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Compliance Monitoring Plan/Contingency Plan for Interim Remedies at Lawrence Livermore National Laboratory Site 300

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September 2002

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Environmental Protection Department
Environmental Restoration Division

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Certification

I certify that the work presented in this report was performed under my supervision. To the best of my knowledge, the data contained herein are true and accurate, and the work was performed in accordance with professional standards.

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Acronyms and Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMP/CP	Compliance Monitoring Plan/Contingency Plan
DCE	Dichloroethylene
COC	Contaminant of concern
DNAPL	Dense Non-Aqueous Phase Liquid
DOE	U.S. Department of Energy
DTSC	California Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
ft	Feet
HEAST	Health Effects Assessment Summary Tables
HERD	DTSC Human and Ecological Risk Division
HMX	High-Melting Explosive
IRIS	Integrated Risk Information System
LLNL	Lawrence Livermore National Laboratory
LOAEL	Lowest-observed-adverse-effect-level
mg/kg	Milligram per kilogram
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	No-observed-adverse-effect-level
PCBs	Polychlorinated biphenyls
ppb	Parts per billion
ppt	Parts per trillion
PRG	Preliminary Remediation Goal
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RDX	Research Department Explosive
ROD	Record of Decision
RWQCB	California Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SOP	Standard Operating Procedure
SPACT	Sample Planning and Chain-of-Custody Tracking
TBOS	Tetra-butyl-orthosilicate
TCDD	2,3,7-8 tetrachloro-dibenzodioxin
TCE	Trichloroethylene
PCE	Tetrachloroethylene
TKEBS	tetra-kis-2-ethylbutylorthosilicate
TRV	Toxicity reference value
UCL	Upper confidence limit
VOCs	Volatile organic compounds

Summary

Lawrence Livermore National Laboratory (LLNL) Site 300 is a U.S. Department of Energy (DOE) facility operated by the University of California. Site 300 is situated in the eastern Altamont Hills about 17 miles east of Livermore and 8.5 miles southwest of Tracy, California. Site 300 is a remote experimental testing facility where DOE conducts research, development, and testing of high explosives and integrated non-nuclear weapons components. This work includes formulating, processing, machining, assembling, and detonating explosives.

During past Site 300 operations, contaminants were released to the environment from surface spills and piping leaks, leaching from unlined landfills and pits, high-explosive test detonations, and disposal of waste fluids in lagoons and dry wells (sumps). The primary contaminants of concern at Site 300 include volatile organic compounds, high-explosive compounds, perchlorate, tritium, depleted uranium, nitrate, polychlorinated biphenyls, dioxins, furans, silicone oils, and metals.

DOE is the lead agency for environmental restoration at Site 300. The U.S. Environmental Protection Agency (U.S. EPA) and the State of California oversee Site 300 environmental restoration activities. DOE began environmental restoration activities at Site 300 in 1981, and the site was placed on the U.S. EPA National Priorities List in 1990.

In 2001, DOE completed an Interim Site-Wide Record of Decision for Site 300 (the Interim ROD). This ROD was designated as interim to ensure that cleanup continues while additional site characterization, evaluation of remediation technologies, and negotiation of final ground water cleanup standards occurs. The Interim ROD specified remedies for most of the contaminant releases at Site 300, but did not include some areas where site characterization is in progress or a final remedy has already been selected. A Final ROD is scheduled to be completed in 2007. After the Interim ROD, DOE completed a Remedial Design Work Plan that outlined DOE's overall strategy and schedule for implementing the selected interim remedies. The remedies included soil vapor and ground water extraction, soil excavation, monitored natural attenuation, enhanced monitoring of landfills, and risk and hazard management.

This Compliance Monitoring Plan/Contingency Plan (CMP/CP) is the next step in implementing the interim remedies. It contains the procedures DOE will use to monitor the progress of remediation, detect any new contaminant releases, control risks and hazards, manage the data obtained during monitoring, and includes contingency procedures and measures DOE will implement if cleanup does not proceed as planned.

There is currently no comprehensive monitoring plan for environmental restoration activities at Site 300. This CMP/CP consolidates and supercedes the elements of a number of existing area-specific monitoring plans.

This CMP/CP provides the overall guidance for generating detailed sampling and analysis plans. Detailed plans will be generated after the CMP/CP is finalized and modified periodically to reflect changing site conditions, new monitor and extraction wells, and stakeholder concerns. At a minimum, these plans will be consistent with the guidelines included in this document. In some cases, DOE may collect data beyond that specified in this CMP/CP to support more detailed hydrogeologic interpretations, improve contaminant distribution and migration

evaluations, manage and optimize extraction and treatment systems and other remedial actions, or to ensure that human health and the environment are protected.

Section 1 of this document provides an overview of the environmental restoration program at Site 300, describes the areas of contamination, and defines the scope of the document. This CMP/CP only applies to the areas of environmental contamination included in the Interim ROD. Some areas of current or potential contamination were not included in the Interim ROD and are not addressed by this CMP/CP because: (1) a remedy is already in place (the General Services Area operable unit), or (2) site investigation is still being performed (the Pit 7 Landfill Complex, Buildings 812 and 865, and the Sandia Test Site). Similarly, monitoring programs to comply with non-CERCLA facility-specific RCRA or RWQCB closure requirements are in effect in some areas (the Pit 1 Landfill, the High Explosives Surface Water Impoundments, and the High Explosives Open Burn Facility) and will not be affected by this CMP/CP. This CMP/CP will also not affect the surveillance monitoring of water-supply wells, air, vegetation, and storm water runoff conducted by the LLNL Operations and Regulatory Affairs Division.

Section 2 describes the overall objectives of this CMP/CP and reiterates the Remedial Action Objectives established in the Interim ROD. The general objectives of this CMP/CP are to provide the framework for:

- Sampling and analyzing ground and surface water to monitor the effectiveness of the interim remedial actions.
- Conducting detection monitoring, inspection, and maintenance at the Pit 2, 8, and 9 Landfills to identify and prevent future contaminant releases from these landfills.
- Monitoring the performance of soil vapor and ground water extraction and treatment facilities to ensure regulatory compliance.
- Managing risks and hazards to human and ecological receptors to prevent unacceptable exposure from occurring during remediation.
- Implementing procedures to ensure the quality of monitoring data.
- Reporting the results of monitoring data.
- Implementing contingency measures if cleanup does not proceed as planned.

The Remedial Action Objectives include goals for restoring ground water and preventing risk and hazard to human and ecological receptors.

Section 3 describes the Ground and Surface Water Monitoring Program. This program includes the regular sampling and analysis of water samples from ground water monitor wells and surface water bodies. Some Site 300 monitor wells are designated as “guard wells” to provide timely indication of contaminant movement that may impact water-supply wells, contaminate water-supply aquifers, or result in migration across the site boundary. The guard wells will be sampled more frequently than other monitor wells. Many of the other monitor wells at Site 300 are designated as “plume tracking wells.” Samples from these wells are used to determine the distribution and concentration of contaminant plumes in ground water. Depending on the location of each well in relation to the contaminant plumes, plume tracking wells will be sampled semiannually, annually, or biennially. All onsite and nearby offsite springs will be sampled.

Section 4 describes the Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 8, and 9 Landfills. Firing table debris was placed in these landfills from the 1950s to the 1970s and covered with non-engineered native soil. There is no evidence of contaminant releases from these three landfills. The remedy selected in the Interim ROD includes vadose zone and ground water monitoring to detect any future releases of contaminants from these landfills.

Ground water samples will be collected quarterly from designated “detection monitor wells” at the three landfills and analyzed for all constituents that could reasonably be expected in the buried waste. Lysimeters (or comparable soil moisture sample collection devices) will be installed beneath each of the three landfills and sampled to detect potential future releases of contaminants from the landfills to the underlying vadose zone.

The Pit 2, 8, and 9 Landfills will be inspected to identify any degradation or damage to the surface of the landfills that could lead to increased infiltration of precipitation, exposure of the landfill contents, or flow of surface water on or adjacent to the landfill. Any required maintenance will be performed promptly.

Section 5 describes the Extraction and Treatment Facility Monitoring Program. All ground water extraction wells will be sampled semiannually. Aqueous treatment system influent samples will be analyzed quarterly and effluent samples will be analyzed monthly. These samples will be analyzed for all contaminants identified in any ground water extraction well connected to the treatment system or that could potentially be captured by an extraction well. More frequent sampling will be performed upon initial startup of a facility, a shutdown due to non-compliance with discharge requirements, or any treatment system shutdown or modification that could result in non-compliance. The effluent of soil vapor treatment facilities will be monitored weekly, and soil vapor samples from extraction wells will be analyzed semiannually for VOCs.

The Risk and Hazard Management Program in Section 6 describes the measures DOE will implement to ensure that the interim remedies protect human health and the environment during cleanup. For protection of human health, DOE will model contaminant fate and transport and collect additional ambient air and soil samples in areas where an unacceptable risk or hazard has been identified. Building or area occupancy will be reviewed regularly, and risk and hazard estimates will be revised to reflect current conditions. If needed, institutional or engineering controls will be maintained or implemented to prevent exposure. The ecological portion of this program includes sampling, biological surveys, periodic hazard re-evaluation, and steps to mitigate impacts to plants and animals, if needed.

Section 7 summarizes the Data Management Program that controls the structure and flow of data collected during site characterization, remediation, and monitoring. The management of data, both hard copy and electronic, follows a process that tracks information from the sampling plan through storage to archiving. The data management process includes chain-of-custody tracking, application of quality control procedures, data presentation, and use of data in decision-support tools, such as risk assessment and compliance monitoring.

Section 8 describes the Quality Assurance/Quality Control procedures and systems used to ensure the quality of data collected during site characterization, monitoring, and remediation. A Quality Assurance Project Plan has been implemented for the Site 300 environmental restoration project that includes the framework and requirements for planning, performing, documenting, and verifying the quality of work activities and data collected. Standard Operating Procedures have been developed for most activities described in this CMP/CP. Methodologies for activities for which no Standard Operating Procedure exist (e.g., some risk and hazard management tasks) are described in detail in this CMP/CP.

Section 9 outlines the scope and content of reports that will be generated to convey project information to the regulatory agencies and other stakeholders. DOE will regularly inform the Remedial Project Managers of project status, compliance issues, and any new contaminant releases or detections. DOE will submit semiannual compliance monitoring reports.

The Contingency Plan in Section 10 describes how DOE and the regulatory agencies plan to address foreseeable problems that may arise during the remediation of Site 300. Both technical and logistical contingencies are addressed.

Technical contingencies are related to the physical remediation of soil, bedrock, and ground water at Site 300 and include loss of hydraulic control of ground water contaminant plumes, increases in contaminant concentrations, impacts to water-supply aquifers, concerns over the performance of monitored natural attenuation remedies, new sources or releases of contaminants, and uncontrollable natural events such as earthquakes.

Logistical contingencies include changes in access restrictions, building/land use, personnel, funding, the mission and operation of LLNL, and future property ownership.

1. Introduction

1.1. Overview

Lawrence Livermore National Laboratory (LLNL) Site 300 is a U.S. Department of Energy (DOE) experimental test facility operated by the University of California. Site 300 encompasses 11 square miles and is situated in the eastern Altamont Hills about 17 miles east of Livermore and 8.5 miles southwest of Tracy, California (Figure 1-1). Site 300 is located primarily in San Joaquin County, except for the westernmost portion that lies within Alameda County.

DOE is the lead agency for environmental restoration at Site 300. The U.S. Environmental Protection Agency (U.S. EPA) Region IX, the California Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (RWQCB) Central Valley Region oversee Site 300 environmental restoration activities. A Federal Facility Agreement is in place between DOE and these regulatory agencies (U.S. DOE, 1992). DOE began environmental restoration activities at Site 300 in 1981, and the site was placed on the U.S. EPA National Priorities List in 1990. Since then, the majority of environmental restoration work has been conducted in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA), and State of California regulations. Other environmental restoration activities are regulated under the Resource Conservation and Recovery Act (RCRA).

DOE has completed a Site-Wide Remedial Investigation report (Webster-Scholten, 1994), a Site-Wide Feasibility Study (Ferry et al., 1999), and a Site-Wide Proposed Plan (Dresen et al., 2000). In February 2001, an Interim Site-Wide Record of Decision (Interim ROD) for Site 300 was signed (U.S. DOE, 2001). This ROD was designated as interim to ensure that cleanup continues while additional site characterization, evaluation of remediation technologies, and negotiation of final ground water cleanup standards occurs. The Interim ROD specified selected remedies for most of the contaminant releases at Site 300. Many of the selected interim remedies are continuations of remediation that began as treatability studies, removal actions, or area-specific interim remedial actions. A Final ROD is scheduled to be completed in 2007.

After the Interim ROD, DOE completed a Remedial Design Work Plan for the Interim Remedies (Ferry et al., 2001a) that outlined DOE's overall strategy and schedule for implementing the selected remedies. Interim Remedial Design documents have been completed for two areas: (1) the Building 834 operable unit (Gregory et al., 2002), and (2) the High Explosives Process Area (Madrid et al., 2002). Interim Remedial Design documents are scheduled to be completed for Building 854 (2003), Building 850 (2004), and Building 832 Canyon (2005). Remedial Design documents are not required for areas where monitoring only or monitored natural attenuation are the sole component of the interim remedy (the Pit 6 Landfill, the Pit 2, 8, and 9 Landfills, and Buildings 801, 833, 845, and 851).

This Compliance Monitoring Plan/Contingency Plan (CMP/CP) describes the monitoring activities and procedures to be followed during the implementation of the selected interim remedies and includes:

- Ground and Surface Water Monitoring Program – Describes regular sampling and analysis of samples from ground water monitor wells and surface water bodies and the measurement of ground water elevations to monitor the effectiveness of the interim remedial actions. Springs are the only surface water bodies at Site 300 applicable to the monitoring programs included in this CMP/CP.
- Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 8, and 9 Landfills – Specifies requirements for sampling monitor wells and lysimeters in the vicinity of these three landfills with the objective of identifying any releases of contaminants to the vadose zone or ground water beneath the landfills. Provisions are included for regularly inspecting the landfills to identify any erosion, subsidence, or breaching of the landfill surfaces, and performing as-needed maintenance.
- Extraction and Treatment Facility Monitoring Program – This program specifies the sampling of ground water and soil vapor extraction wells and treatment facility influent and effluent, water level measurements in extraction wells, and the location and frequency of flow volume measurements. It also describes the procedures for operating and maintaining the treatment facilities.
- Risk and Hazard Management Program – Includes modeling, sampling, and analysis procedures to ensure that the interim remedies protect human health and the environment during cleanup, and describes the institutional and engineering controls that will be implemented or maintained.
- Data Management Program – Describes the structure and flow of environmental restoration data collected during cleanup.
- Quality Assurance/Quality Control Program – Specifies procedures and systems to ensure the quality of data collected during cleanup.
- Reporting – Describes how DOE will convey information on the progress and status of Site 300 monitoring and remediation activities to the regulatory agencies and other stakeholders.
- Contingency Plan – Describes the measures and procedures to be implemented if cleanup does not proceed as planned.

This CMP/CP provides the overall guidance for generating detailed sampling and analysis plans. Detailed plans will be generated after the CMP/CP is finalized and modified to reflect changing site conditions and stakeholder concerns. At a minimum, these detailed plans will be consistent with the provisions of this CMP/CP. In some cases, DOE may collect data beyond that specified in this CMP/CP to support more detailed hydrogeologic interpretations, improve contaminant distribution and migration evaluations, manage and optimize extraction and treatment systems and other remedial actions, or to ensure that human health and the environment are protected.

Any significant modifications to this CMP/CP will be made with the concurrence of the regulatory agencies.

1.2. Site Description

Site 300 is a remote facility where DOE conducts research, development, and testing of high explosives and integrated non-nuclear weapons components. This work includes formulating, processing, machining, assembling, and detonating explosives.

During past Site 300 operations, contaminants were released to the environment from surface spills and piping leaks, leaching from unlined landfills and pits, high-explosive test detonations, and disposal of waste fluids in lagoons and dry wells (sumps). Environmental investigations have found a number of locations where contaminants were released to the environment. All release sites at Site 300 are assigned to one of eight operable units, as shown on Figure 1-2. In some cases, ground water contamination has resulted from these releases (Figure 1-3). The primary contaminants of concern at Site 300 include:

- Volatile organic compounds (VOCs), primarily trichloroethylene (TCE), tetrachloroethylene (PCE), and dichloroethylene (DCE). At Site 300, VOCs were commonly used as heat-exchange fluids and degreasing solvents.
- High-explosive compounds, primarily High-Melting Explosive (HMX) and Research Department Explosive (RDX), that were formulated and tested at Site 300.
- Perchlorate, a component of many explosives.
- Tritium and depleted uranium used in explosive tests.
- Nitrate resulting from releases of explosives formulation rinsewater, septic-system effluent, and/or leaching of naturally-occurring nitrate from bedrock. DOE is currently evaluating the relative contributions of these nitrate sources to the total amount of nitrate in ground water at Site 300.
- Polychlorinated biphenyls (PCBs), dioxins, and furans that were present in capacitors and transformers destroyed in explosive tests.
- Tetra-butyl-orthosilicate (TBOS) and tetra-kis-2-ethylbutylorthosilicate (TKEBS), silicone oils that were used in TCE-based heat-exchange systems to lubricate pumps and seals.
- Metals (primarily beryllium, cadmium, lead, copper, and zinc) that occur as byproducts of explosives tests and in rinsewater discharges.

The locations of all environmental restoration activities at Site 300 are shown on Figure 1-4. More detailed background information on individual areas of Site 300 that were addressed in the Interim ROD is presented below, including the nature of contamination, remedial activities, and the major components of DOE's selected interim remedies. Many of the selected interim remedies are continuations of previous treatability studies, removal actions, or area-specific interim remedial actions. All the remedies include monitoring, and some include risk and hazard management, if needed.

Building 834 (OU 2) - Spills and piping leaks from the early 1960s to the mid-1980s resulted in contamination of the subsurface with VOCs and TBOS/TKEBS. Nitrate in ground water results from septic-system effluent but may also have natural sources. Completed remedial activities include excavating VOC-contaminated soil (1983) and installing a surface water drainage diversion system to prevent rainwater infiltration in the contaminant source area (1998). Ground water and soil vapor extraction and treatment have been underway since 1995 and have significantly reduced the concentration and volume of contaminants in the subsurface. An Interim ROD for the Building 834 operable unit (U.S. DOE, 1995) was superceded by the Interim ROD for Site 300. Significant *in situ* bioremediation is occurring, and treatability studies focusing on understanding and enhancing this process are underway. The selected interim remedy for Building 834 is to continue ground water and soil vapor extraction and treatment with risk and hazard management. An Interim Remedial Design document (Gregory et al., 2002) and a Five-Year Review report (Ferry et al., 2002) have been completed for this operable unit.

Pit 6 Landfill (OU 3) - From 1964 to 1973, approximately 1,900 cubic yards of waste from LLNL Livermore Site and Lawrence Berkeley Laboratory was buried in nine unlined trenches and animal pits at the Pit 6 Landfill. Contaminants in the subsurface include VOCs (primarily TCE), tritium, nitrate, and perchlorate. In 1971, DOE excavated portions of the waste contaminated with depleted uranium. In 1997, a landfill cap was installed as a CERCLA removal action to prevent infiltrating precipitation from further leaching contaminants from the waste. Because of decreasing TCE concentrations in ground water, the presence of TCE degradation products, and the short half-life of tritium (12.3 years), the selected interim remedy for TCE and tritium at the Pit 6 Landfill is monitored natural attenuation with risk and hazard management. During the period covered by the Interim ROD, DOE will continue evaluating the source, concentration, and distribution of perchlorate and nitrate in ground water at the Pit 6 Landfill. The interim remedy for these substances in ground water is continued monitoring. No Interim Remedial Design document is required for this area.

High Explosives Process Area (OU 4) - Surface spills from 1958 to 1986 resulted in the release of VOCs at the drum storage and dispensing area for the former Building 815 steam plant. High-explosive compounds, nitrate, and perchlorate present in the subsurface are attributed to wastewater discharges to former unlined rinsewater lagoons from the 1950s to 1985. The High Explosives Open Burn Facility was capped under RCRA in 1998. In 1999, DOE implemented a CERCLA removal action to extract ground water at the site boundary and prevent offsite TCE migration. The selected interim remedy for the High Explosives Process Area is to continue ground water extraction and treatment with risk and hazard management. An Interim Remedial Design document has been completed for this area (Madrid et al., 2002).

Building 850 Firing Table (OU 5) - High-explosives experiments have been conducted at the Building 850 Firing Table since 1958. Tritium was used in some of these experiments, primarily between 1963 and 1978. As a result of the destruction and dispersal of test assembly debris during detonations, surface soil was contaminated with metals, PCBs, dioxins, furans, HMX, and depleted uranium. Leaching from firing table debris has resulted in tritium and depleted uranium in subsurface soil and ground water. Nitrate has also been identified in ground water. Gravel was removed from the firing table in 1988 and placed in the Pit 7 Landfill. PCB-contaminated shrapnel and debris was removed from the area around the firing table in 1998. The selected remedies for the Building 850 area include risk and hazard management, excavating contaminated surface soil and a nearby sand pile as a final remedy, and monitored natural attenuation of tritium in ground water as an interim remedy. An Interim Remedial Design document is scheduled to be completed in 2004.

Pit 2 Landfill (OU 5) - From 1956 to 1960, the Pit 2 Landfill received debris and gravel from the Building 801 and 802 firing tables. This material was buried to depths of 6 to 8 ft and covered with compacted soil. No unacceptable risk or hazard to human health or ecological receptors has been associated with the Pit 2 Landfill, and there is no evidence of any release from the landfill. The selected interim remedy for the Pit 2 Landfill is enhanced vadose zone and ground water monitoring to detect any future releases from the landfill. No Interim Remedial Design document is required for this area.

