload".

Select "SPACT II - Sample Planning". In the "Create Plan" column, enter driver_code, year, quarter. Click "Submit Plan Create". Select "Data Team", In Templates, Select SQL. Select "Sampling" and choose appropriate query. sampling_plan_LLNLreport.sql for Livermore Site 200, sampling_plan_S300report.sql for S300). In the query update the year, the quarter, and the op_unit_set_name. Run query. Download query output as tsv file, and save as an Excel spreadsheet. Save spreadsheet as the DRAFT Sampling Plan.

6.3 Update Sampling Plan Tables with Sampling Recommendations.

The appropriate electronic records are updated, by DMT, to reflect the recommendations from the HGs, EFA analysts, and FP, in the driver_events, op_unit, op_unit_set_names, driver_op_unit_accounts, field_locations,samp_collect, locgroups, location, area2, pci_map tables. Delete the draft sampling plan, re-create Sampling Plan, finalized Sampling Plan, and create an achievable copy of the plan.

6.3.1 Delete Draft Sampling Plan, and re-create an updated Sampling Plan.

Log in to TEIMS. Select "Data Team",SPACT_Upload". Select "SPACT II, Sample Planning": Highlight appropriate Plan Code from "Delete/Finalized Plan(s)" list to delete the existing plan choose "Submit Delete Plan". In "Create Plan" column, select: "driver_code", "year", "quarter". Choose “Submit Plan Create”: to re-create plan.

6.3.2 Editing, verifying, and proofing Sampling Plan(s).

Log in to TEIMS. Select "Data Team" In template section, Select "SQL", Select "Sampling" and choose appropriate query: "sampling_plansLLNLreport.sql" for Livermore Site 200, and "sampling_plan_S300report.sql for S300".

Update query by choosing appropriate driver_code, year, quarter, op_unit_set_name Run query. Download query output as tsv file, and save it as an Excel spreadsheet. Print file. Proof output 100% against the final Sample Plan recommendations from the HGs, EFA analysts, and FP spreadsheet.

Run Sampling Plan verifications.

Login to TEIMS, Select "Data Team". Select "Spact_Upload", In the "Verification Scripts" section, choose "pa_prep verify". Run verifications.

If changes are made to the existing plan delete existing plan and re-create plan.

Login to TEIMS, Select "Data Team". Select "Spact_Upload". Select "SPACT II". Highlight appropriate Plan Code from "Delete/Finalize Plans(s)" column.

Choose “Submit Delete Plan”: Re-Create Plan as in Section 6.3.1. Edit, verify and proof Sampling Plan as in Section 6.3.2. Repeat Sections 6.3.1 and 6.3.2 until all records are correct.

6.4 Finalize Sampling Plan.

6.4.1 Login to TEIMS. Select "Data Team". Select "Spact_Upload". Select SPACT II - Sampling Planning". Highlight appropriate Plan Code in the "Delete/Finalize Plan(s) "column. Highlight plan and select “Submit Finalize Plan”. Plan will be removed from "Delete/Finalize Plan(s)" column and appear in "Finalized Plans (Current & Next quarter) column.)".

6.5 Duplicate Sample Check in Sampling Plan.

Check for duplicate sample rows and decide which of the duplicate rows will be removed, if any:

6.5.1 Login to TEIMS. Select "Data_Team". Select Spact_upload. Select "View Possible Duplicate Planned Analyses". Enter op_unit_set_name, year, quarter. Choose “View Duplicates”. If duplicates rows are found, identify rows which will not be used in the sampling plan because another row will satisfy the sampling requirements, by adding the PAID from the row you want to keep in the sampling plan to the “BASE_PAID” field in the row you don’t want to keep in the sampling plan, and choose “Submit All Changes”.

6.6 Add QA Samples to Sampling Plan(s).

6.6.1 Login to TEIMS. Select "Data Team". Select Spact_Upload. Select "Create QA Samples".

Add a blinded QA (Intra Lab Duplicates) sample row, find the row of the actual sample location name. Click on Lab_loc_name (Single QA) DUP link for that row. Enter the blinded QA sample location name.

Add Intra Lab Duplicates (blinded QA) samples, provided by the SC, to the sampling plan, two samples taken at the same sampling location, during the same sampling event, for the same requested analysis. Both samples sent to the same analytical lab using the actual sampling location name for one of the samples, and a blinded QA name for the second sample.

Add Inter Lab Duplicates samples, provided by the SC, to the sampling plan, two samples taken at same sampling location, during the same sampling event, for the same requested analysis. Samples are sent to different analytical labs, using the actual sampling location name for both. Note: The Site 300 SC provides the Field Blank IDs to DMT.

Add Inter Lab Duplicates sample row, find the row of the actual sample location name. Click on the Labcode (single QA) DUP link for that row. Enter the labcode for the second sample.

6.7 Create Sampling Redundancy Report to check for redundant sampling for S200.

6.7.1 Login to TEIMS. Select "Data Team". Select "Spact_Upload". Select "Sampling Redundancy Report". Select Appropriate "requested analysis" and "Driver Code Set". Select "Display Current and Previous Qtr" and " Display Current and Next Qtr". Send output report to appropriate HG. Make changes per HG's recommendations.

6.8 Create Archived Sampling Plan(s) to preserve original sampling plan(s).

6.8.1 Log into TEIMS. Select "Data Team". Select "Spact_Upload".

Select "Copy Plan to PA_AS_CREATED (save a pristine copy of the plan)". Highlight the appropriate plan. Select "Copy_to_PA_as_created". Electronically store the finalized sampling plan on erdfilespace.

6.9 Create Sampling Event records in SPACT.

Create sampling events for samplers to schedule sampling events, create and print Chain of Custody's, and sample bottle labels.

6.9.1 Log into TEIMS. Select "Data Team". Select Spact_Upload". Select "Create Sampling Events". Select op_unit_set_name, norm_year, norm_qtr. Select "View Groupings". Select appropriate rows. Select "Create Sampling Events". Notify samplers the sampling plan is ready to schedule sampling events.

6.10 Electronic Ground Water Sampling Data Sheets.

Electronically generated ground water sampling Data Sheets are produced from SPACT by the FP at the time the COC is created.

6.11 Revise Final Sampling Plan.

A request must be made via email to modify the final SPACT plan after the quarter begins. The requested change will result in modifying the SPACT tables. Modification of the sampling plan is highly recommended during the draft development phase and not after the quarter has begun and the plan has been finalized.

7.0 QA RECORDS

7.1 Copy of the Sampling Plan. See section 6.8.

8.0 ATTACHMENTS

Not applicable.

LLNL Environmental Restoration Department (ERD)
Standard Operating Procedure (SOP)

ERD SOP 5.20: Cost Effective Sampling (CES) Algorithm Preparation—Revision: 2

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#
ERD

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Type of Procedure (per ES&H Manual, Document 3.4)

☒ **Informational Use** ☐ **General Use** ☐ **Continuous Use**

1.0 PURPOSE

The purpose of this SOP is to prepare statistically-based ground water sampling frequency recommendations. The method used to produce the recommendations is referred to as the Cost Effective Sampling (CES) Algorithm.

See the references for information about the CES methodology.

2.0 APPLICABILITY

Applicability of the CES algorithm to particular wells and analytes is decided on a case-by-case basis by ERD project staff. In general it is applicable to wells being used for routine monitoring of known ground water contaminants, and is not applicable to wells in active use for remediation, such as pump and treat wells. Currently the CES algorithm is used only at the Livermore Site, so this SOP applies only to Livermore Site wells and analytes.

This document focuses primarily on tasks to be performed by individuals referred to as the "Algorithm Custodian" (AC) and the "Algorithm Reviewer" (AR). These roles may be referred to below using the acronyms (AC and AR). Additional roles are described in Section 5.0.

3. REFERENCES

3.1 Goodrich, R. and G. Lorega (2012). SOP-5.15, "Preparation of Required Routine Groundwater and Treatment Facilities Sampling Plans" (UCRL-AM-109115 Rev. 14).

3.2 Ridley, M. R. (1999). Cost-Effective Sampling of Groundwater Monitoring Wells: A Data Review & Well Frequency Evaluation (UCRL-AR-133310).

