# Appendix A
# Sampling and Analysis Plan for the Building 419 Facility

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# Sampling and Analysis Plan for the Final Closure of the B-419 Facility

## I. Introduction

### I.1 Purpose and Scope

The purpose of this Sampling and Analysis Plan (SAP) is to establish the procedures for characterization of the Building 419 hazardous waste treatment facility concrete floor and soil, based on the closure performance standards described in Section 8 of the Final Closure Plan for the Building 419 Facility (Closure Plan). The overall scope of work for closure is discussed in the main portion of the Closure Plan. Sampling and analysis results, generator knowledge, supporting calculations, and previous analytical data has been used to characterize the building structure, ancillary piping, underground tank system vault, remaining equipment (i.e., fume hoods).

In the event that additional decontamination is necessary, all rinsate and materials used in the process will be collected, sampled and analyzed for hazardous constituents. If rinse water is determined to be non-hazardous and if it meets City of Livermore discharge criteria, it will be discharged into the sanitary sewer. Otherwise, it will be managed as hazardous waste and treated onsite or transported to a permitted hazardous waste facility for treatment.

Analytical data will be reviewed to determine if the concrete foundation contains hazardous waste residues. Based on analytical results, the concrete foundation will be evaluated for disposal and against the offsite facility's waste acceptance criteria.

## II. Facility Description

A description of the B-419 facility is provided in Section 2.0 of the Closure Plan. **Figure A-1** of this SAP shows the layout of the B-419 Facility, including the location of remaining underground piping and the locations where underground piping associated with the retention tank system was removed. **Figure A-2** shows the B-419 Facility locations where sample boreholes will be placed. Should soil characteristics prevent penetration to the planned depth, the sample location will be adjusted as appropriate.

Concrete-asphalt-soil (CAS) samples collected at the Building 419 Facility will be taken at the soil-concrete interface and at incremental depths of 2, 5, 10, and 15 ft. If contamination is found, a step out, step down approach will be used to determine the extent of contamination in the soil. This SAP primarily addresses the below-ground-level contamination evaluation.

# III. Sampling

## III.1 Sampling and Analysis Procedures

Sampling and analysis will be performed by a California-certified laboratory using the methods and procedures specified in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846, U.S. Environmental Protection Agency [EPA], 1986 [and updates]). The applicable SW-846 method will be selected based on the constituent(s) suspected from a specific waste stream. **Table A-1** lists the constituents of concern for the B-419 Facility. **Table A-3** lists the SW-846 test methods for various constituents. **Table A-4** lists the inorganic persistent and bioaccumulative toxic substances and their Soluable Threshold Limit Concentrations (STLC) and Total Threshold Limit Concentration (TTLC) values. **Table A-5** is a list of organic Toxicity Characteristic Leaching Procedure (TCLP) regulatory limit values. Sampling frequencies have been determined using rationale provided in SW-846 (EPA, 1986 [and updates]).

Various methods—including direct-push method, hollow-stem augers, mud rotary, air or air-mist rotary—may be used to collect soil samples. The choice of method will be determined based on soil conditions and relative ease of access to sampling locations. Also, hand-driven sampling devices may be used to obtain individual, shallow subsurface samples.

For samples for metals analysis, stainless steel tubes will be used to minimize cross contamination to collect soil medium for samples. The tube ends are sealed with either Teflon tape or plastic caps and secured with duct tape; or the soil medium is transferred to a wide-mouth glass jar and sealed with duct tape.

For concrete samples, drills will be used to cut cores and obtain samples.

Swipe samples will be taken, if necessary, by using filter paper from a 10-cm-by10-cm area. The paper may be wetted with different agent to collect samples for specific constituents.

## III.2 Sample Control, Sample Tracking, and Data Control

Analytical sample custody and the analytical sample custody logbooks are to be handled and preserved as described in this section.

### *III.2.1 Sample Control and Documentation*

#### III.2.1.1 Field Logbooks

A complete record of all samples and sampling events will be maintained by making entries into field logbook(s). Field logbooks are bound volumes with consecutively numbered pages. The sampling team leader assigns each logbook a unique code and issues the logbooks upon request. A list of issued logbooks and their locations is maintained by the sampling team leader. Completed logbooks are returned to sampling team leader.

Entries in the sampling field logbooks reflect the sampling event and include the following 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 laboratory 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 which may have an impact on analytical results.

Specific field data collection forms might be 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 logbook page number that was used to document that sampling event.

#### III.2.1.2 Chain-of-Custody (CoC) Records

The primary objective of using CoC documents 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.

*Issuance and Archival of CoC Records*

- CoC forms are provided by the sampling team leader.
- Completed CoC records are archived by the sampling team leader.

*Required Documentation*

Each CoC document will be completed using waterproof ink and contain the following information:

- Document control number.
- Sample matrix code. (Sample matrix codes are listed on the back of the CoC form.)
- Name of sampler and employer.
- Requested analysis code.
- Number and type of container(s).
- Sample ID and sample date and time.
- Area from which the sample originated.
- Name of the analytical laboratory name where the samples are to be sent as designated by the Sampling Plan.
- Requester name. This is the organization for which the samples are being collected.
- 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.

#### III.2.1.3 Sample Identification Labels

ID labels are to be used 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. Waterproof ink will be used on the label.

*Issuance and Archival*

Sample labels may be obtained from the analytical laboratory where the samples are to be sent. The field personnel will have a small stock on hand at all times. Labels are not archived and are destroyed with sample disposal at the laboratory.

*Required Documentation*

The Sample ID Label will 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. If a new location is to be sampled, the Project Leader will approve all new sample IDs.

- Project name.
- Sample date. The date when the sample was collected.
- Sample time. Time is recorded according to the 24-hour clock (e.g., 1:00 a.m. = 0100 hour, 3:00 p.m. = 1500 hours).
- Samplers' initials. The initials of personnel conducting the sampling.
- Preservation method. Any preservative added to the sample should be indicated.
- Comments. Any additional information should be provided in the Comments section.
- Requested analysis. The type of analysis to be performed on the sample.

### *III.2.2 Sample Container and Preservation*

Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing. Methods of preservation are intended to retard biological action and hydrolysis of chemical compounds and complexes, and to reduce the volatility of analytes and adsorption effects.

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 will be used for collecting environmental media.

All sample containers will be pre-cleaned. Volatile Organic Analysis (VOA) vials will be certified clean by the vendor. Using this Sampling Plan, sampling personnel will determine the type of bottles, preservatives, holding times, and filtering requirements. Sample containers will be filled so that the sample does not come into contact with the sampler's gloves, thus potentially causing contamination.

If the samples are to be preserved, sampling personnel will consult a Quality Control Chemist to determine the approximate volume of acid (or base) needed to preserve a sample and will then use the pre-determined amount of acid (or base).

If samples that require preservation at the time of collection cannot be preserved in the field or upon returning from the field, samples will be preserved by the laboratory immediately upon receipt. This will be clearly noted on the CoC document. In all cases, samples are to be preserved within 12 hours from the time of collection except in the instances where the samples can be analyzed within their unpreserved holding time.

Samples requiring refrigeration of 4°C will be protected from getting wet. Samples will be immediately placed in an ice chest containing either Blue Ice packs (in air-tight plastic bags), or bagged or loose ice cubes. A temperature blank will always be included in the ice chests so that the laboratory can check the temperature of the cooler at time of sample receipt. If samples are not submitted to the laboratory daily, ice chests will be checked periodically, and thawed ice replaced.

Sample preservation methods will be noted as appropriate in the sampling logbook, on the sample label, and on the CoC document.

### *III.2.3 Shipping*

All samples will be shipped off site according to the U.S. Department of Transportation regulations.

Properly identified sample containers will be placed inside Ziploc®-type storage bags, sealed, and then placed in picnic-cooler-type containers. Samples to be shipped will 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 the samples preserved. Temperature blanks will accompany all samples that require temperature preservation (4°C). They consist of a 250-ml poly container or equivalent filled with water. The receiving analytical laboratory will be instructed to measure these blanks to ensure sample integrity.

## III.3 Component Characterization

Generator knowledge and bulk-sampling will be used to characterize wastes for proper disposal. **Table A-6** summarizes how unit components will be characterized.