Building 854 (OU 6) - TCE was released to soil and ground water through leaks and discharges of heat-exchange fluid, primarily between 1967 and 1984. Other contaminants in ground water include nitrate and perchlorate. TCE-contaminated soil was excavated at the northeast corner of Building 854F in 1983. Treatability studies to assess VOC, nitrate, and perchlorate extraction and treatment are underway. The selected interim remedy for Building 854 includes ground water and soil vapor extraction and treatment with risk and hazard management. An Interim Remedial Design document is scheduled to be completed in 2003.

Building 832 Canyon (OU 7) - TCE was released to soil and ground water through leaks and discharges of heat-exchange fluid at Buildings 830 and 832 between the late 1950s and 1985. Nitrate and perchlorate are also present in ground water. In 1999, DOE began a treatability study to evaluate ground water and soil vapor extraction. Another treatability study has been completed to test the effectiveness of iron filings (zero-valent iron) in removing VOCs from ground water in the downgradient portion of the VOC plume. The selected interim remedy for Buildings 830 and 832 is to continue soil vapor and ground water extraction and treatment with risk and hazard management. An Interim Remedial Design document is scheduled to be completed in 2005.

Building 801 Dry Well and the Pit 8 Landfill (OU 8) - Waste fluid was discharged to a dry well (sump) located adjacent to Building 801D from the late 1950s to 1984, resulting in minor subsurface VOC contamination. The dry well was decommissioned and filled with concrete in 1984. The adjacent Pit 8 Landfill received debris from the Building 801 Firing Table until 1974, when it was covered with compacted soil. No unacceptable risk or hazard to human health or ecological receptors has been associated with the Pit 8 Landfill, and there is no evidence of any release from the landfill. The selected interim remedy for Building 801 is continued monitoring, and the interim remedy for the Pit 8 Landfill is enhanced vadose zone and ground water monitoring to detect any future releases from the landfill. No Interim Remedial Design documents are required for these areas.

Building 833 (OU 8) - TCE was used as a heat-exchange fluid in the Building 833 area from 1959 to 1982 and was released through spills and rinsewater disposal, resulting in minor VOC contamination of the shallow soil/bedrock and perched ground water. The selected interim remedy for Building 833 is continued monitoring with risk and hazard management. No Interim Remedial Design document is required for this area.

Building 845 Firing Table and the Pit 9 Landfill (OU 8) - High-explosives experiments were conducted at the Building 845 Firing Table from 1958 to 1963. Leaching from firing table debris resulted in minor contamination of subsurface soil with depleted uranium and HMX. No ground water contamination has been detected. Debris and gravel from the Building 845 Firing Table was routinely placed in the adjacent Pit 9 Landfill, but on one occasion in 1988 this material was placed in the Pit 1 Landfill. No unacceptable risk or hazard to human health or ecological receptors has been associated with the Pit 9 Landfill, and there is no evidence of any release from the landfill. The selected interim remedy for Building 845 is continued monitoring, and the interim remedy for the Pit 9 Landfill is enhanced vadose zone and ground water monitoring to detect any future releases from the landfill. No Interim Remedial Design documents are required for these areas.

Building 851 Firing Table (OU 8) - The Building 851 Firing Table has been used for high-explosives research since 1982. These experiments resulted in minor VOC, depleted uranium, metals, and RDX contamination in soil and ground water. No unacceptable risk or hazard was identified in this area. In 1988, the firing table gravel was removed and has been replaced periodically since then. The selected interim remedy for Building 851 is continued monitoring. No Interim Remedial Design document is required for this area.

1.3. Scope of the Compliance Monitoring Plan/Contingency Plans

This CMP/CP only applies to the following areas of environmental contamination that were included in the Interim ROD:

- Building 834 - Ground water and soil vapor extraction, risk and hazard management.
- Pit 6 Landfill - Monitored natural attenuation of tritium and VOCs in ground water, monitoring of nitrate and perchlorate, risk and hazard management.
- High Explosives Process Area - Ground water extraction, risk and hazard management.
- Building 854 - Ground water and soil vapor extraction, risk and hazard management.
- Building 832 Canyon - Ground water and soil vapor extraction, risk and hazard management.
- Building 850 - Monitored natural attenuation of tritium in ground water, removal of contaminated surface soil and sand pile, risk and hazard management.
- Pit 2, 8, and 9 Landfills - Vadose zone and ground water monitoring.
- Buildings 801, 833, 845, and 851 - Monitoring only, risk and hazard management.

There is currently no overall monitoring plan for the CERCLA environmental restoration activities contained in the Interim ROD. The objective of this CMP/CP is to create a single plan to monitor and evaluate the effectiveness of the remedial actions selected in the Interim ROD for Site 300. Prior to this CMP/CP, monitoring of CERCLA activities was conducted through a variety of regulatory mechanisms, or voluntarily by DOE. Table 1-1 presents a comparison of pre- and post-CMP/CP monitoring programs. For example, Substantive Requirements were issued by the RWQCB to establish limits on the discharge of treated water from treatment systems. Because there were no mechanisms in place to document ground water monitoring requirements at the time, the RWQCB attached a Monitoring and Reporting Program to the Substantive Requirements for each area. Ground water monitoring and reporting requirements are now included in this CMP/CP. Standards for the discharge of treated ground water remain in the RWQCB Substantive Requirements and are not affected by this CMP/CP.

There are also release sites for which remedies were selected in the Interim ROD that do not currently have an approved sampling plan because there are no treatment facilities in place or planned under the remedy (i.e., monitoring only or Monitored Natural Attenuation remedies). DOE has monitored these areas voluntarily in the past, but this monitoring is now included in this CMP/CP.

Sampling and analysis plans are a required part of the CERCLA Remedial Design/Remedial Action process. In the past, these plans have often been attached to the Remedial Design documents. In many areas, remediation that began as a treatability study, removal action, or area-specific interim remedial action will continue under the Interim ROD, but the Interim Remedial Design documents will be produced over the next several years. DOE will immediately implement this CMP/CP to monitor cleanup in all areas included in the Interim ROD and no longer include the sampling plans in the Remedial Design documents.

Some areas of Site 300 will continue to be monitored under other programs or regulatory requirements, such as RCRA or a Final Record of Decision for an operable unit not included in the Interim ROD. In other areas, sufficient information was not available at the time of the Interim ROD to determine if remediation is warranted or to select a remedy. DOE will continue voluntarily monitoring these areas until they are formally incorporated into an amended Interim ROD and as an addendum to this CMP/CP.

The following paragraphs provide more detailed information on the areas of current or potential contamination at Site 300 that were not included in the Interim ROD and are therefore not addressed by this CMP/CP:

General Services Area Operable Unit - An area-specific Final ROD is in place for this operable unit (U.S. DOE, 1997a) and vadose zone and ground water remediation has been underway since 1991. A CMP/CP for the General Services Area was included in the Remedial Design document for this area (Rueth et al., 1998). Monitoring will not be affected by the provisions of this CMP/CP.

Pit 7 Landfill Complex - The Pit 3, 5, and 7 Landfills, collectively designated the Pit 7 Landfill Complex, are still being characterized and remedial options are being evaluated. These landfills will be addressed in a future, area-specific Remedial Investigation/Feasibility Study. After a remedy is selected, DOE will amend the Interim ROD and issue an addendum to this CMP/CP. RCRA Closure and Post-Closure documents have been approved for the Pit 7 Landfill Complex (Corey, 1988; Rogers/Pacific, 1990) and the area is monitored under Waste Discharge Requirements issued by the RWQCB. This monitoring will not be affected by this CMP/CP.

Pit 1 Landfill - RCRA Closure and Post-Closure documents (Corey, 1988; Rogers/Pacific, 1990) have been approved and this facility is currently monitored under Waste Discharge Requirements issued by the RWQCB. This monitoring will not be affected by this CMP/CP.

High Explosives Open Burn Facility - A RCRA Closure Plan (U.S. DOE, 1997b) has been approved and this facility is monitored as specified in that document. This monitoring will not be affected by this CMP/CP.

High Explosives Surface Water Impoundments - These facilities are monitored under Waste Discharge Requirements issued by the RWQCB. This monitoring will not be affected by this CMP/CP.

Pit 6 Landfill - The designated "detection monitor wells" for this landfill will continue to be sampled as specified in the Detection Monitoring Plan contained within the Post-Closure Plan for this landfill (Ferry et al., 1998). This monitoring will not be affected by this CMP/CP. Wells in the area that are not designated as detection monitor wells will be sampled as described in the Ground and Surface Water Monitoring Program presented in Section 3.

Ongoing Investigations - Site characterization activities are in progress at Building 865 (the Advanced Test Accelerator), Building 812, and the Sandia Test Site. Monitor wells in these areas are sampled as part of the remedial investigations and are not addressed in this CMP/CP. When remedies are selected for these areas, DOE will amend the Interim ROD and issue an addendum to this CMP/CP to include these three areas.

Surveillance Monitoring - The monitoring of water-supply wells, air, vegetation, and storm water runoff by the LLNL Operations and Regulatory Affairs Division will not be affected by this CMP/CP.

2. Objectives

2.1. General Objectives

This CMP/CP describes the monitoring and compliance activities to be conducted in support of the remedies selected in the Interim ROD, including:

- Performing regular ground and surface water sampling and analysis to monitor the effectiveness of the interim remedial actions.
- Conducting detection monitoring, inspection, and maintenance of the Pit 2, 8, and 9 Landfills to identify and prevent future contaminant releases from these landfills.
- Monitoring the performance and regulatory compliance of soil vapor and ground water extraction and treatment facilities to ensure the regulatory compliance.
- Managing risks and hazards to human and ecological receptors to prevent unacceptable exposure from occurring during remediation.
- Managing the collection, processing, and quality of monitoring data.
- Reporting the monitoring results and interpretations to the regulatory agencies and other stakeholders.
- Establishing contingency measures and procedures to be implemented if cleanup does not proceed as planned.

2.2. Remedial Action Objectives

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) specifies that Remedial Action Objectives be developed that address: (1) contaminants of concern, (2) media of concern, (3) potential exposure pathways, and (4) preliminary remediation levels. For the areas addressed in the Interim ROD, the Remedial Action Objectives are:

<u>For Human Health Protection:</u>

- Restore ground water containing contaminant concentrations above the cleanup standards that will be set in the Final ROD.
- Prevent human incidental ingestion and direct dermal contact with contaminants in surface soil that pose an excess cancer risk greater than 1×10^{-6} or a hazard quotient greater than 1, a cumulative excess cancer risk (all carcinogens) in excess of 1×10^{-4}, or a cumulative hazard index (all noncarcinogens) greater than 1.
- Prevent human inhalation of VOCs volatilizing from subsurface soil to air that pose an excess cancer risk greater than 1×10^{-6} or a hazard quotient greater than 1, a cumulative excess cancer risk (all carcinogens) in excess of 1×10^{-4}, or a cumulative hazard index (all noncarcinogens) greater than 1.
- Prevent human inhalation of VOCs volatilizing from surface water to air that pose an excess cancer risk greater than 1×10^{-6} or a hazard quotient greater than 1, a cumulative

excess cancer risk (all carcinogens) in excess of 1×10^{-4}, or a cumulative hazard index (all noncarcinogens) greater than 1.

- Prevent human inhalation of contaminants bound to resuspended surface soil particles that pose an excess cancer risk greater than 1×10^{-6} or a hazard quotient greater than 1, a cumulative excess cancer risk (all carcinogens) in excess of 1×10^{-4}, or a cumulative hazard index (all noncarcinogens) greater than 1.
- Prevent human exposure to contaminants in media of concern that pose a cumulative excess cancer risk (all carcinogens) greater than 1×10^{-4} and/or a cumulative hazard index greater than 1 (all noncarcinogens).

For Environmental Protection:

- Restore water quality, at a minimum, to protect beneficial uses within a reasonable timeframe. Prevent migration of contaminants into pristine waters. This applies to both individual and multiple constituents that have additive toxic or carcinogenic effects.
- Ensure ecological receptors important at the individual level of ecological organization (State of California or federally-listed or endangered species or State of California species of special concern) do not reside in areas where relevant hazard indices exceed 1.
- Ensure changes in contaminant conditions do not threaten wildlife populations and vegetation communities.

3. Ground and Surface Water Monitoring Program

The Site 300 Ground and Surface Water Monitoring Program includes the sampling of monitor wells and surface water. Excluded from this program are:

- Monitor wells already included in other monitoring programs (see Section 1.3).
- Monthly monitoring of onsite and nearby offsite water-supply wells. The analyte list for these wells is extensive, and includes all contaminants of concern identified in ground water in the area near each water-supply well.
- Detection monitoring wells at the Pit 2, 8, and 9 Landfills (see Section 4).
- Ground water extraction wells (see Section 5).

Data from the monitoring activities listed above will be evaluated along with those obtained from this Ground and Surface Water Monitoring Program to facilitate comprehensive analyses of hydrogeologic conditions, contaminant distribution and migration, and the progress of remediation.

This program supercedes the ground water monitor well sampling requirements previously included in Monitoring and Reporting Programs issued by the RWQCB for the High Explosives Process Area, Building 832 Canyon, Building 834, and Building 854 areas.

Monitoring will be performed using the Standard Operating Procedures and quality assurance/quality control measures described in Section 8.

Reporting requirements are described in Section 9. Changes to the monitoring program will be documented in the semiannual compliance monitoring reports.

3.1. Ground and Surface Water Sampling and Analysis

Ground and surface water sampling locations are divided into the following three categories:

1. "Guard wells" to provide timely indication of contaminant movement that could impact water-supply wells, water-supply aquifers, or approach the site boundary.
2. "Plume tracking wells" to define the lateral and vertical extent of ground water contamination.
3. Surface water (springs).

Sections 3.1.1 through 3.1.3 present the general approach for collecting and analyzing samples from these wells and springs. This CMP/CP does not include detailed sampling and analysis plans for each well or spring. These plans will be submitted to the regulatory agencies prior to implementation, then generated quarterly and modified periodically to reflect changing site conditions, new monitor wells, and stakeholder concerns. At a minimum, these plans will be consistent with the guidelines included in the following sections. Future revisions to the monitoring program will be documented in the semiannual reports described in Section 9.

3.1.1. Guard Wells

A subset of all Site 300 wells are designated as guard wells, where time-sensitive information is needed to identify of contaminant movement that may:

1. Impact water-supply wells (shown on Figure 3-1).
2. Contaminate unimpacted portions of water-supply aquifer(s).
3. Result in migration across the site boundary.

Other wells of strategic importance may also be designated as guard wells (e.g., a well near a suspected new contaminant release). Guard wells will generally be sampled more frequently than other wells.

Table 3-1 lists the preliminary selection of guard wells for Site 300, and describes the hydrostratigraphic completion interval, purpose, analytes, and sampling frequency of each well. Sixteen existing monitor wells may be used as guard wells and five new guard wells may be installed. The guard wells are located in the High Explosives Process Area, Building 834, Building 832 Canyon, and Pit 6 Landfill areas, as shown on Figure 3-2. The final selection of guard wells, analytes, and sampling frequency will be defined in detailed sampling and analysis plans.

Ground water contaminant plumes in other areas of the site (e.g., Buildings 854, 851, and 801) are located in the interior portion of Site 300, well away from the site boundary and water-supply wells and the rate of contaminant migration is relatively low. Time-sensitive contaminant concentration data are not needed to monitor these plumes, and all monitor wells in these areas will be sampled as described in Section 3.1.2. Guard wells for the General Services Area are established in the Remedial Design document for that operable unit (Rueth et al., 1998) and are not included in this CMP/CP.

The list of guard wells will be reviewed annually and modified as needed. Any changes will be documented in the semiannual reports. Section 10.1.1.3 describes procedures that would be implemented for evaluating guard wells that have been impacted by site contaminants and should be considered for replacement.

3.1.2. Plume Tracking Wells

Plume tracking wells are used to monitor the distribution and concentration of contaminants concern (COCs) in ground water identified in the Interim ROD. For compliance monitoring purposes, primary and secondary COCs are defined for each area of Site 300.

Primary COCs are those that generally exhibit:

1. Higher migration rates than secondary COCs.
2. Larger horizontal and vertical extent of contamination than secondary COCs.
3. Any other contaminant or area-specific consideration that indicates that a more frequent sampling schedule is appropriate (e.g., a highly toxic contaminant).

The extent of a ground water plume is defined by the presence of contamination above the analytical detection limit. Primary COCs will be monitored at a higher frequency than secondary

COCs. Vadose zone COCs are those which have been detected in the unsaturated zone but have not been detected in ground water.

Table 3-2 presents the preliminary analytes for the Ground and Surface Water Monitoring Program, and shows the contaminants that have been designated primary, secondary, or vadose zone COCs for each area of Site 300. The final list of monitoring locations, analytes, and sampling frequency will be defined in detailed sampling and analysis plans. The list of COCs will be reviewed annually and modified as needed. Any changes will be documented in the semiannual reports.

Samples from wells within and adjacent to the lateral and vertical extent of a primary COC plume will be analyzed semiannually for primary COCs and annually for secondary COCs. Wells that show no evidence of anthropogenic contamination and are not located hydraulically downgradient of a contaminant plume will be monitored biennially (every other year) for all primary and secondary COCs identified in the area. Figure 3-3 shows an example of how this sampling program would be implemented in the High Explosives Process Area, where commingled TCE, perchlorate, high-explosive compounds, and nitrate plumes occur. DOE will create similar illustrations for each area at Site 300 and present them to the regulatory agencies as part of the detailed sampling and analysis plans.

A subset of wells in each area will be sampled biennially for COCs that have been identified in the vadose zone (or surface soil) but not detected in ground water. The objective of sampling for these analytes is to detect contaminants that may migrate downward into ground water. The wells will be chosen based on the lateral extent, depth, and concentration of vadose zone COCs.

Some wells that provide redundant data (i.e., wells in close proximity to one another, completed in comparable hydrostratigraphic intervals, and yielding similar contaminant concentration data) may be excluded from the sampling program or sampled at a reduced frequency.

3.1.3. Surface Water

All onsite and nearby offsite springs will be sampled. The analytes and sampling frequency criteria for each spring will be identical to that for a well present at that location, but the time of sampling may be adjusted to accommodate sampling during the wet season when most flow occurs.

There are no natural perennial streams or ponds at Site 300. Stormwater runoff sampling is conducted through a surveillance monitoring program by the LLNL Operations and Regulatory Affairs Division with regulatory oversight.

3.2. Ground Water Elevation Measurements

Ground water elevations will be measured quarterly in all onsite monitor wells and in offsite monitor wells in the vicinity of Site 300. For some wells, the measurement frequency may be increased to provide additional information on seasonal fluctuations or the performance of ground water extraction systems.

4. Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 8, and 9 Landfills

The Pit 2, 8, and 9 Landfills received firing table debris from the 1950s to the 1970s. Based on knowledge of typical firing table operations, the debris buried in these unlined pits may contain tritium, depleted uranium, metals, and/or high-explosive compounds. The debris was subsequently covered with non-engineered native soil.

The depth to static ground water is approximately 50 ft beneath the Pit 2 Landfill and 120 feet beneath the Pit 8 and 9 Landfills. The bedrock beneath the landfills consists of interbedded siltstone, claystone, and sandstone.

There is no evidence of contaminant releases from these three landfills, and no unacceptable risk or hazard to human or ecological receptors has been identified. The remedy selected in the Interim ROD includes vadose zone and ground water monitoring to detect any future releases of contaminants from these landfills.

The Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 8, and 9 Landfills includes:

- Installing additional ground water monitor wells.
- Regularly collecting and analyzing ground water samples.
- Installing vadose zone sampling devices beneath the landfills to collect soil moisture samples.
- Regularly collecting and analyzing soil moisture samples.
- Regularly inspecting the landfills to identify any erosion, subsidence, or breaching of the landfill surface.
- Maintaining the landfill surfaces.

Monitoring will be performed using the Standard Operating Procedures and quality assurance/quality control measures described in Section 8.

Reporting requirements are described in Section 9. Changes to the monitoring program will be documented in the semiannual compliance monitoring reports.

4.1. Ground Water Sampling and Analysis

Designated “detection monitor wells”, situated in close proximity to the landfills, will be used to identify any impact to ground water resulting from future releases from the landfills. The preliminary locations of the planned and existing detection monitor wells for the Pit 2, 8, and 9 Landfills are shown on Figures 4-1, 4-2, and 4-3, respectively. The landfills are shown in cross-section on Figures 4-4, 4-5, and 4-6. To supplement the existing wells, two additional detection monitor wells will be installed at the Pit 2 Landfill and one additional well at the Pit 9 Landfill. No additional wells are needed at the Pit 8 Landfill.

Ground water samples will be collected quarterly from the detection monitor wells. Table 4-1 lists the preliminary selection of analytes to be performed on the ground water samples. The samples will be analyzed for tritium more frequently (quarterly) than other analytes (annually or biennially) because tritium is more mobile than the other analytes and is therefore an effective indicator of contaminant release from the landfills. The list of analytes includes all constituents that could reasonably be expected in the buried waste.

A detailed sampling and analysis plan will be created that shows the location, completion interval, sampling frequency, and analyte list for all detection monitor wells.

4.2. Ground Water Elevation Measurements

Ground water elevations will be measured quarterly in all detection monitor wells for the Pit 2, 8, and 9 Landfills.