3.3 R Core Team (2014). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

4.0 DEFINITIONS

The following definitions are specific to this procedure:

CES Algorithm	The Cost Effective Sampling (CES) Algorithm is a system that is used to prepare statistically-based ground water sampling frequency recommendations. See references 3.1 and 3.2.
CES Algorithm run	The use of the CES Algorithm computer codes to produce sampling frequency recommendations.
CES Cutoffs	The criteria used by the CES Algorithm to determine a sampling frequency.
CES Planning quarter	The quarter for which sampling frequency recommendations are being produced.
CES Previous quarter	The quarter before the planning quarter.
CES Raw recommendation	A recommendation produced by the CES algorithm computer program, before review by any human being.
CES AR recommendation	An algorithm-based recommendation after review by the AR.
CES Final recommendation	A sampling frequency recommendation made by the project staff after consideration of the AR recommendation.

CES Working directory — The Linux directory containing the computer files for the CES algorithm run being performed for the CES Planning quarter.

5.0 RESPONSIBILITIES

Programmatic Responsibilities

5.1 Department Head (DH)

The DH's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures including the institutional work planning and control process, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Program Leader (PL) and/or Authorizing Individual (AI)

The PL's responsibility is to ensure that all activities are performed safely and comply with all pertinent regulations and procedures, work is authorized through an Integration Work Sheet (IWS), and there is sufficient funding to initiate the work.

SOP Specific Responsibilities

5.1 Algorithm Custodian (AC)

The algorithm custodian is responsible for performing routine algorithm runs. The algorithm custodian is responsible for computer source code development and maintenance, under the direction of the algorithm developer. This procedure assumes that the Algorithm Custodian is familiar with the Linux operating system, R software, the TEIMS database, and structured query language (SQL) database programming.

5.2 Algorithm Reviewer (AR)

The AR is responsible for providing recommendations for cases in which the algorithm was unable to produce a recommendation. In addition, for wells and chemicals where the algorithm recommendations are used as minimum-permitted sampling frequencies, only the AR is authorized to increase the sampling frequency relative to the raw recommendation.

5.3 Project Staff

Project staff consists of scientists, hydrogeologists, and engineers responsible for deciding which wells and chemicals are submitted to the CES algorithm, and for using the algorithm recommendations to produce a sampling plan.

5.4 Algorithm Developer (AD)

The algorithm developer is the individual most responsible for developing and evaluating the algorithm methodology.

5.5 Sampling Coordinator (SC)

The sampling coordinator is the individual responsible for scheduling the sample collection effort.

5.6 Sampling Plan Custodian

The sampling plan custodian maintains lists of algorithm wells and an electronic version of the final sampling plan in the database.

6.0 PROCEDURES

The algorithm is run quarterly to generate recommendations for the following calendar quarter (the CES planning quarter). Normally, an algorithm run is initiated about four to six weeks before the beginning of the planning quarter. The initiation of the algorithm begins with the process described in SOP 5.15 "Preparation of Required Routine Groundwater and Treatment Facilities Sampling Plans".

6.1 Procedure Overview

Steps to perform an algorithm run are these:

1. Project staff review and update the list of wells included in the algorithm run. The list of guard wells is reviewed and updated.
2. The algorithm custodian archives the previous quarter's run, then performs a run to generate "raw" recommendations for the planning quarter.
3. The algorithm reviewer identifies cases where the algorithm was unable to make a recommendation (if any) and makes recommendations for such cases.
4. The algorithm custodian prepares the AR recommendations for review by the project staff. Graphs of the data with AR recommendations are made available on the "Data Mining" website.
5. Project staff review the AR recommendations to identify wells at which more frequent sampling is appropriate.
6. Project staff submit the final sampling decisions to the sampling plan custodian.

See Section 5.0 for a more detailed description of the steps performed by the Algorithm Custodian and Algorithm Reviewer.

6.2 Computer Resources

The software components of this system include:

- Analytical results from ground water samples stored in a relational database management system (RDBMS).
- Computer programs that perform the algorithm calculations.
- Data transfer capability between the algorithm software and the database.
- Spreadsheets.
- A web server.
- Scripts used by the web server to display the algorithm results in a browser.

At present the database, named TEIMS, is maintained using Oracle® software. The algorithm calculations use R software (reference 3.3), and the spreadsheets use Microsoft Excel.®

The computer hardware components of this system include:

- Linux servers.
- Personal desktop computers.
- Hard disk space sufficient to store the necessary computer files.
- Network connections between the Linux and desktop systems.

The Oracle database runs on a Linux system. The R software runs in the command line environment included with the Macintosh Operating System. It may also be run in a Linux command line environment. The spreadsheets reside on standard desktop computers.

All CES algorithm files are stored in the CES file system. The top level, or root, CES directory in the ERD Linux environment is `/erd/statistic/project/ces`. The CES root directory name should stored at the operating system level in the environment variable CESHOME. This is normally done in the algorithm custodian's shell initialization scripts.

Table 1 lists the principal subdirectories of $CESHOME and their purposes.

Table 1. Principal CES algorithm subdirectories.

Directory	Description
support/rces	R scripts and function definitions
support/rpkg	R code to define the R packages named "cesn" and "rrevn"
support/rwww	Computer programs used for review of the recommendations via the web server

6.2.1 Algorithm Run Identification

Each algorithm run is uniquely defined by the set of wells specified for the run, the analytes that are evaluated at those wells, and the planning quarter.

Previous usage of the CES algorithm employed a system of abbreviations to refer to various different sets of wells and analytes, but this is currently not necessary, as CES is currently used only at the Livermore Site for one set of wells and analytes. Internally, the computer programs retain these abbreviations, but their values do not need to be changed from one run to the next.

6.2.2 Algorithm Run Directories

The root directory for Livermore Site runs is named $CESHOME/s200. Within the Livermore Site root directory there is a directory for each algorithm run. The directory representing the planning quarter is always named "r-crnt". The previous quarter's directory is always named "r-prev". Directories for runs previous to those have names of the form `r-yyyy-q`, where `yyyy-q` represents the four digit year and the quarter.

Table 2 shows some example directory names, assuming that the planning quarter is Q2014-3.

Table 2. Example of Livermore Site VOC algorithm run directory names, using Q2014-3 as an example planning quarter.

Working directory name	Description
`$CESHOME/s200/r-crnt`	Used while performing runs planning for Q2014-3
`$CESHOME/s200/r-prev`	Previously used for planning for Q2014-2
`$CESHOME/s200/r-2014-1`	Archive of the directory used for planning for Q2014-1

6.3 Algorithm Custodian Tasks

The following is a concise summary of the steps to follow.

1. Verify that the lists of wells have been reviewed and, if necessary, updated.
2. Archive the existing previous quarter directory by renaming it from "r-prev" to "r-yyyy-q".
3. Rename the existing planning quarter directory from "r-crnt" to "r-prev".
4. Create a new planning quarter directory named "r-crnt" by copying the entire "r-prev" directory including all of its contents.
5. Move to the new planning quarter directory.
6. Remove old output files.
7. Update the control files "cesprep.r" and "cesctrl.r" to reflect the new planning quarter.
8. Review the control files and make any other necessary changes. With one exception described below, changes are rarely needed for routine runs.
9. Run the R script `runprep.r`.
10. Run the R script `getdat.r`.
11. Run the R script `runalg.r`.
12. Run the R script runae`.r`.
13. Review the recommendations in the RDBMS and update as needed (Section 6.1, step 3).
14. Run the R script `runtl.r`.
15. Review the recommendations in the RDBMS and update as needed (Section 6.1, step 5).
16. Run the R script runfnl`.r`.

The following sections provide details and indicate who is responsible for the above steps.

6.3.1 Verify that the well list has been reviewed (Section 6.3, step 1)

The sampling plan custodian gives the project staff a list of wells currently designated for the algorithm run. The project staff review the list. If there are changes the project staff inform the sampling plan custodian, who updates the list. This is also done for the list of guard wells. The sampling plan custodian then informs the algorithm custodian that the lists are ready.

The lists of wells for each site are maintained in the database table `locgroups`. The location group names for VOCs at the Livermore Site is "`alg_ls`". New location groups would be created if needed for a new site, a different set of wells, or different analytes.

6.3.2 Create a directory for the planning quarter (Section 6.3, steps 2 through 5)

The algorithm custodian performs this step.

Login to a computer in the ERD network and move to the appropriate site and www group directory (see Section 6.22). Currently this is $CESHOME/s200 for Livermore Site runs.