## III.4 Sampling Methodology

Sampling methodology is discussed in this section and in **Sections IV.4 and IV.5**. This section focuses on sampling activities that may occur above ground. Its subsections cover sampling of the Building 419 roofing, dry and liquid wastes from decontamination activities, if any; and the surface and below-surface concrete-asphalt-soil (CAS) layer. Any above-surface sampling activities can be done simultaneously or in any convenient sequence as long as all controls and procedures are followed. **Sections IV.4 and IV.5** focuses on sampling activities at below-surface levels.

### *III.4.1 Tank, Piping, Ancillary Equipment, and Roofing*

The B-419 retention tank system was closed and removed, as described in Section 7.2 of the Closure Plan. Some ancillary piping was also removed and disposed of during the retention tank system closure project. **Figure A-1** shows piping that still remains in place. Any additional piping that is excavated from beneath the building will be rinsed with water. The rinse waters will be captured and evaluated for hazardous and radiological contamination. The dismantled piping will be sampled at 20-ft intervals and at each elbow for radioactive and hazardous contaminants. Any residues will be bulked-sampled and analyzed. After removal, the piping will be disposed of either as totality or cut up as required by transportation and disposal site requirements.

The roof of B-419 will be characterized by obtaining a sample from the center of every 20-ft interval.

#### *III.4.2 Building Structure, and Walk-in Hoods*

No further sampling and analysis are planned for characterization of the tank vault, rooms 124, 155, and 167, except for the concrete floor. The rooms have been characterized and the demolition debris will be disposed as radioactive and mixed wastes. The demolition debris, including the walk-in hoods, piping, overhead crane, doors, etc., from room 124 will be considered radioactive waste and the debris from rooms 155, 167 and the tank vault will be considered mixed waste.

Some areas of the Building 419 Facility are considered outside the scope of the Closure Plan since hazardous waste operations were not performed in these areas. Those areas include utility rooms, storage rooms, offices, air locks, and one room used previously as a battery shop on the first floor, and four rooms used previously as offices, located on the second floor. A separate facility structure sampling plan will be developed for these areas of the facility. These areas of the facility structure will be managed as radioactive waste or mixed waste, depending upon the results of the analyses, at an authorized disposal facility. The required level of radiological sampling and analyses will be completed in order to meet the waste acceptance criteria of the receiving disposal facility.

#### *III.4.3 Supplies, Chemicals, and Supporting Equipment*

All chemicals, supplies and supporting equipment were removed from the B-419 Facility during previous closure activity.

#### *III.4.4 Rinse Water and Decontamination Solutions*

Rinse water and solutions generated during any decontamination procedures will be collected in 55-gal containers and evaluated for the hazardous constituents listed in **Table A-3** of this SAP.

#### *III.4.5 Dry Wastes from Decontamination*

Resulting dry wastes (e.g., chemwipes and rags) from decontamination and sampling efforts will be sampled and analyzed for the constituents listed in **Table A-2** of this SAP.

#### *III.4.6 Soil Sampling*

Concrete–asphalt-soil (CAS) samples will be analyzed to determine the presence of contaminants listed in **Table A-1** of this SAP. Sample locations are shown in **Figure A-2**, Sample Borehole Locations at the Building 419 Facility. In addition, if a crack in the secondary containment floor penetrates the depth of the concrete, the depth of existing cracks, if any, will be investigated visually using a 7–10X, handheld magnification lens. Additional soil samples will also be obtained to determine the possible nature and extent of contamination. Additional sample locations will be documented on a map of the area, and the map will be maintained in either the sampling or closure logs.

Using accepted drilling methods for CAS 1 through 39 (see **Section III.1)**, technicians will obtain a core sample of concrete in the area of the crack, followed by taking samples of soil underlying the concrete at the surface and at the following intervals: 2 ft, 5 ft, 10 ft, and 15 ft. CAS samples 40 and 41 will be collected at 5-ft intervals to groundwater depth, and groundwater samples will also be collected.

Soil matrix samples for VOC analysis will be collected using EPA method 5035 techniques.

The concrete-asphalt-soil (CAS) samples will be analyzed for organic, inorganic, and radiological parameters, as described in **Section IV.5**.

Background soil (SO) sample acquisition measurement locations to be obtained from random locations throughout the LLNL site for development of metal and radiological background levels are listed in **Table A-7** of the SAP. The SO samples will be analyzed to determine the levels of inorganic and radiological constituents listed in **Table A-2** of the SAP.

### *III.4.7 Sampling Equipment Decontamination*

Decontamination shall be performed in the same level of PPE used during sampling activities.

Equipment and supplies used for equipment decontamination may include (but are not limited to) the following:

- Deionized (DI), distilled or (otherwise) analyte-free water.
- Soap and/or detergent solutions
- Trisodium phosphate (TSP)
- Isopropyl alcohol (IsOH)
- Nitric acid (dilute $HNO_3$)
- Cleaning brushes
- Chemical-free cloths or paper towels
- Plastic buckets, galvanized steel pans
- Steam cleaner

There are four basic techniques employed at LLNL for removing contaminants from sampling equipment:

a. Rinsing thoroughly with analyte-free water (used for cleaning small items lightly contaminated with polar compounds).
b. Hand washing with a suitable detergent, e.g., "Alconox" (used when contaminant types are known or suspected, particularly when organic constituents are involved).
c. Systematically applying the following cleaning agents (used primarily when sampling concentrated chemical waste):
   - Clean equipment with tap water and a trisodium phosphate (TSP)/water solution using a brush over a tub to remove particulate matter.
   - Rinse with distilled water.
   - Rinse with a 5% nitric acid solution.
   - Rinse with distilled water.
   - Rinse with pesticide-grade isopropanol.
   - Rinse with distilled water and collect rinsate in a sample collection container for equipment blank analyses.
   - Allow equipment to air dry.
   - Collect decontamination liquids and properly dispose of as waste.
d. Steam cleaning (performed when equipment is too large to wash by hand).

In all cases, rinsate from decontamination activities is collected, analyzed, and properly handled.

The procedures, described above, are followed when the decontamination activities involve non-disposable sampling equipment, used in bulk and soil sampling operations. Swipe sampling involves the use of disposable collection media; therefore, decontamination techniques do not apply.

### III.5 Subsurface Investigations

B-419 is located in the southeastern quadrant of the Livermore Site. During the Navy era, the area around B-419 was used for aircraft assembly, overhaul, and maintenance where solvents including trichloroethylene (TCE), perchloroethylene (PCE), and carbon tetrachloride, and 1,2-Dichloroethane (1,2-DCA) were used and possibly washed into the storm drains during rain storms. Later, the Navy used the 7,860-ft building as a paint and dope shop. The building was then restructured as an assay lab used by Health Chemistry through 1975, and subsequently as a decontamination and reduction facility used by the Radioactive and Hazardous Waste Management (RHWM) Division.

During past closure activities, soil contamination was discovered, as described in **Section 7** of the Closure Plan. Both mercury and uranium were found in the flooring and in the sediments under the floor of B-419, Room 167 during 1995. Soil samples collected outside the building during other phases of the retention tank closure project also indicated low levels of soil contamination in the area, as described in **Section 7.2** of the Closure Plan.

CERCLA ground water investigations in the area of B-419 indicate that TCE is the primary VOC detected in the ground water at the site. PCE, carbon tetrachloride, and 1,2-DCA were also detected at concentrations under the north end of B-419 that exceeds the State and Federal Maximum Contaminant Levels (MCLs) of 5 $\mu g/l$; however, monitor wells in the immediate vicinity area adjacent to B-419 do not contain appreciable levels of tritium or metals.

Although soil data reveal releases of metals, tritium and VOCs did occur in the area, the highest concentrations are in the shallow vadose zone and do not appear to extend to depths greater than 25 ft.

## IV. Analysis Criteria

The below-ground-level soils will be sampled and analyzed for radioactive and hazardous contaminates. Hazardous constituent analysis will be performed by a California-certified laboratory. Hazardous constituents are analyzed per SW-846 (EPA, 1986 [and updates]).

### IV.1 Hazardous Constituents

An evaluation of the area and past hazardous waste operations was performed, and a list of constituents of concern was developed. These are materials that may have been present during the operation of the B-419 area by both the U.S. Navy and by LLNL. The list included as **Table A-1**.

