LLNL-TR-850350

Environmental Functional Area
Environment, Safety and Health

Lawrence Livermore National Laboratory
Livermore Site
4200 Block Development Project
Soil Sampling and Analysis Plan
(June 2023)

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Lawrence Livermore National Laboratory

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List of Abbreviations and Acronyms

ALAB	Analytical Laboratory
bgs	below ground surface
CAS	Chemical Abstracts Service
CEL	Consolidated Engineering Laboratories
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CoC	Chain of Custody
DMT	Data Management Team
DOE	U.S. Department of Energy
DOHS	Department of Health Services
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
EA	Environmental Analyst
EFA	Environmental Functional Area
ELAP	Environmental Laboratory Accreditation Program
EMRL	Environmental Monitoring Radioanalytical Laboratory
ES&H	Environment, Safety & Health
FFA	Federal Facilities Act
GEL	GEL Laboratories LLC
HAZWOPER	Hazardous Waste Operations and Emergency Response
HP	Health Physicist
IH	Industrial Hygienist
ISMS	Integrated Safety Management System
IST	Integrated Safety Team
LLNL	Lawrence Livermore National Laboratory
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
PATS	Packaging and Transportation Services
PID	Photoionization Detector
PMO	Project Management Office
PPE	Personal Protective Equipment
QA/QC	Quality Analysis/Quality Control
RHWM	Radioactive and Hazardous Waste Management
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
RL	Reporting Limit
S300	Experimental Test Site 300
SAP	Sampling and Analysis Plan
SO	Security Organization
SPT	Standard Penetration Test
SSMP	Soils Screening and Management Plan
SSLs	Soil Screening Levels
STLC	Soluble Threshold Limit Concentration
TAT	Turn-Around-Time
TSD	Technical Services Department
TEIMS	The Environmental Information Management System
WCP	Work Control Process

PCBs	Polychlorinated Biphenyls
VOCs	Volatile Organic Compounds

pCi/g	picocurie per gram
µg/L	microgram per liter
mg/kg	milligram per kilogram
µg/kg	microgram per kilogram
ppb	part per billion

1 Introduction

This Soil Sampling and Analysis Plan (SAP) was prepared by the Environmental Function Area (EFA)/Technical Services Department (TSD) of the Environment, Safety & Health (ES&H) Directorate for the Project Management Office (PMO) for the proposed Maintenance Shop Facility in the 4200 Block (project) (**Figure 1**). The purpose of the SAP is to describe the procedures for collection and analysis of environmental samples and evaluation of analytical data (chemical and radiological) to determine management options of excavated soil during project construction. This SAP follows criteria established in Lawrence Livermore National Laboratory's (LLNL) *Soils Screening and Management Plan* (SSMP) (LLNL 2022), which was formalized in accordance with U.S. Environmental Protection Agency (EPA) guidance for developing Data Quality Objectives for environmental data (EPA 2006) and the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance (U.S. NRC, U.S. EPA, U.S. DOE, and U.S. DOD 2000). The scope of this SAP is based on design information provided by PMO.

2 Project Description

The Livermore Site occupies approximately one square mile in the eastern portion of the City of Livermore. The Livermore Site is bounded to the north by Patterson Pass Road, to the south by East Avenue, to the east by Greenville Road, and to the west by South Vasco Road.

The project area is in the southeast portion of the southeast quadrant of the LLNL Livermore Site – within the 4200 Block. The proposed project involves the construction of three buildings (B420, B421, and B422), along with their respective utilities, and a designated parking area.

3 Conceptual Site Model

LLNL has been actively operating the Livermore Site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) since finalization of the Federal Facilities Agreement (FFA) between the U.S. Department of Energy (DOE), the EPA Region 9, the California Department of Health Services (DOHS) (currently Department of Toxic Substances Control [DTSC]), and the San Francisco Bay Regional Water Quality Control Board (RWQCB) in 1988 (LLNL, 1988).

Constituents of Concern (COCs) identified in the Record of Decision (ROD) for the Livermore Site include volatile organic compounds (VOCs) (*e.g.*, trichloroethene [TCE], perchloroethene [PCE], chloroform, 1,1-dichloroethene [1,1-DCE], and carbon tetrachloride), inorganic substances (*e.g.*, chromium and lead), gasoline constituents in a limited area (*e.g.*, benzene, toluene, ethylbenzene, and xylenes), and radioactive constituents (*e.g.*, tritium) (LLNL, 1992).

To determine the appropriate soil management for the proposed project, this SAP proposes to analyze soil samples for VOCs, Total Petroleum Hydrocarbons (TPH), metals, and radiological constituents consisting of gross alpha, gross beta, tritium, and gamma spectroscopy. Based on historical and current land uses of the project area, this SAP proposes a sampling strategy that

utilizes Tier 2 spacing (**Figure 1**). The project proposes constructing a parking area within the previous footprint of Building 412. Soil samples from this area were collected in 2021 during a site investigation project. Soil data from that investigation will be used to determine the appropriate soil management strategy for this specific area. Therefore, collection and analysis of soil samples from the Building 412 footprint is excluded from this SAP.

4 Organization

The following table identifies the key individuals and/or organizations involved in the project. The description of responsibilities is not comprehensive. For some responsibilities, a person is not identified, but the responsibilities are assigned to a department.