Create the new working directory. This is can be done as follows:

1. Archive the existing "r-prev" directory by changing its name to "r-yyyy-q" (replace "yyyy-q" with the appropriate year and quarter; see Table 2 for an example).
2. Rename the existing current quarter directory from "r-crnt" to "r-prev".
3. Copy the entire previous quarter's directory (the one that was renamed "r-prev" in step 2) into a new directory named "r-crnt".

Move to the new "r-crnt" directory and prepare it for the current quarter. Assuming that it was created by copying "r-prev" as in step 3 above, delete all files within the "in" and "out" subdirectories (because they are last quarter's files). Also delete all files with suffixes ".lst" and ".out".

The "out" and "in" subdirectories are no longer essential because the review process is now done directly in the RDBMS, but they are being retained in case they are needed in the future.

out Contains R script output files that may be used by reviewers.

in Contains spreadsheets after they have been reviewed.

6.3.3 Prepare Command and Control Files (Section 6.3, steps 7, 8)

There are two categories of files necessary to perform an algorithm run: command files and control files. In addition, there should be an informational file named README. The algorithm custodian prepares them as described below.

Command files contain the computer programs that perform the algorithm run. The required command files are:

```
runprep.r
```

```
getdat.r
runalg.r
runae.r
runtl.r
runfnl.r
dbcon.r
```

Control files contain specifications that control various aspects of how the run is performed. The required control files are:

```
cesctrl.r
cesprep.r
cutoffs.s00
mcls.s200
```

Inspect the README file from the previous quarter for any notes that may have relevance for the planning quarter. Add notes as needed. Update it to refer to the planning quarter.

In `cesctrl.r` and `cesprep.r` update all references to the planning quarter. Use the format `yyyy-q` for the quarter (`e.g., 2014-1`).

In `cesctrl.r`, update the values of the variables `basedate`, and `cutdate`. Normally, `basedate` is one month before the beginning of the planning quarter and `cutdate` is the beginning of the planning quarter.

Review the values of `shistlo`, and `shisthi`. These need to be updated once per year. Normally, `shisthi` is the year of the previous quarter and `shistlo` is 3 years before. For example, if planning for Q2015-1, then `shistlo=2011` and `shisthi=2014`, but when planning for Q2015-2 then `shistlo=2012` and `shisthi=2015`.

If instructed to do so by the algorithm developer, edit other variables in `cesctrl.r` or the values in the `cutoffs.s200` or `mcls.s200` files, and make a note in the README file.

All of the command files should have comments near the beginning of the file that include the filename, the date the file was created, and any other comments that may be useful.

The “dbcon.r” file contains information that specifies how the R software connects to the database. Normally this does not need to be changed.

6.3.4 Prepare CES RDBMS tables (Section 6.3, step 9)

The algorithm custodian performs this step. If necessary, login to a Linux computer in the ERD network and move to the working directory.

Execute the R script that prepares the CES RDBMS tables by typing “R” at the Linux prompt to start the R software. Then type

```
source('runprep.r')
```

This step updates database tables that store the current lists of wells, analytes, and guard wells, based on the lists prepared in step 6.3.1.

6.3.5 Retrieve data from the RDBMS (Section 6.3, step 10)

The algorithm custodian performs this step. If necessary, login to a Linux computer in the ERD network and move to the working directory.

Execute the R script that retrieves data from the database by typing “R” at the linux prompt to start the R software. Then type

```
source('getdat.r')
```

This step retrieves data for the specified wells and chemicals.

Review the file `getdat.lst` for information about the data that was retrieved.

6.3.6 Calculate raw recommendations (Section 6.3, step 11)

The algorithm custodian performs this step. If necessary, login to a Linux computer in the ERD network and move to the working directory.

Execute the R script that calculates the CES raw recommendations by typing “R” at the linux prompt to start the R software. Then type

```
source('runalg.r')
```

This step fits statistical models to the data, compares the results to criteria in the cutoffs, guard, and mcls files, and determines recommended sampling frequencies.

Review the file `runalg.lst` for error and warning messages.

6.3.7 Prepare for review by Algorithm Reviewer (Section 6.3, steps 12, 13)

The algorithm custodian performs this step. If necessary, login to a Linux computer in the ERD network and move to the working directory.

Execute the R script that prepares for AR review by typing “R” at the linux prompt to start the R software. Then type

```
source('runae.r')
```

Inform the AR that new raw recommendations are ready for review in the RDMS.

6.3.8 Prepare for review by project staff (Section 6.3, steps 14, 15)

The algorithm custodian performs this step after AR review from step 6.3.7 is complete. If necessary, login to a Linux computer in the ERD network and move to the working directory.

Execute the R script that prepares for staff review by typing “R” at the linux prompt to start the R software. Then type

```
source('runtl.r')
```

Inform project staff that the CES recommendations are ready for review in the RDBMS.

This step also prepares for the graphical review program that is accessed via the WWW. The WWW review page is within the password protected “ERD Only” internal web pages.

6.3.9 Prepare for implementation in sampling plan (Section 6.3, steps 16)

The algorithm custodian performs this step after staff review from step 6.3.8 is complete. If necessary, login to a Linux computer in the ERD network and move to the working directory.

Execute the R script that prepares for staff review by typing “R” at the linux prompt to start the R software. Then type

```
source('runfnl.r')
```

Inform project staff that the final CES recommendations are ready to be used to update the Site 200 Routine Groundwater Sampling Plan.

6.3.10 Data Storage

The computer program files, log files, output files, and input files are kept online for at least one year. Backups are kept using the ERD domain backup system.

7. QA RECORDS

The final Site 200 Routine Groundwater Sampling Plan is the QA Record for this procedure.

8. ATTACHMENTS

Not applicable.

SOP Glossary

Accuracy

The ability of a procedure to determine the “true” concentration of an analyte.

Adsorption

A physical phenomenon whereby molecules adhere to a surface with which they come into contact.

Affected Worker

An LLNL worker or supplemental labor worker who is not performing servicing or maintenance on equipment but who typically operates or works in the vicinity of such equipment.

Air Lifting Pumping

The process by which well water is hydraulically forced to the surface by lowering its specific gravity by pumping compressed air through an air line into a submerged eductor pipe (Driscoll, 1986).

Alkalinity

Alkalinity of a water is its acid-neutralizing capacity. Because the alkalinity of many waters is primarily a function of carbonate, bicarbonate, and hydroxide content, it is taken as an indication of the concentration of these constituents.

AMS-TR7000

Art’s Manufacturing & Supply, Inc. Well Management System.

Analytical Result

Report of data obtained from analysis, observation, or measurement.

Annulus

The space between the drill string or casing and the wall of the borehole.

Applicable or Relevant and Appropriate Requirements (ARARs)

ARARs are legally applicable or relevant and appropriate requirements, as used in Comprehensive Environmental Response, Compensation and Liability Act of 1980.

Aqueous Phase Carbon

Carbon used for adsorbing contaminants in water.

Archaeological Survey

For Site 300, a mandatory survey conducted by a trained archaeologist to inspect an undisturbed area for archaeological interest prior to conducting environmental activities.

ASCII

An acronym for American Standard Code for Information Interchange. ASCII defines the codes the computer uses internally to store letters, numbers, punctuation, and some control codes.

Bailer

A bailer is used for grab sampling or for evacuating small diameter wells or larger diameter wells with low yields and/or small casing volumes. A bailer is a small-diameter cylindrical-shaped tube made from Teflon, stainless steel, polyvinyl chloride (PVC), or polyethylene materials. A check ball is housed in the bottom of the tube. The check-ball rises as the tube is lowered downhole allowing the tube to fill with water. As the tube is raised to the surface, the check-ball seats, preventing water loss. To collect a sample from the tube, a bottom-emptying device is inserted into the tube which expels the water. Appropriate sample containers are then filled.

Base Station

Also called a reference station. A receiver that is set up at a known locations specifically to collect data for differentially correcting rover files. The base station calculates the error for each satellite and, through differential correction, improves the accuracy of GPS positions collected at unknown location by a roving GPS receiver. You can use a Trimble GPS Community Base Station or a Trimble GPS receiver in base station mode.

Batch

A group of 20 samples or less, of similar matrix type, prepared together or analyzed together if no sample preparation is required, under the same conditions and with the same reagents.

Biological/Ecological/Archaeological Survey

For Site 300, a mandatory survey conducted by a trained biologist to inspect an undisturbed area for endangered species or sensitive habitats prior to conducting environmental activities.