Any bulk sample will be characterized in accordance with hazardous waste criteria for inorganic substances, as specified in Title 22 of the *California Code of Regulations* (CCR).

Bulk samples will also be analyzed by the Total Threshold Limit Concentration (TTLC) and TCLP for metals and organics, and STLC metals as necessary. The resulting TCLP extract will be analyzed for volatile organic compounds, volatile aromatics, and semi-volatiles. These analyses give speciated organic substances, whose TCLP values are presented in **Table A-5**. If the TCLP or STLC values are equaled or exceeded in the waste, the waste is considered hazardous waste.

The TTLC results for concrete-asphalt-soil (CAS) samples obtained in accordance with Section IV.5 of this SAP will be compared to the maximum allowable concentrations for metals in soil to determine the clean closure criteria. The allowable metals concentrations will be determined by obtaining composite soil samples throughout the LLNL site as described in section IV.4.

CAS samples will undergo the following analyses by a California-certified laboratory using the methods listed in **Table A-3**:

- STLC procedure for metals using the California WET.
- TTLC procedure for metals and organics in accordance with procedures in 22 CCR 66700.
- TCLP procedure for metals using the SW-846 (EPA, 1986).
- TCLP for organics. The sample will be extracted using ZHE. The resulting extract will be analyzed for volatiles, volatile aromatics, semivolatiles, and petroleum hydrocarbons.

The STLC will be run if the total constituent concentration is equal to or greater than 10 times the STLC hazardous waste threshold. The TCLP will be run if the total constituent concentration is equal to or greater than 20 times the TCLP hazardous waste threshold.

### IV.2 Decontamination Wastewater Analysis

Decontamination activities (if necessary) will be performed using methods described in **Table 3** of the Closure Plan. Collected aqueous waste generated during decontamination activities will be treated and analyzed, and the data compared to the City of Livermore Water Reclamation Plant (LWRP) sewer discharge requirements and limits in effect at the time of closure.

### IV.3 Rain Water

Rain water that enters the facility during these activities will be sampled and analyzed in accordance to the Waste Analysis Plan (WAP) in the 1998 Part B Permit Application (LLNL, 1998).

### IV.4 Background Soil Sample Acquisition Throughout the LLNL Site

Background soil samples will be obtained from locations throughout LLNL in order to determine the maximum allowable concentrations of metals in soil, and establish radiological background levels. As required by the statistical Multi-Agency Radiation Survey and Site Investigation Manual [MARSSIM]) method, these background levels will be developed from 35 random sampling locations. The following steps were taken to achieve this number:

- Two hundred sampling locations within the LLNL perimeter were initially identified using a random number generator.

- Using a basemap showing locations of buildings, roads, etc., the two hundred randomly selected points were screened, and locations that existed beneath buildings were eliminated.
- The remaining 166 locations were reviewed by LLNL staff from the Environmental Restoration Division CERCLA remediation effort, and 33 locations considered to be inappropriate for use as background were identified and further eliminated, leaving 133 potential sampling locations.

Background sample locations on top of paved roads, or otherwise inaccessible, will be discarded. Since the number of discarded locations is unknown until the time sampling is performed, 50 of the 133 locations are shown in Figure A-3, and are described as SO1 through SO50 in **Table A-7**. The remaining 83 locations will be held in reserve in case fewer than 35 of the 50 are found to be viable.

Background soil (SO) samples will be analyzed for radiological and inorganic parameters, as indicated in **Table A-2**. In addition to gross alpha, gross beta, and tritium analyses, isotopic speciation will be performed on all SO samples to identify the isotopes and facilitate comparison with the concrete-asphalt-soil (CAS) samples obtained at the Building 419 Facility.

**IV.5 Concrete-Asphalt-Soil (CAS) Sample Acquisition at the Building 419 Facility**

Concrete-Asphalt-Soil (CAS) samples at the Building 419 Facility will be collected to determine the locations and extent of existing contamination. CAS locations are identified as indicated in **Figure A-2** and described in **Table A-8**. All measurements are within the B-419 Facility area.

CAS samples will be analyzed for radiological contamination (alpha, beta, and tritium). The extent of follow-up radiological analysis will be determined after the CAS sampling results are compared to the radiological background levels obtained through soil (SO) sample acquisition throughout the LLNL site.

In addition to radiological analysis, CAS samples will be analyzed for radiological, organic, and inorganic parameters as described here using the methods listed in **Table A-3**. Concrete sample results will be used to characterize the waste for disposal purposes. CAS samples 1 through 39 will be taken with incremental depths of surface, 2, 5, 10 and 15 ft. Samples will be taken and evaluated in order from the surface to 15 ft deep. If the samples from 5 and 10 ft do not show contamination, then the sample location will be considered clean, i.e., the sample collected from a depth of 15 ft will not be tested. A step-down, step-out approach will be used in order to determine the extent of soil contamination as necessary. An adequate volume of each CAS sample acquired at the Building 419 Facility from depths of surface, 2 ft, and 5 ft. will be reserved in order to allow for the possibility of further radiological and/or chemical analyses, if required.

Additional soil samples will be obtained beneath the underground pipe areas in Room 124. A trench will be dug along each pipe run before removing the slab, and samples will be collected along the pipes at strategic locations, such as junction points, locations where there is evidence of staining, leaks, odors, and points where damaged or pipe fragments are observed. If obvious sampling locations, as stated, are not observed, one sample will be taken at 15-ft intervals. Samples will be taken immediately under the pipes and at depths of 5, 10, and 15 ft deep as measured from the soil surface under the concrete floor consistent with the other CAS sampling depths.

With regard to sampling at locations beneath the piping that has already been removed, samples of the "clean" backfill material will not be necessary; however, soil samples beneath the clean fill will be obtained at 15-ft intervals of original pipe location at the depth stated. Samples in Room 167 will be obtained at depths of 1, 5, 10 and 15 ft at the locations stated below:

- 6.5 ft from the South wall and 8 ft from the East wall
- 11 ft from the West wall and 6.6 ft from South wall
- 4 ft from the South wall and 13 ft from East wall
- 1 ft from South wall and 13 ft from East wall
- 9 ft from the South wall and 17 ft from West wall
- 7 ft from South wall and 1 ft from West wall.

CAS samples of the underground tank vault will consist of concrete and soil samples as stated in **Table A-8**. One soil sample will be obtained at each sampling location at the interface of soil and concrete.

Analytical results of the concrete sample will be evaluated to determine whether any residual contamination that might be detected is from waste management activities in the unit or is an artifact of the concrete itself.

CAS samples 40 and 41 within the north yard coincide with locations of source areas identified in the *Livermore Site Southeast Corner VOC Source Study—B-419/511 Area*, dated June 1, 2000. These soil samples will consist of deep soil boring activities with samples collected at 5-ft intervals to the first encounter with groundwater as well as a groundwater sample. Analytical results of shallow CAS samples in the north yard will be used to determine if CAS sample locations 40 and 41 need to be adjusted to areas where the highest VOC concentrations were found to exist.

### *IV.5.1 Radiological Constituents*

CAS samples acquired at the Building Facility and SO samples acquired throughout the LLNL site will be analyzed for radioactivity by means of a bulk radiochemical analysis.

# V. Data Evaluation

The resulting data will be evaluated according to the following:

- Core samples and concrete samples of the soil and concrete floor will be analyzed in accordance with SW-846 (EPA, 1986 [and updates]) to test for respective contaminants.
- Equipment that have handled listed wastes will be characterized as such.
- The acquired CAS samples at the Building 419 Facility will be compared to the maximum allowable concentrations for metals in soil and the radiological background levels obtained through soil (SO) sample acquisition throughout the LLNL site. An adequate volume of each CAS sample acquired at the Building 419 Facility from depths of the surface, 2 ft., and 5 ft., will be reserved in order to allow for the possibility of further radiological or chemical analyses.

# VI. Quality Assurance/Quality Control

Quality assurance (QA) is a management system for ensuring that all information, data, and decisions are technically sound and properly documented. This SAP contains guidance for the parameters in the following list:

- Sampling and decontamination.
- Sample custody.
- Calibration procedures and frequency.
- Analytical procedures.
- Data reduction, validation, and reporting.
- Internal quality control checks.
- Frequency, performance, and system audits.
- Specific routine procedures used to assess data precision, accuracy, and completeness.
- Corrective actions.
- QA reports to management.