Table 1. Key Personnel Roles and Responsibilities

Role/Organization	Name	Responsibilities
Project Management Office (PMO) Project Manager	Michael Fedor	• Approves project documents and field activities. • Selects subcontractor and oversees project cost/schedule.
PMO Construction Manager	Alex Leung	• Ensures subcontractors have received the appropriate training for the project. • Obtains necessary authorizations, such as access to project location and dig permits.
PMO Design Manager	Blake Brown, P.E.	• Provides project design support.
Integrated Safety Team (IST) Environmental Analyst (EA)	David Herrera	• Responsible for gathering information necessary to define the scope of the soil sampling effort (i.e., evaluates the historical operations and releases in project area). • Evaluates analytical data and composes memorandum regarding the appropriate soil management strategies. • Ensures compliance with other environmental and permitting requirements (e.g., SWPPP, waste management).
Soil Office EA and Project Manager	Aaron Felish Reginald Ramirez, P.E.	• Responsible for developing the SAP in coordination with the IST EA. • Coordinates the sampling effort with other departments. • Performs data quality review and validation.
TSD Sampling Technologist / Sample Coordinator	Steve Hall	• Responsible for complying with applicable portions of the SAP and obtaining the required resources to collect soil samples. • Collect soil samples and prepare samples for shipment to the analytical laboratory.
TSD Data Management	Bruce Curtis	• Responsible for reviewing applicable portions of the SAP, entering sample location information into The Environmental Information Management System (TEIMS), and generating Chain of Custodies (CoCs).
Radioactive & Hazardous Waste Management	Claude Cardenas	• Conducts pre-shipment radiological screening of samples. • If necessary, will collect samples if soil is expected to be hazardous or radioactive.
Environmental Monitoring Radioanalytical Laboratory (EMRL)	Richard Bibby	• In-house laboratory that provides radiological analysis. • May also provide technical support for interpretation of radiological data.
GEL Laboratories	Heather Shaffer	• Outside environmental laboratory that provides chemical and radiological analysis.
Analytical Laboratory	Corazon Madden	• In-house analytical laboratory primarily used for volatile organic compound testing.

5 Pre-Drilling Task Roles and Responsibilities

Prior to conducting the proposed drilling and sampling activities, all field sampling personnel, the EA assigned to the project, and the TSD Data Management Team (DMT) are responsible for reviewing the applicable sections of this SAP. Also, prior to the proposed field activities, the following tasks will be completed by PMO.

Line Locating

The PMO Project Manager, or their designee, is responsible for marking the proposed boring locations and arranging for locating any underground utilities that may be present in the project area. Proposed boring locations may be adjusted in the field to avoid conflicts but should remain in the general vicinity of the proposed location. Any proposed boring that could not be performed due to a conflict should be communicated back to the Field EA assigned to the project.

Excavation Permit

The PMO Project Manager, or their designee, is responsible for obtaining the excavation permit or any other permits to conduct the drilling on the project and ensuring the permit has been completed (e.g., reviewed and signed) by the necessary disciplines.

Scheduling

The PMO Project Manager, or their designee, is responsible for scheduling the drilling rig and coordinating sampling with the ES&H team and other staff. The drill rig will be provided by Consolidated Engineering Laboratories (CEL).

Site Access and Security

The PMO Project Manager or their designee, is responsible for contacting the LLNL Security Organization and the representative or Area Facility Manager(s), at minimum, to notify them of the planned drilling operations.

6 Health and Safety

All work will be performed under LLNL's Integrated Safety Management System (ISMS) (DOE, 2017). Work will be coordinated through the institutional Work Control Process (WCP) and ES&H, and TSD Work Control Documents (WCDs) - WCD #100359 - *Water, Air, Monitoring and Analysis Group Field Sampling Activities*.

Only trained personnel shall be permitted to perform surveying or sampling. Outlined below in **Table 2** are the minimum training requirements for field personnel on the project.

Table 2. Training Requirements

Project Role	Training
Drilling/Sampling Personnel	General Employee Radiation Training
Drilling/Sampling Personnel	Site 200 Safety Orientation Training
Drilling/Sampling personnel	Site 200 Competent Worker Training
Drilling/Sampling personnel	40-Hour HAZWOPER(1) Training

(1) HAZWOPER – Hazardous Waste Operations and Emergency Response

All personnel are authorized to pause or stop work at any time when needed to address a safety concern or issue. Prior to commencing field work, all project personnel are required to demonstrate that they are up to date on any project required training. Safety (tailgate) meetings will be held at the beginning of each day of work to review safety hazards and controls, radiological controls, and any location, or weather-specific hazards for the day, as well as to discuss any work or safety-related issues and worker feedback.

If debris or suspect items, *e.g.*, drums, boxes, cans, bottles, or discolored, malodourous, or otherwise suspected contaminated soil and debris, are encountered during sampling activities, the samplers will stop all work and immediately notify the ES&H Integrated Safety Team (IST) EA, Health Physicist (HP) and Industrial Hygienist (IH), and ES&H Environmental Functional Area (EFA) Soils Office EA. Drilling will continue when the individuals jointly agree that a health risk is not present to the drillers and sampling team by the identified media.

Decontamination procedures will be conducted in accordance with TSD procedures for personnel, tools and equipment, and personal protective equipment (PPE). Generally, for radiological contamination, ES&H Health & Safety Technicians will conduct the survey. If radiological contamination is found, the ES&H IST HP will be notified to determine the extent of contamination and direct/supervise appropriate decontamination measures.

7 Work Scope

The proposed drilling, sampling, environmental testing, and data management programs are discussed in the following sections. Evaluation of analytical data, including screening against the Soil Screening Levels (SSLs), will be performed by the Field EA assigned to the project. The proposed boring locations were selected following guidelines in LLNL's SSMP, which is consistent with MARSSIM, and input from CEL, which is PMO's geotechnical consultant.