4.3. Vadose Zone Sampling and Analysis

Lysimeters (or comparable soil-moisture sample collection devices) will be installed and sampled to monitor for potential future releases of contaminants from the landfills to the underlying vadose zone. The lysimeters will be emplaced using horizontal or directional drilling. The preliminary locations of the lysimeters for the Pit 2, 8, and 9 Landfills are shown in plan view on Figures 4-1, 4-2, and 4-3, and in cross-section on Figures 4-4, 4-5, and 4-6, respectively.

A detailed workplan for the vadose zone sampling devices will be provided to the regulatory agencies prior to installation. This workplan will describe the: (1) device type, (2) installation methodology, (3) locations and depths, and (4) sample collection procedures.

Soil moisture samples from the lysimeters will be collected and analyzed using the same schedule and analyte list as described for the ground water samples from the detection monitor wells (Section 4.1).

4.4. Landfill Inspection and Maintenance

The Pit 2, 8, and 9 Landfills will be inspected quarterly to identify any degradation or damage to the surface of the landfills that could lead to: (1) increased infiltration of precipitation, (2) exposure of the landfill contents, and (3) flow of surface water on or adjacent to the landfill.

LLNL Plant Engineering staff will perform the landfill inspections and the annual subsidence monitoring required by DOE. Any required maintenance will be performed promptly, and measures to prevent reoccurrence of the degradation or damage will be implemented.

5. Extraction and Treatment Facility Monitoring Program

The Site 300 Extraction and Treatment Facility Monitoring Program includes regular sampling, flow measurements, and maintenance of ground water and soil vapor extraction wells and treatment facilities. Monitoring of the facilities in the General Services Area is excluded from this program, as described in Section 1.3.

This program supercedes all extraction well and ground water treatment facility monitoring requirements included in Monitoring and Reporting Program issued by the RWQCB for the High Explosives Process Area, Building 832 Canyon, Building 834, and Building 854 areas, and will be applicable to the additional facilities identified in the Interim ROD and the Remedial Design Work Plan.

Discharge specifications, prohibitions, and effluent discharge limitations for treated ground water are contained in the Substantive Requirements issued by the RWQCB, and are not affected by this CMP/CP.

For treated soil vapor, monitoring requirements and effluent discharge limitations are contained in the Permit Unit Requirements issued by the San Joaquin Valley Unified Air Pollution Control District (1998). This Extraction and Treatment Facility Monitoring Program is consistent with, but do not supercede, District requirements.

Monitoring will be performed using the Standard Operating Procedures and quality assurance/quality control measures described in Section 8.

Reporting requirements are described in Section 9. Modifications to the monitoring program will be documented in the semiannual compliance monitoring reports.

5.1. Ground Water Extraction and Treatment

Sections 5.1.1 and 5.1.2 describe the compliance monitoring activities for ground water extraction wells and treatment facilities.

5.1.1. Ground Water Extraction Wells

The analytes and sampling frequency for ground water extraction wells will be identical to that described for monitor wells used for plume tracking, as described in Section 3.1.2. Water levels in all extraction wells will be measured quarterly.

5.1.2. Ground Water Treatment Facilities

Water samples will be collected, at a minimum, at the influent and effluent points of the treatment stream. Additional influent or effluent samples may be collected at intermediate points within the process stream to manage the performance of the treatment system.

Influent samples will be collected and analyzed quarterly. Effluent samples will be collected and analyzed monthly. There will be sufficient time allowed between sampling events to avoid sample clustering. Influent samples will be collected at approximately the same time as the effluent samples. Effluent samples will be representative of the volume and nature of the discharge. Influent or effluent samples may be collected more frequently to manage the performance of the treatment system.

The influent and effluent samples will be analyzed, at a minimum, for all contaminants identified in any ground water extraction well connected to the treatment system or that could potentially be captured by any extraction well. Table 5-1 presents the preliminary sampling and analysis plan for each ground water treatment facility at Site 300. The final selection of analytes will be defined in detailed sampling and analysis plans. Future changes to the plans will be documented in the semiannual reports.

All aqueous treatment facility effluent is discharged to the atmosphere through misting towers or is returned to ground water through infiltration trenches. No effluent is discharged into a surface water drainage, so no receiving water sampling is required. Therefore, monitoring for specific conductance, total dissolved solids, and temperature in the facility influent and effluent is not needed and will not be conducted. There are no effluent limitations for these parameters in the Substantive Requirements. Specific conductance and total dissolved solids values are generally lower in the effluent than the influent and should not negatively impact ground water upon recharge. Temperature differences up to 10°F have been measured between the effluent and influent as a result of heating or cooling (depending on the season) as the water moves through the system piping. Effluent temperature should return to ambient ground water temperature rapidly upon discharge to the infiltration trenches without adversely impacting the environment. The temperature of misted effluent should quickly normalize to the ambient atmospheric temperature before reaching the ground surface.

Upon: (1) initial startup of a facility, (2) a facility shutdown due to non-compliance with discharge requirements, or (3) any treatment system shutdown or modification that could result in non-compliance, effluent samples will be collected and analyzed within two days of system restart, one week after restart, and return to the normal sampling schedule thereafter. No additional sampling will be performed after shutdowns due to routine maintenance or for modifications that do not affect compliance.

For quality control, one sampling blank and one duplicate sample will be collected and analyzed for every ten samples collected. These quality control samples will be analyzed for the same constituents as the other samples collected.

Flow volume measurements will be recorded weekly. More frequent measurements may be performed to manage the performance of the facility.

All treatment facilities will be visually inspected weekly to identify any maintenance issues or other problems that could affect facility performance or compliance.

Detailed sampling and analysis plans will be generated as needed. These plans will be modified as needed to reflect changing site conditions, new extraction wells, and stakeholder concerns.

5.2. Soil Vapor Extraction and Treatment

Sections 5.2.1 and 5.2.2 describe the compliance monitoring activities for soil vapor extraction wells and treatment facilities.

5.2.1. Soil Vapor Extraction Wells

All wells used to extract soil vapor will be sampled and analyzed semiannually for VOCs. The negative pressure in each extraction well will also be measured semiannually.

5.2.2. Soil Vapor Treatment Facilities

This monitoring program is consistent with, but does not supercede, the provisions of the Permit Unit Requirements which are part of the facility-wide Permit to Operate for Site 300 issued by the San Joaquin Valley Unified Air Pollution Control District (1998). The Permit to Operate and Permit Unit Requirements are modified and reissued periodically, and are incorporated into this CMP/CP by reference. Future modifications will not require an amendment to this CMP/CP.

For the purposes of this CMP/CP, the following two Permit Unit Requirements are applicable:

- "TCE Vapor Extraction System #2 Served by Two Carbon Canisters in Series or by a Catalytic Oxidizer." This requirement is applicable to soil vapor treatment facilities at Buildings 834, 832, 830, and 854.
- "Single Baffled Polyethylene Bubble Tank System (#3) for Groundwater Remediation Served by a Carbon Adsorption System or Catalytic Oxidizer." This requirement is applicable to the treatment of vapor effluent from the air-sparging unit used to treat extracted ground water at Building 834.

A flame-ionization detector, photo-ionization detector, or other District-approved VOC detection device will be used to monitor the effluent vapor stream weekly. Records of the cumulative running time and effluent concentrations will be maintained.

5.3. Treatment Facility Operation and Maintenance

All treatment facilities will be operated and maintained to ensure proper operation and compliance with discharge requirements. Operation and maintenance procedures and safety plans for soil vapor and ground water treatment facilities are contained in the following documents:

- Health and Safety Plan and Quality Assurance/Quality Control Plan for the Operation and Maintenance of the Building 834 Treatment Facilities, contained within the Interim Remedial Design document (Gregory et al., 2002).
- Building 834 Treatment Facility Operations and Maintenance Manual (LLNL, 2002, in progress).
- Operations and Maintenance Manual, Volume 1: Treatment Facility Quality Assurance and Documentation (LLNL, 2000a).

- Integration Work Sheet Safety Procedure #552: Ground Water and Soil Vapor Extraction at Building 834 (LLNL, 2000b).
- LLNL Livermore Site and Site 300 Environmental Restoration Project Standard Operating Procedures (Dibley and Depue, 2002).
- Site Safety Plan for Lawrence Livermore National Laboratory CERCLA Investigations at Site 300 (LLNL, 2000c).
- Quality Assurance Project Plan, Livermore Site and Site 300 Environmental Restoration Projects (Dibley, 1999).
- Permit to Operate and Permit Unit Requirements issued by the San Joaquin Valley Unified Air Pollution Control District (1998).

6. Risk and Hazard Management Program

The overall goals of the Site 300 Risk and Hazard Management Program are to control exposure to contaminants and to ensure the selected interim remedies for Site 300 protect human health and the environment while the Remedial Action Objectives are being achieved. The Site 300 Remedial Action Objectives are described in Section 2.2.

The baseline risk assessment was included in the Site-Wide Remedial Investigation report for Site 300 (Webster-Scholten, 1994) and an addendum to that report (Taffet et al., 1996). Risk assessment information is also provided in the Site-Wide Feasibility Study (Ferry et al., 1999) and the Interim ROD (U.S. DOE, 2001). The risks and hazards to human and receptors identified in the baseline risk assessment are summarized in Table 6-1. Hazards to ecological receptors are summarized in Table 6-2.

In the context of this Risk and Hazard Management Program, the term “risk” is used to refer to carcinogenic health effects, and “hazard” is used to refer to non-carcinogenic (toxic) health effects as expressed by the hazard quotient or hazard index. The term “hazard” does not refer to physical hazards, such as construction-related injuries.

In the Interim ROD, risk and hazard management was identified as a component of the selected remedies for the following areas:

- Building 834.
- Pit 6 Landfill.
- High Explosives Process Area.
- Building 850.
- Building 854.
- Building 832 Canyon.
- Building 833.

The risk and hazard management components of the selected interim remedies for each of these areas are summarized in Table 6-3.

Risk and hazard management is included as part of an interim remedy where the risk at any exposure point exceeds 1×10^{-6} or the hazard index is greater than 1, exclusive of ingesting contaminated ground water. Measures to prevent ingestion of ground water, as discussed in Section 6.1.5, are included in risk management wherever ground water contamination may adversely impact human health.

More details of the Risk and Hazard Management Program are presented in this section than in other sections of this CMP/CP because some of the methodologies and decision processes used to implement this program have not previously been included in other Site 300 documents. The methodologies used in other monitoring programs in this CMP/CP (e.g., the Ground and Surface Water Monitoring Program in Section 3) are presented in detail in the LLNL Standard Operating Procedures and other documents (e.g., various Operation and Maintenance Manuals and the Site 300 Quality Assurance Project Plan).

The Risk and Hazard Management Program to protect human health and the environment is described in Sections 6.1 and 6.2, respectively. Reporting requirements for the Risk and Hazard Management Program are described in Section 9. Modifications to the program will be documented in the semiannual compliance monitoring reports.

6.1. Human Health Risk and Hazard Management

Risk and hazard management protects human health by restricting access to or activities in areas of elevated risk or hazard (institutional controls), thereby preventing unacceptable exposure to contaminants during the remediation process. Engineering controls will be implemented to mitigate exposure when institutional controls are not sufficient to manage exposure. These controls are not intended as final remedies, but are designed to manage exposure to contaminants until remedial actions have reduced the risk and hazard to acceptable levels.

Acceptable levels are defined by the Remedial Action Objectives as carcinogenic risk below 1×10^{-6} and non-carcinogenic hazard index below 1. Only risks and hazards identified in the baseline risk assessment that exceed the Remedial Action Objectives are addressed in this CMP/CP.

The baseline human health risk assessment evaluated two primary exposure scenarios. Both scenarios assumed that no soil or ground water remediation would be performed at Site 300. The adult onsite worker scenario assumed that Site 300 workers could be exposed to contaminants by:

1. Inhaling contaminants volatilizing from the subsurface into the atmosphere or into buildings.
2. Inhaling contaminants bound to resuspended surface soil.
3. Direct dermal contact with contaminated soil.
4. Incidental ingestion of contaminated soil.

A number of areas at Site 300 where unacceptable risk or hazard is present were identified. Ingestion of contaminated ground water is not a complete exposure pathway because: (1) workers at the site consume either bottled water or ground water from onsite water-supply well

20, and (2) Site 300 is expected to be connected to the Hetch-Hetchy water-supply system in the future.

The second scenario (offsite residential) assumed that members of the public living adjacent to Site 300 could potentially be exposed to contaminated ground water withdrawn from private offsite water-supply wells, but not to contaminated soil within the site boundary, or to resuspended particulates or volatilized contaminants transported through the atmosphere across the site boundary. In the baseline risk assessment, future impacts to ground water quality (assuming no remediation was performed at Site 300) were estimated at nearby private water-supply wells and at hypothetical water-supply wells that might be installed at the Site 300 boundary downgradient from onsite ground water contaminant plumes.

Fencing and a full-time security force prevent access to Site 300 by unauthorized members of the public, and only risk and hazard management measures that supplement these existing institutional controls are included in this CMP/CP. Site 300 building occupancy and site use restrictions are necessary only to prevent exposure of onsite workers. These restrictions are implemented and maintained by Site 300 management.

Sections 6.1.1 through 6.1.8 describe the specific measures that will be taken to manage human exposure to contaminants within Site 300 and the adjacent offsite area.

6.1.1. Inhalation of VOCs Volatilizing from the Subsurface to Indoor Ambient Air

In the baseline risk assessment, risk and hazard were calculated for volatile contaminants in the subsurface migrating upward through the floors of buildings into indoor ambient air and being inhaled by workers within the building. This assessment assumed that an onsite worker would spend 8 hours a day, 5 days a week, for 30 years within the buildings. An unacceptable risk or hazard was identified within six buildings:

1. Building 834D - Cumulative risk 1×10^{-3}, hazard index 35.7, due to TCE and PCE.
2. Building 854A - Cumulative risk 1×10^{-6}, due to six VOCs. No VOCs were detected in past ambient air samples, and risk was calculated using detection limits.
3. Building 854F - Cumulative risk 9×10^{-6}, due to TCE, chloroform, and other VOCs.
4. Building 830 - Cumulative risk 2×10^{-6}, due to TCE and vinyl chloride.
5. Building 832F - Cumulative risk 3×10^{-6}, due to dichloropropane.
6. Building 833 - Cumulative risk 1×10^{-6}, due to TCE and chloroform.

There are currently no workers occupying these buildings full-time, and building occupancy restrictions are in effect. These baseline risk and hazard data are presented in more detail in Table 6-1.

To prevent unacceptable exposure within the buildings, risk and hazard management measures will be implemented using the following process, also shown on Figure 6-1:

1. Estimate inhalation risk and hazard using the U.S. EPA Air Model, version 2.3 (U.S. EPA, 2000) to estimate subsurface vapor intrusion into buildings. This model incorporates both convective and diffusive mechanisms for estimating the transport of

contaminant vapors emanating from either subsurface soil or ground water into indoor spaces located directly above the source of contamination. The modeling will be performed annually.

2. If the estimated risk is below 10^{-6} and the hazard index is below 1, maintain the building occupancy restrictions and continue annual modeling and risk estimation. If the estimated risk remains below 10^{-6} and the hazard index remains below 1 for two years, risk and hazard management is complete for the building.
3. If the estimated risk exceeds 10^{-6} or the hazard index exceeds 1, annually review the building occupancy conditions. If workers do not occupy or plan to occupy the building in the near future, maintain the building occupancy restrictions and continue the annual modeling and risk estimation.
4. If the estimated risk is above 10^{-6} or the hazard index exceeds 1 and the building is occupied or occupation is planned, implement engineering controls such as installing a building ventilation system or requiring personal protective equipment within the building. Continue the annual modeling and risk estimation.

6.1.2. Inhalation of VOCs Volatilizing from the Subsurface to Outdoor Ambient Air

In the baseline risk assessment, risk and hazard were calculated for volatile contaminants in the subsurface migrating upward into outdoor ambient air and being inhaled by onsite workers. This assessment assumed a worker would spend 8 hours a day, 5 days a week, for 30 years working in these areas. An unacceptable risk or hazard was identified at five locations:

1. Building 834D - Cumulative risk 7×10^{-4}, hazard index 21.4, due to TCE and PCE.
2. Building 815 - Cumulative risk 5×10^{-6}, due to TCE and PCE.
3. Building 854F - Cumulative risk 1×10^{-5}, due to chloroform and 1,2-DCA.
4. Building 830 - Cumulative risk 1×10^{-5}, due to chloroform, 1,2-DCA, and vinyl chloride.
5. Pit 6 Landfill - Cumulative risk 5×10^{-6}, due to multiple VOCs. Although an unacceptable risk was identified in the baseline risk assessment, an engineered cap was later placed over the Pit 6 Landfill that includes an impermeable geomembrane layer covering the entire landfill area that prevents VOC vapors from reaching outdoor ambient air where workers could be exposed. No further risk management measures to prevent inhalation of VOCs are needed.

There are currently no workers occupying these areas full-time, and local site use restrictions are in effect. These baseline risk and hazard data are presented in more detail in Table 6-1.

To prevent exposure outside the four buildings, risk and hazard management measures will be implemented using the following process, also shown on Figure 6-2:

1. Estimate the inhalation risk and hazard resulting from transport of contaminant vapors from subsurface soil and/or ground water to the ground surface and subsequent volatilization into outdoor ambient air using an EPA-approved model. DOE will work with the U.S. EPA and the state regulatory agencies to select the most appropriate model. The modeling will be performed annually.

2. If the estimated risk is below 10^{-6} and the hazard index is below 1, maintain the site use restrictions and continue the annual modeling and risk estimation. If the estimated risk remains below 10^{-6} and the hazard index remains below 1 for two years, risk and hazard management is complete for the site.
3. If estimated risk exceeds 10^{-6} or the hazard index exceeds 1, annually review the local site use conditions. If workers do not occupy or plan to occupy the site in the near future, maintain the site use restrictions and continue the annual modeling and risk estimation
4. If the estimated risk is above 10^{-6} or the hazard index exceeds 1 and the site is occupied or occupation is planned, implement engineering controls such as paving the area for a long-term solution, wetting the soil for a short-term activity, and/or requiring personal protective equipment while working in the area. Continue the annual modeling and risk estimation.

6.1.3. Inhalation of VOCs Volatilizing from Surface Water to Outdoor Ambient Air

In the baseline risk assessment, risk and hazard were calculated for contaminants in surface water volatilizing into the atmosphere and being inhaled by onsite workers. This assessment assumed an onsite worker would spend 8 hours a day, 5 days a week, for 30 years working near the contaminated surface water. An unacceptable risk or hazard was identified at four locations:

1. Spring 7 (southeast of the Pit 6 Landfill) - Cumulative risk 4×10^{-5}, hazard index 1.1, due to TCE, PCE 1,2-DCA, and chloroform. Spring 7 flows at the ground surface only during extremely wet years.
2. Spring 5 (High Explosives Process Area) - Cumulative risk 1×10^{-5}, due to 1,1-DCE and TCE. The flow from spring 5 is negligible and the spring is characterized by moist soil with wetland vegetation. In the baseline risk assessment, the concentration of VOCs in surface water from spring 5 was assumed to be equal to the maximum historical concentrations detected in nearby monitor well W-817-03A. Since no actual standing surface water exists at spring 5, risk and hazard management measures are not necessary to prevent inhalation exposure. Well W-817-03A will continue to be monitored, and spring 5 will be surveyed periodically for standing water. Risk and hazard management measures will be implemented if unacceptable exposure risk or hazard is identified in the future.
3. Spring 3 (Building 832 Canyon) - Cumulative risk 6×10^{-5}, hazard index 2.3, due to TCE and PCE.
4. The Carnegie State Vehicular Recreation Area pond (east of the Pit 6 Landfill): Cumulative risk 2×10^{-6}, due to TCE. At the recreation area, water-supply well CARNRW-2 is used to fill a pond, but the water is not subsequently used by the recreation area staff and visitors. The baseline risk assessment indicated that if the VOC source in the Pit 6 Landfill was not controlled, contaminated ground water could migrate to well CARNRW-2 and result in an unacceptable risk from inhaling VOC vapors volatilizing from the pond. Although an unacceptable risk was identified in the baseline risk assessment, an engineered cap was later placed over the Pit 6 Landfill that included an impermeable geomembrane layer that prevents infiltration of precipitation and further

releases of contaminants from the landfill. No VOCs have been detected in the pond or in well CARNRW-2. If VOCs are detected in the upgradient guard wells (described in Section 3.1) or in well CARNRW-2, the pond will be sampled for VOCs. If VOCs are detected in the pond at concentrations that present an unacceptable risk or hazard, risk and hazard management measures will be implemented for the pond.

There are currently no full-time Site 300 staff or members of the public working near these areas, and local site use restrictions are in effect. These baseline risk and hazard data are presented in more detail in Table 6-1.

To prevent exposure, risk and hazard management measures will be implemented using the following process, also shown on Figure 6-3:

1. Collect annual samples of outdoor ambient air above contaminated surface water (when surface water is present) to determine VOC concentrations. Air sampling will be conducted using the SUMMA™ canister sampling methodology outlined in "Estimation of Baseline Air Emissions at Superfund Sites" (U.S. EPA, 1990a, 1990b), the "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air" (U.S. EPA, 1999a), and LLNL Standard Operating Procedure (SOP) 1.11 (Dibley and Depue, 2002). The SUMMA™ canister samples will be analyzed for VOCs that cause the unacceptable risk or hazard using U.S. EPA Method TO-14. The sampling and analysis plan for outdoor air above contaminated surface water is presented in Table 6-4.
2. Compare the measured VOC concentrations to the U.S. EPA Region IX PRGs for ambient air. If the concentrations are below the PRGs, maintain site use restrictions and continue the annual sampling. If the concentrations remain below the PRGs for two years, risk and hazard management is complete for the site.
3. If concentrations exceed the PRGs, annually review the local site use conditions. If workers do not occupy or plan to occupy the site in the near future, maintain the site use restrictions and continue the annual sampling. If workers occupy or plan to occupy the site in the near future, recalculate the risk and hazard based on projected actual exposure.
4. If the recalculated risk is below 10^{-6} and the hazard index is below 1, continue the annual sampling. If the risk remains below 10^{-6} and the hazard index remains below 1 for two years, risk and hazard management is complete for the site. If risk and hazard have not been below these standards for two years, continue the annual sampling.
5. If the recalculated risk is above 10^{-6} or the hazard index exceeds 1 and the site is occupied or occupation is planned, implement engineering controls such as ground water extraction or requiring personal protective equipment while in the area. Continue the annual sampling.