This section provides information on QA objectives for the procedures and the data relevant to this SAP. QA considerations for procedures include field and laboratory techniques. Data quality is assessed by determining the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters.

## VI.1 Quality Assurance Chain-of-Custody Practices

For each sample collected in the field, sampling personnel will follow the practices described in **Section III.2.1**, including the use of field logbooks and a CoC document and a standard identification label to accompany each sample at all times. The CoC form will accompany the samples through the sampling and analysis process. When samples change custody, the relinquishing and the receiving parties sign the CoC document.

### VI.2 Quality Assurance Performance Criteria

All sampling and analysis activities will be performed in accordance with the QA/quality control (QC) practices described in this SAP and according to the *Laboratory Quality Assurance Plan* (LLNL, 1992) and related procedures. Contract laboratories selected to perform any of the analytical tests will possess a laboratory certification from the California Department of Health Services (DHS) and will conform to the related certification QA/QC requirements.

### VI.3 Quality Assurance /Quality Control Practices

The QA/QC practices to be followed during the execution of this plan are summarized in this section. Adherence to these practices will produce data capable of withstanding scientific and legal scrutiny.

#### *VI.3.1 Field QA/QC*

Field QA/QC is ensured by uniform procedures for sample collection, handling, CoC, and shipping and by evaluation of QC samples collected in the field. Field samples used to assess QA/QC are the following:

- Field blanks.
- Trip blanks.
- Rinsates (equipment blanks).
- Swipe blanks.
- Field replicates.

#### *VI.3.2 Laboratory QA/QC Practices*

This section summarizes laboratory practices that ensure analytical QA/QC.

##### VI.3.2.1 General Laboratory Controls

In addition to instrument calibration and the analysis of QC samples, the California-certified laboratory that performs the analyses must implement the following analytical controls:

- Reagents and solvents will have certified compositions.
- Reagent storage environment and duration will meet the manufacturers' guidelines.

- Laboratory equipment will be calibrated/standardized following the referenced procedures for the methods used and shall be documented.
- Volumetric measurements will be made with certified glassware.
- Data reduction computations will be independently checked.
- Qualified personnel will perform laboratory analyses using approved methods.
- QA/QC requirements and guidelines specified in the selected analytical methods will be followed.

These requirements are standard in a certified laboratory and will be verified during the laboratory inspection and validation process.

#### VI.3.2.2 Laboratory QA/QC

The laboratory performing the analysis will spike samples with a known concentration of an analyte and analyze the sample to determine the accuracy as percent recovery. The percent recovery will be recorded on the analytical QC forms. If the results fall outside internal limits, the samples will be reanalyzed. Examples of laboratory QC samples are the following:

- Method blanks.
- Method blank spike.
- Laboratory control sample for inorganics.
- Matrix spikes.
- Laboratory duplicate samples.
- Known laboratory QC check sample.

## VI.4 Precision, Accuracy, Representativeness, Comparability, and Completeness (PARCC)

Data will be evaluated according to the PARCC parameters in order to have a level of assurance of the quality of the measurement data. These characteristics are necessary when considering the usefulness of a set of data for interpretation.

### *VI.4.1 Precision*

Precision measures the reproducibility of measurements under a given set of conditions. It is a quantitative measure of the variability of a group of measurements compared to their average value. Precision is assessed by means of laboratory duplicate or field replicate sample analysis and is usually stated in terms of standard deviation or relative standard deviation (coefficient of variation). Field precision will be assessed by replicate samples, field audits, and checklists performed on a routine basis. These audits will document the use (or nonuse) of uniform sampling methods and of handling and shipping procedures. Laboratory precision is assessed by duplicate samples and laboratory splits.

Replicate frequencies will be based on sample batches acquired. One field replicate per 20 samples will be taken. When a sampling event has fewer than 20 samples, a field replicate will also be obtained. Stained areas, depending on size, will be candidates for replicate locations.

### *VI.4.2 Accuracy*

Accuracy refers to the nearness of a result, or the mean of a set of results, to the true or accepted value. Accuracy measures the average or systematic error of a method. Accuracy may be determined by the evaluation of the results of field/trip blanks, field replicates, check samples, and matrix spikes. Accuracy is most often expressed as the percent recovery of the measurement of a sample with known concentration of the analyte of interest. Field accuracy will be evaluated from the results of field audits, including on-site assessment of sample-collection procedures, instrument performance, and calibration procedures. Sampling accuracy will also be assessed through the use of trip blanks and field blanks and replicates. These blanks will identify compounds inadvertently introduced into the samples during shipment or from contaminated sampling equipment.

### *VI.4.3 Representativeness*

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. The representativeness of a sample is a qualitative parameter mainly concerned with sample-collection design. Representativeness is best satisfied by making sure that the sampling locations are selected properly (representative of a given point in space and time) and that a sufficient number of samples is collected. The following criteria must be met to provide evidence of representativeness:

- Material content of sampling equipment and sampling containers meet criteria for acceptability of parameters to be analyzed.
- Sampling procedure does not alter samples regarding parameters of concern.
- Sample preservation procedures meet criteria for acceptability of parameters and media to be analyzed.
- Contamination of field blanks is not evident.
- Decontamination of sampling equipment between samples reveals no apparent cross-contamination.
- Collection of samples in space and time is adequate to represent the condition of concern.

- The actual measurement result represents the concept or parameter that is of interest.

### *VI.4.4 Comparability*

Comparability refers to the qualitative parameter expressing the confidence with which different data sets can be compared. Sample data should be comparable with other measurement data for similar samples and sample conditions. Standard techniques are used to collect and analyze representative samples in order to ensure comparable results. Analytical results will be reported in appropriate units for convenient comparison to historical data.

### *VI.4.5 Completeness*

Completeness is the percentage of measurements made that are judged to be valid. The criteria specified for precision, accuracy, representativeness, and comparability for each analytical method used must be validated in order to fulfill the completeness goals. Completeness of the data is the amount of valid data obtained from a measurement system versus the amount of planned data.

## VI.5 Data Evaluation

The resulting data will be evaluated according to the following:

- Core samples, and concrete samples are to be analyzed in accordance with SW-846 (EPA, 1986 [and updates]) to test for respective contaminants. Analytical results from this testing will be compared to RCRA and California hazardous regulatory limits where appropriate.
- Samples that identify hazardous constituents that do not have regulatory waste limits will be evaluated in accordance with 22 CCR 66261.24(b) and 22 CCR 66261.24(c) for toxicity characteristics.
- Concrete-asphalt-soil (CAS)samples acquired at the Building 419 Facility will be evaluated for DOE-added radioactivity and will be compared to the maximum allowable concentrations for metals in soil and the radiological background levels obtained through soil sample acquisition throughout the LLNL site.

## VI.6 Reports

At the completion of the sampling and analysis effort, a report will be generated by summarizing the analytical results for the CAS and background soil (SO) samples.