Blind Collocated Samples

Blind collocated samples are samples that have their real identifications replaced with fictitious identifications prior to submittal to analytical laboratories.

Borehole

Any penetration of the ground surface created by drilling equipment.

Borehole Rugosity

Borehole wall roughness or irregularities in borehole diameter.

Borehole/Well Construction Log

A data collection form completed during drilling and well construction activities describing the lithology, well completion, and soil sampling details.

Breakthrough

A stage at which carbon (GAC) is unable to adsorb any more contaminants.

Bridging

An obstruction in the drill hole or annulus. A bridge is usually formed by caving of the wall of the borehole, by the intrusion of a large boulder, or by filter pack materials during well completion.

Calibration

The comparison of a measurement, standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies, and to report or eliminate those inaccuracies by adjustments.

Capable of Being Locked Out

An energy isolating device is capable of being locked out if it has a hasp or other means of attachment to, or through which, a lock can be affixed, or it has a locking mechanism built into it. Other energy isolating devices are capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild or replace the energy isolating device, or permanently alter its energy control capability.

Calibration Blanks

Calibration blanks are prepared and analyzed with standards to create a calibration curve. A calibration blank should differ from other standards only by the absence of an analyte and provide the “zero-point” for the curve.

Centralizer

A device used to keep the well casing centered within the borehole.

Chain-of-Custody (CoC)

A method and record used for documenting the history and sequential possession of a sample from the time of collection or generation through analysis and data reporting.

Christy Box

A cement or steel enclosure for below-grade completed monitor wells installed in areas of vehicular traffic.

Cleanwell Program

A program that produces a printout of pertinent information regarding “hits” in sampled locations where no hits should be observed.

Collocated Samples

Collocated samples are independent samples collected in such a manner that they are equally representative of the parameter(s) of interest at a given point in space and time.

Controlled Document

A document that is prepared, reviewed, approved, and distributed in accordance with established implementation procedures. Controlled documents are subject to controlled distribution and to a defined and controlled change process.

Contaminants

Chemicals or substances detrimental to human health.

Core

A continuous columnar sample of sediment or rock extracted from a borehole during air, mud-rotary, or hollow-stem auger drilling using a core barrel or split-barrel sampler.

Core Barrel Sampler

A reaming shell and length of tubing used during drilling to collect subsurface samples in unconsolidated or bedrock formations.

Core Run

An uninterrupted drilling sequence that results in the cutting (coring) of an interval of sediment or rock from a borehole. The length of a core run interval is determined by the driller and is based on the rig and drilling conditions.

Cost Effective Sampling (CES)

A methodology with supporting software, for estimating an appropriate frequency (and, as a result, lowest cost) of a sampling schedule for a given ground water monitoring location and still provide needed information for remedial and compliance-related decision making. The CES algorithm bases sampling frequency decisions on quantitative analyses of the trends and variability of important contaminants (e.g., volatile organic compounds) at a given monitoring location.

CSV

An ASCII file containing field values separated by commas.

Data Dictionary

Information that describes features that will be located in the field. This description includes feature names, data type classification (point, line or area), attribute names, attribute types, and attribute values. After being created on a PC, a data dictionary is downloaded to a data collector and used when collecting data in the field.

Data Logger

A data logger is used to acquire data from analog or digital sensors and to log these data in a digital format. These devices can use analog to digital converters to collect data from analog sensors such as thermistors, thermocouples, net radiometers, pressure transducers, soil moisture sensors, wind direction sensors and sonic anemometers. They can also acquire data from sensors that produce signals in the form of a pulse such as wind speed sensors, radiation sensors, motor speed sensors and flow meters. Once the data logger has acquired these data, they are stored in the data loggers' electronic memory along with other information, such as the time and date that they are collected. Periodically, these data are transferred from the data logger to a computer where they can be processed and stored for future use.

Differential Correction (Differential GPS, DGPS)

The process of correcting GPS positions at an unknown location with data collected simultaneously at a known location (base station). Differential correction usually applies to receivers that use C/A code positioning techniques. The process of differentially correcting one receiver's location relative to another's can be done during post processing or in real-time, if radios are used.

Dip

The maximum angle of inclination from the horizontal of bedding or other planar features. The angle is measured in a vertical plane perpendicular to the strike.

Dissolved Oxygen (DO)

DO is the amount of oxygen dissolved in water at a given temperature. The dissolved oxygen content of a water sample at the time of collection is measured in milligrams per liter (mg/L).

Document

Any written, pictorial or electronically stored information describing, defining, specifying, reporting, or certifying activities, requirements, plans, procedures, or results. A document is not considered to be a QA record until it satisfies the definition of QA record.

Document Control

The process that provides for document adequacy review, approval for release by authorized personnel, and distribution for use at the prescribed work locations.

Double Blind Samples

A double blind sample is a performance evaluation (PE) check sample, which is submitted to the laboratory. The sample is disguised to look like a routine sample; therefore, the laboratory does not know it is a PE.

Drill Cuttings/Laydown Area

The Drill Cuttings/Laydown Area is located at the Livermore Site. The entrance to the Drill Cuttings/Laydown Area can be accessed from Outer Loop Road, south of East Gate Drive. It consists of two separate bermed storage pits inside a larger bermed area used as a temporary storage for drilling derived soils and drilling fluid.

This area can be used to store drilling derived soil cuttings and used drilling fluid when their chemical concentrations are equal to or below the Livermore Site background concentrations for contaminants of concern.

The gravel road on the perimeter of these storage pits is also used as a laydown area by the drilling contractor for drilling supplies and drilling related equipment.

Drilling Workplan and Sampling Plan

A detailed document describing the procedures used to collect, handle, and analyze sediment or rock samples to ensure that data quality objectives are met.

Duplicates

Duplicates are additional aliquots of a sample that are subjected to the same preparation and analytical scheme as the sample. The duplicate measures the precision of a given analysis and is expressed as the relative percent difference.

Edit Report

A printed report showing data from within a set of working tables. The printed report is used for proofreading and verification purposes.

Ephemeris

A list of predicted (accurate) positions or locations of satellites as a function of time. A set of numerical parameters that can be used to determine a satellite's position.

Electrical Conductivity (EC) or Specific Conductance

EC is a measure of the ability of a material to conduct a current under the influence of an applied electric field. It is the reciprocal of resistivity and is measured in micro-mhos/cm (μmhos/cm).

Electrical Resistivity

A physical property of materials which limits or opposes the flow of electrical current. Electrical resistivity is the inverse of conductivity and commonly measured in units of ohm-meter and is directional in nature.

Electric Submersible Pump

An electrical submersible pump is a motor driven device that forces water to the surface through centrifugal force. This action is accomplished by impellers housed in a stainless steel cylindrical casing that propels water up through the discharge tube and to the surface. In order to regulate flow, a sampling "T" is attached to the terminus of the wells discharge line. This "T" is equipped with a ball valve to adjust flow. Some electric submersible pumps, such as the Redi-Flo 2 is equipped with a rheostat mechanism allowing a much wider range of discharge rates to be achieved.

Submersible pumps are generally constructed of plastic, rubber, and metal parts that can affect the analyses of samples for certain trace organics and inorganics. As a consequence, care must be taken in choosing an appropriate submersible pump for wells that may contain trace concentrations of these constituents. Grundfos electrical pumps, which are constructed from stainless steel and NBR Nitril rubber, are acceptable in investigations involving trace constituents. However, the use of Grundfos pumps is limited to wells with an internal diameter >4 in. Electrical-powered submersible pumps can run off a 115-, 230-, or 460-volt AC power supply. The Redi-Flo 2 pump can be used in 2-in. diameter wells. Pumps with 115-volt vacuum motors are single phase, 230-volt vacuum motors may be either single or three phase, and 460-volt motors are three phase pumps.

Elevation Mask

The lowest elevation, in degrees, at which a receiver can track a satellite. Measured from the horizon, 0°to 90°. Normally set to 15° to avoid interference problems caused by building, trees, and multipath errors.

EMS

Environmental Management System.

Energized

Connected to an energy source, or containing residual or stored energy.

Energy-isolating Devices

Mechanical devices that physically prevents the transmission or release of energy, including but not limited to, the following:

- Manually operated electrical breaker.
- Disconnect switch.
- Manually operated switch that disconnect the conductors of a circuit from all ungrounded supply conductors and that does not allow the poles to be operated independently.
- Line valve.
- Block.
- Similar device used to block or isolate energy.