6.1.4. Inhalation, Ingestion, and Dermal Contact with Contaminants in Surface Soil

In the baseline risk assessment, risk and hazard were calculated for inhalation of resuspended particulates, incidental ingestion of surface soil, and direct dermal contact with contaminated surface soil. These estimates assumed an onsite worker would spend 8 hours a day, 5 days a week, for 30 years working near the contamination. An unacceptable risk was identified at two locations:

1. Building 850 - Cumulative risk 5×10^{-3}, due to PCBs, dioxins, and furans.
2. Building 854 - Cumulative risk 7×10^{-5}, due to PCBs. The estimated risk is based on PCBs detected in a single surface soil sample; additional sampling will be performed as described below.

The Building 850 and 854 areas are not currently occupied on a full-time basis, and local site use restrictions are in effect. These baseline risk and hazard data are presented in more detail in Table 6-1.

To prevent unacceptable exposure in these areas, risk management measures will be implemented using the following process, also shown on Figure 6-4:

1. Sample surface soil and analyze for PCBs, dioxins, and furans in the vicinity of the two buildings. A sampling plan for the Building 850 area will be submitted to the regulatory agencies, and the results will be included in a compliance monitoring report (Section 9). A sampling plan for the Building 854 area will be included in the Characterization Summary report for Building 854, and the results will also be included in a compliance monitoring report. The sampling plans will contain information on sampling locations, sample collection procedures, and analytical methods.
2. Compare the measured concentrations of PCBs, dioxins, and furans to the U.S. EPA Region IX industrial PRGs for surface soil. If the concentrations are below the PRGs, risk and hazard management is complete for the area.
3. If the concentrations exceed the PRGs, review the local site use conditions. If workers do not occupy or plan to occupy the site in the near future, maintain the site use restrictions until soil removal or other remedial action is complete. If workers occupy or plan to occupy the site in the near future, recalculate the risk and hazard based on actual exposure.
4. If the recalculated risk is below 10^{-6} and the hazard index is below 1, risk and hazard management is complete for the area.
5. If the recalculated risk is above 10^{-6} or the hazard index exceeds 1 and the site is occupied or occupation is planned, implement temporary engineering controls such as wetting the soil to control fugitive dust or requiring personal protective equipment until soil removal or other remedial action is complete.

6.1.5. Ingestion of Contaminants in Ground Water

The following sections address the potential ingestion of ground water from onsite and offsite water-supply wells. The locations of these wells are shown on Figure 3-1.

6.1.5.1. Potential Onsite Receptors

Onsite water-supply well 20 is currently used to supply water to workers at Site 300 and is monitored regularly. VOCs have been sporadically detected in samples from this well at concentrations below the drinking water standard. LLNL plans to connect to the Hetch-Hetchy water-supply system in the near future and no additional water-supply wells are planned for Site 300. All other water-supply wells at Site 300 are used only as backup wells for fire suppression, or have been sealed and abandoned.

6.1.5.2. Potential Offsite Receptors

In the baseline risk assessment, an unacceptable risk (1×10^{-5}) was associated with the potential ingestion of ground water over a 30-year period from a hypothetical (i.e., not currently existing or planned) offsite well located at the Site 300 boundary downgradient from contamination in the High Explosives Process Area. The offsite water-supply well closest to this area is Gallo-1, located approximately 1,125 ft hydraulically cross-gradient from the TCE plume in the High Explosives Process Area (Figure 3-1). This well is owned by the Gallo Ranch and used only to water livestock. DOE's planned actions if any offsite property owner proposes to install a water-supply well downgradient of a contaminant plume are discussed in the Contingency Plan (Section 10).

DOE monitors all offsite private water-supply wells located in close proximity to Site 300 monthly to ensure the wells are not impacted by contaminant plumes emanating from the site.

6.1.6. Institutional Controls

Institutional controls, such as onsite building access and local site use restrictions, are a component of many of the risk management actions included in the Interim ROD.

Building occupancy and local site use are controlled by Site 300 management. The LLNL Environmental Restoration Division coordinates with Site 300 management and the LLNL Hazards Control Department to ensure that all facility managers and site workers are aware of risks and hazards that may be encountered in contaminated areas. Current building occupancy and site use restrictions will be maintained in areas identified to have an unacceptable risk or hazard until revised risk assessments show that the risk or hazard has been reduced to acceptable levels.

Currently, no Site 300 staff work full-time in any area or building where an unacceptable risk or hazard has been identified. Site 300 management must approve building use changes. Site 300 management will notify the LLNL Hazards Control Department and the LLNL Environmental Restoration Division of any proposed changes to building occupancy or local site use in areas of unacceptable risk. Warning signs are posted in all areas and buildings where an unacceptable risk or hazard has been identified, stating that permanent occupancy of the facility (or area) on a full-time basis must be approved by the LLNL Hazards Control Department. If full-time use is required, the LLNL Environmental Restoration Division will work with the program requesting the change in building occupancy or site use to implement the appropriate engineering controls necessary to prevent unacceptable worker exposure to contaminants. Engineering controls are discussed in Section 6.1.7.

The LLNL Environmental Restoration Division coordinates with Site 300 management to ensure that no excavation occurs in areas of contamination or at landfills except for approved remedial actions or under the supervision of the LLNL Hazards Control Department. Activities in landfill areas are restricted to those that will not expose landfill material or compromise the integrity of the landfill surfaces.

DOE will notify the regulatory agencies of any action that would be inconsistent with these restrictions, and will evaluate the risk to human health or the environment posed by the proposed activity. If necessary, DOE will amend the Interim ROD to address any necessary changes to the selected interim remedies.

6.1.7. Engineering Controls

Under some circumstances, full-time building occupancy or local site use may be required in areas where and unacceptable risk or hazard has been identified. In these cases, engineering controls will be implemented to prevent unacceptable worker exposure to contaminants.

Engineering controls may include installing a building ventilation system, paving an area to minimize volatilization of contaminants into the atmosphere, or requiring personal protective equipment while in the area. If construction or other temporary ground-disturbing activities become necessary in areas of soil contamination, controls such as wetting the soil to prevent resuspension of soil particles or the use of personal protective equipment will be implemented.

6.1.8. Changes to Risk and Hazard Estimates

DOE will notify the regulatory agencies of any changes to risk and hazard estimates through the semiannual reports described in Section 9. This notification will include any proposed response action necessary to provide adequately protect workers (e.g., implementing engineering controls or increasing access restrictions). The regulatory agencies will also be notified of any relaxation in access restrictions or discontinuation of engineering controls in response to a decrease in risk or hazard levels.

The LLNL Environmental Restoration Division will also notify Site 300 management and the LLNL Hazards Control Department of changes to risk or hazard levels that require changes to institutional or engineering controls.

6.2. Ecological Risk and Hazard Management

This section describes the ecological risk and hazard management measures developed to meet the Remedial Action Objectives for environmental protection. These objectives are to:

1. Ensure ecological receptors important at the individual level of ecological organization (special status species, i.e., State of California or federally-listed threatened or endangered species or State of California species of special concern) do not reside in areas where relevant hazard indices exceed 1.
2. Ensure changes in contaminant conditions do not threaten wildlife populations and vegetation communities.

Sections 6.2.1 and 6.2.2 describe the ecological risk and hazard management process for receptors important on an individual level. Section 6.2.3 describes the ecological risk and hazard management process to address changes in contaminant conditions.

6.2.1. Inhalation of VOCs in Subsurface Burrow Air

In the baseline ecological assessment included in the Site-Wide Remedial Investigation report (Webster-Scholten, 1994), hazard (defined as a hazard index greater than 1) to species important at the individual level (referred to as "important" species) was identified for ground squirrel and kit fox associated with the inhalation of VOCs in burrow air in the Building 834 and Pit 6 Landfill areas (Table 6-2). In the baseline assessment, kit fox (a State and Federal endangered species) was used as a representative important fossorial (burrowing) vertebrate species. Risk and hazard management measures were developed to ensure individuals of important fossorial vertebrate species do not reside in the portions of the Building 834 and Pit 6 Landfill areas associated with a hazard index greater than 1 for kit fox. Hazard to ground squirrel populations is managed as described in Section 6.2.3.

Figure 6-5 shows the decision-making process and risk and hazard management measures for inhalation of VOCs in burrow air by fossorial vertebrates. To prevent important species from residing in areas associated with a hazard index greater than 1 for the inhalation of VOCs in burrow air, the following risk and hazard management process will be implemented:

1. Sampling burrow air annually at the Building 834 and Pit 6 Landfill areas to determine current exposure concentrations. The survey areas are shown on Figures 6-6 and 6-7.
2. Integrating exposure concentration data into hazard calculations to determine any changes to hazard posed by VOCs in burrow air.
3. Conducting semiannual surveys in areas associated with hazard indices greater than 1 for the presence of important burrowing species.
4. If the presence of important species is confirmed, notifying appropriate resource agencies and determining actual exposure through additional chemical analysis and species monitoring.
5. If actual exposure is determined to be significant, developing an appropriate response plan.

Samples of burrow air will initially be collected annually during August/September to evaluate exposure. Scheduling of burrow air sampling will be determined through discussions with experts in vadose zone air movement to determine if sampling dates can be selected with some consideration of external conditions (i.e., barometric pressure, and temperature). Timing of sample collection at Building 834 will be coordinated so that operation of the soil vapor extraction system does not influence the results. The survey areas were selected based on the results of previous soil vapor studies. Burrows to be sampled should have a diameter of at least 3 to 4 inches (i.e., large enough to be used by current special status species), and the depth of the burrow should be at least 2 ft (i.e., should not be caved). Smaller burrows will be sampled only if more appropriately-sized burrows cannot be located or if special status is conferred upon smaller species occupying such burrows.

Table 6-5 shows the preliminary sampling and analysis plan for VOCs in burrow air. A more specific and detailed sampling plan will be created prior to sampling. Burrows will be sampled by adapting standardized procedures for conducting active vacuum induced soil vapor sampling (SOP 1.10: "Soil Vapor Surveys" in Dibley and Depue, 2002) for use with SUMMA™ canisters.

SUMMA™ canister use is described in SOP 1.11: "Soil Surface Flux Monitoring of Gaseous Emission" (Dibley and Depue, 2002).

Results from the burrow sampling will be used to calculate exposure to important species. The kit fox will initially be used as a representative species. Should other important species be identified, exposure models will be developed for each. The ecological exposure model presented in the baseline risk assessment will be used and modified as necessary to incorporate new information that has become available since the time the exposure model was developed in 1992. Table 6-6 shows the current assumptions for use in the exposure model for kit fox.

As described in the baseline risk assessment, inhalation of burrow air was the only significant exposure pathway for VOCs; exposure through ingestion and inhalation of ambient surface air was insignificant. Thus, only the inhalation of burrow air will be considered. However, the Toxicity Reference Values (TRVs), both those used in the baseline risk assessment and included in this CMP/CP, are based on the oral pathway. Consistent with the baseline risk assessment, the inhalation exposure will be converted to an equivalent oral exposure by assuming 50% of the contaminant exposure through inhalation is retained (an absorption fraction of 0.5). A review of the cases in the U.S. EPA Health Effects Assessment Summary Tables (HEAST) and Integrated Risk Information System (IRIS) compiled for the baseline risk assessment where absorption was considered in the inhalation pathway revealed that absorption fractions ranged from 0.3 to 0.5. To be conservative, 0.5 was selected as the fraction of contaminant in air absorbed.

The exposure for each individual burrow and the overall burrow air exposure will be calculated using the 95% upper confidence level (UCL) of the mean concentration, as outlined in California Department of Toxic Substances Control Human and Ecological Risk Division (HERD) (1999). The resultant exposures will then be compared to the TRVs listed in Table 6-7. These TRVs have been revised since the 1992–1994 Site 300 baseline ecological risk assessment. The TRVs listed in Table 6-7 are from a study performed by Oak Ridge National Laboratory (Sample et al., 1996) wherein data from laboratory toxicity tests were used to develop TRVs for wildlife species by adjusting for differences in body size and trophic level. However, given the large uncertainties involved in such interspecies extrapolation, the chronic no-observed-adverse-effect-level (NOAEL) reported for the original test species in the Oak Ridge report will be used. For VOCs, these values are considerably more conservative than those used in the baseline risk assessment. TRVs will be continually reviewed and revised as more data and additional analysis of toxicity data become available.

In areas where there is continued hazard, indicated by a hazard index greater than 1, surveys will be conducted to identify the presence of important species. Species to be monitored include:

1. Federally-listed endangered, threatened, or candidate species that are fossorial in nature, currently including kit fox.
2. State-listed endangered, threatened, candidate, or species of concern that are fossorial in nature, including kit fox and burrowing owl.

In areas where the results of the initial burrow air sampling indicates concentrations to be below the ecological hazard threshold, additional burrow air samples will be collected during three other times throughout the year, selected to correspond to seasonal differences in temperature and barometric pressure. The average of the burrow air concentrations over the year will be used to determine if ecological hazard is indeed below the hazard threshold, and thus the area can be eliminated from further monitoring.

In addition, surveys will be conducted for California tiger salamander, the California red-legged frog, and the Alameda whipsnake in those areas near known or potential dispersal corridors. Burrows in each survey area will be evaluated semiannually during the reproductive and dispersal periods for those special-status species potentially present in the area. Burrows will be categorized by the species most likely to be present. Burrows identified as potentially belonging to an important species will be monitored visually for one week to determine if the burrow is active. If the burrow is active, resident species will be identified. If the burrow occupants are an important species, the appropriate resource agency will be notified and additional chemical sampling and species movement monitoring will be conducted to estimate actual exposure. If the actual exposure is significant, a response plan will be developed that could involve animal relocation or continued monitoring of animal movement and exposure conditions. If the actual exposure is not significant, the risk management process will be complete for this species in the specific area. Evaluations of changes in contaminant or ecological conditions will continue as described in Section 6.2.3. The remaining risk management process will be revised as appropriate.

6.2.2. Ingestion and Inhalation of Cadmium, PCBs, Dioxins, and Furans in Surface Soil

In the baseline ecological assessment, hazard, defined as a hazard index greater than 1, was associated with the combined oral ingestion and inhalation of cadmium in the Building 834 area, and PCBs, dioxins, and furans in the Building 850 area (Table 6-2). Hazard was identified for ground squirrel, deer, and kit fox. In the baseline assessment, kit fox were used as a representative important fossorial vertebrate species. Ecological risk and hazard management measures were developed to ensure individuals of important fossorial vertebrate species do not reside in portions of the Building 834 and Building 850 areas associated with an hazard index greater than 1 for kit fox. Hazard to ground squirrel and deer populations is managed as described in Section 6.2.3.

Figure 6-8 shows the risk and hazard decision-making process and management measures for the inhalation and ingestion of cadmium, PCBs, dioxins, and furans in surface soil by important fossorial vertebrates. To prevent important species from residing in areas associated with a hazard index greater than 1 for the inhalation/ingestion of these contaminants in surface soil, risk and hazard management measures will be implemented:

1. Sampling surface soil at least every five years or after significant remediation activities to determine exposure concentrations in the Building 834 and Building 850 areas (Figures 6-9 and 6-10, respectively). Sampling at Building 850 will be coordinated with the sampling planned for the human health risk management process described in Section 6.1.4. Soil sampling for PCBs, dioxins, and furans in the Building 854 area is also planned.

2. Integrating concentration data into hazard index calculations to determine current hazard posed by cadmium, PCBs, dioxins, or furans in surface soil.

3. Conducting surveys for the presence of important burrowing species semiannual in areas associated with hazard indices greater than 1.
4. If the presence of important species is confirmed, notifying appropriate resource agencies and determining actual exposure through additional chemical analysis and species monitoring.
5. Developing an appropriate response plan if actual exposure is determined to be significant.

Surface soil samples will be collected every five years or after significant remediation activities in areas containing cadmium, PCBs, dioxins, or furans to evaluate exposure conditions. The survey areas were selected based on the results of previous surface soil sampling, summarized on Figures 6-9 (Building 834) and 6-10 (Building 850). Tables 6-8 and 6-9 outline the preliminary sampling and analysis plans for Buildings 834 and 850, respectively. More specific and detailed sampling plans will be prepared prior to sampling. Sampling will be conducted using LLNL SOP 1.12 for surface soil (Dibley and Depue 2002).

The number of samples collected will initially be based on the sampling density previously used for PCBs in surface soil at Building 850 (Taffet et al., 1996), as shown on Figure 6-10. A minimum of 40 samples will be collected. Additional samples may be collected depending upon results. Sampling locations will be located uniformly through the survey areas, focusing on areas with burrow activity. Semi-quantitative immunoassay field kits will be used to obtain initial PCB concentrations, with no less than 10% of the collected samples analyzed in a certified laboratory using U.S. EPA Method 8082. A subset of the samples will also be analyzed for dioxins and furans using U.S. EPA Method 8290.

Using a similar sampling density at Building 834, a minimum of 20 samples will be collected and analyzed for cadmium. Only two surface soil samples have been previously collected and analyzed for this metal (Figure 6-9). Cadmium was not reported in one of the samples (detection limit 0.1 mg/kg) but was detected in the second sample at 16.0 mg/kg. Cadmium hazard calculated in the baseline risk assessment for the Building 834 area was due to this single analysis.

Results from the soil sampling will be used to calculate hazard indices for important species, using the kit fox as a representative species. Should other species important at the individual level be identified during the surveys, exposure models will be developed for each species. The basic ecological exposure model used in the baseline risk assessment will be used and modified as necessary to incorporate new information available since the time the exposure model was developed in 1992. Table 6-6 shows the exposure assumptions to be used in the model for kit fox. Consistent with the baseline risk assessment, the inhalation and oral pathways will be combined and compared to a single oral TRV. As described in Section 6.2.1, this will be performed by assuming 50% of the contaminant exposure through inhalation is retained. The exposure for each individual sampling point as well as an overall surface soil exposure will be calculated using the 95% UCL as outlined in HERD (1999).

The resultant exposures will then be compared to the TRVs listed in Table 6-7. Engineering Field Activity West (1997), as referenced in HERD (1999), developed the selected TRVs for cadmium and PCBs. For dioxin, the chronic NOAEL reported by Murray et al. (1978) as referenced in Sample et al. (1996) was selected. For cadmium, PCBs, and dioxin, hazard indices have been previously calculated only for cadmium and are reported in the baseline risk assessment. The cadmium TRV selected for use in the baseline risk assessment was from a study by Wills et al. (1981). Sample et al. (1996) found that cadmium benchmarks based on the results of Wills et al. (1981) resulted in a NOAEL and lowest-observed-adverse-effect-level (LOAEL) that were much lower than those reported in other studies. When the benchmarks developed from Wills et al. (1981) were used in risk assessments performed at Oak Ridge National Laboratory, the results indicated that cadmium toxicity could be expected at uncontaminated background locations. Because exposures at uncontaminated background locations are assumed to be non-hazardous, the results of Wills et al. (1981) were considered too conservative and inappropriate for deriving benchmarks. Two other studies (Machemer and Lorke, 1981; Sutou et al., 1980) were considered more suitable. These studies considered multiple dose levels, identified experimental cadmium NOAELs and LOAELs, and the benchmark concentrations exceeded background. Of the two studies, the lowest NOAEL (1.0 mg/kg•d) was reported by Sutou et al. (1980). This value is within the range of TRV values listed in Engineering Field Activity West (1997). Thus, the lower value from Engineering Field Activity West (1997), while still conservative, should result in a more realistic hazard evaluation.

The PCB Arochlor 1254 will be used as the indicator for PCBs and 2,3,7-8 tetrachloro-dibenzodioxin (TCDD) as the indicator for dioxins and furans. The TRVs for these chemicals are listed in Table 6-7. For dioxins and furans, the toxicity equivalent method of van den Berg et al. (1998) will be used to estimate toxicity of all congeners based on the equivalent toxicity of the 2,3,7-8 tetrachloro-dibenzodioxin dioxin congener. TRVs will be continually reviewed and revised as necessary as more data become available.

In areas where there is continued hazard, as indicated by a hazard index greater than 1, surveys will be conducted to identify the presence of important species as described in Section 6.2.1. Should the actual exposure be significant, a response plan will be developed that could involve animal relocation or continued monitoring of animal movement and exposure conditions. If the actual exposure is not significant, the risk management process is complete for this species in the specific area. The remaining risk management process will be revised as appropriate.

6.2.3. Evaluating Changes in Contaminant and Ecological Conditions

To ensure changes in contaminant conditions do not threaten wildlife populations and vegetation communities, DOE will evaluate existing contaminant and ecological conditions at Site 300 every five years. The purpose of these evaluations is to determine if contaminant or ecological conditions have changed sufficiently to warrant re-evaluating the conclusions reached in the baseline ecological risk assessment. Figure 6-11 shows the risk management process to evaluate changes in contaminant conditions. Figure 6-12 shows the steps required to evaluate changes in ecological conditions at Site 300.