## VII. References

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## VIII. Acronyms

| | |
|---|---|
| 1,2-DCA | 1,2-Dichloroethane |
| ASTM | American Society of Testing and Materials |
| CAS | Concrete, asphalt, and soil |
| CCR | California Code of Regulations |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CoC | Chain of custody |
| DHS | California Department of Health Services |
| DOE | U.S. Department of Energy |
| DTSC | California Department of Toxic Substances Control |
| DWTF | Decontamination and Waste Treatment Facility |
| EPA | Environmental Protection Agency |
| ERD | Environmental Restoration Division |
| fCi/g | femto [$10^{-15}$] curies per gram |
| ID | Identification |
| LLNL | Lawrence Livermore National Laboratory |
| LWRP | Livermore Water Reclamation Plant |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| MCL | Maximum Contaminant Levels |
| PARCC | precision, accuracy, representativeness, comparability, and completeness |
| PCB | Polychlorinated biphenyls |
| PCE | perchloroethylene |
| pCi/g | picocuries per gram |
| pCi/Lsm | picocuries per liter of soil moisture |
| QA | Quality assurance |
| QC | Quality control |

| | |
|---|---|
| RCRA | Resource Conservation and Recovery Act |
| RHWM | Radioactive and Hazardous Waste Management |
| S | Structural |
| SAP | Sampling and Analysis Plan |
| STLC | Soluble Threshold Limit Concentration |
| SVS | Soil vapor survey |
| TCE | trichloroethylene |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TTLC | Total Threshold Limit Concentration |
| VOA | Volatile organic analysis |
| VOCs | Volatile organic compounds |
| WAP | Waste Analysis Plan |
| WET | Waste Extraction Test |
| ZHE | Zero Headspace Extraction |
| $\mu Ci/ms^2$ | microcuries per meter second squared |