Pushbuttons, selector switches, interlocks, and other control circuit-type devices are not energy-isolating devices.

Energy Source

Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy. The term “multiple energy sources” includes equipment using more than one form of energy or more than one source of the same type of energy, e.g., two electrical circuits that are controlled independently of one another.

Equipment Supervisor

The person designated by management to be in charge of a piece of equipment. For example, this person may be an FPOC, principal investigator, or Responsible Individual. The equipment supervisor is the responsible user or caretaker of the equipment, which may be programmatic equipment or installed real property. The equipment supervisor is usually the first person to notice (or have reported to him/her) that a piece of equipment is not working properly. An equipment supervisor may also be a LOTO- authorized worker.

Equipment Blank

A sample of analyte-free media which has been used to rinse the sampling equipment. It is collected after the completion of decontamination and prior to sampling. This blank is useful in documenting adequate decontamination of sampling equipment.

Field

One basic independent element of a data record. For example, the sample log number is one of the fields of a sample record.

Field Blank

The field blank is deionized, analyte-free water which is poured into sample containers in the field at a predesignated sample location. This will indicate any contamination from the sampling container and/or the environment in which the primary sample was collected.

Field Logbook

Field logbooks are controlled documents that are bound notebooks with numbered pages.

Fixed GAC Canister

Large GAC canisters which are anchored to the supporting base and cannot be moved manually.

Flame Ionization Detector (FID) Meter

A portable field instrument used for the quantification of organic compounds ranging from methane to aromatic compounds such as benzene. The FID works by ionizing molecules by a hydrogen flame, and measuring the current generated. The measured current is directly proportional to the number of ionized molecules, and so the concentration of the compound(s) can be determined. As the organic compounds burn, positively charged, carbon-containing ions are produced and are collected by a negatively charged collecting electrode. The current produced is directly proportional to the compound concentration. Due to the use of the flame, this instrument is less sensitive to moisture in the vapor stream than the photoionization detector. The FID is usually calibrated against methane, but can also be calibrated using other compounds.

Freeboard

The amount of space left unfilled in a hole or depression.

Galvanic Resistivity

Electrical resistivity that is a result of direct galvanic coupling of the measuring circuit to the material to be measured, and is measured using electrodes.

Ground Water Sampling Log

A data collection form which is completed in the field describing a ground water sampling event in detail.

Gypsum Block

A gypsum block is a device used to measure soil moisture by electrical resistance. It consists of two concentric stainless steel cylinders imbedded in gypsum and is deployed directly into soils. When Properly deployed, the moisture content of the gypsum block will come to equilibrium with the moisture in the soil after a short time. Wires from each of the stainless steel cylinders in the gypsum block are connected to a data logger. The data logger measures and logs the electrical resistance between the cylinders. When moisture in the soil increases, the resistance of the gypsum blocks drops. Conversely, as the soils dry, the resistance across these wires increases. A fifth order polynomial equation is used to covert electrical resistance to bars of soil moisture tension.

Halocarbon

A carbon-based compound containing one or more halogen atoms (fluorine, chlorine or bromine).

HE Data

The results from analytical testing for high explosive compounds.

Headspace

The space within a container which is composed of air above a solid or liquid.

Hit

A reported chemical constituent concentration above the reporting limit of a particular analytical method.

Hydraulic Derrick

A hydraulic crane having a boom hinged near the base of the mast for lifting and moving heavy objects.

Hydraulic Test

A hydraulic test is a controlled field experiment performed to determine the hydraulic properties of water-bearing materials.

Hydrologic Unit

A group of one or more stratigraphic units that is considered a single hydraulic system.

Imhoff Cone

A graduated clear plastic cone used to measure the volume of silt and sand that is present in water.

Inductive Conductivity

Electrical conductivity is a result of inductive coupling of the measuring circuit to the material to be measured, and is measured using co-axial coils.

Intake Shroud

A tube or pipe installed on the lower end of an electrical submersible pump that forces the ground water to run past the motor portion of the pump before entering the pump intake. This helps reduce or prevent the pump to over heat during low flow operation.

Internal Standards

Internal standards are measured amounts of a certain compound added after sample preparation or extraction. They may be used in an internal standard calibration method to correct sample results suffering from instrumentation problems such as capillary column injection losses, purging losses, or the effects of viscosity. Evaluation of internal standards performance ensures the stability of sensitivity and response during each analysis.

Interlaboratory Collocated Samples

Interlaboratory collocated samples are collocated samples which are collected and sent to different laboratories for analysis. Interlaboratory collocated samples provide interlaboratory precision information for the entire measurement system including sample acquisition, homogeneity, handling, shipping, storage, preparation, and analysis.

Intralaboratory Collocated Samples

Intralaboratory collocated samples are collocated samples which are collected and sent to the same laboratory for analysis; usually one is sent as a blind sample. Intralaboratory collocated samples provide intralaboratory precision information for the entire measurement system including sample acquisition, homogeneity, handling, shipping, storage, preparation, and analysis.

Investigation-Derived Wastes (IDW)

Investigation-Derived Wastes (IDW) are drill cuttings, core samples, drilling mud, initial development water, and/or purged ground water which are typically produced during field activities (i.e., the drilling of boreholes, installation/development of wells, and ground water sampling).

Isolation (of Energy)

The prevention of the transmission of hazardous energy by means of a direct, positive method, such as opening a circuit breaker or closing a valve. Indirect means, such as control switches and interlocks, are not permissible isolation methods.

ISMS

Integrated Safety Management System.

Isotherm Constants

Empirical constants of different VOCs, determined from their experimental graphs showing relationship between the amount of the VOC adsorbed and the concentration of the VOC in the water.

Item

An all-inclusive term used in place of any of the following: appurtenance, assembly, component, data, equipment, material, module, part, sample, structure, subassembly, subsystem, system, or unit.

ITS

Institutional Tracking System database.

IWS

Integration Work Sheet.

Key Reviewers

Those persons responsible for reviewing and/or approving procedures for technical or administrative content.

Laboratory Control Standards (LCSs)

LCSs are aliquots of organic-free or deionized water to which known amounts of an analyte have been added. They are subjected to the same preparation/extraction procedure and analysis as samples. Stock solutions used for LCSs are purchased or prepared independently of calibration standards. LCS recovery indicates the accuracy of the analytical methods, equipment, and laboratory performance. For LCSs, the percent recovery is:

$$\frac{LC}{LT} \times 100$$

where:

LC = Laboratory LCS result.

LT = Expected result or true value of the LCS.

Lifetime QA Records

Records that provide baseline data for in-service inspection or records of significant value to demonstrate safe operation (i.e., maintain, repair, rework, replace, or modify) an item, or determine the cause of an accident or malfunction of an item, required to be maintained for the life of the facility by any applicable statute, regulation, or policy. Lifetime QA Records can also include any QA Record of activities affecting quality that is designated by the Environmental Restoration Department or ERD Data Management Team (DMT).

Linear Regression

A method for fitting a straight line through a set of data pairs. In the outlier algorithm, linear regression is used to model analyte concentrations as a function of time.

Lithology

A description of sediment or rock characteristics such as color, composition, grain size, bedding, sedimentary structures, sequences, and fossils.

Lithology Log

A detailed description of the method, technique, and chronology of drilling activities as well as sediment or rock characteristics such as color, composition, grain size, bedding, sedimentary structures, sequences, and fossils with depth. In addition, the lithologic log includes the length of core runs and the percentage of recovery. The sampling intervals and IDs are also listed on this form.

LLNL Personnel

The term includes all Laboratory personnel, including full-time employees (FTE), term (including students and post-doctoral researchers), and part time. It also includes Supplemental Labor Only (SLO), guests, and participating guests (See "outside subcontractor").

LLNL Single-Point LOTO

A specific procedure for a machine tool or other piece of equipment with only one energy-isolating device that can be readily identified and isolated. For some equipment with only one energy-isolating device, a detailed written lockout and tag procedure is not required. See SOP 4.16, "ERD Lockout/Tag Program," Section 4.2, for details.

Lab_loc_name

Lab_loc_name is the name of the field in TEIMS database tables which contains information about the sample location. For example, B-1001 is the lab_loc_name code for the borehole in which monitor well W-1001 was installed.