As shown in Figure 6-11, analytical data for ecologically relevant media (surface water and soil to a depth of 12 ft) will be examined for the presence of previously undetected contaminants. Consistent with the baseline risk assessment and Site-Wide Feasibility Study (Ferry et al., 1999), a frequency of 2% will be used to identify the presence of new contaminants. For any contaminant detected at a frequency greater than 2%, the literature will be reviewed to determine its ecological significance. Hazard indices will be calculated for any chemical that the literature suggests is ecologically significant. Chemicals with hazard indices greater than one will be added to the ecological risk and hazard management process. For those chemicals historically present at Site 300, maximum concentrations detected with the current five-year period will be compared to historical maxima. Hazard indices will be recalculated for contaminants whose current maxima exceed historical maxima by 50%.

Figure 6-12 outlines the process that will be used evaluate changes in ecological conditions at Site 300. All available ecological survey results for Site 300 obtained over the five-year period will be reviewed, noting the presence of any new important species. In the first year of the five-year period DOE will:

1. Conduct semiannual surveys in each of the areas listed in Table 6-2 to identify species in these areas.
2. Conduct deer and ground squirrel population studies to determine changes in population density.
3. Evaluate aerial photos taken over the five-year period and/or any new vegetation maps to determine gross changes in vegetation communities.

In consultation with the regulatory agencies, modifications to the ecological risk and hazard management process will be made as necessary after considering the results of the contaminant and ecological condition reviews.

7. Data Management Program

This section describes the systems used to manage environmental data collected during site characterization, remediation, and monitoring activities at Site 300.

7.1. Overview

The LLNL Environmental Restoration Division uses the EPDData database to serve Sample Planning and Chain-of-Custody Tracking (SPACT) needs. EPDData contains sample tracking, sample location, media, geological information, and analytical results. The database is maintained on a Sun Sparc 20 with OpenIngres relational database software.

The flow of data, both hard copy and electronic, follows a process that tracks information from the sampling plan through storage to archiving. The data management process includes chain-of-custody tracking, analytical result receipt, quality control procedures, data presentation, and electronic use of data in decision support tools, such as risk assessment and compliance monitoring. The use of this system promotes and provides a consistent data set of known quality. Quality assurance and quality control are performed uniformly on all data.

7.2. Structure and Flow

A sampling and analysis plan is developed prior to data collection to establish the sampling method, frequency, type, location, and requested analyses. Field logbooks and chain-of-custody forms confirm that the collection of the samples and the requested analyses are consistent with this plan. A unique document control number is assigned to each sample. A controlled system of field logbook labels permits electronic tracking of an environmental sample from field collection through receipt of the analytical result. The flow of data is managed using SPACT. The important fields in each SPACT record are the document control number, sample location, sampling date, analytical laboratory, analytical laboratory log number, and the analyses requested. SPACT also tracks invoice information. SPACT records are updated upon receipt of official printed analytical results and invoices. A data record is marked complete only when all analytical results have been received.

Analytical results are stored in separate, but correlated, relational database tables. These tables are accessed by the MONITOR application and contain fields identical to those in SPACT. Additional information is included for each analysis that describes the requester, project, sample media, sample type, units, error, detection limit, dilution factor, dates of extraction, analytical results, and comments. Data sources for these tables include geologic borehole logs, surveyor reports, and field and laboratory measurements. Types of data stored include descriptive sample information, such as coordinates, elevations, lithology, and screened intervals of monitoring wells, as well as measurements and analytical information, including physical and chemical parameters, media identification, and ground water elevation measurements.

Data verification and validation are achieved through a combination of methods. Computerized verifications check data for duplication, empty fields, and reported results that are inconsistent with reported detection limits. Data are also thoroughly checked manually before being formally added to the database. Electronically-delivered laboratory data are groomed by filling in empty fields and ensuring consistency in format. Random audits are conducted to compare electronically-delivered results against official printed results. Analytical results in the database are reviewed and validated by qualified LLNL Environmental Restoration Division chemists.

The database also stores all quality control data reported from the analytical laboratories for each batch of samples. These data include laboratory control standard recovery, matrix spike and matrix duplicate relative percent difference, duplicate relative percent difference, and method blank results. Chemists use these data to validate analytical results.

The Site 300 database also contains fields dedicated to internal quality control. These fields include flags indicating analytical result qualification and data quality level. The result qualifier flags show dilution factors greater than one, compound detection in method blanks, or other quality control information. Data quality levels can range from screening-level field analyses to U.S. EPA approved methods performed by a certified analytical laboratory.

8. Quality Assurance/Quality Control Program

A Quality Assurance Project Plan (QAPP) (Dibley, 1999) has been implemented for the Site 300 environmental restoration project that contains the framework and requirements for planning, performing, documenting, and verifying the quality of activities and data. The QAPP was prepared for CERCLA compliance and ensures that the precision, accuracy, completeness, and representativeness of project data are known and are of acceptable quality. The QAPP was prepared following U.S. EPA guidance and specifications (U.S. EPA, 1980; 1987; 1994a, b; 1997a) and approved by the regulatory agencies. The QAPP is used in conjunction with the

LLNL Environmental Restoration Division Standard Operating Procedures (SOPs), Site Safety Plans, workplans, Operations and Maintenance Manuals, and the LLNL Environmental Protection Department Quality Assurance Management Plan. SOPs have been established for all aspects of well drilling and logging, soil and water sampling, hydraulic testing, quality control procedures, and data management (Dibley and DePue, 2002). Current LLNL Environmental Restoration Division SOPs are listed in Table 8-1. All LLNL Environmental Restoration Division SOPs and revisions are submitted to the U.S. EPA for review and approval.

9. Reporting

To inform the regulatory agencies and other stakeholders of the status and progress of the environmental restoration activities described in this CMP/CP, DOE will regularly apprise the Remedial Project Managers of:

1. Project status.
2. Compliance issues.
3. Treatment facility status.
4. New contaminant releases.
5. Contaminant detection in guard wells.
6. Contaminant detection in the vadose zone or monitor wells at the Pit 2, 8, and 9 Landfills.

In addition, formal compliance monitoring reports will be submitted semiannually no later than the last day of the third month following the reporting period. The following elements will be included in the compliance monitoring reports, if appropriate:

Ground and Surface Water Monitoring Program

1. Data summary.
2. Analysis of contaminant distribution and concentration trends.
3. Modifications to sampling and analysis plans.
4. Identification of data gaps.
5. Evaluation of guard well selection, analytes, and sampling frequency (annual).
6. Isoconcentration maps (annual, but maps for some areas may be generated semiannually upon the request of the regulatory agencies).
7. Potentiometric surface elevation contour maps (annual, but maps for some areas may be generated semiannually upon the request of the regulatory agencies).

Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 8, and 9 Landfills

1. Data summary.
2. Analysis of contaminant detection and concentration trends.
3. Modifications to sampling and analysis plans.

4. Results of landfill inspections.
5. Results of subsidence monitoring (annual)
6. Description of any maintenance performed.
7. Potentiometric surface elevation contour maps (annual, but maps for some areas may be generated semiannually upon the request of the regulatory agencies).

Extraction and Treatment Facility Monitoring Program

1. Data summary.
2. Analysis of the progress of remediation.
3. Isoconcentration maps (annual, but maps for some areas may be generated semiannually upon the request of the regulatory agencies).
4. Potentiometric surface elevation contour maps (annual, but maps for some areas may be generated semiannually upon the request of the regulatory agencies).
5. Capture zone analyses (annual).
6. Contaminant mass removal data.
7. Flow volume measurements.
8. Treatment system influent/effluent concentration data.
9. Facility performance assessment.
10. Modifications to sampling and analysis plans.
11. Operations and maintenance issues.
12. Compliance summary.
13. Interruptions in operation and corrective measures taken.

Risk and Hazard Management Program

Human Health

Annual:

1. Data summary.
2. Results of annual modeling and risk estimation.
3. Results of building/site occupancy review.
4. Activities planned in response to the results of the risk estimation.

Following the surface soil sampling to be conducted at Buildings 850 and 854 (single occurrence):

1. Surface soil sampling data summary.
2. Comparison of soil sample concentrations to the PRGs.
3. Results of access and use conditions review.

4. Results of risk and hazard assessment (if contaminant concentrations exceed the PRGs and the area is occupied).
5. Activities planned in response to the results of the PRG comparison or risk assessment.

Ecological

Annual:

1. Burrow air sampling data summary.
2. Comparisons of burrow air to TRVs.
3. Results of semiannual surveys for important species.
4. Activities in response to the identification of any important species during surveys.

Following the surface soil sampling to be conducted at Buildings 834, 850, and 854 (single occurrence):

1. Surface soil sampling data summary.
2. Comparison of soil sample concentrations to TRVs.
3. Recommendations for modifications to ecological risk and hazard management.

Following five-year review of contaminant and ecological conditions:

1. Results of identification of new contaminants or significant increases in concentrations for existing contaminants.
2. Results of literature evaluation of any newly identified contaminants.
3. Results of any calculations or recalculation of ecological hazard for newly identified contaminants or existing contaminants exhibiting a significant increase in concentration.
4. Results of species surveys for all areas.
5. Results of review of ecological surveys conducted throughout Site 300 within the past five years.
6. Results of ground squirrel and deer population studies.
7. Result of evaluation of vegetation communities.
8. Recommendations for modifications to ecological risk and hazard management.

Data Management Program

1. Modifications to procedures.
2. New procedures.

Quality Assurance/Quality Control Program

1. Modifications to procedures.
2. New procedures.
3. Quality issues and corrective actions.

10. Contingency Plan

This Contingency Plan describes how DOE and the regulatory agencies plan to address foreseeable problems that may arise during the remediation and monitoring of contaminants conducted under the Interim ROD. It also describes the approaches for modifying Site 300 remediation systems as remediation progresses and as additional information is collected.

This Contingency Plan is designed to address routine, long-term contingencies and uncontrollable natural events (e.g., earthquakes) that could impact the effectiveness of the interim remedial actions. Numerous LLNL Health and Safety documents and Operational Safety Procedures identify physical hazards that could be associated with remediation activities and include controls for these hazards; they are not addressed in this Contingency Plan.

This Contingency Plan does not apply to the General Services Area operable unit because a separate plan has been completed for that area (Rueth et al., 1997). The Pit 3, 5, and 7 Landfills, collectively designated the Pit 7 Landfill Complex, are still being characterized and remedial options are being evaluated. These landfills will be addressed in a future, area-specific Remedial Investigation/Feasibility Study. After a remedy is selected, DOE will amend the Interim ROD and issue an addendum to this CMP/CP.

Potential contingencies are presented in Sections 10.1 (Technical Contingencies), 10.2 (Logistical Contingencies), and 10.3 (Regulatory Framework). Technical contingencies are related to the physical remediation of ground water, bedrock, and soil at the site. Logistical contingencies include funding and other personnel issues.

Table 10–1 summarizes the potential contingencies including the planned responses DOE may implement if cleanup does not proceed as planned. Human health and ecological risk and hazard contingencies and planned responses are incorporated into Section 6 of this CMP/CP.

Actions DOE may implement in response to the issues described in this Contingency Plan will be performed in consultation with the regulatory agencies. Significant modifications to this Contingency Plan will also be subject to concurrence by the regulatory agencies. The possible actions described to address contingencies do not constitute modifications to the selected interim remedies. Section 10.3 discusses the regulatory framework for considering and implementing changes to remedies selected in the Interim ROD.

10.1. Technical Contingencies

Potential technical contingencies that may arise during the remediation of soil, bedrock, and ground water at Site 300, and a discussion of uncontrollable events such as natural disasters, are presented in Sections 10.1.1 through 10.1.6. DOE's planned response is described with each issue.

10.1.1. Ground Water Remediation

As described in the Interim ROD, DOE is extracting (or planning to extract) ground water to remove contaminants in the High Explosives Process Area, Building 834, Building 854, and Building 832 Canyon areas. Monitored natural attenuation is the selected interim remedy for the

Building 850 and Pit 6 Landfill areas. Monitoring is the selected interim remedy for the Pit 2, 8, and 9 Landfills, and for the Building 801, 833, 845, and 851 areas.

Site characterization, hydraulic tests, and ground water modeling have been conducted to understand the Site 300 ground water flow system. However, there are uncertainties regarding the effectiveness of any ground water extraction and treatment system, as discussed below.

10.1.1.1. Hydraulic Control of Plumes

The effectiveness of the Site 300 ground water extraction and treatment facilities will be determined by measuring ground water elevations in extraction wells and surrounding monitor wells, and by measuring contaminant concentrations in ground water extracted from these wells. Ground water elevation contour maps showing the estimated hydraulic capture area of each extraction wellfield will be constructed. In conjunction with isoconcentration contour maps that show the distribution of contaminants in each hydrogeologic unit, the estimated capture areas will be used to determine whether the plumes are being successfully contained.

If ground water elevation contour maps and/or isoconcentration contour maps indicate insufficient plume hydraulic capture in a particular hydrogeologic unit, the flow rates of nearby extraction wells will be adjusted, if possible, to increase the overall hydraulic capture area and/or eliminate stagnation zones within the appropriate hydrogeologic units. If monitoring still indicates inadequate plume capture after extraction well flow rates have been adjusted, DOE may consider modifying the remedial system, possibly by expanding the extraction wellfield. DOE may also consider other remedial technologies, such as bioremediation, to address insufficient plume capture.

10.1.1.2. Increases in Contaminant Concentrations in Ground Water

Ground water chemistry data are inherently variable. Concentration fluctuations over time occur in response to:

- Climatic changes, such as variable precipitation and infiltration rates.
- Changes within the aquifer, including variable hydraulic gradients, water levels, sorption/desorption, and contaminant transport rates in response to ground water extraction.
- Changes in conditions unrelated to the site environment, such as minor variations inherent in analytical methods and laboratory procedures.

Therefore, not all fluctuations in contaminant concentration require extraction well/treatment facility modification.

DOE will continue to measure contaminant concentrations in Site 300 monitor and extraction wells throughout the cleanup. If ground water contaminant concentrations increase in a consistent and significant manner for reasons not attributable to remediation efforts (e.g., cyclic pumping), or natural aquifer or laboratory variables, modifications to the remedial action will be considered. If possible, extraction rates will be adjusted to obtain better hydraulic control of the contaminant plume(s). However, if adjusting the flow rate(s) does not effectively improve hydraulic control of the plume, DOE may modify the remedial systems (e.g., by increasing treatment facility capacity or expanding the extraction wellfield).

If contaminant concentrations increase in areas outside of active remediation, DOE may conduct additional field investigations, if warranted. Based on these investigations, the need for modifications to the remedial action will be evaluated. Section 10.3 describes the process to modify the Interim ROD and change the remedial strategy.

10.1.1.3. Impacts to Guard Wells

If a guard well were to become impacted by contaminants, DOE would confirm the results by resampling. If contaminants are confirmed, DOE will report the results to the regulatory agencies and develop a plan to evaluate whether the guard well should be replaced. Possible actions that DOE may take include:

- Designating an existing, appropriately completed downgradient well, if available, to replace the impacted well.
- Conducting additional field investigation to assess the distribution of contaminants in the area of the impacted guard well to site a new guard well downgradient of the plume margin.
- Conducting contaminant transport modeling to predict plume migration and assist with siting of an appropriate new guard well.

The decision to replace a guard well will be reviewed with the regulatory agencies prior to implementation.

10.1.1.4. Impacts to Water-Supply Aquifers

If monitoring detects significant additional impacts to water-supply aquifers from Site 300 contaminants, DOE will confirm the detections by resampling. If contaminants are confirmed, DOE will report the results to the regulatory agencies, evaluate the possible sources of the contamination, and develop a plan to address the contaminants. Possible actions include:

- Investigating the source(s) of the contaminants detected in the aquifer.
- Increasing the frequency and locations of monitoring.
- Conducting fate and transport modeling to assess the migration of the detected contaminants and estimate future concentrations.
- Assessing health and ecological risks.
- Installing additional wells to monitor the extent of contamination and/or begin ground water extraction to hydraulically control the contaminants.
- Installing or expanding systems to treat water extracted from the affected aquifer.
- Treating water at the point of use.

10.1.1.5. Monitored Natural Attenuation

Monitored natural attenuation is the remedy selected in the Interim ROD for tritium in ground water at the Building 850 area and for TCE and tritium in ground water at the Pit 6 Landfill. As discussed in U.S. EPA (1997b), the effectiveness of monitored natural attenuation should be evaluated by "trigger" criteria that, if exceeded, would signify unacceptable performance. These triggers include:

- Increasing contaminant concentrations in soil or ground water at specified locations.
- Large increases in contaminant concentrations in wells located near source areas indicating a new or renewed release.
- Detection of contaminants in wells located outside the original plume boundaries indicating renewed contaminant migration.
- Insufficient rate of contaminant concentration decrease to meet remediation objectives.
- Changes in land and/or ground water use that adversely affect the protectiveness of the monitored natural attenuation remedy.

If monitoring demonstrates that one or more of these triggers is activated, DOE will notify the regulatory agencies, assess the possible causes of the stable or increasing concentrations or plume migration, and recommend future actions.

The future actions may include sampling soil, bedrock, or ground water to search for an undiscovered source, removal of a source, and/or installing an active remediation system, such as ground water extraction and treatment, to hydraulically control and remediate affected ground water. Extraction and treatment in areas with tritium in ground water (e.g., the Pit 6 Landfill and Building 850) would likely be conducted in conjunction with reinjection of tritiated ground water since there is currently no economically feasible technology to treat tritium. DOE may apply new technologies that may become available in the future to effectively treat tritium. Ground water extraction and treatment may be considered for VOCs in the Pit 6 Landfill area if VOC concentrations do not continue to naturally attenuate.

10.1.1.6. Modeling

Modeling has been conducted in some areas of Site 300 to assist in selecting the interim remedies. However, uncertainties exist in all modeling results. When site-specific data indicate that the model assumptions are no longer valid, both the conceptual model and model calibrations will be updated. In addition, simulations may be conducted, as appropriate, to ensure that model results are representative of field observations (e.g., if actual capture areas and/or stagnation zones are significantly different than those estimated by modeling). If the updated model results suggest that changes to the remediation strategy are necessary, DOE will consider modifying the remedial action appropriately.

10.1.2. Vadose Zone Remediation

As discussed in the Interim ROD, DOE will use vapor extraction to remove soil vapor containing VOCs from unsaturated soil and bedrock (the vadose zone) in the Building 834, Building 854, and Building 832 Canyon areas. No further action was selected in the Interim ROD for vadose zone VOCs in the High Explosives Process Area, Building 801, and Building 851 areas.

In areas where active vadose zone VOC remediation will be conducted, extracted soil vapor will be treated at above ground treatment facilities unless new, cost-effective technologies are developed for *in situ* treatment. Data from ongoing field monitoring, as well as fate and transport modeling, trend analysis, mass balance, and/or other methods will be used to estimate when vadose zone remediation will be considered complete. Soil vapor system shutdown criteria are contained in the Interim Remedial Design document for the Building 834 operable unit (Gregory et al., 2002), and will be included in other Remedial Design documents where soil vapor extraction is part of the selected remedy.

As discussed in the Interim ROD, non-volatile contaminants in the vadose zone at Site 300 include tritium, depleted uranium, HMX, RDX, and nitrate. No further action was selected in the Interim ROD for these vadose zone contaminants in the High Explosives Process Area, Building 832 Canyon, Building 851, and Building 845 areas.

The following sections describe possible vadose zone remediation contingency issues.

10.1.2.1. Potential Impacts of Vadose Zone Contaminants of Concern on Ground Water

As described in the Interim ROD, soil vapor extraction will be conducted at the Building 834, Building 854, and Building 832 Canyon areas to remediate VOCs in the vadose zone and maximize VOC mass removal. To ensure that contaminants in the unsaturated zone will not adversely impact ground water beneath these areas, or in any other part of Site 300, including those with no further action or monitoring interim remedies, DOE will continue to monitor ground water as remediation progresses. In addition, VOC concentrations will be monitored at soil vapor extraction wells throughout vadose zone remediation. If ground water and/or soil vapor monitoring data indicate that a soil vapor extraction system is not effectively remediating volatile contaminants, the remedial system operation may be modified to increase the VOC mass removal rate and the extent of pressure influence, if possible. If monitoring data indicate that system operation modifications are not sufficiently effective, measures such as installing additional soil vapor or ground water extraction wells will be evaluated and implemented as appropriate.

If monitoring results indicate that the soil vapor/ground water remediation strategy for VOCs in the Building 834, Building 854, and Building 832 Canyon areas is not effective in reducing contaminant concentrations to levels protective of ground water, modifications to the remedial action will be evaluated.

If monitoring indicates that vadose zone contaminants may be impacting ground water in an area where vadose zone remediation is neither in progress nor planned, additional investigations will be considered. These additional investigations may include:

- Sampling soil, bedrock, soil vapor, and/or ground water.
- Performing fate and transport modeling.
- Conducting additional risk assessment.
- Considering new or additional institutional controls.

Ground water will be monitored locally for the non-volatile Site 300 vadose zone contaminants known or suspected to present a threat to ground water quality. If monitoring determines that such contaminants are unacceptably impacting ground water, DOE will notify the regulatory agencies, evaluate the impacts, and prepare a preliminary plan for addressing the impacts. Possible courses of action may include:

- Sampling soil and/or bedrock to determine the vertical and horizontal extent of the vadose zone contaminants.
- Additional soil/bedrock excavation and removal, if technically and economically feasible.
- Vadose zone and/or ground water fate and transport modeling.
- Evaluating any new *in situ* technologies that may be applicable to the contaminants and determining the feasibility of application at Site 300.
- Extraction and treatment to contain, remove, and remediate the contaminants in ground water.