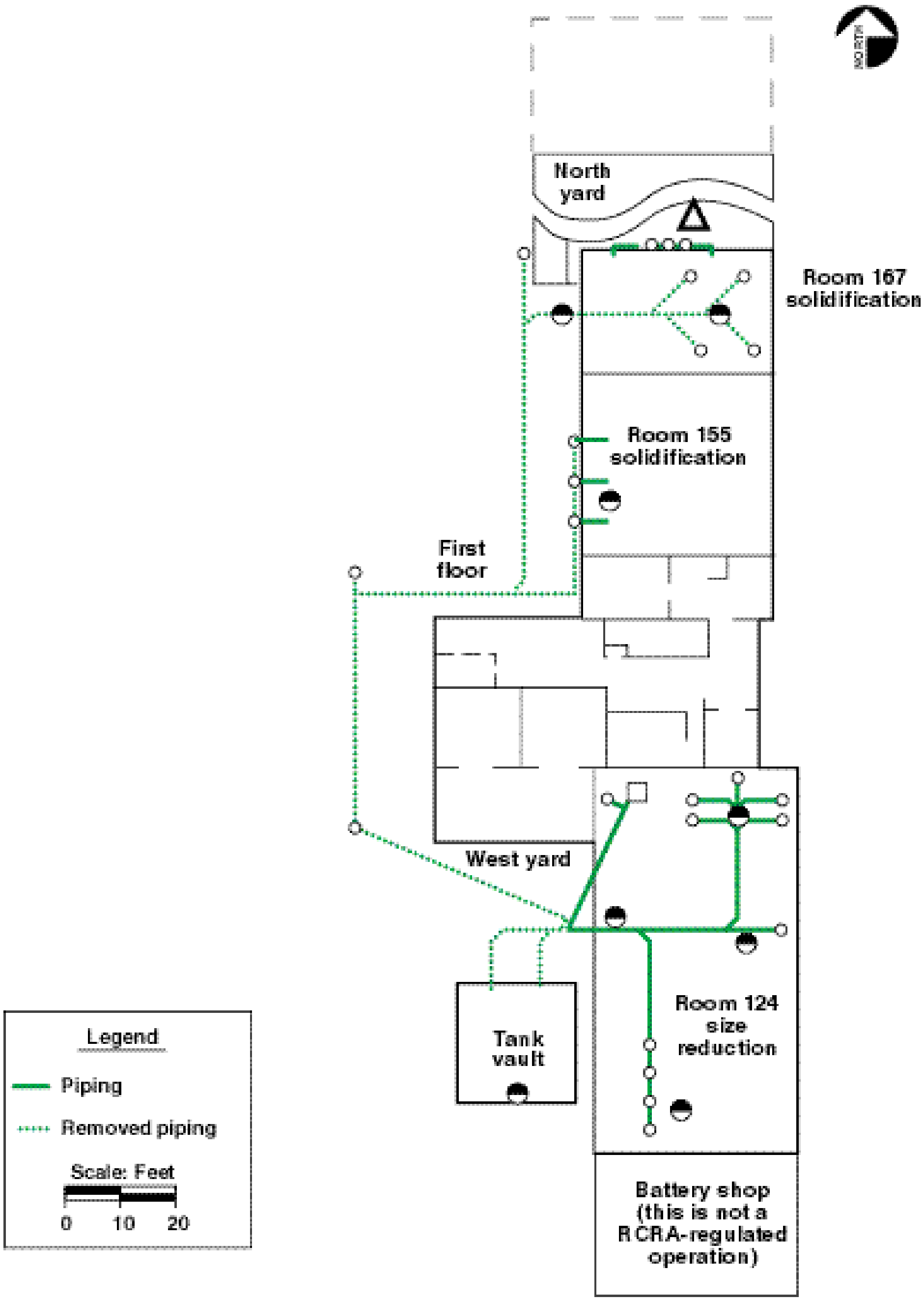


**Figure A-1. Schematic of Building 419 showing location of UST piping and removed piping locations**

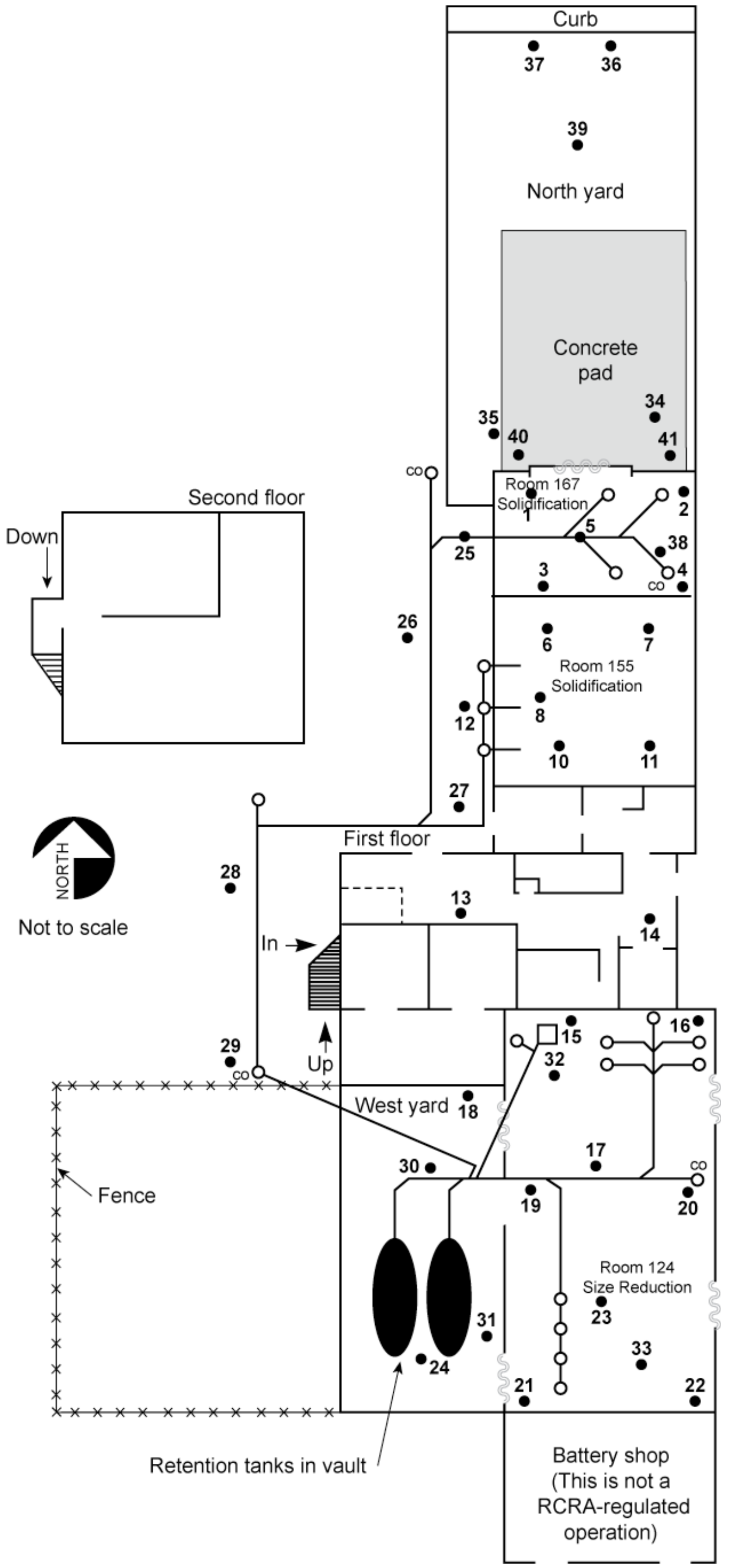


**Figure A-2. Sample borehole locations at the B-419 Facility**

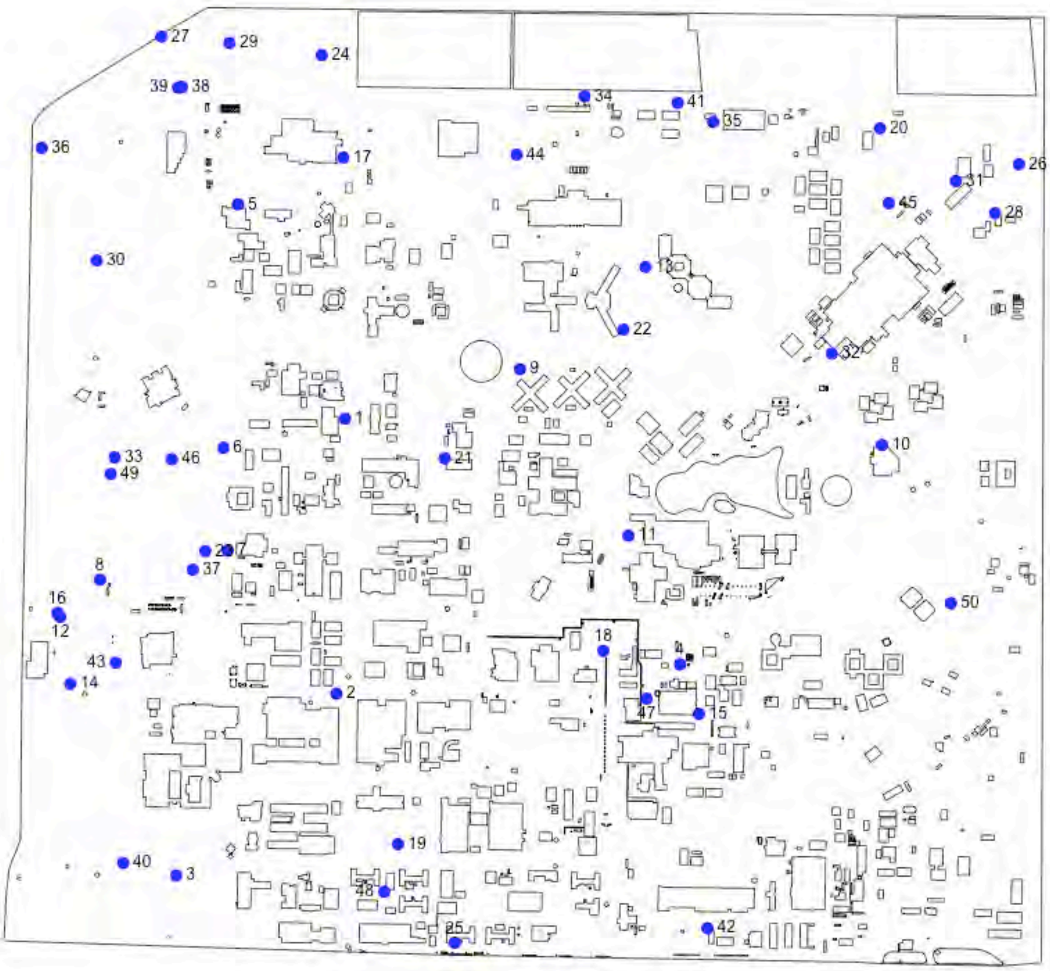


**Figure A-3. Sample borehole locations throughout the LLNL site**

**Table A-1a. Potential Historical Contaminants at the Building 419 Hazardous Waste Treatment Facility**

| |
|---|
| **Size Reduction Unit** |
| Toxic metal including beryllium, copper, chromium, arsenic, nickel, cadmium, mercury, and lead |
| Oil (lubricating oils, diffusion pump oils) and grease |
| Radionuclides |
| Freon |
| Methyl chloride |
| TCE |
| PCE |
| Methyl ethyl ketone |
| **Solidification Unit** |
| 1,1-Dichloroethylene |
| 1,2-Dichloroethane |
| 1,4-Dichlorobenzene |
| Acids and bases |
| Carbon tetrachloride |
| Chlorobenzene |
| Chloroform |
| Toxic metals |
| Methyl ethyl ketone |
| Oil and grease |
| Pyridine |
| Radionuclides |
| Spent cyanide plating solution |
| Spent cyanide stripping solution |
| Spent halogenated solvents |
| Tetrachloroethylene |
| Trichloroethylene |

**Table A-1b. Potential Contaminants EPA and DTSC Waste Codes**

| Contaminants | EPA Codes | Solid Waste DTSC Codes | Aqueous Waste DTSC Codes | Non-Aqueous Waste DTSC Codes |
|---|---|---|---|---|
| 1,1,1-trichloroethane | F001,F002 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| 1,1-dichloroethene | D029 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| 1,2-dichloroethane | D028 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| 1,4-dichlorobenzene | D027 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| 2-butanone (MEK) | F005, D035 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| acetone | F003 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| carbon tetrachloride | F001, D019 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| chlorobenzene | F002, D021 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| chloroform | D022 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| methylene chloride | F001, F002 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| o-xylene | F003 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| p- & m-xylene | F003 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| tetrachloroethene | F001, F002, D039 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| trichloroethene | F001, F002, D040 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| trichlorofluoromethane | F002 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| lindane | D013 | 351/352 | 133/134/731/741 | 341/343/731/741 |
| Antimony | N/A | 181 | 121/122/132/135/791/792 | 221/342/343 |
| Arsenic | D004 | 181 | 121/122/132/135/721/791/792 | 221/342/343/721 |
| Barium | D005 | 181 | 121/122/132/135/791/792 | 221/342/343 |
| Beryllium | N/A | 181 | 121/122/132/135/791/792 | 221/342/343 |
| Cadmium | D006 | 181 | 121/122/132/135/722/791/792 | 221/342/343/722 |
| Chromium | D007 | 181 | 121/122/132/135/723/791/792 | 221/342/343/723 |
| Cobalt | N/A | 181 | 121/122/132/135/791/792 | 221/342/343 |
| Copper | N/A | 181 | 121/122/132/135/791/792 | 221/342/343 |
| Lead | D008 | 181 | 121/122/132/135/7247 91/792 | 221/342/343/724 |

**Table A-1b. Potential Contaminants EPA and DTSC Waste Codes (continued)**

| Contaminants | EPA Codes | Solid Waste DTSC Codes | Aqueous Waste DTSC Codes | Non-Aqueous Waste DTSC Codes |
|---|---|---|---|---|
| Mercury | D009 | 181 | 121/122/132/135/725/791/792 | 221/342/343/725 |
| Molybdenum | N/A | 181 | 121/122/132/135/791/792 | 221/342/343 |
| Nickel | N/A | 181 | 121/122/132/135/726/791/792 | 221/342/343/726 |
| Contaminants | EPA Codes | Solid Waste DTSC Codes | Aqueous Waste DTSC Codes | Non-Aqueous Waste DTSC Codes |
| Selenium | D010 | 181 | 121/122/132/135/727/791/792 | 221/342/343/727 |
| Silver | D011 | 181 | 121/122/132/135/791/792 | 221/342/343 |
| Thallium | N/A | 181 | 121/122/132/135/728/791/792 | 221/342/343/728 |
| Vanadium | N/A | 181 | 121/122/132/135/791/792 | 221/342/343 |
| Zinc | N/A | 181 | 121/122/132/135/791/792 | 221/342/343 |
| Cyanide | D003 | 181/351/352 | 131/135/711 | 341/343/731/711/741 |
| Oil and grease | N/A | 181/351/352 | 222/223 | 341/343 |
| Oil containing waste | N/A | 181/223/351/352 | 222/223 | 341/343 |
| Acids | D002 | 181/351/352 | 791/792 | 341/343 |
| Bases | D002 | 181/351/352 | 122 | 341/343 |