LOTO

Lockout and tagout. Specifically, the applying of a lock and associated identifying tag on an energy-isolating device, in accordance with an established procedure, to ensure that this device and equipment being controlled cannot be operated until the lock and associated tag are removed.

Lockout Device

A device that utilizes a positive means such as a lock to hold an energy-isolating device in a safe position and prevent a machine or equipment from energizing. Included are blank flanges and bolted slip blinds.

LOTO-Authorized Worker

A worker who locks out or tags out machines or equipment to perform service or maintenance. An affected worker may become a LOTO-authorized worker only when all of the following apply:

- The person's duties include performing service of maintenance activities covered under the LLNL LOTO Program.
- The person has completed the training requirements for the LLNL LOTO Program.
- The person has been authorized by his or her supervisor.

LOTO Tag

An approved LLNL form (see Figure 2 in Section 3.9) that can be securely fastened to an energy-isolating device with a lock in accordance with procedures established in the LLNL LOTO Program. This tag indicates that the energy-isolating device and the equipment being controlled shall not be operated until the lock and tag are removed.

Log File

An electronic file used for recording commands used and results obtained during execution of a procedure.

Log Number (log_no)

The number used as the unique identifier of a sample collected by LLNL, usually assigned by the analytical laboratory.

Logging Speed

The rate at which the logging tool is pulled up the borehole generally 10 to 20 ft/min.

Low-Yielding Monitoring Well

A ground water monitoring well completed in an aquifer having low hydraulic conductivity, and thus a limited capacity to transmit water. If the well is purged at a constant flow rate, either the screened interval or the pump intake will be exposed to the air prior to the removal of three well-casing volumes.

Master Logbook

The master logbook is a controlled document used for recording the creation, assignment, custody, and status of all field log books.

Matrix Spikes (MS)

MS are aliquots of samples to which known amounts of an analyte have been added. Stock solutions used for spiking should be purchased or prepared independently of calibration standards. Spikes are prepared and analyzed in each batch of samples and are subjected to the same preparation/extraction procedure and analysis as the samples in question. Spike recovery measures the effects of interferences from the sample matrix and reflects the accuracy of the determination. Spike recoveries are calculated as follows:

$$P = \frac{100(A - B)}{T},$$

where:

P = Percent spike recovery,

A = Concentration determined on spiked sample,

B = Concentration determined on original unspiked sample, and

T = True value of spike added.

Matrix Spike Duplicate (MSD)

An MSD measures the accuracy of the determination and the matrix effects as described in Sections 4.12 of this SOP, as well as repeatability or Relative Percent Difference of the measurements described in Section 4.19. The MS and MSD are aliquots of the same sample spiked with identical concentrations of target analytes. The MS and MSD are analyzed sequentially.

Measuring and Test Equipment (M&TE)

Devices or systems used to calibrate, measure, gauge, test, or inspect in order to control or acquire data to verify conformance to specified requirements.

Method Blanks

Method blanks consist of organic-free or deionized water (or clean sand for soil testing) carried through the analytical scheme like a sample. They serve to measure contamination associated with laboratory storage, preparation, or instrumentation.

Monitor

The TEIMS application and the set of data tables in the TEIMS relational database used by ERD for storage and retrieval of sampling location and analytical data results generated in environmental sampling and analysis activities.

MS Excel

The product name of a spreadsheet software application.

MS Word

The product name of a word-processing software application.

Multipath Error

A positioning error resulting from interference between radio waves that have traveled between the transmitter and the receiver by two paths of different electrical lengths.

New Data Log Table (new_data_log)

A data table where log numbers, CoC access numbers, and date of receipt for analytical results are recorded electronically.

Nonconformance

A deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate. Examples of nonconformance include: physical defects, test failures, incorrect or inadequate documentation, and deviation from prescribed procedures.

Ohm

The unit of electrical resistance one ampere of current will flow when the potential difference across the material is one volt.

Ohm-Meter

The standard unit of measurement for electrical resistivity logs. An ohm-meter is the resistivity of one cubic meter of material, which has a resistance of one ohm when electrical current flows through the material.

Organic Vapor Analyzer (OVA)

An OVA is used to measure total organic vapor concentration is a gas stream. Two different models were used in these studies. The first is a FID (flame ionization detector) and the second is a PID (photo ionization detector).

Organic Vapor Meter (OVM)

The OVM is a broad category of instruments which can determine total volatile organic compound concentrations in vapor. FID and PID meters are commonly referred to as OVMs.

Outside Subcontractor

Service and maintenance contractors, construction contractors, salvage contractors, and labor-only contractors.

Other Workers

Workers other than LOTO-authorized and affected employees, who work in an area where LOTO procedures may be used.

Parameter Code Designator

Person designated to create parameter codes. This person should have sufficient database and chemistry knowledge to distinguish between chemical names and possible duplicates

Payroll Supervisor

The person who is administratively in charge of LOTO-authorized workers assigned to perform maintenance, including locking out and tagging out of equipment. The payroll supervisor ensures that LOTO-authorized workers are trained, assigns activities to LOTO-authorized workers, maintains a list of their names, has access to their training records, and is usually the person who writes LOTO-authorized workers performance appraisal. A payroll supervisor may be the work supervisor or a LOTO-authorized worker.

PDOP (Position Dilution of Precision) Mask

The highest PDOP value at which a receiver will compute position.

PDOP (Position Dilution of Precision) Switch

The PDOP value at which a receiver switches from computing 3D positions to computing 2D positions (used only in Auto 2D/3D mode).

Percent Relative Standard Deviation (%RSD)

A measure of precision.

$$\%RSD = \left(\frac{100}{\sqrt{2}}\right) * \left[\frac{2|R1 - R2|}{(R1 + R2)}\right],$$

where:

R1 and R2 = The reported concentrations for each duplicate sample.

Permeability

The ability of a sediment or rock to transmit ground water or other fluids through pores, cracks, and/or fractures.

Personnel Protective Equipment (PPE)

Appropriate protective equipment, including personal protective equipment for eyes, face, head and extremities; protective clothing; respiratory devices; and protective shields and barriers. Such equipment shall be provided, used, and maintained in a sanitary and reliable condition for use wherever there are hazards capable of injuring or impairing the function of any part of the body through absorption, inhalation, or physical contact. Such hazards include those from processes or environment, chemical hazards, electrical hazards, radiological hazards, and mechanical irritants.

PETREX

PETREX is a patented name used by the Northeast Research Institute for a passive soil vapor collector that utilizes a carbon adsorbent contained in a glass housing that is capable of detecting trace amounts of volatile organic compounds in soil vapor.

Photoionization Detector (PID) Meter

A portable field instrument used to quantify purgeable aromatic compounds such as benzene, toluene, and xylene in vapors, but is also useful for other organic compounds. It is most effective on unsaturated compounds containing double bonds. The PID works by directing UV light onto the molecules, ionizing them, and measuring the current generated. The measured current is directly proportional to the number of ionized molecules, so the concentration of the compound(s) can be determined. It is usually calibrated against isobutylene, but can be calibrated using a compound of interest such as trichloroethene (TCE). However, this devise is not compound specific and its measurements represent an aggregate concentration of all compounds that are ionized and detected. Response factors can be changed to target specific compounds. This device is sensitive to moisture, therefore moist vapor streams should be analyzed using an alternate instrument such as an FID meter.

Piezometer

A small diameter monitor well (typically 2" or 4.5" in diameter) primarily used for the purpose of determining ground water elevation.

Portable GAC Canister

Carbon canisters of 55 gallon size or smaller which are not anchored to the base and which can be moved by a couple of technicians.

Position Dilution of Precision (PDOP)

A unitless figure that expresses the relationship between the error in user position and the error in satellite position. Good values are small, less than 3. Values greater than 7 are poor. A small PDOP indicates widely separated satellites, ensuring better accuracy.

Potential of Hydrogen (pH)

The hydrogen ion concentration of water is expressed as pH. The pH is measured on a scale from 0 to 14. It is a measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solution. A pH less than 7 indicates an acid solution, whereas a pH greater than 7 indicates an alkaline solution. The pH is related to the hydrogen-ion concentration as follows:

$$pH = - \log [H^{+}]$$

ppb

Parts per billion (ppb) as used in this document is a unit of concentration in a gas based on a volume to volume ratio. Ppb refers to the volume of pollutant or compound per billion volumes of air (1 ppb = $1 \cdot 10^{-9}$ m^3 analyte/m^3 air).

ppm

Parts per million (ppm) as used in this document is a unit of concentration in a gas based on a volume to volume ratio. Ppm refers to the volume of pollutants or compound per million volumes of air (1 ppm = $1 \cdot 10^{-6}$ m^3 analyte/m^3 air).