10.1.2.2. Increases in VOC Concentrations in Soil Vapor

As with ground water chemistry data, soil vapor chemistry data are also inherently variable. Concentration fluctuations over time occur in response to:

- Climatic changes (variable precipitation and infiltration rates).
- Changes within the unsaturated zone (soil moisture content, water level changes, sorption/desorption).
- Changes in contaminant transport rates in response to soil vapor extraction.
- Changes in conditions unrelated to the site environment (minor variations inherent in analytical methods and laboratory procedures).

Therefore, not all fluctuations in soil vapor contaminant concentrations necessitate extraction well/treatment facility modification.

DOE will monitor VOC concentrations in soil vapor extraction wells. DOE will analyze trends and variability of contaminant concentrations in these wells. If the contaminant concentration in a soil vapor extraction well increases in a consistent and significant manner over time, the relationship between VOC concentration data, historical data trends, and factors that can affect VOC concentrations in soil vapor (e.g., climatic changes, changes within the unsaturated zone, cyclical pumping) will be evaluated. If appropriate, the sampling frequency will be modified. If increases in soil vapor VOC concentration are known to be associated with a planned remediation optimization effort, the soil vapor sampling frequency will not be altered.

If contaminant concentrations in the vadose zone soil/bedrock or soil vapor are increasing in a consistent and significant manner for reasons not attributable to remediation efforts or natural unsaturated zone or laboratory variables, the need for modifications to the remedial action will be considered. If possible, soil vapor extraction rates will be adjusted to obtain better removal of volatile contaminant mass from the unsaturated or dewatered zone. However, if adjusting the flow rate(s) does not effectively increase VOC mass removal, or if another technology must be used to remediate non-volatile contaminants of concern, DOE may consider modifying the remedial strategies, perhaps by increasing soil vapor extraction treatment facility capacity, expanding the soil vapor extraction wellfield, or testing and employing an alternate technology.

If vadose zone contaminant concentrations increase in areas outside of active remediation, DOE will consider additional field investigations. Based on these investigations, the need for modifications to the remedial actions will be evaluated.

Should future field measurements indicate that VOCs in unsaturated bedrock or sediments are migrating to ground water in areas other than the Building 834, Building 854, and Building 832 Canyon areas, a more detailed analysis of migration processes followed by implementation of the appropriate source remediation measures will be evaluated.

10.1.3. Surface Soil

No further action is the selected interim remedy for surface soil containing metals, HMX, and tritium in the Building 854 area, HMX at Building 832 Canyon, and RDX and metals in the Building 851 area.

The remediation plan for Building 850 includes excavating surface soil contaminated with PCBs, dioxins, and furans, and removing a nearby tritium-contaminated sand pile. As discussed in the Interim ROD, the soil excavation and sand pile removal are expected to be completed before the Final ROD is issued and are therefore the final remedies for these media. Cleanup standards for the surface soil and sand pile excavation and removal are specified in the Interim ROD. Sampling will be conducted after the soil and sand pile are removed to verify that the cleanup standards specified in the Interim ROD are achieved.

If, after the soil and sand pile are removed, soil sampling and/or subsequent risk assessment indicate that contaminant concentrations remain that present an unacceptable human health or ecological risk, DOE will notify the regulatory agencies and develop a response to reducing the health risk to acceptable levels. Appropriate actions may include additional soil removal and/or institutional controls.

10.1.4. New Sources, Releases, or Contaminants

As the Site 300 interim remedies are implemented and operated, evidence of new sources, new releases, and/or new contaminants may be identified by:

- Increasing contaminant concentrations in soil vapor or ground water.
- Appearance of new contaminants in surface soil, subsurface soil/bedrock, or ground water, or changes in regulatory standards for existing contaminants.
- High concentrations of contaminants in soil samples collected from boreholes or during construction activities.

If ground water contaminant concentrations increases are confirmed by resampling in an area with little or no previous characterization, DOE will assess the need to investigate for previously undetected sources. Most past releases have already been identified in the Site-Wide Remedial Investigation report (Webster-Scholten, 1994); hence, an extensive document review will likely not be needed. New contaminant sources from recent releases will be identified by notification from the LLNL department documenting the release. Following initial health and safety assessment by the LLNL Hazards Control Department, samples will be collected to delineate the lateral extent and depth of contamination and determine if the release is of sufficient magnitude to potentially affect ground water quality.

DOE will notify the regulatory agencies if monitoring and/or investigations indicate that a:

- Previously undetected contaminant source has impacted ground water;
- New release has occurred from an existing potential source, such as an onsite landfill; and/or
- New contaminant is present for which the remedies in the Interim ROD will not meet Remedial Action Objectives.

DOE will then evaluate the new data and develop plans to address the new source, release, or contaminants. Anticipated actions may include:

- Increased monitoring to identify potential source(s).
- Delineating contaminant distribution by field sampling.
- Source investigation and delineation.
- Ground water and/or vadose zone fate and transport modeling to assess potential impacts on ground water.
- Risk assessment to evaluate the potential impact to human health and the environment.
- Conducting source control or removal activities.
- Modifying existing extraction wellfields and/or treatment systems to capture and treat new contaminants.
- Installing and operating new extraction or monitor wells.

For potential contaminant release from existing landfills at Site 300 that could result from damage or degradation of the landfill surface, possible responses include:

- Assessing the damage and degree of contaminant exposure or migration.
- Repairing the damage or degradation.
- Removing released contaminants by soil vapor and/or ground water extraction.
- Implementing additional engineering controls if needed to prevent future exposure or mobilization of the landfill contents, such as diverting surface water.
- Installing an engineered landfill cover.
- Excavating landfill contents and relocating the material onsite or disposing offsite.

10.1.5. New Technologies

DOE is evaluating new and innovative technologies and remediation techniques for ground water and vadose zone cleanup. While many of these techniques and technologies may not be economically feasible, it is possible that a rapid and cost-effective remediation strategy will be developed that could potentially shorten cleanup time or reduce residual contaminant concentrations. These technologies may be employed at Site 300 if site conditions change, or if technology development and testing indicate a potential for cost-effective and expedited remediation.

10.1.6. Uncontrollable Events

Uncontrollable natural events may occur during the Site 300 cleanup that could disrupt monitoring or remedial activities, including wildfires, large magnitude earthquakes, floods, or severe atmospheric storm events. If significant damage occurs to treatment facilities or extraction wellfields, ground water and/or soil vapor remediation in some areas of Site 300 may temporarily cease. DOE will then evaluate the damage to the remedial infrastructure and estimate the time and funding needed to return to normal operation. Damaged infrastructure will be modified, replaced, or decommissioned.

10.2. Logistical Contingencies

Logistical contingencies include, but are not limited to, changes in personnel, funding, land/ground water use and demand, changes in building use, property transfer, and changes to LLNL mission and operation.

10.2.1. Personnel

As with any long-term project, personnel changes will occur during the Site 300 cleanup. Past personnel changes at DOE, LLNL, and regulatory agencies have been accommodated while minimizing adverse impact to the project. Remedial Project Managers and other knowledgeable staff will continue to assist new personnel to familiarize them with the project. This teamwork approach will be employed for any future personnel changes. New personnel can refer to the Interim ROD, Remedial Design Work Plan, the Site 300 Federal Facility Agreement, the Site 300 Administrative Record, and the Site 300 Standard Operating Procedures for information regarding the approved remediation plan and schedule.

Changes in LLNL subcontractors have been successfully implemented in the past, and LLNL procurement practices will continue to enable smooth transitions in the future. If DOE believes that an outgoing incumbent subcontractor can provide valuable knowledge to help ensure a smooth transition, LLNL will request a phase-in/phase-out period to allow the incumbent to work directly with the new subcontractor for an appropriate period of time.

10.2.2. Funding

DOE will take all necessary steps to request timely and sufficient funding to meet its obligations under the Interim ROD. The regulatory agencies will be notified of any potential budget constraints that may affect Site 300 milestones included in the Site 300 Federal Facility Agreement, the Remedial Design Work Plan, and other documents.

If the regulatory agencies mutually agree that budget reductions constitute *force majure* as outlined in Section 10 of the Federal Facility Agreement for LLNL Site 300 (U.S. DOE, 1992), or “good cause” pursuant to Federal Facility Agreement Section 9.2, milestone extensions may be granted. Interested community representatives will be provided an opportunity to provide input to this process.

Any revision of milestones will follow the priorities established for site remediation. The current order of priorities for Site 300 environmental restoration funding is:

1. Protecting worker health and safety.

2. Monitoring to ensure the remedies are effectively protecting human health and the environment.
3. Preventing offsite plume migration and remediating plumes that extend offsite.
4. Preventing further contamination, and/or conducting remediation of the water-supply aquifers.
5. Preventing further contamination, and/or conducting remediation of contamination in soil and ground water within the site boundary.

Tasks based on these priorities will be accomplished in an order established by DOE. Thus, if funding is less than projected, tasks will be performed in the same relative order as funding allows, but over a longer period of time. The community will be informed of significant actions and provided an opportunity to remain involved throughout this process.

10.2.3. Land/Ground Water Use and Demand

If routine monitoring indicates that others may be using contaminated ground water originating from Site 300, or if ground water use by others is adversely affecting remediation, DOE will: (1) notify the U.S. EPA, RWQCB, and DTSC, (2) acquire all available information on location, magnitude, and duration of the private ground water use, and (3) develop a mitigation plan, if necessary. Possible mitigations include altering the remedial pumping scheme, negotiating with land owners, seeking regulatory intervention, providing alternative water supply, and installing point-of-use treatment at existing private water-supply wells, if necessary.

If DOE becomes aware of plans for local property owners to install a well or wells downgradient of a contaminant plume that could adversely impact the Site 300 cleanup, DOE will: (1) notify the U.S. EPA, RWQCB, and DTSC, (2) notify the San Joaquin County Public Health Services Environmental Health Division, the agency responsible for issuing the well permit, (3) evaluate the potential impacts on the contaminant plume, and (4) develop a mitigation plan, if necessary. Possible mitigations may include negotiating with the land owner to relocate the well to a more favorable location, restricting use of the new well, or providing an alternate supply of water to the land owner.

As discussed in Section 2.6.6 of the Interim ROD, a number of water-supply wells are in use near Site 300. In the event that Site 300 contaminants of concern are confirmed in private water-supply wells, DOE will report the detections to the regulatory agencies and develop an action plan, if necessary, for discussion with the well owners and regulatory agencies. Possible actions include providing alternate water supplies (e.g., bottled water, using alternative or new wells) or treatment at point-of-use.

Future onsite development may restrict available locations for piezometers, monitor wells, and extraction wells. Current onsite DOE planning procedures require thorough environmental review and sampling prior to any significant construction activities that mitigates the potential for inadvertent development at critical remedial locations. Designating portions of Site 300 or adjacent lands as critical habitat could restrict the locations of piezometers, extraction wells, monitor wells, and treatment facilities. If critical habitat designation(s) limit optimal siting of remediation infrastructure, DOE will discuss options with the appropriate regulatory agencies, including the U.S. Department of Fish and Game.

Offsite land restrictions are expected to have less impact on remedial activities because the highest contaminant concentrations detected in ground water, and therefore the extraction well locations, are all onsite.

10.2.3.1. Changes in Building Access Restrictions or Use

Site 300 management must approve any changes in Site 300 building use or access restrictions and will notify LLNL Hazards Control and the Environmental Restoration Division of any proposed changes to building occupancy or land use where such changes may result in exposure and unacceptable risk. The LLNL Environmental Restoration Division will work with the program implementing the change to install engineering controls or other measures to prevent worker exposure to contaminants, as discussed in Sections 6.1.6 and 6.1.7.

10.2.3.2. Property Transfer

As discussed in Section 2.6.2 of the Interim ROD, the Site 300 Federal Facility Agreement (U.S. DOE, 1992) contains provisions that would apply if ownership of some or all of Site 300 were transferred from DOE. Sections 28.1 and 28.2 of the Site 300 Federal Facility Agreement state that DOE will retain its liability in accordance with CERCLA Section 120(h), 42 U.S.C. S9620(h) in the event of a change in ownership or possession of Site 300. In summary, the Site 300 Federal Facility Agreement stipulates that:

- Prior to transfer of ownership, DOE will give written notice of release of hazardous substances, or property necessary for the performance of the remedial action, to the recipient of the real property interest.
- At least 30 days prior to any transfer subject to Section 120(h) of CERCLA, DOE must notify the Federal Facility Agreement signatories of any transfer, and the provisions made for any additional remedial actions, if required.
- DOE shall take appropriate actions to ensure that all remediation activities will not be impeded or impaired by any transfer of real property. Such actions may include but are not limited to providing the following in any deed, lease, or other instrument for the transaction:
  - Notification of the existence of the Federal Facility Agreement.
  - The parties to the Federal Facility Agreement shall have rights of access to the property.
  - There shall be provisions for complying with all health and safety plans approved in accordance with the Federal Facility Agreement, and for operation of any response or remedial actions on the property such as wells and treatment facilities.
  - Subsequent transactions for the property shall include access rights, compliance with health and safety plans, and operation of remedial actions.
  - Copies of any property transaction documents must be sent by certified mail within 14 days of the effective date of the transaction.

Since LLNL's mission and operation are not expected to change in the foreseeable future (Section 10.2.5), no significant change in the use of Site 300 is expected. If any land use changes should occur for some or all of the site, the provisions of the Federal Facility Agreement and the Interim ROD will apply.

10.2.4. LLNL Mission and Operation

LLNL's current and future mission and operation will include CERCLA compliance and cleanup implementation as specified in the Site 300 Federal Facility Agreement and the Interim ROD. In addition, DOE is committed to honoring its responsibilities for environmental restoration independent of any possible future decisions regarding the continued existence of LLNL. DOE is expected to continue to operate Site 300 for the foreseeable future.

10.3. Regulatory Framework

Over the course of the Site 300 cleanup, changes to the selected remedies may be needed to achieve the Remedial Action Objectives specified in the Interim ROD. A modification to the Interim ROD may be necessary to accommodate such changes. The lead agency (DOE), with the concurrence of the regulatory agencies, will determine if the proposed change is: (1) non-significant or minor, (2) significant, or (3) fundamental, as described in U.S. EPA guidance (U.S. EPA, 1999b).

A non-significant change generally reflects modifications to optimize performance and minimize cost. Non-significant changes are documented in the Administrative Record.

A significant change is generally a change to a remedy component that does not fundamentally alter the overall remedial approach (e.g., adjustments to cleanup standards). For a significant change, an Explanation of Significant Differences will be prepared and a brief description and notice of availability of the Explanation of Significant Differences will be published in a major local newspaper. The Explanation of Significant Differences will be available to the public through the Administrative Record and information repository.

A fundamental change requires reconsidering the remedial approach selected in the Interim ROD. For a fundamental change, the required public participation and documentation procedures include preparing a revised Proposed Plan, providing a public comment period, and preparing a Responsiveness Summary before implementing the change.

The regulatory agencies and DOE will discuss community recommendations regarding Site 300 cleanup. The regulatory agencies and DOE will evaluate community suggestions based on cost and benefit and will report their findings publicly. If regulations change, DOE and the regulatory agencies will determine how these changes may affect cleanup. The community will be informed of any regulatory changes that affect the Site 300 cleanup.

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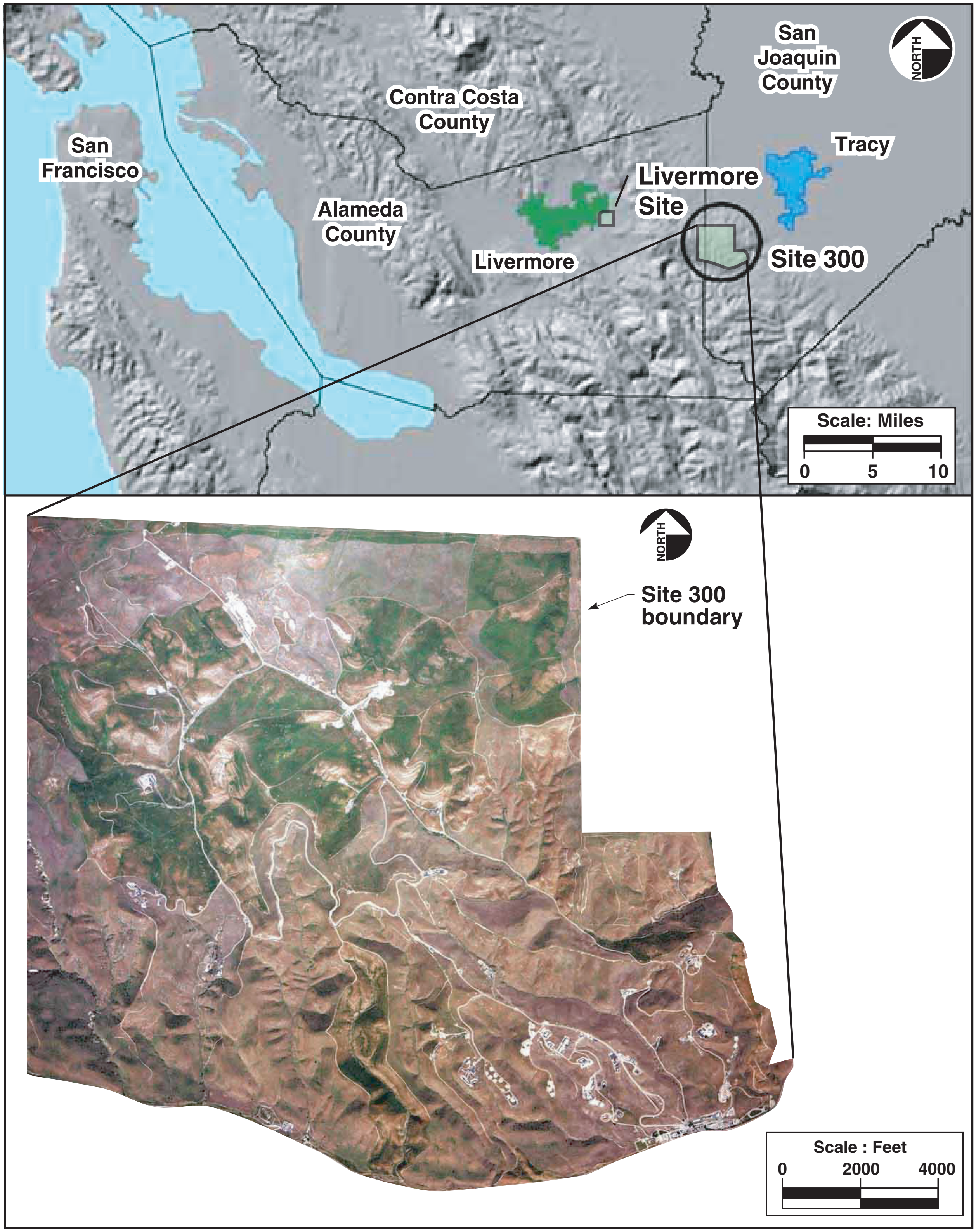
Figures



ERD-S3R-02-0018

Figure 1-1. Location of LLNL Site 300.

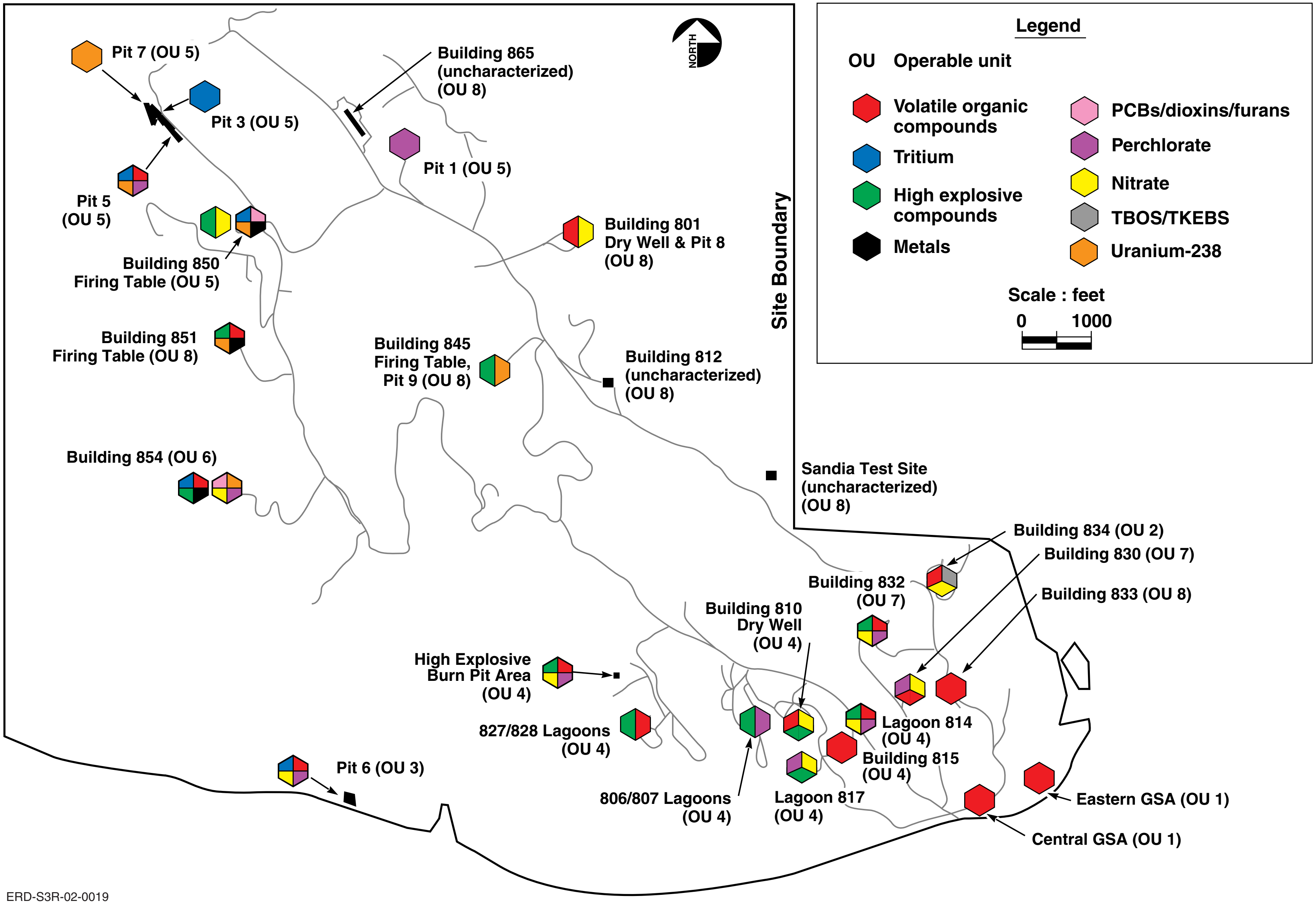


Figure 1-2. Site 300 contaminant release sites.