**Table A-2. Parameters for Analysis and Analytical Methods for Background Soil Samples Obtained Throughout the LLNL Site to Establish Maximum Allowable Concentrations for Metals in Soil, and Radiological Background Levels**

| Parameter/constituent | Method | Comments/Rationale |
|---|---|---|
| Antimony | 6010B | TTLC analysis |
| Arsenic | 6010B | TTLC analysis |
| Barium | 6010B | TTLC analysis |
| Beryllium | 6010B | TTLC analysis |
| Cadmium | 6010B | TTLC analysis |
| Chromium (total) | 6010B | TTLC analysis |
| Cobalt | 6010B | TTLC analysis |
| Copper | 6010B | TTLC analysis |
| Lead | 6010B | TTLC analysis |
| Mercury | 7471A | TTLC analysis |
| Molybdenum | 6010B | TTLC analysis |
| Nickel | 6010B | TTLC analysis |
| Selenium | 6010B | TTLC analysis |
| Silver | 6010B | TTLC analysis |
| Thallium | 6010B | TTLC analysis |
| Vanadium | 6010B | TTLC analysis |
| Zinc | 6010B | TTLC analysis |
| Gross alpha | 9310 | – |
| Gross beta | 9310 | – |
| Tritium | 906 | – |
| Gamma Spectroscopy | – | – |
| Alpha Spectroscopy | – | Includes analysis for Thorium, Uranium, Plutonium, and Americium |
| Strontium 90, Technetium 99, and Carbon14 | – | – |

**Table A-3. Parameters for Analysis and Analytical Methods for Bulk Samples, Swipe Samples, and Wastewater Generated during Closure and Decontamination Activities (concluded)**

| Parameter/constituent | Method[a] | Comments/Rationale |
|---|---|---|
| Halogenated volatile organics | 8260 | |
| Nonhalogenated volatile organics | 8270 | |
| Aromatic volatile organics | 8260/8210 | |
| Polychlorinated biphenyls (PCB) | 8082 | |
| Semivolatile organics | 8270 | |
| Volatile organics | 8260 | |
| Total petroleum hydrocarbons | Modified 8015 | |
| TCLP Zero Headspace Extraction | Method 1311 | |

[a] Refers to EPA SW-846, 3rd ed., unless otherwise noted. SM is *Standard Methods for the Examination of Water and Wastewater*, 17th ed., 1989. ASTM is American Society for Testing and Materials.

[b] STLC parameters based on CCR Title 22, Section 66700, Zero Headspace Extraction.

**Table A-4. List of Inorganic Persistent and Bioaccumulative Toxic Substances and Their STLC and TTLC Values[a]**

| Substance | TTLC[b] (mg/kg) | STLC[b] (mg/L) |
|---|---|---|
| Antimony and/or antimony compounds | 500 | 15.0 |
| Arsenic and/or arsenic compounds | 500 | 5.0 |
| Asbestos[c] (as percent) | 1.0 | — |
| Barium and/or barium compounds (excluding barite)[d] | 10,000 | 100 |
| Beryllium and/or beryllium compounds | 75 | 0.75 |
| Cadmium and/or cadmium compounds | 100 | 1.0 |
| Chromium(Vl) compounds | 500 | 5.0 |
| Chromium and/or chromium(III) compounds | 2,500 | 560 |
| Cobalt and/or cobalt compounds | 8,000 | 80 |
| Copper and/or copper compounds | 2,500 | 25 |
| Fluoride salts | 18,000 | 180 |
| Lead and/or lead compounds | 1,000 | 5.0 |
| Mercury and/or mercury compounds | 20 | 0.2 |
| Molybdenum and/or molybdenum compounds | 3,500 | 350. |
| Nickel and/or nickel compounds | 2,000 | 20.0 |
| Selenium and/or selenium compounds | 100 | 1.0 |
| Silver and/or silver compounds | 500 | 5.0 |
| Thallium and/or thallium compounds | 700 | 7.0 |
| Vanadium and/or vanadium compounds | 2,400 | 24 |
| Zinc and/or zinc compounds | 5,000 | 250 |

[a] From 22 CCR 66261.24(a)(2), Table II.

[b] TTLC = total threshold limit concentration.

STLC = soluble threshold limit concentration; Waste Extraction Test (WET) analysis used.

STLC and TTLC values are calculated on the concentrations of the elements, not of the compounds.

[c] In the case of asbestos and elemental metals, applies only if they are in a friable, powdered, or finely divided state. Asbestos includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

[d] Excluding barium sulfate.

**Table A-5. List of Organic Toxicity Characteristic Leaching Procedure (TCLP) Regulatory Limit Values[a]**

| Substance | TCLP (mg/L) |
|---|---|
| Benzene | 5.0 |
| Carbon tetrachloride | 0.5 |
| Chlordane | 0.03 |
| Chlorobenzene | 100.0 |
| Chloroform | 6.0 |
| Cresols | 200.0 |
| 1,4-Dichlorobenzene | 7.5 |
| 1,2-Dichloroethane | 0.5 |
| 1,1 Dichloroethylene | 0.7 |
| 2,4-Dichlorophenoxyacetic acid | 10.0 |
| 2,4 Dinitrotoluene | 0.13 |
| Endrin | 0.02 |
| Heptachlor | 0.008 |
| Hexachlorethane | 3.0 |
| Hexachlorobenzene | 0.13 |
| Hexachlorobutadiene | 0.5 |
| Lindane | 0.4 |
| Methoxychlor | 10.0 |
| Methyl ethyl ketone | 200.0 |
| Nitrobenzene | 2.0 |
| Pentachlorophenol | 100.0 |
| Pyridine | 5.0 |
| Tetrachloroethylene | 0.7 |
| Toxaphene | 0.5 |
| Trichloroethylene | 0.5 |
| 2,4,5-Trichlorophenol | 400.0 |
| 2,4,6-Trichlorophenol | 2.0 |
| 2,4,5-Trichlorophenoxypropionic acid (Silvex) | 1.0 |
| Vinyl chloride | 0.2 |

[a] From 22 CCR 66261.24(a)(2) Table I.

**Table A-6. B-419 Decontamination/Size Reduction Facility Unit Component and Waste Characterization**

| Unit Component or Waste | Radiological Constituent | Metals Residue | Organic Residue | Other |
|---|---|---|---|---|
| Concrete core and soil samples | Bulk analysis | Bulk analysis—STLC, TCLP, TTLC metals, including mercury and hex. chromium | TTLC or TCLP organics using ZHE: volatiles, volatile aromatics, semivolatiles, petroleum hydrocarbons and PCBs | Generator knowledge, Total cyanide |
| Structural samples, including wall, ceiling, tile, and roof samples | Bulk analysis | Bulk analysis—STLC, TCLP, TTLC metals including mercury and hex. chromium | TTLC or TCLP organics using ZHE: volatiles, semivolatiles | Generator knowledge |
| Swipe samples, including those obtained from fixtures, cranes, ducting and utility piping | Gross alpha, beta and tritium | TTLC metals, including mercury and hex. chromium | None | Generator knowledge |
| Decontamination rags and wipes | Bulk radiochemical analysis | Bulk analysis—STLC metals | TTLC or TCLP organics using ZHE: volatiles, volatile aromatics, and semivolatiles, PCBs | Generator knowledge |
| Decontamination wastewater | Bulk radiochemical analysis | Bulk analysis—STLC metals | 8080 | pH, cyanide |
| Decontamination sludges and residues | Bulk radiochemical analysis | Bulk analysis—STLC, TTLC metals | TCLP organics using ZHE: volatiles, volatile aromatics, and semivolatiles, PCBs | Generator knowledge |
| Rain water | See Waste Analysis Plan | | | |

Notes:

1. The STLC will be run if the total constituent concentration is equal to or greater than 10 times the STLC hazardous waste threshold.
2. The TCLP will be run if the total constituent concentration is equal to or greater than 20 times the TCLP hazardous waste threshold.