Practical Quantitation Limit (PQL)

The PQL is approximately five times the method detection limit and represents a practical and routinely achievable detection limit with a relatively good certainty that any reported value is reliable.

Precision

The agreement among a set of replicate measurements without assumption of knowledge of the true value. Precision is estimated by means of duplicate/replicate analyses. The most commonly used estimates of precision are the percent relative standard deviation (RSD) 4.16 of this SOP, and relative percent difference (RPD) 4.19 of this SOP.

Pressure Transducers

Pressure transducers are devices to measure hydrostatic pressure, which can be converted to ground water elevations. A transducer is designed to measure pressures over a specific range of submergence. Outside this range, measurements will not be accurate, and the transducer can be damaged if submerged to depths exceeding the design range or subjected to negative pressures.

Procedure

A sequence of events described in an approved document which specifies how an activity is to be performed; the methods used; any specific equipment or material requirements; the sequence of operations; and how data is collected, recorded and reported.

Procedure Writer

A person assigned to develop a procedure that specifies or describes how an activity is to be performed.

Pseudorandom Code

A code that appears to be randomly distributed, but is a complicated repeating pattern of 1s and 0s.

QBF

Query By Forms. The TEIMS application used for retrieving data from the TEIMS relational database.

Quality

The degree to which an item or process meets or exceeds the user's requirements.

Quality Affecting Activities

Activities that, if not performed properly, could compromise the validity of information or data, could result in unacceptable risk to the radiological or environmental health or safety of the public or the workers involved, or could have a detrimental effect on the achievement of the prime objectives of the Laboratory.

Quality Assurance (QA) Record

A completed record or any authenticated portion of a record that provides objective evidence of the quality of items or activities.

Quality Control (QC) Data

A report of data used to evaluate the validity of analytical results, determining the quality of the analytical data.

Quality Control Samples

Samples that are introduced during the different phases of the data collection process to monitor the performance of the system.

Radioactivity

Radiation, including alpha particles, beta particles or electrons, and/or gamma rays emitted as a consequence of spontaneous nuclear reactions and/or decay of unstable isotopes.

Rawhiding

The process of pulsing compressed air into formation ground water in the screened interval of a well to loosen trapped fine sediment in the filter pack. Air pressure is increased for several seconds, then decreased suddenly. This process causes the column of water in the well to rise and fall, breaking fine sediment and drilling mud free from the filter pack.

RCRA Characteristic Waste

A waste which exhibits ignitability, corrosivity, reactivity, or toxicity.

Records Center (Division)

A facility, or area within a facility, designated as ERD's storage site for QA Records.

Redox Potential (Eh)

The potential for water to either oxidize (loss of electrons) or reduce (gain of electrons) dissolved constituents. Readings are made in millivolts.

Redox Potential (Eh)

Eh is a measure of a chemical reaction in which an atom or molecule loses electrons to another atom or molecule. The reaction is also known as oxidation-reduction. Oxidation is the loss of electrons, while reduction is the gain in electrons. The redox potential of water is measured in millivolts (mV).

Relative Percent Difference (%RPD)

$$\frac{(R1 - R2)}{\left[\frac{R1 + R2}{2}\right]} \times 100$$

where R1 and R2 are the result of analyzing replicate aliquots of a sample, with R1 indicating the first analysis of the sample and R2 its corresponding duplicate.

Relative Response Factor (RRF)

RRF is the calibration factor calculating the response versus peak area as compared to a known internal standard.

$$RRF = \frac{(A_s C_{is})}{(A_{is} C_s)},$$

where:

A_s = Response for the analyte to be measured,

A_{is} = Response for the internal standard,

C_{is} = Concentration of the internal standard, μg/L, and

C_s = Concentration of the analyte to be measured, μg/L.

Repeat Section

A quality assurance/quality control (QA/QC) procedure to evaluate the repeatability of the geophysical measurement. Generally, an interval of 50 ft or greater is logged twice and compared for repeatability.

Replicate Samples

Replicate samples are samples that have been divided into two or more portions at some step in the measurement process. A sample may be replicated in the field or at different points in the analytical process.

Rover

Any mobile GPS receiver collecting data during a field session. The receiver's position can be computed relative to another, stationary GPS receiver.

Safety Watch

A person designated and assigned by the functional supervisor to assist an authorized employee in performing maintenance or service on equipment that has no lockout attachment. This person shall be posted at an unlocked energy-isolating device to ensure that the device is not operated for the duration of the operation. The safety watch shall have no other duties, nor shall he/she leave his/her station for any reason, except when formally relieved from duty or for personal safety.

Sample

A representative fraction of material tested or analyzed in order to determine the nature, composition, and percentage of specified constituents, and possibly their reactivity (e.g., environmental samples, blanks, etc.).

Sample Blanks

Sample blanks should be used when characteristics such as color or turbidity interfere with a determination. In a spectrophotometric method, for example, the natural absorbency of the sample is measured and subtracted from the absorbency of the developed sample.

Sample Port

Valves with outlet through which water or gas samples are collected.

Sample Ts

A device composed of PVC pipe and Teflon tubing. It is attached to the discharge line of a submersible pump that allows the majority of the discharge to flow in the direction of the collection container or ground surface, as applicable, but allows a less turbulent flow of ground water through Teflon tubing for sample collection.

SAS

The product name of the statistical analysis and graphics software package used to identify and review outliers.

Scintillation Detector

A device for counting and recording frequency and intensity of light flashes (scintillations) emitted in certain media by absorption of ionizing particles or photons.

Selective Availability

Artificial degradation of the satellite signal by the Department of Defense. A DoD program to control the accuracy of pseudorange measurements, where the user receives a false pseudorange in error by a controlled amount. The error in position caused by S/A can be up to 100 meters. Differential GPS techniques can reduce these effects for local applications.

Service or Maintenance

Workplace activities that may include constructing, installing, setting up, adjusting, inspecting, modifying, and maintaining or servicing machines or equipment. These activities include lubricating, cleaning, or unjamming machines or equipment and making adjustments or tool changes where personnel may be exposed to the unexpected energization of the equipment or release of hazardous energy.

Shiner

A metal tag fixed to the monitor well's cement pad indicating the location that was officially surveyed, providing the coordinates and elevation of the location. The tag is stamped with the monitor well's ID.

Single Blind Samples

A single blind sample is a performance evaluation (PE) check sample submitted to the laboratory. The laboratory knows it is a PE but does not know the analyte concentrations.

Slug/Bail Test

A slug/bail test measures the recovery of the ground water level in a well due to an instantaneous change in pressure.

Soil Surface Flux

Soil surface flux is the rate of exchange of one or more gases between soils and the atmosphere. An emission isolation flux chamber is used to measure this rate by placing the chamber on a soil surface and purging the air inside the chamber with pure sweep-air at a known rate. Gases which diffuse from the soil surface enter the emission isolation flux chamber and mix with the sweep air. By measuring the concentration in the chamber of each target gas once the chamber is at equilibrium, the flux rate ($mg \cdot m^{-2} \cdot min^{-1}$), may be calculated with the following formula:

$$F = (SR*C) / A$$

where

F = Flux rate ($mg \cdot m^{-2} \cdot min^{-1}$),

SR = Sweep Rate ($m^3 \cdot min^{-1}$),

C = Concentration of analyte ($mg \cdot m^{-3}$), and

A = Basal area of the flux chamber (m^2).

Soil Vapor Survey

A technique for the collection and analysis of soil vapor conducted to determine the presence of subsurface contamination of volatile and semivolatile compounds.

Solar Treatment Unit (STU)

A ground water treatment unit which uses solar power to pump water for treatment through carbon beds.

Soluble Threshold Limit Concentration (STLC)

A State of California method and value that can be used to determine if a waste is hazardous. Specifically, the STLC is the concentration of a solubilized and extractable bioaccumulative or persistent toxic substance as determined by the California Assessment Manual, Waste Extraction Test (CAM WET), which if equaled or exceeded in a waste or waste extract, renders the waste hazardous.

Sonde

The borehole geophysical measurement device lowered into boreholes and/or cased wells for measuring the physical properties of the geological materials penetrated by the borehole.