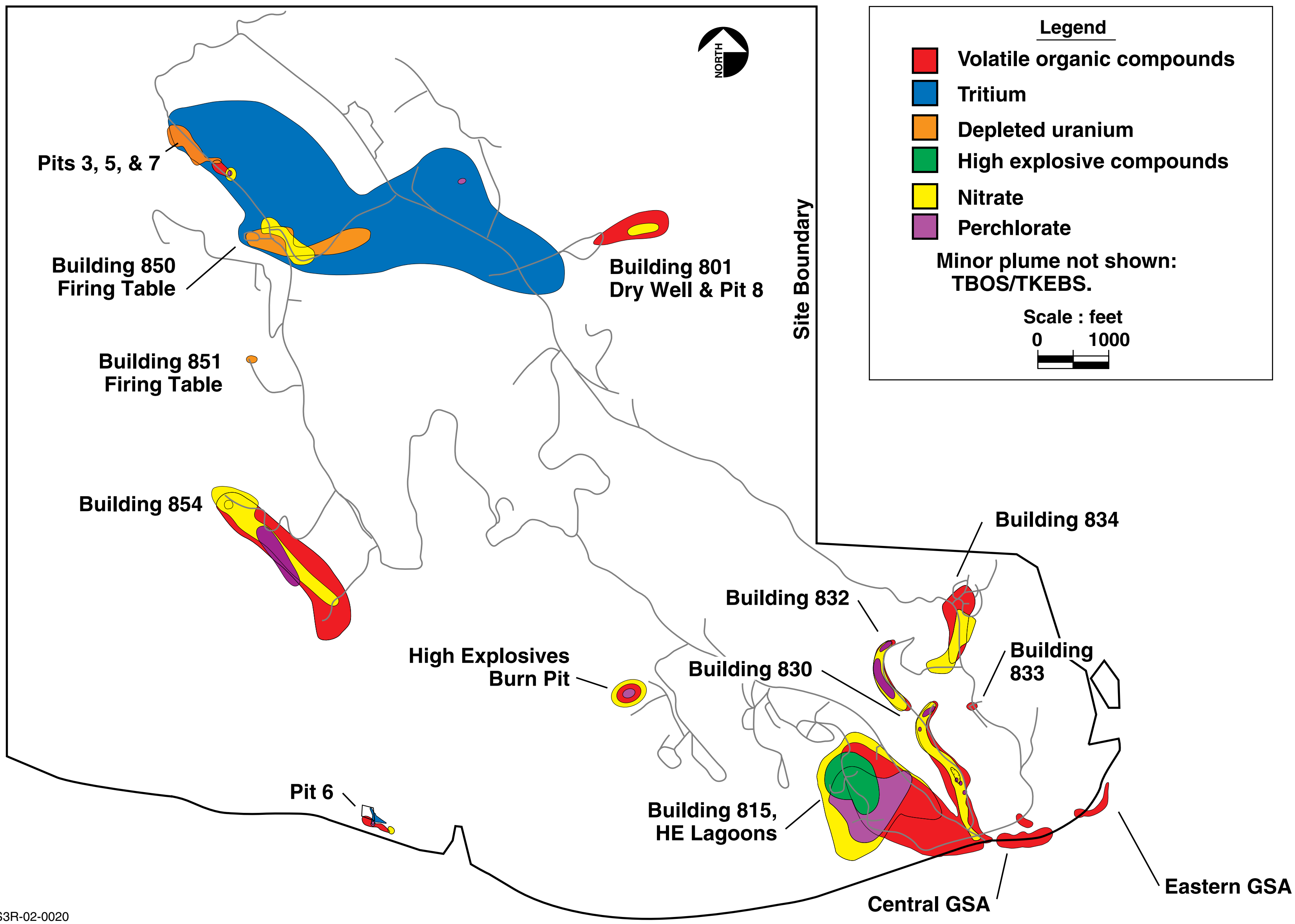


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Figure 1-3. Site 300 ground water contaminant plumes.

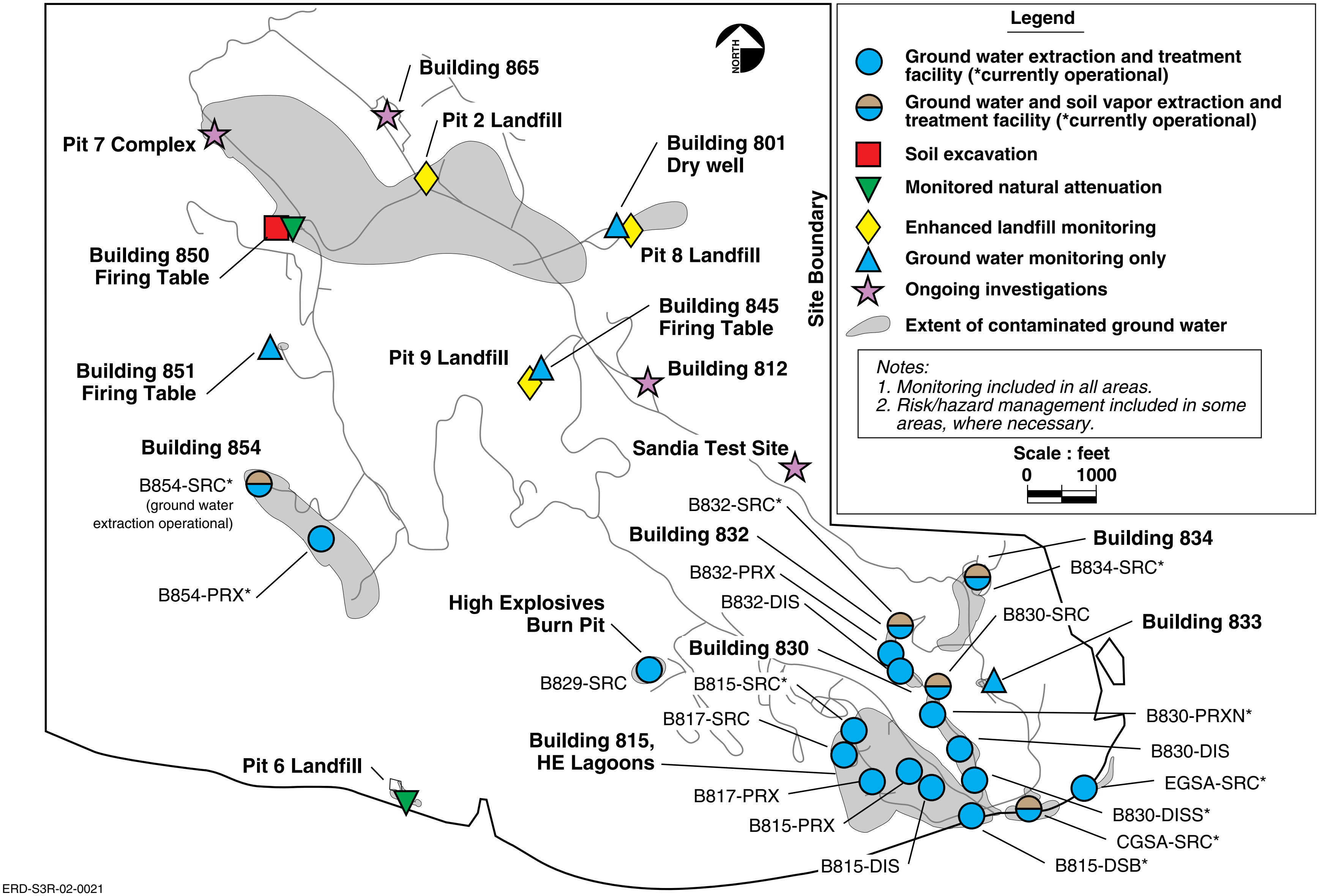

Figure 1-4. Locations of environmental restoration activities at Site 300.

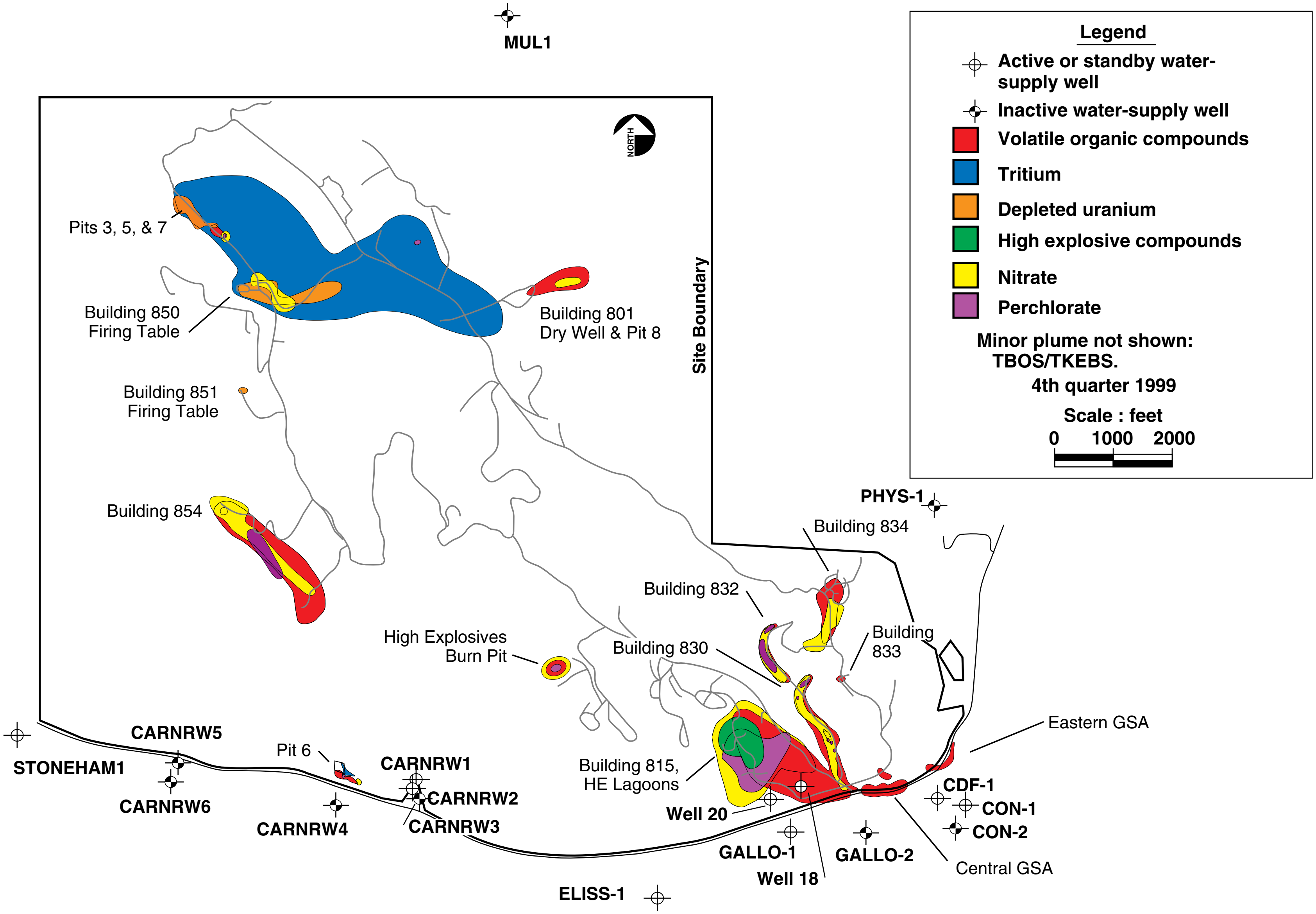

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Figure 3-1. Locations of water-supply wells.

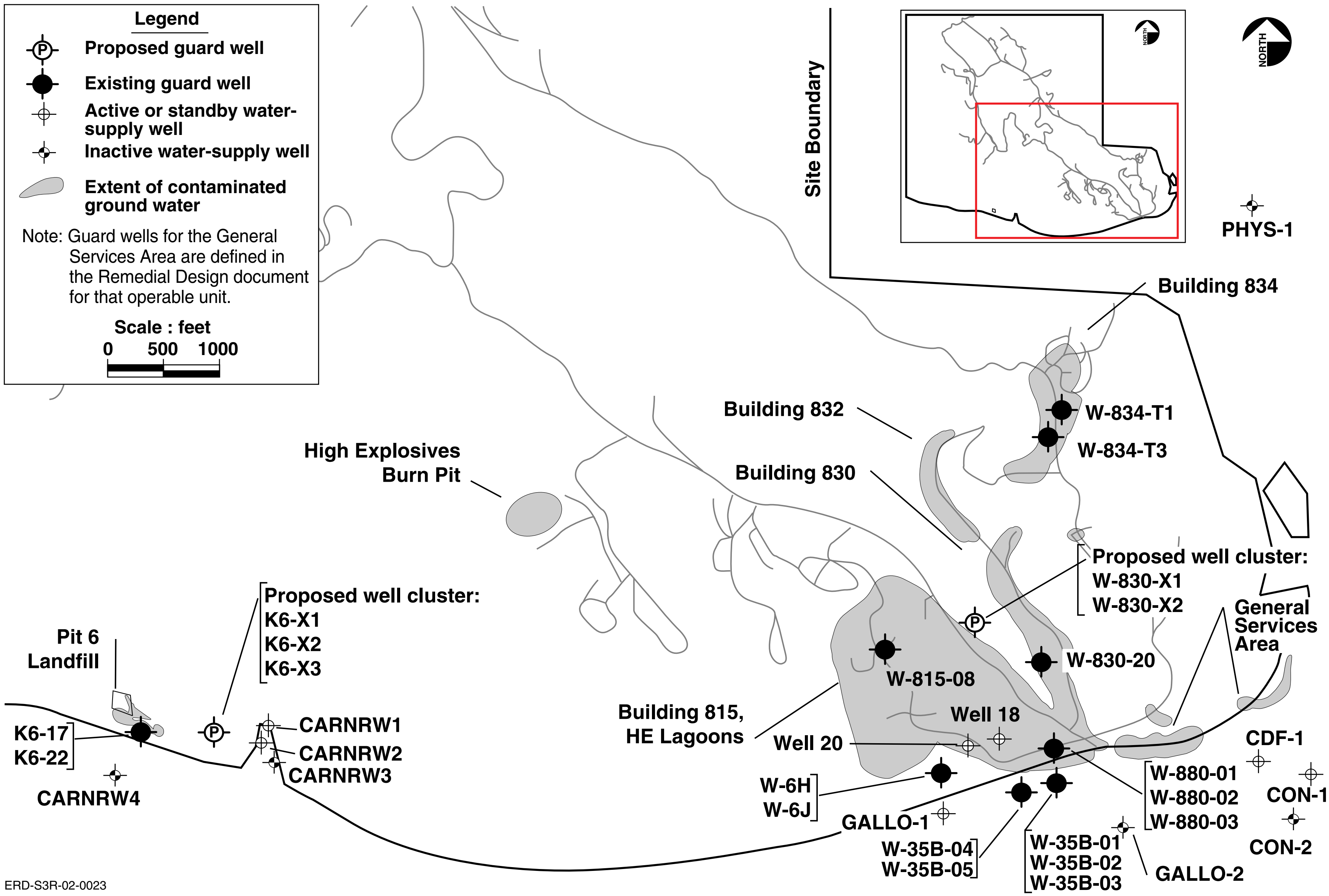

Figure 3-2. Preliminary locations of guard wells.

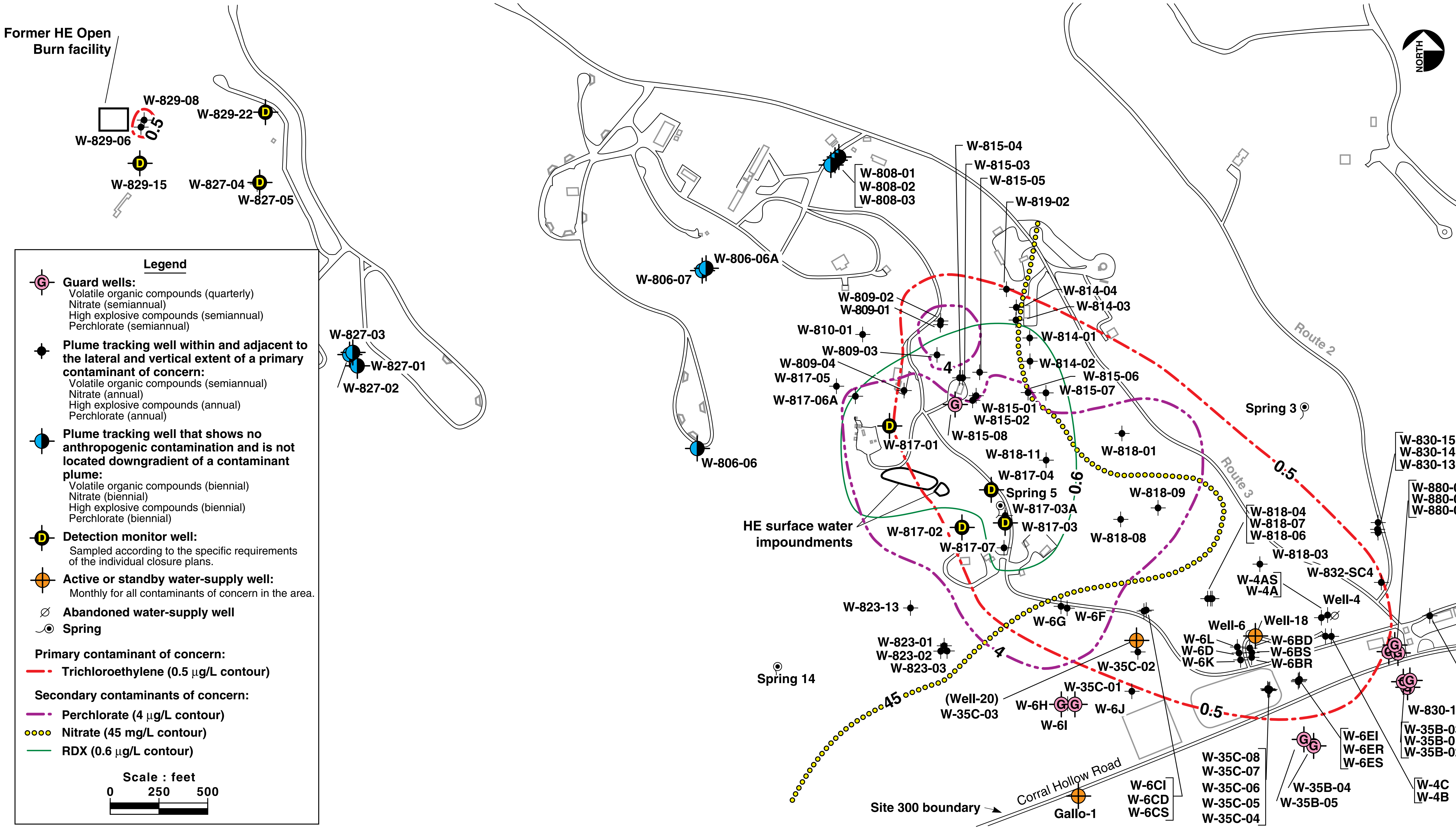

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Figure 3-3. Example of ground water sampling frequency and analytes in the High Explosives Process Area.