7.1 Drilling

A total of twelve environmental soil borings (SB-1 through SB-12) will be advanced in areas where soil disturbance is proposed. All soil borings will be advanced to a target depth of 6 feet below ground surface (bgs) which is the anticipated design depth for building foundation. All soil borings will be advanced using a drill rig from ground surface. The drill rig will be operated

under the direct supervision of CEL. The proposed boring identifiers, field markings, boring depths in feet from ground surface, and associated horizontal coordinates are shown in **Table 3**.

Table 3. Proposed Boring Location Identifiers and Associated Horizontal Coordinates[1]

Proposed LLNL Location Identifier	Field Marking	Depth (feet below ground surface)	Horizontal Coordinates	
			Latitude	Longitude
PC-B4200-001	SB-1	6	37.681845°	-121.705342°
PC-B4200-002	SB-2	6	37.681722°	-121.704973°
PC-B4200-003	SB-3	6	37.681730°	-121.704400°
PC-B4200-004	SB-4	6	37.681795°	-121.703779°
PC-B4200-005	SB-5	6	37.681910°	-121.703391°
PC-B4200-006	SB-6	6	37.681956°	-121.702974°
PC-B4200-007	SB-7	6	37.681481°	-121.704847°
PC-B4200-008	SB-8	6	37.681410°	-121.704244°
PC-B4200-009	SB-9	6	37.681563°	-121.703900°
PC-B4200-010	SB-10	6	37.681231°	-121.704980°
PC-B4200-011	SB-11	6	37.681233°	-121.704402°
PC-B4200-012	SB-12	6	37.681237°	-121.703767°

Final boring locations may be repositioned in the field as needed following underground utility markings and the location of overhead utilities. If drilling refusal is met at a location, the drilling crew will move roughly one to two feet from the original borehole and attempt to advance another boring to the proposed depth. If drilling refusal at the new location occurs, the location will be abandoned – another attempt to drill will not occur (see Section 7.3 for boring abandonment procedures). Logging of the soil lithology will not be performed. The horizontal position of each boring will be recorded using a Trimble device following completion of drilling activities.

Actual sample depth intervals may change in the field, however; based on surface conditions, *e.g.*, presence of thick asphaltic concrete or cement paving, native soil, vegetation, etc.

7.1.1 Environmental Soil Samples

Soil samples for environmental analyses will be collected using an un-sleeved Modified California or Standard Penetration Test (SPT) split-barrel sampler, and in accordance with the procedures contained in ESP-04, Instruction 04 - *Collecting Surface and Subsurface Soil; and*

[1] From Google Earth.

Asphalt and/or Concrete Samples. At each environmental soil boring location, a discrete sample will be collected at approximately 1.5 feet bgs and a two to four-point vertical composite sample will be collected by homogenizing soil in the field.

The discrete sample will be analyzed for VOCs and the composite sample will be analyzed for TPH in the diesel and motor oil ranges, Title 22 metals, hexavalent chromium, gross alpha, gross beta, tritium, and gamma spectroscopy.[2] Additional analysis may be performed depending on analytical results (*e.g.,* soluble metals by Waste Extraction Test or Toxicity Characteristic Leaching Procedure) or if contamination is observed while sampling. Any overlying asphalt pavement will be removed prior to drilling to prevent the introduction of asphalt fragments in environmental soil samples which could interfere with analytical testing.

A portion of the soil collected from each sampling depth interval will be screened for VOCs as follows:

- Wearing nitrile (or appropriate alternative) gloves, place a small amount of soil from each sampling depth interval into a Ziplock®-type, sandwich- or quart-size plastic bag.
- Seal the bag and label the bag with the boring location and approximate depth where the soil was collected.
- Place the sealed bag on a dark surface, e.g., the tailgate of the sampling pickup.
- After roughly 10 to 15 minutes, use a photoionization detector (PID) to check the headspace of the bag for the presence of VOCs.
- Note the PID readings in the daily logbook for the project.
- Empty the soil from the plastic bags into the drilling spoils pile for each boring, before the soil is placed back into the borehole and dispose of the plastic bags.

7.1.2 Geotechnical Soil Samples

Geotechnical soil samples will also be collected from the project area. The geotechnical soil samples will remain at the Livermore Site until the Soils Office reviews the analytical data and confirms the samples are suitable for release to the geotechnical laboratory (*i.e.*, radiological activities in soil samples are indistinguishable from background or are below the pre-approved authorized limits for unrestricted release). Once cleared for release, the geotechnical soil cores will be transported by CEL to the geotechnical laboratory.

7.2 Laboratory Programs

Testing of environmental soil samples will be performed by GEL, EMRL, RHWM, and ALAB. GEL will analyze samples for TPH, metals, gross alpha, gross beta, tritium, and gamma emitting isotopes. EMRL will analyze duplicate samples for gross alpha, gross beta, and tritium. RHWM will screen all environmental soil samples for radioactivity prior to shipping the samples to GEL. ALAB will analyze samples (including the duplicate sample) for VOCs.

[2] Analysis for VOCs is intended to satisfy landfill requirements for daily cover material.

7.2.1 Environmental Testing

Each of the laboratories that will perform the analytical testing is certified by the State of California, under the Environmental Laboratory Accreditation Program, to perform analytical testing.