Sorbant-pads

Sorbant-pads are affixed to the outside of an IMT membrane and are used to collect and retrieve soil pore-water samples for laboratory analysis. If the sorbant-pad membrane is equipped with electrode pairs under each sorbant-pad, the electronic resistance of each pad can be measured and logged. These resistance values can be used to may make estimates of soil moisture content.

Source-to-Detector (or Transmitter-to-Receiver) Spacing

The distance between an electrode, radioactive source, coil or acoustic transmitter, and the receiver or detector.

SPACT

The TEIMS application and the set of data tables in the TEIMS relational database used by ERD to store and retrieve data generated in the sampling plan and chain-of-custody tracking activities.

Specific Capacity

Specific capacity is an expression of the productivity of a well obtained by dividing the rate of discharge (Q) by the drawdown (Δs) of water in the well. Specific capacity should be described based on the number of hours of pumping prior to the time the drawdown measurement is made.

Specific Conductance

A measurement of the electrical conductivity of water. Specific conductance is measured in microhmos per cm and is a function of ion concentration.

Specific-Depth Grab Sample

In instances where the task leader has indicated that a grab sample is adequate, a specific-depth grab sample may be substituted for the standard 3 casing volume pre-sample purge, or other low-volume techniques. These devices, such as the EasyPump are designed to capture a sample from a specific point within the screened interval of a well using low voltage pumps and disposable sample capture attachments.

Specific-Depth Grab Sampling Device

A specific-depth grab sampling device, such as the EasyPump, is commonly used in wells exhibiting characteristics that do not allow for significant pre-sample purging techniques (>90% of one casing volume), or where it is believed that a representative sample can be collected with minimal pre-sample purging. This device incorporates a disposable sample capture chamber (specially modified, double-check valve bailers). It is equipped with a low-voltage pump at the top of the bailer which pulls water through the sample capture chamber.

Split Samples

Split samples are replicate samples divided into two portions, sent to different laboratories, and subjected to the same environmental conditions and steps in the measurement process.

SQL

Structured Query Language. A language used for retrieving data from a relational database.

Stove Pipe

A lockable, steel enclosure that prevents unauthorized access to above-grade completed monitor wells. The well ID is painted on the stove pipe for easy identification.

Stratigraphic Unit

A discrete unit or section of sediment or rock identified primarily by material with similar characteristics.

Strike

The angle between true North and the horizontal line contained in any planar feature (inclined bed, dike, fault plane, etc.); also the geographic direction of this horizontal line.

Surface Soil

Surface soil is defined as the top six inches of soil.

Surge Block

A well development device composed of one or more round rubber seals attached to a rod. The rubber seals are similar to the diameter of the well casing. As the rod is lowered and raised, a suction is created which helps to loosen and pull the silt and clay fines into the well. The fines then can be removed by pumping or bailing.

Surrogates

Surrogates are measured amounts of certain compounds added before sample preparation or extraction. Analysts measure the recovery of the surrogate to determine systematic extraction problems.

Sweep Air

Sweep air is contaminant free air used to exchange or “sweep” the air inside the flux chamber at a known rate. Sweep air may be provided in the form of ultra-pure “zero air” pressurized gas cylinders with a pressure regulator, or in the form of pumped ambient air filtered through activated carbon and desiccant columns. Accurate measurement of the sweep flow rate is essential to calculate soil vapor flux.

TAT

TAT is defined as turnaround time.

TEIMS

Taurus Environmental Information Management System.

Temperature Blank

A temperature blank is a container of water placed in the sample shipping container that the receiving laboratory measures to determine the water temperature, which indicates sample integrity and preservation.

Testing

Determination that machinery, equipment, or equipment parts are de-energized. This involves the use of approved, properly operating test equipment designed for and capable of determining if any energized conditions exist.

Thermistor

A thermistor is a thermal resistance device. The electrical resistance across this device changes proportionally with changes in its temperature. A properly calibrated thermistor can report temperatures with resolutions of less that 0.1^{o} C. Thermistors were used in these studies because of their raggedness, ease of measurement and immunity to electrical noise.

Thermocouple

A thermocouple is an electronic device used to measure temperatures. These measurements are based on the premise that a small current will flow through the junction of two dissimilar metals that is proportional to the difference in temperature between the junction and the other end of the wires. The output from a thermocouple is only 1 or 2 millivolts. Signals with this magnitude are difficult to measure accurately and are subject to any type of electronic noise in the vicinity. When using these devices, extreme care must be taken to properly account for the temperature of the thermocouple wire pair at the data logger.

Time Constant

The time in seconds a gamma ray detector accumulates gamma ray emissions (counting time) to establish count rates.

Toxicity Characteristic Leaching Procedure (TCLP)

The TCLP is a U.S. Environmental Protection Agency (USEPA) analytical method designed to determine the mobility of both organics and inorganics in liquid, solid, and multiphase waste. It is used to determine applicability of Land Ban regulations to a waste.

Transducer

Transducers are devices used to measure some physical parameter, such as pressure or temperature, and convert these measurements to an electrical signal.

Tremie Pipe

A section of small diameter pipe, usually composed of polyvinyl chloride (PVC) tubing, which is used when adding sand, bentonite, or grout into the annulus of the borehole around the well casing so the annulus is filled from the bottom up. This helps to prevent bridging.

Trilateration

The process of determining a distance of an unknown location to four known reference points. This enables the 3D position of an unknown location to be computed.

Trip Blank

A trip blank consists of deionized (DI), nitrogen-purged or laboratory demonstrated analyte-free water prepared and provided by the contract analytical laboratory (CAL). Trip blanks are placed in the ice chest with the samples, transported to the field during sample collection, and then to the laboratory along with the samples. Trip blanks are not to be opened in the field; otherwise they are to be handled and analyzed for volatile organics in the same way as samples acquired that day. Trip blanks act as an indicator of sample contamination through handling, preservation, and shipping.

Tritium

A radioisotope of hydrogen, hydrogen-3 (^3H). A tritium atom contains one proton and two neutrons. It emits low-energy beta radiation and is relatively short-lived, with a half-life of approximately 12.3 years.

Turbidity

A measurement of water clarity.

Turnaround Time

The time span between the submittal of samples to the analytical laboratory and the receipt of results.

User

ERD or other designated programs.

Verification

The act of evaluating and documenting whether processes, items, services, or documents meet specified requirements.

Verify

To perform appropriate measurements and attempt to operate equipment controls, after an energy-isolating procedure has been performed but before maintenance or repair work is initiated, to determine that the hazardous energy as been isolated and the equipment cannot be energized or restarted.

Vertical Resolution

The minimum thickness of a geologic unit that can be resolved by a particular geophysical measurement. Vertical resolution is related to source-to-detector spacing, and the physics of the individual measurements.

Volatile Organic Compounds (VOCs)

A group of organic compounds characterized by their tendency to evaporate easily at room temperatures (e.g., gasoline, paint thinners, and nail polish remover).

Volatilization

The rapid loss of compounds through evaporation at ordinary temperatures.

Walk-about

A walk-about is an informal assessment used to help management better understand the work being done, and increase his or her visibility and availability in an informal work setting, hear first hand employee concerns and comments and receive input/feedback, observe working conditions and practices, and recognize accomplishments and acknowledge good work practices.

Well Disinfection

Each well that is designated as part of the network to be sampled for total and fecal coliform bacteria must be disinfected prior to sampling. These wells will be disinfected by using a disinfectant containing at least 100 mg/L of available chlorine.

Well Screen

The section of the completed well with perforations in the casing that allows water to flow into the casing.

Wlithologic

A personally owned working table in the TEIMS database used while processing lithologic data in preparation for appending it to the global lithologic table.

Work Supervisor

The person designated by management to be the day-to-day supervisor of a LOTO-authorized worker. A work supervisor may be the payroll supervisor of a LOTO-authorized worker assigned a specific, short-term duty in an area. LOTO-authorized workers assigned duties in more than one area may have more that one work supervisor. A work supervisor shall assure that LOTO-authorized workers are trained and qualified to perform assigned tasks. A work supervisor may also be a LOTO-authorized worker.

Working Tables

Tables within the TEIMS database which are owned by an individual's personal account. All working table names begin with a "w," e.g., wsample, wanalysis. Data within such tables can only be accessed by the individual owner and is not yet part of the globally accessible data in the database.

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