**Table A-7. Background Soil (SO) Sample Acquisition Measurement Locations Throughout the LLNL Site**

| SO number | Longitude | Latitude |
|---|---|---|
| SO-1 | -121.710454 | 37.6888268 |
| SO-2 | -121.7105596 | 37.68424625 |
| SO-3 | -121.7138716 | 37.68118367 |
| SO-4 | -121.7033598 | 37.68480665 |
| SO-5 | -121.7127563 | 37.69237573 |
| SO-6 | -121.7129984 | 37.688318 |
| SO-7 | -121.712879 | 37.68660883 |
| SO-9 | -121.7155501 | 37.68609405 |
| SO-10 | -121.7068007 | 37.68969052 |
| SO-11 | -121.699184 | 37.68850616 |
| SO-12 | -121.7044765 | 37.68694167 |
| SO-13 | -121.7163733 | 37.6854662 |
| SO-14 | -121.7041886 | 37.69142014 |
| SO-15 | -121.7161437 | 37.68435263 |
| SO-16 | -121.7029476 | 37.68398829 |
| SO-17 | -121.7164334 | 37.6855315 |
| SO-18 | -121.710561 | 37.69317661 |
| SO-19 | -121.7049758 | 37.68501686 |
| SO-20 | -121.7092289 | 37.68175631 |
| SO-21 | -121.6993133 | 37.69378105 |
| SO-22 | -121.7083556 | 37.68819325 |
| SO-23 | -121.7046406 | 37.69037228 |
| SO-24 | -121.7133482 | 37.68659424 |
| SO-25 | -121.7110412 | 37.69487749 |
| SO-26 | -121.7080117 | 37.68012248 |
| SO-27 | -121.6963873 | 37.6932113 |
| SO-28 | -121.7144063 | 37.69515222 |
| SO-29 | -121.6968733 | 37.69239258 |
| SO-30 | -121.712978 | 37.69505993 |
| SO-31 | -121.7157052 | 37.69141028 |
| SO-32 | -121.697705 | 37.69291717 |
| SO-33 | -121.7002623 | 37.69001675 |
| SO-34 | -121.7152772 | 37.68813363 |
| SO-35 | -121.7055156 | 37.69424942 |
| SO-36 | -121.7028098 | 37.69384822 |
| SO-37 | -121.7168894 | 37.6932716 |
| SO-38 | -121.7136056 | 37.68628185 |
| SO-39 | -121.7139664 | 37.69431746 |
| SO-40 | -121.7140444 | 37.69430534 |
| SO-41 | -121.7149877 | 37.68138022 |
| SO-42 | -121.7035635 | 37.69416152 |
| SO-43 | -121.702715 | 37.68042105 |

**Table A-7. Background Soil (SO) Sample Acquisition Measurement Locations Throughout the LLNL Site (continued)**

| SO number | Longitude | Latitude |
|---|---|---|
| SO-44 | -121.7069249 | 37.69326324 |
| SO-45 | -121.699105 | 37.69253572 |
| SO-46 | -121.7140752 | 37.68811672 |
| SO-47 | -121.7040506 | 37.68423056 |
| SO-48 | -121.7095043 | 37.68095734 |
| SO-49 | -121.715354 | 37.68785617 |
| SO-50 | -121.6976972 | 37.6858848 |

**Table A-8. Concrete-asphalt-soil (CAS) Sample Acquisition Measurement Locations at the B-419 Facility**

| CAS number | Location |
|---|---|
| CAS-1 | Rm 167 NW corner/Degreasing station<br>5 ft from the North wall and 5 ft from the West wall |
| CAS-2 | Rm 167 NE corner/Hood FHE-6<br>6 ft from the North wall and 6 ft from the East wall |
| CAS-3 | Rm 167 SW corner/Degreasing station<br>6 ft from the South wall and 6 ft from the West wall |
| CAS-4 | Rm 167 SE corner/Vapor Blaster<br>6 ft from the South wall and 6 ft from the East wall |
| CAS-5 | Rm 167 Rm center 15 ft from the East wall and 10 ft from the North wall |
| CAS-6 | Rm 155 NW corner/Bake out oven<br>6 ft from the North wall and 6 ft from the West wall |
| CAS-7 | Rm 155 NE corner/Vapor Blaster<br>6 ft from the North wall and 6 ft from the East wall |
| CAS-8 | Rm 155 West wall/Hoods FHE-12, FHE-8<br>15 ft from the North wall and 6 ft from the West wall |
| CAS-9 | Open |
| CAS-10 | Rm 155 SW corner/Hood FHE-8, Sink<br>6 ft from the West wall and 6 ft from the South wall |
| CAS-11 | Rm 155 SE corner 6 ft from the South wall and 6 ft from the East wall |
| CAS-12 | Rm 155 outside 35 ft south of NW building corner and 5 ft west from west wall |
| CAS-13 | Rm 150 Office center 6 ft from the East wall and 6 ft from the South wall |
| CAS-14 | Building Entry/Center 10 ft from the North wall and 4 ft from the East wall |
| CAS-15 | Rm 124 NW corner/Ultrasonic Cleaner<br>8 ft from the North wall and 10 ft from the West wall |
| CAS-16 | Rm 124 NE corner 8 ft from the North wall and 8 ft from the East wall |
| CAS-17 | Rm 124 Center 20 ft from the North wall and 15 ft from the East wall |
| CAS-18 | Rm 124 outside 30 ft from south of SW building corner and 5 ft west from West wall |
| CAS-19 | Rm 124 West Center 30 ft from the South wall and 8 ft from the West wall |
| CAS-20 | Rm 124 NW East wall/Electropolisher<br>8 ft from the East wall and 30 ft from the South wall |
| CAS-21 | Rm 124 SW corner/Walk-in Hood<br>8 ft from the South wall and 8 ft from the West wall |
| CAS-22 | Rm 124 SE corner/Bake-out oven<br>8 ft from the South wall and 8 ft from the East wall |
| CAS-23 | Rm 124 South Center/Bake-out oven<br>20 ft from the South wall and 15 ft from the East wall |
| CAS-24 | Tank Vault outside Rm 124 Tank Vault interior/Center South side |
| CAS-25 | Outside building/pipe outlet from Rm 167<br>10 ft South of NW building corner and 5 ft West from West wall |
| CAS 26 | 12 ft from outer West wall and 31 ft from outer South wall of the building |
| CAS 27 | 5 ft from the outer West wall and 8.5 ft from outer South wall of the building |
| CAS 28 | 13 ft from the outer West wall and 3 ft from the edge of building (see Figure A-2) |
| CAS 29 | 36.5 ft from the outer West wall and 29 ft from the edge of the tank vault |
| CAS 30 | 12 ft from the West of wall of Rm 124 and 16.5 from the tank vault |
| CAS 31 | Inside the West Yard, 3.5 ft from the outer West wall of Rm 124 and 9 ft from the chain link fence on the South end |

**Table A-8. Concrete-asphalt-soil (CAS) Sample Acquisition Measurement Locations at the B-419 Facility (continued)**

| CAS number | Location |
|---|---|
| CAS 32 | Inside Rm 124, 12.5 ft from the West wall and 7 ft from the North wall |
| CAS 33 | Inside Rm 124, 11 ft from the East wall and 18 ft from the South wall |
| CAS 34 | Inside the North Yard, 8 ft from the chain link fence on the side and 16.5 ft from the outer North side of the building |
| CAS 35 | Inside the North Yard, edge of the concrete pad, 12 ft from the outer North wall of the building and 12.5 ft to the chain link fence on the West side of the yard |
| CAS 36 | Inside the North Yard, 15 ft to the chain link fence on the East side of the yard on the South side of the concrete curb |
| CAS 37 | Inside the North Yard, 15 ft to the chain link fence on the West side of the yard on the South side of the concrete curb |
| CAS 38 | Inside Rm 167, inside the walk-in hood near the floor drain, 9.5 ft to the North wall and 7 ft from the East wall |
| CAS 39 | Inside the North Yard, 25 ft from north concrete curb, and 20 ft from the east chain link fence. |
| CAS 40 | Inside the North Yard, just north of Building 419, and 22 ft. from the east chain link fence. |
| CAS 41 | Inside the North Yard, just north of Building 419, and 7 ft. from the east chain link fence. |
| CAS 42 | Tank Vault outside Rm 124 North wall, immediately below where the piping penetrates the wall (concrete and soil interface only) |
| CAS 43 | Tank Vault outside Rm 124, the midpoint of the South wall and 3 ft above the floor (concrete and soil interface only) |
| CAS 44 | Tank Vault outside Rm 124, midpoint of the East wall and 3 ft above the floor (concrete and soil interface only) |
| CAS 45 | Tank Vault outside Rm 124, midpoint of the West wall and 3 ft above the floor (concrete and soil interface only) |