Based on detected analyte concentrations in the collected samples, additional testing may occur, *i.e.*, specific radiological isotopes will be analyzed for if detected gross alpha or beta activities exceed their respective LLNL SSMP SSL; or, if any detected metal concentration exceeds ten times (10x) its Soluble Threshold Limit Concentration (STLC) the metal or metals will be analyzed for STLC.

All analyses will be requested with a 10-day turn-around-time unless specifically requested by PMO to rush the analyses to meet project schedules. The availability of rush analysis is contingent upon the duration required to conduct the analysis and the laboratory's workload and capacity. There may be instances where it is unavailable.

Appendix A is a listing of sample identifiers and proposed analytical testing groups and laboratories for the soil samples, and the trip blank samples.

Appendix B is a listing of the analytical groups proposed for the collected samples, types of containers to be used, preservative (if any) and holding times for each of the proposed analytical groups.

Appendix C is a listing of the proposed analytical testing groups, the analytes included within each testing group and their Chemical Abstracts Service (CAS) numbers, and project reporting limits (RLs).

7.3 Borehole Abandonment for Environmental and Geotechnical Borings

Once total depth is achieved and sampling is completed, drilling refusal is met, or further drilling has been stopped by the HP, each borehole will be backfilled with the drilling cuttings – compacted in-place using the drilling auger. Any paved surface drilled through will be patched using asphalt patch or concrete. Therefore, drilling activities are not anticipated to generate excess soil.

7.4 Quality Control

A minimum of ten percent (10%) duplicate sampling will occur on the project in accordance with the SSMP. A duplicate soil sample for each analysis will be collected at SB-8. A duplicate sample may be collected elsewhere if a duplicate sample cannot be collected at SB-8 (*e.g.,* poor recovery or refusal). Duplicate sample results will be treated as environmental field data. In other words, duplicate sample results will also be screened against SSLs. One trip blank will be included per sample cooler/shipping container sent to ALAB.

7.5 Radiological Screening

One of the soil sample containers – normally a 125-ml polyethylene bottle, will be delivered to LLNL's Radioactive and Hazardous Waste Management (RHWM) laboratory. RHWM will scan the soil for radioactivity before the remaining soil sample containers are sent offsite for analytical testing pursuant to ES&H ESP-04, Instruction 07 - *Submitting Samples to the Analytical Laboratory*.

7.6 Shipping

Post radiological screening, the soil samples and trip blank samples will be packaged and shipped to the analytical laboratory or laboratories following the guidelines outlined in ES&H ESP-04, Instruction 07.

7.7 Data Validation and Data Management

All received environmental analytical results will undergo data validation. Data validation will be performed by the Soils Office.

Management of environmental data for the project will be pursuant to ES&H ESP-04 – *Site Evaluation Procedure*; and begins with the entry of the planned sampling locations into The Environmental Information Management System (TEIMS) and preparation of Chain-of-Custody (CoC) documents. As sampling proceeds, CoC information is entered in TEIMS. Field notes are retained in the project file.

Laboratory analytical data is delivered to the TSD Data Management Team (DMT) and EFA Soils Office EA in electronic and hard copy format. The Soils Office EA completes a Quality Assurance/Control (QA/QC) validation review of the laboratory data and provides the results to the TSD DMT for upload into TEIMS and Universal Content Management (UCM). The laboratory analytical data is released to the ES&H IST Field EA after QA/QC validation.

References

DOE (2017) *Integrated Safety Management System Manual*. U.S. Department of Energy, DOE M 450.2. January 17.

EPA (2006) *Guidance on Systematic Planning Using the Data Quality Objectives Process*. U.S. Environmental Protection Agency, EPA QA/G-4, EPA/240/B-06/001, February 2006.

LLNL (1988) *Lawrence Livermore National Laboratory (Main Site) Federal Facility Agreement Under CERCLA Section 120*, November 1, 1988.

LLNL (1992) *Record of Decision for the Lawrence Livermore National Laboratory Livermore Site,* Lawrence Livermore National Laboratory. July 15, 1992.

LLNL (2020a) *ESP-04, Site Evaluation Procedure*, September 2020.

LLNL (2020b) *ESP-04, Instruction 07 - Submitting Samples to the Analytical Laboratory*, September 2020.

LLNL (2022) *Lawrence Livermore National Laboratory Soils Screening and Management Plan*, LLNL, LLNL-AR-755337-REV-2-21833, November 2022.

MARSSIM (2000) *Multi-Agency Radiation Survey and Site Investigation Manual Revision 1*, NUREG-1575, Rev.1, EPA-402-R-97-016, Rev. 1, DOE/EH-0624, Rev. 1.

Figure

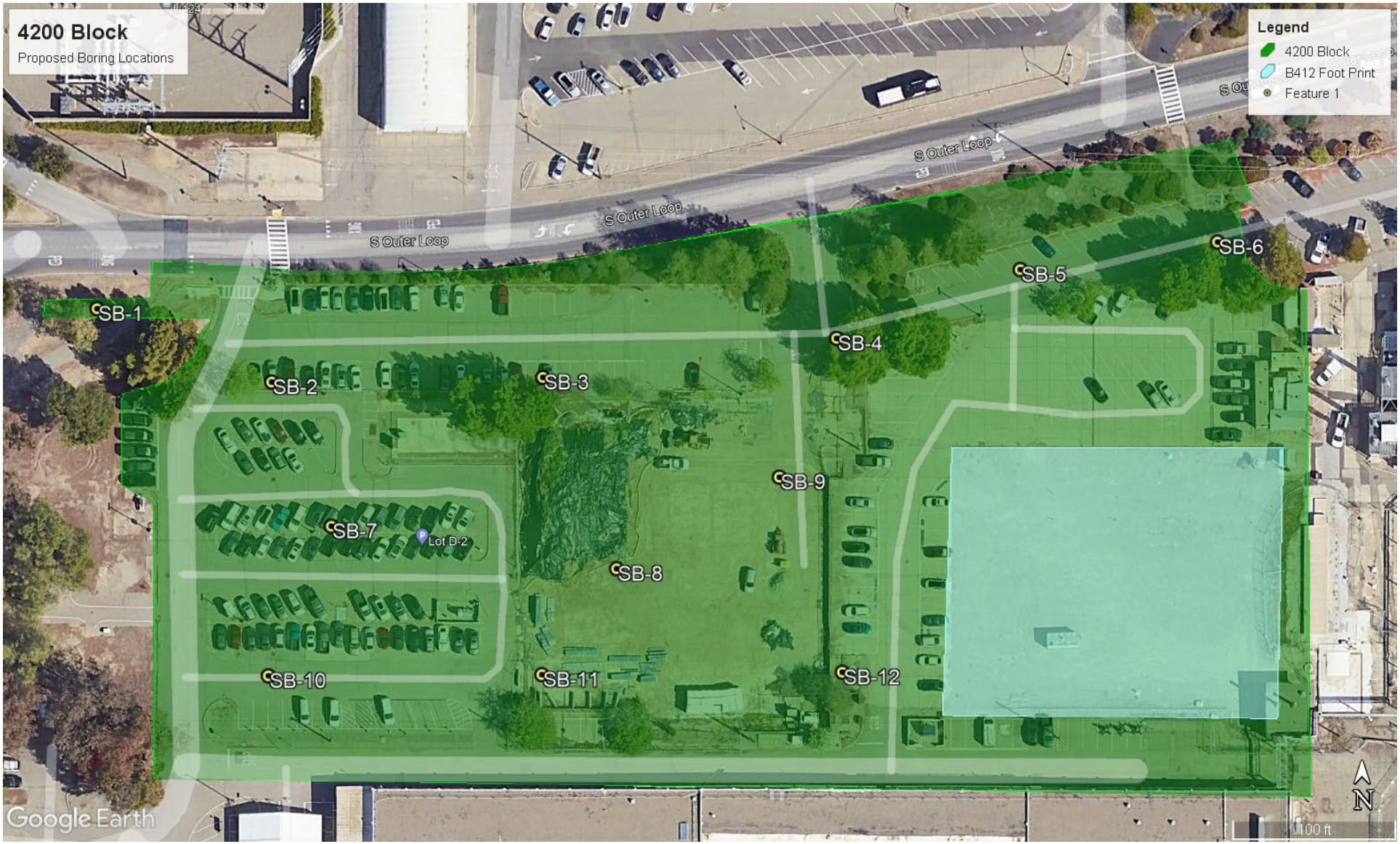

Figure 1. Proposed Boring Locations

Appendix A
Proposed Analytical Groups by Boring and Depth, and Laboratory

Proposed Analytical Groups by Boring and Depth, and Laboratory

LLNL Sample Identifier	Field Marking	Sampling Depth (feet)	Analytical Group	RHWM - RHWMSCAN	GEL – EM8015:DIESEL	GEL - EM8015:MOTOROIL	GEL - TTLCMET5:ALL	GEL - WPCB:ALL	GEL – W8290	GEL – GAMMASPEC:ALL	GEL - GABWASTE:ALL	GEL - RADWG:H3	EMRL - EMRLE900	EMRL - EMRLE906	ALAB - W8260MODTC:ALL	ALAB: W8021MOD:ALL	ALAB - TTLCMET5:ALL
Soils																	
PC-B4200-001-01-01-SOT-1.5U	SB-1	1.5	W8260MODTC:ALL												●		
PC-B4200-001-02-01-SC-6U	SB-1	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-002-01-01-SOT-1.5U	SB-2	1.5	W8260MODTC:ALL												●		
PC-B4200-002-02-01-SC-6U	SB-2	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-003-01-01-SOT-1.5U	SB-3	1.5	W8260MODTC:ALL												●		
PC-B4200-003-02-01-SC-6U	SB-3	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-004-01-01-SOT-1.5U	SB-4	1.5	W8260MODTC:ALL												●		
PC-B4200-004-02-01-SC-6U	SB-4	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-005-01-01-SOT-1.5U	SB-5	1.5	W8260MODTC:ALL												●		
PC-B4200-005-02-01-SC-6U	SB-5	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-006-01-01-SOT-1.5U	SB-6	1.5	W8260MODTC:ALL												●		
PC-B4200-006-02-01-SC-6U	SB-6	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-007-01-01-SOT-1.5U	SB-7	1.5	W8260MODTC:ALL												●		
PC-B4200-007-02-01-SC-6U	SB-7	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-008-01-01-SOT-1.5U	SB-8	1.5	W8260MODTC:ALL												●		
PC-B4200-008-01-02-SOTD-1.5U	SB-8	1.5	W8260MODTC:ALL												●		
PC-B4200-008-02-01-SC-6U	SB-8	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-008-02-02-SCD-6U	SB-8	0 – 6.0	TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906		●	●	●			●			●	●			
PC-B4200-009-01-01-SOT-1.5U	SB-9	1.5	W8260MODTC:ALL												●		
PC-B4200-009-02-01-SC-6U	SB-9	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-010-01-01-SOT-1.5U	SB-10	1.5	W8260MODTC:ALL												●		
PC-B4200-010-02-01-SC-6U	SB-10	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			

Proposed Analytical Groups by Boring and Depth, and Laboratory

LLNL Sample Identifier	Field Marking	Sampling Depth (feet)	Analytical Group	RHWM - RHWMSCAN	GEL – EM8015:DIESEL	GEL - EM8015:MOTOROIL	GEL - TTLCMET5:ALL	GEL - WPCB:ALL	GEL – W8290	GEL – GAMMASPEC:ALL	GEL - GABWASTE:ALL	GEL - RADWG:H3	EMRL - EMRLE900	EMRL - EMRLE906	ALAB - W8260MODTC:ALL	ALAB: W8021MOD:ALL	ALAB - TTLCMET5:ALL
PC-B4200-011-01-01-SOT-1.5U	SB-11	1.5	W8260MODTC:ALL												●		
PC-B4200-011-02-01-SC-6U	SB-11	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
PC-B4200-012-01-01-SOT-1.5U	SB-12	1.5	W8260MODTC:ALL												●		
PC-B4200-012-02-01-SC-6U	SB-12	0 – 6.0	RHWMSCAN, TTLCMET5:ALL, E8015:DIESEL, E8015:MOTOROIL, GAMMASPEC:ALL, EMRLE900, EMRLE906	●	●	●	●			●			●	●			
Trip Blank	---	---	W8021MOD:ALL													●	

Notes:
Highlighted cells represent duplicate samples.

Appendix B
Analytical Groups and Sampling Requirements

Analytical Groups and Sampling Requirements

LLNL Analysis Code	Analytical Method	Minimum Sample Volume	Container	Preservative	Maximum Holding Time
SOLIDS					
W8260MODTC:ALL (Total VOCs)	EPA 8260B	5 g	3 each pre-weighed VOAs, 60 g amber	Methanol or sodium bisulfate, 4 °C ± 2 °C	7 days
EM8015:DIESEL (TPH as Diesel)	EPA 8015B	50 g	8 oz glass jar	4 °C ± 2 °C	14 days
EM8015:MOTOROIL (TPH as Oil)	EPA 8015B	50 g	8 oz glass jar	4 °C ± 2 °C	14 days
STLCMETFCR:ALL (Soluble Metals)	EPA 6010B Cr^{+6} EPA 7196A Mercury EPA 7470/7471	50 g	8 oz polyethylene	none	90 days
W8290 (Dioxins)	EPA 8290A	50 g	8 oz glass jar	4 °C ± 2 °C	7 days
TTLCMET5:ALL (Total Metals)	EPA 6010 or 6020 Cr^{+6} EPA 7196A Mercury EPA 7470	50 g	4 oz polyethylene	none	180 days Cr^{+6} – 30 days Hg – 28 days
GABWASTE:ALL (Gross Alpha & Gross Beta)	EPA 900.0	20 g	4 oz polyethylene	none	180 days

Analytical Groups and Sampling Requirements

LLNL Analysis Code	Analytical Method	Minimum Sample Volume	Container	Preservative	Maximum Holding Time
EMRLE 900 (Gross Alpha & Gross Beta)	EPA 900.0	20 g	4 oz polyethylene	none	180 days
RADWG:H3 (Tritium)	EPA 906.0	20 g	4 oz polyethylene	none	180 days
EMRLE 906 (Tritium)	EPA 906.0	20 g	4 oz polyethylene	none	180 days
GAMMASPEC:ALL	Gamma Spec	200 g	250 mL Polyethylene	None	180 days
TUPA:ALL	Alpha Spec	200 g	16 oz polyethylene	none	180 days
LLNL Analysis Code	**Analytical Method**	**Minimum Sample Volume**	**Container**	**Preservative**	**Maximum Holding Time**
AQUEOUS					
W8260MOD:ALL	EPA 8260B	40 mL	60 g amber VOA	4 °C ± 2 °C	48 hours

Notes:

g - gram
oz – ounce or ounces
mL – milliliter or milliliters

Appendix C
Analytical Groups and Included Analytes

Analytical Groups and Included Analytes

Soil

W8260MODTC – Volatile Organic Compounds

EPA Method 8260B

Analyte	CAS Number	Project Reporting Limit (mg/kg) [1]
1,1,1,2-Tetrachloroethane	630-20-6	0.005
1,1,1-Trichloroethane	71-55-6	0.005
1,1,2,2-Tetrachloroethane	79-34-5	0.005
1,1,2-Trichloroethane	79-00-5	0.005
1,1-Dichloroethane	75-34-3	0.005
1,1-Dichloroethene	75-35-4	0.005
1,2-Dibromoethane	106-93-4	0.005
1,2-Dichlorobenzene	95-50-1	0.005
1,2-Dichloroethane	107-06-2	0.005
1,2-Dichloroethene (total)	540-59-0	0.005
1,2-Dichloropropane	78-87-5	0.005
1,2,3-Trichloropropane	96-18-4	0.005
1,3-Dichloropropene	542-75-6	0.005
1,3-Dichlorobenzene	541-73-1	0.005
1,4-Dichlorobenzene	106-46-7	0.005
2-Butanone (MEK)	78-93-3	0.005
Acetone	67-64-1	0.005
Benzene	71-43-2	0.005
Benzyl Chloride	100-44-7	0.005
Bromobenzene	108-36-1	0.005
Bromodichloromethane	75-27-4	0.005
Bromoform	75-25-2	0.005
Bromomethane	74-83-9	0.005
Carbon Tetrachloride	56-23-5	0.005
Chlorobenzene	108-90-7	0.005
Chloroethane	75-00-3	0.005
Chloroform	67-66-3	0.005
Chloromethane	74-87-3	0.005

Analytical Groups and Included Analytes

W8260MODTC – Volatile Organic Compounds (cont'd)

EPA Method 8260B

Analyte	CAS Number	Project Reporting Limit (mg/kg) (1)
cis-1,2-Dichloroethene	156-59-2	0.005
cis-1,3-Dichloropropene	10061-01-5	0.005
Dibromochloromethane	124-48-1	0.005
Dibromomethane	74-95-3	0.005
Dichlorodifluoromethane	75-71-8	0.005
Ethylbenzene	100-41-4	0.005
Freon 113	76-13-1	0.005
Methyl isobutyl ketone	108-10-1	0.005
Methyl tert-butyl ether	1634-04-4	0.005
Methylene Chloride	75-09-2	0.005
Styrene	100-42-5	0.005
tert-Butyl alcohol	75-65-0	0.05
Tetrachloroethene	127-18-4	0.005
Toluene	108-88-3	0.005
m-Xylene	108-38-3	0.005
o-Xylene	95-47-6	0.005
p-Xylene	106-42-3	0.005
Total Xylene Isomers	1330-20-7	0.005
trans-1,2-Dichloroethene	156-60-5	0.005
trans-1,3-Dichloropropene	542-75-6	0.005
Trichloroethene	79-01-6	0.005
Trichlorofluoromethane	75-69-4	0.005
Vinyl Chloride	75-01-4	0.005

Notes: (1) mg/kg – milligrams per kilogram

Analytical Groups and Included Analytes

EM8015:DIESEL - Total Petroleum Hydrocarbons as Diesel

EPA Method M8015

Analyte	CAS Number	Project Reporting Limit (mg/kg) (1)
TPH as Diesel	68476-34-6	10

Notes: (1) mg/kg – milligrams per kilogram

EM8015:MOTOROIL - Total Petroleum Hydrocarbons as Motor Oil

EPA Method M8015

Analyte	CAS Number	Project Reporting Limit (mg/kg) (1)
TPH as Motor Oil	'---	10

Notes: (1) mg/kg – milligrams per kilogram

STLCMETFCR:ALL – STLC Metals

EPA Method 6010 (Mercury – 7470/7471) (Chrome VI - 7196A)

Analyte	CAS Number	Project Reporting Limit (mg/L) (1)
Antimony	7440-36-0	0.1
Arsenic	7740-38-2	0.3
Barium	7440-39-3	0.05
Beryllium	7440-41-7	0.05
Cadmium	7440-43-9	0.05
Chromium	7440-47-3	0.05
Hexavalent Chromium	18540-29-9	
Cobalt	7440-48-4	0.05
Copper	7440-50-8	0.1
Lead	7439-92-1	0.1
Mercury	7439-97-6	0.002
Molybdenum	7439-93-7	0.1
Nickel	7440-02-0	0.05
Selenium	7782-49-2	0.3
Silver	7440-22-4	0.05
Thallium	7440-28-0	0.2
Vanadium	7440-62-2	0.05

Analytical Groups and Included Analytes

Analyte	CAS Number	Project Reporting Limit (mg/L) (1)
Zinc	7440-66-6	0.1

Notes: (1) mg/L – milligrams per liter

TTLCMET5:ALL – TTLC Metals
EPA Method 6010 or 6020 (Mercury - 7471) (Chrome VI - 7196A)

Analyte	CAS Number	Project Reporting Limit (mg/kg) (1)
Antimony	7440-36-0	1.0
Arsenic	7740-38-2	1.0
Barium	7440-39-3	0.4
Beryllium	7440-41-7	0.1
Cadmium	7440-43-9	0.2
Chromium	7440-47-3	0.5
Hexavalent Chromium	18540-29-9	0.4
Cobalt	7440-48-4	0.2
Copper	7440-50-8	0.2
Lead	7439-92-1	0.4
Mercury	7439-97-6	0.01
Molybdenum	7439-93-7	0.2
Nickel	7440-02-0	0.4
Selenium	7782-49-2	3.0
Silver	7440-22-4	0.5
Thallium	7440-28-0	0.4
Vanadium	7440-62-2	0.5
Zinc	7440-66-6	2.0

Notes: (1) mg/kg – milligrams per kilogram

GABWASTE:ALL / EMRLE 900 – Gross Alpha & Gross Beta
EPA Method 900.0

Analyte	CAS Number	Project Reporting Limit (pCi/g) (1)
Gross Alpha	12587-46-1	1.0
Gross Beta	12587-47-2	3.0

Analytical Groups and Included Analytes

Notes: (1) pCi/g – picocuries per gram

RADWG:H3 / EMRLE 906 - Tritium

EPA Method 906.0

Analyte	CAS Number	Project Reporting Limit (pCi/g) (1)
Tritium	10028-17-8	2.0

Notes: (1) pCi/g – picocuries per gram

GAMMASPEC:ALL

Gamma Spec

Analyte	CAS Number	Project Reporting Limit (pCi/g) (1)
Actinium 228	0215	Best Achievable
Americium 241	0323	Best Achievable
Antimony 124	0403	Best Achievable
Antimony 125	0401	Best Achievable
Beryllium 7	0901	Best Achievable
Bismuth 212	1375	Best Achievable
Bismuth 214	1380	Best Achievable
Cerium 139	1854	Best Achievable
Cerium 141	1858	Best Achievable
Cerium 144	1859	Best Achievable
Cesium 134	1861	Best Achievable
Cesium 136	1863	Best Achievable
Cesium 137	1860	Best Achievable
Chromium 51	2456	Best Achievable
Cobalt 56	2629	Best Achievable
Cobalt 57	2627	Best Achievable
Cobalt 58	2628	Best Achievable
Cobalt 60	2626	Best Achievable
Europium 152	4726	Best Achievable
Europium 154	4727	Best Achievable

Analytical Groups and Included Analytes

Europium 155	4728	Best Achievable
Iron 59	5355	Best Achievable
Lead 210	5456	Best Achievable
Lead 212	5458	Best Achievable
Lead 214	5459	Best Achievable
Manganese 54	5555	Best Achievable
Mercury 203	5605	Best Achievable
Neodymium 147	5841	Best Achievable
Neptunium 237	5844	Best Achievable
Niobium 94	5879	Best Achievable
Potassium 40	7051	Best Achievable
Radium 228	7252	Best Achievable
Ruthenium 106	7470	Best Achievable
Silver 110m	7810	Best Achievable
Sodium 22	7860	Best Achievable
Thallium 208	8301	Best Achievable
Thorium 230	8304	Best Achievable
Thorium 234	8307	Best Achievable
Uranium 235 (in activity)	8858	Best Achievable
Uranium 238 (in activity)	8862	Best Achievable
Yttrium 88	9005	Best Achievable
Zinc 65	9051	Best Achievable
Zirconium 95	9060	Best Achievable
Barium 133	0482	Best Achievable
Barium 140	0485	Best Achievable
Iridium 192	5346	Best Achievable
Neptunium 239	5845	Best Achievable
Promethium 144	7064	Best Achievable
Promethium 146	7066	Best Achievable
Tin 113	8313	Best Achievable

Analytical Groups and Included Analytes

TUPA:ALL
Alpha Spec

Analyte	CAS Number	Project Reporting Limit (pCi/g) (1)
Americium 241	14596-10-2	Best Achievable
Americium 243	14993-75-0	Best Achievable
Plutonium 238	13981-16-3	Best Achievable
Plutonium 239+240	‘---	Best Achievable
Thorium 230	14269-63-7	Best Achievable
Thorium 228	14274-82-9	Best Achievable
Thorium 232	7440-29-1	Best Achievable
Uranium 235	15117-96-1	Best Achievable
Uranium 238	7440-61-1	Best Achievable

Notes: (1) pCi/g – picocuries per gram

Analytical Groups and Included Analytes

Aqueous

W8260MOD:ALL – Volatile Organic Compounds

EPA Method 8260B

Analyte	CAS Number	Project Reporting Limit (µg/L) [1]
1,1,1,2-Tetrachloroethane	630-20-6	1.0
1,1,1-Trichloroethane	71-55-6	1.0
1,1,2,2-Tetrachloroethane	79-34-5	1.0
1,1,2-Trichloroethane	79-00-5	1.0
1,1-Dichloroethane	75-34-3	1.0
1,1-Dichloroethene	75-35-4	1.0
1,2-Dichlorobenzene	95-50-1	1.0
1,2-Dichloroethane	107-06-2	1.0
1,2-Dichloroethene (total)	540-59-0	2.0
1,2-Dichloropropane	78-87-5	1.0
1,2,3-Trichloropropane	96-18-4	1.0
1,3-Dichloropropene	542-75-6	2.0
1,3-Dichlorobenzene	541-73-1	1.0
1,4-Dichlorobenzene	106-46-7	1.0
2-Butanone (MEK)	78-93-3	5.0
Acetone	67-64-1	5.0
Benzene	71-43-2	1.0
Benzyl Chloride	100-44-7	5.0
Bromobenzene	108-36-1	1.0
Bromodichloromethane	75-27-4	1.0
Bromoform	75-25-2	1.0
Bromomethane	74-83-9	1.0
Carbon Tetrachloride	56-23-5	1.0
Chlorobenzene	108-90-7	1.0
Chloroethane	75-00-3	1.0
Chloroform	67-66-3	1.0
Chloromethane	74-87-3	1.0

Analytical Groups and Included Analytes

W8260MOD:ALL – Volatile Organic Compounds (cont'd)

EPA Method 8260B

Analyte	CAS Number	Project Reporting Limit (µg/L) (1)
cis-1,2-Dichloroethene	156-59-2	1.0
cis-1,3-Dichloropropene	10061-01-5	1.0
Dibromochloromethane	124-48-1	1.0
Dibromomethane	74-95-3	1.0
Dichlorodifluoromethane	75-71-8	1.0
Ethylbenzene	100-41-4	1.0
Freon 113	76-13-1	5.0
Methyl tert-butyl ether	1634-04-4	1.0
Methylene Chloride	75-09-2	5.0
Styrene	100-42-5	1.0
Tetrachloroethene	127-18-4	1.0
Toluene	108-88-3	1.0
m-Xylene	108-38-3	2.0
o-Xylene	95-47-6	1.0
p-Xylene	106-42-3	2.0
Total Xylene Isomers	1330-20-7	3.0
trans-1,2-Dichloroethene	156-60-5	1.0
trans-1,3-Dichloropropene	542-75-6	1.0
Trichloroethene	79-01-6	1.0
Trichlorofluoromethane	75-69-4	1.0
Vinyl Chloride	75-01-4	1.0

Notes: (1) µg/L – micrograms per liter