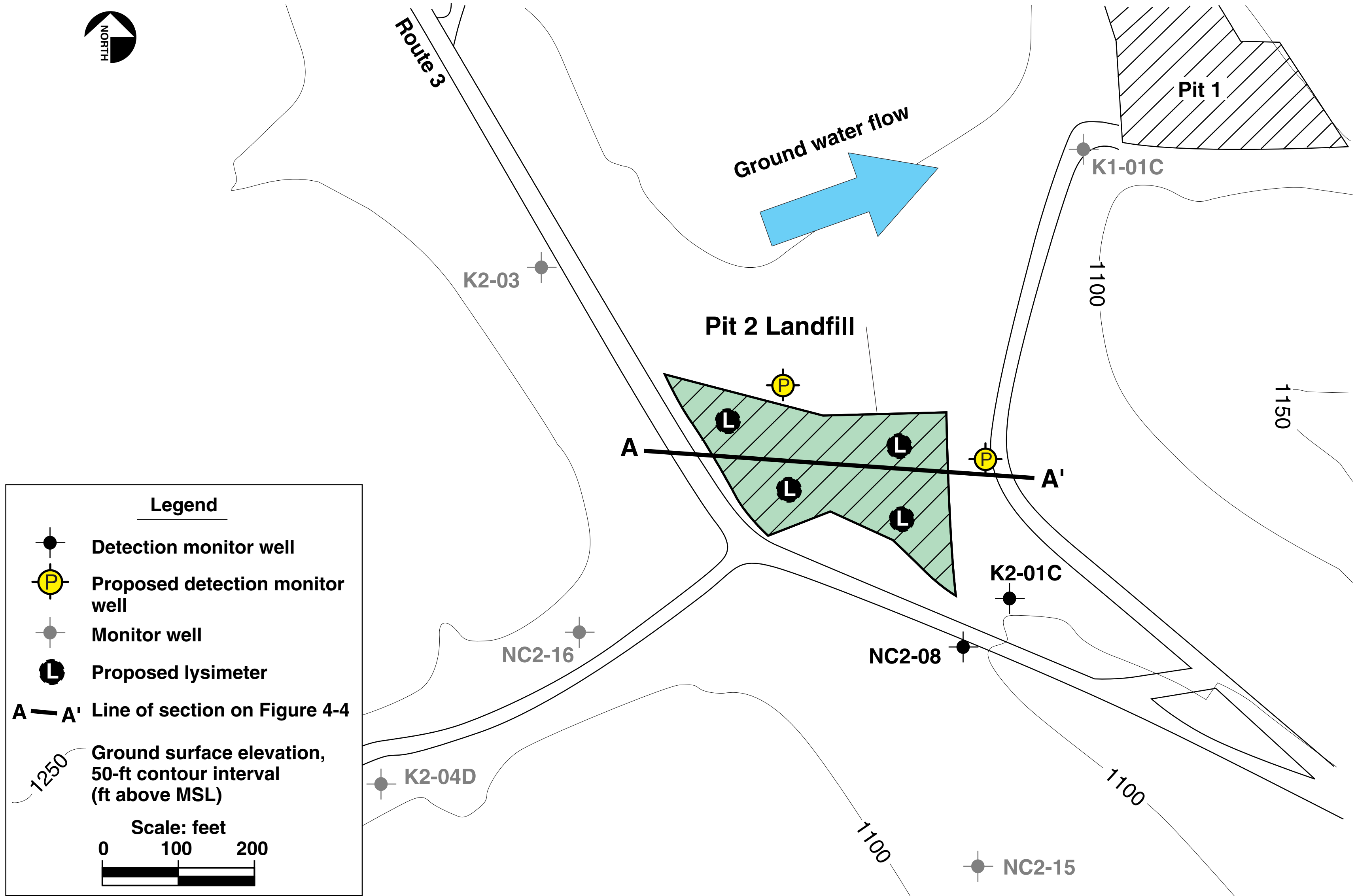

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Figure 4-1. Preliminary locations of detection monitor wells and lysimeters at the Pit 2 Landfill.

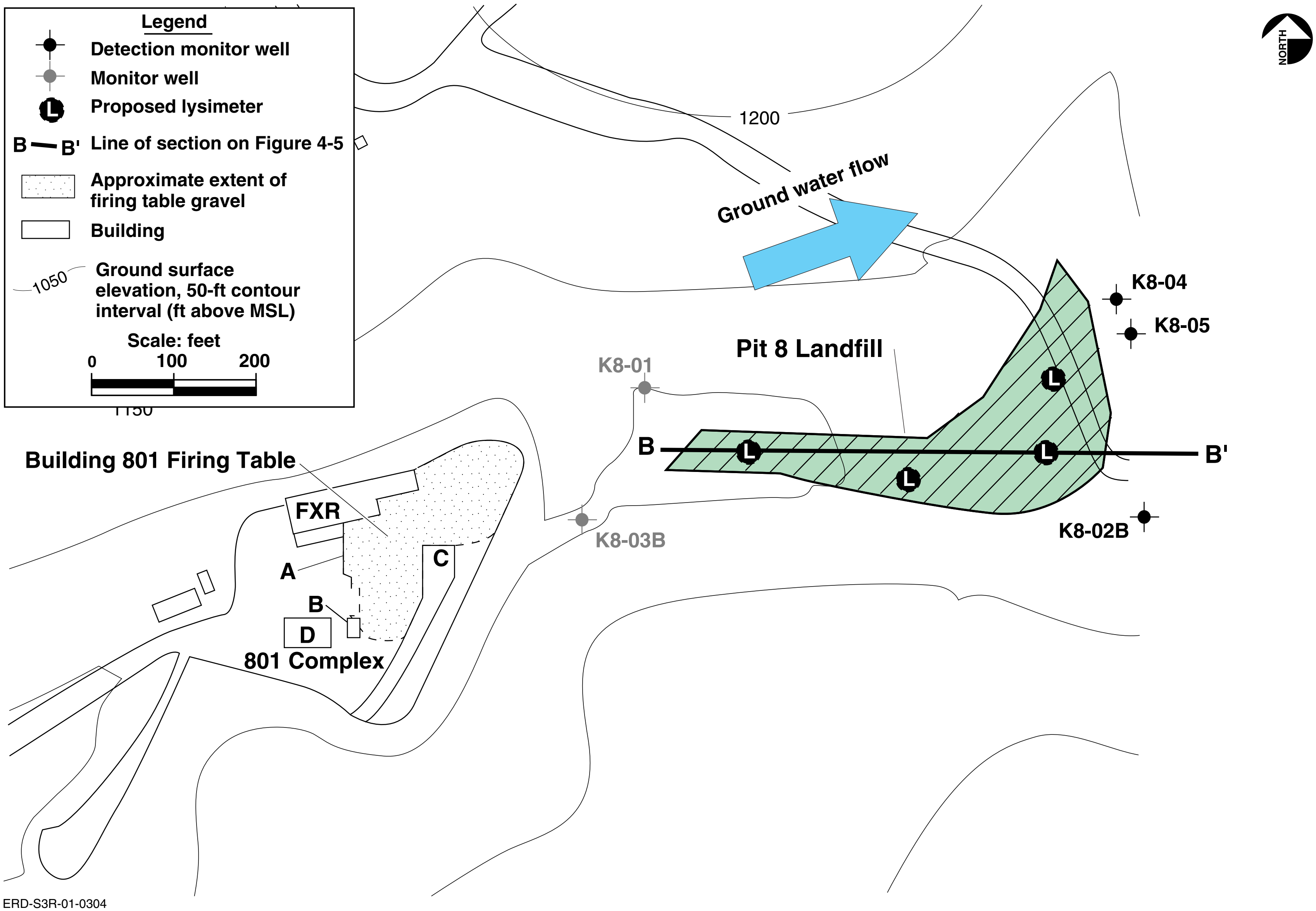

Figure 4-2. Preliminary locations of detection monitor wells and lysimeters at the Pit 8 Landfill.

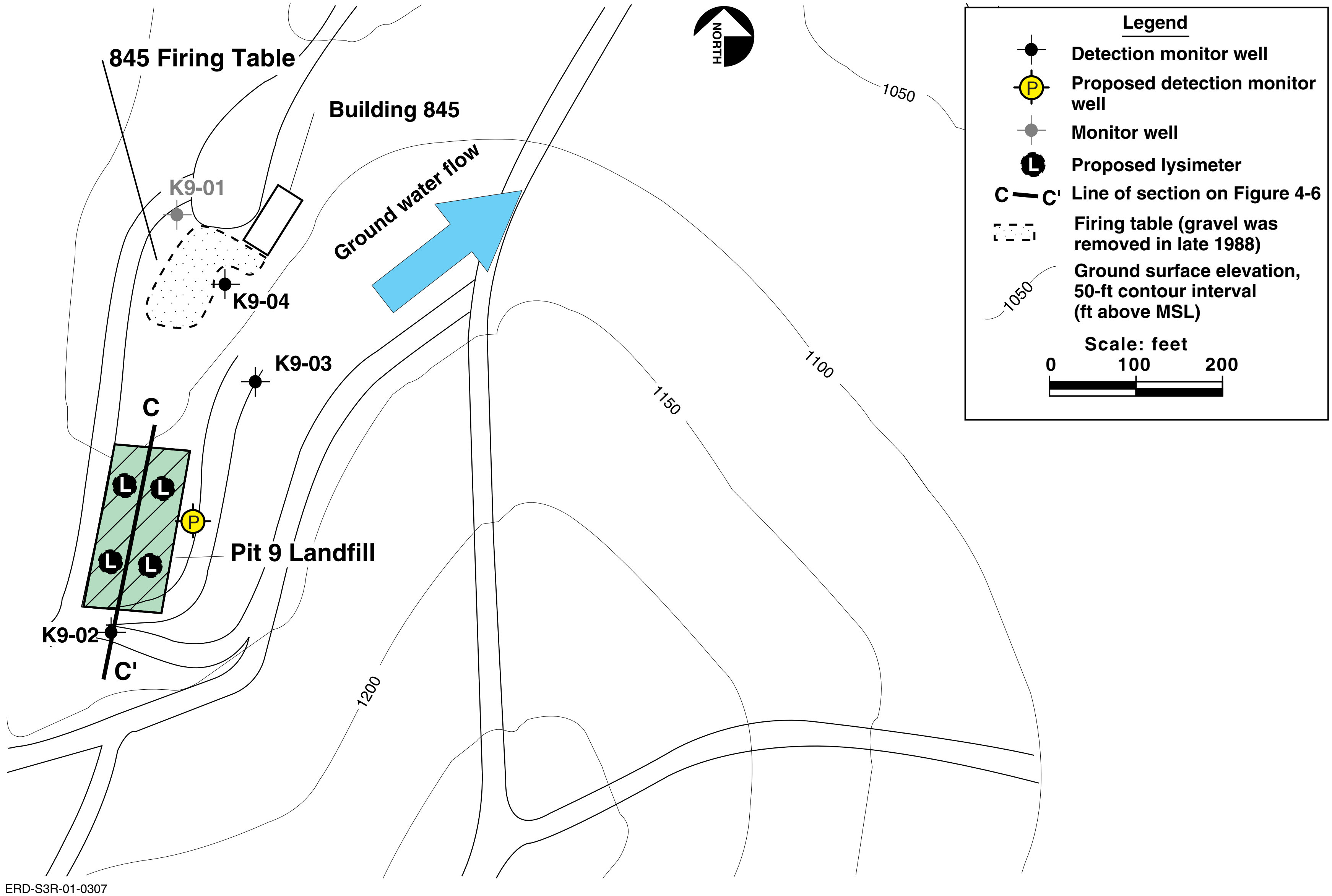

Figure 4-3. Preliminary locations of detection monitor wells and lysimeters at the Pit 9 Landfill.

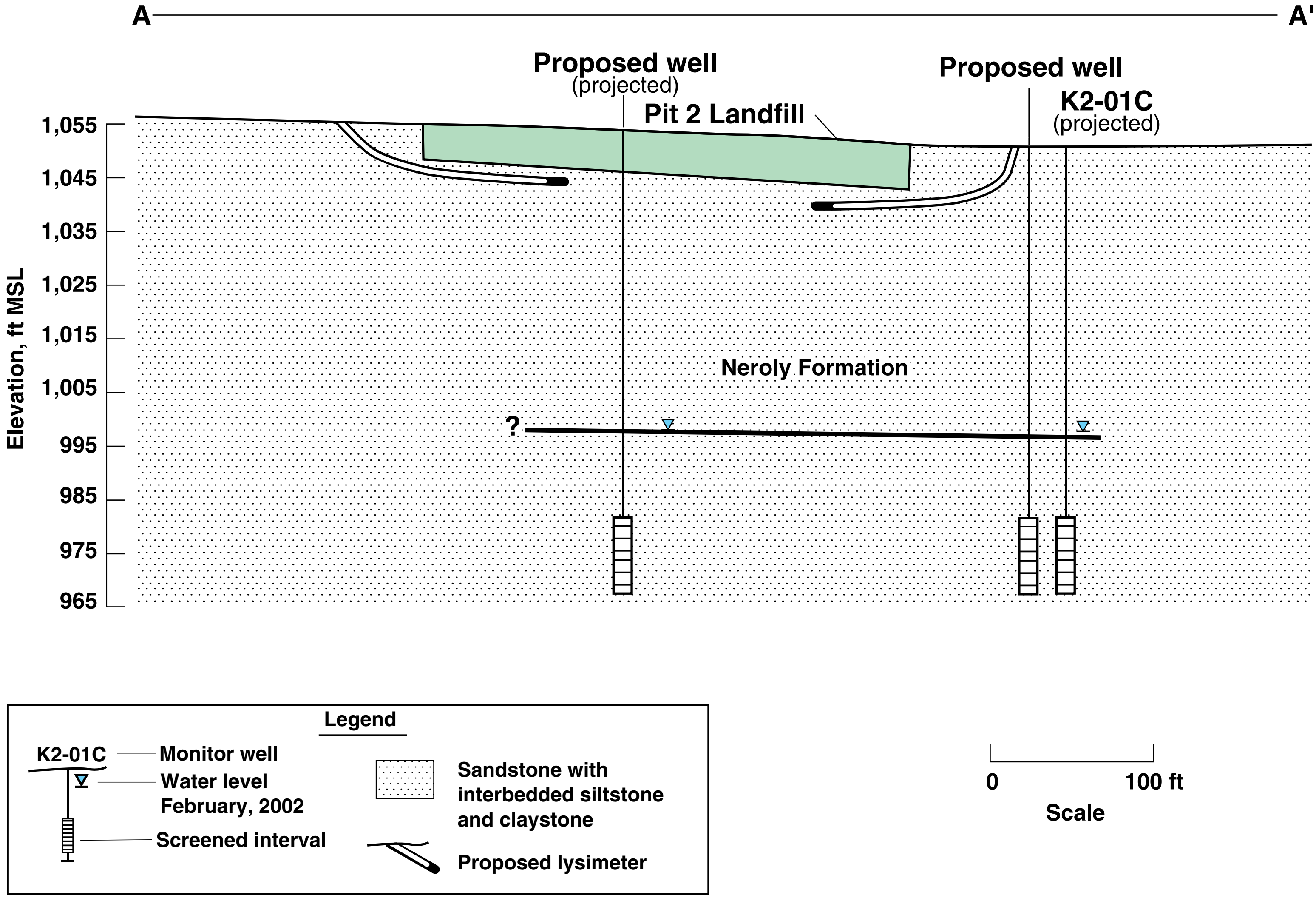

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Figure 4-4. Cross-section of the Pit 2 Landfill area.

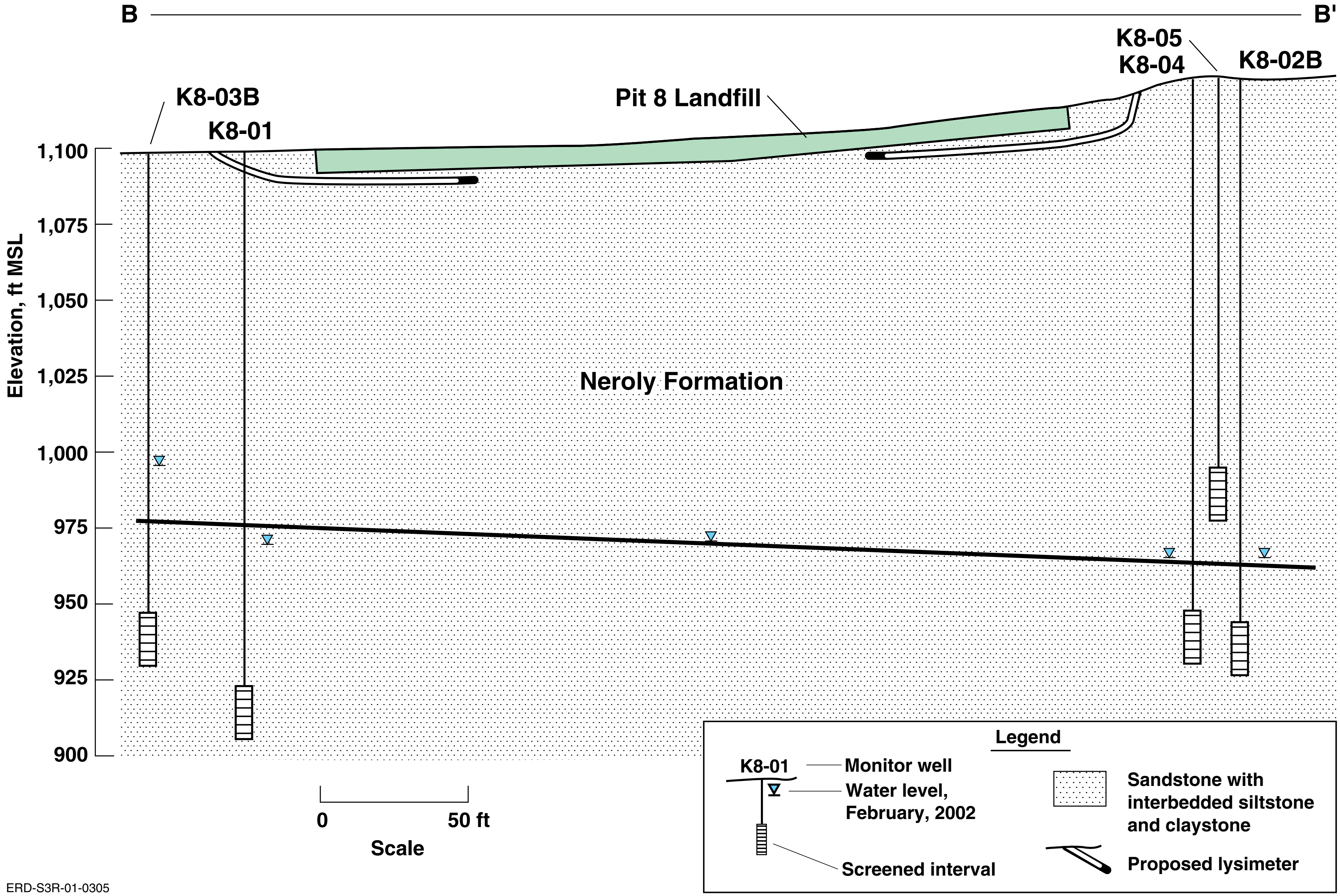

Figure 4-5. Cross-section of the Pit 8 Landfill area.

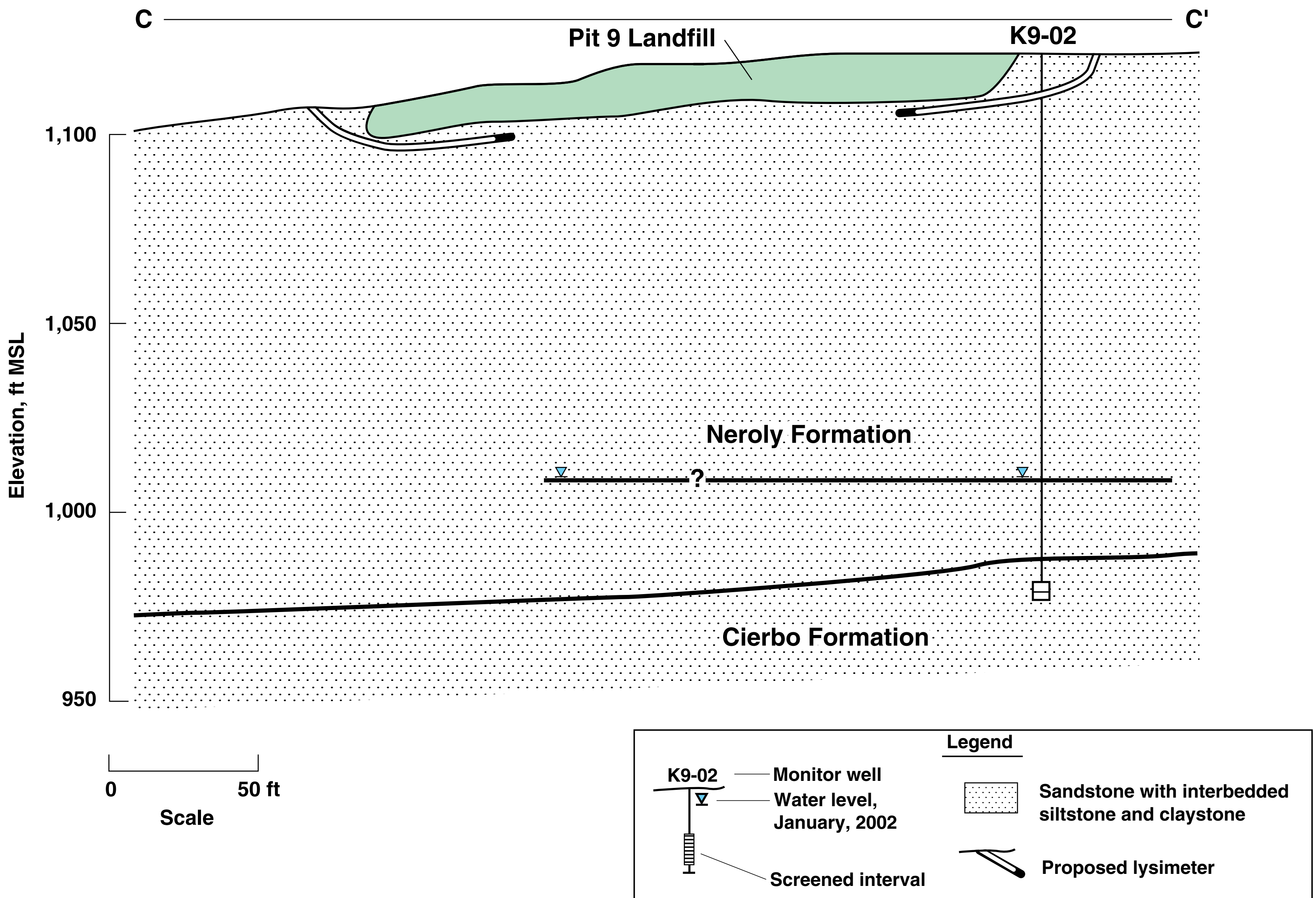

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Figure 4-6. Cross-section of the Pit 9 Landfill area.

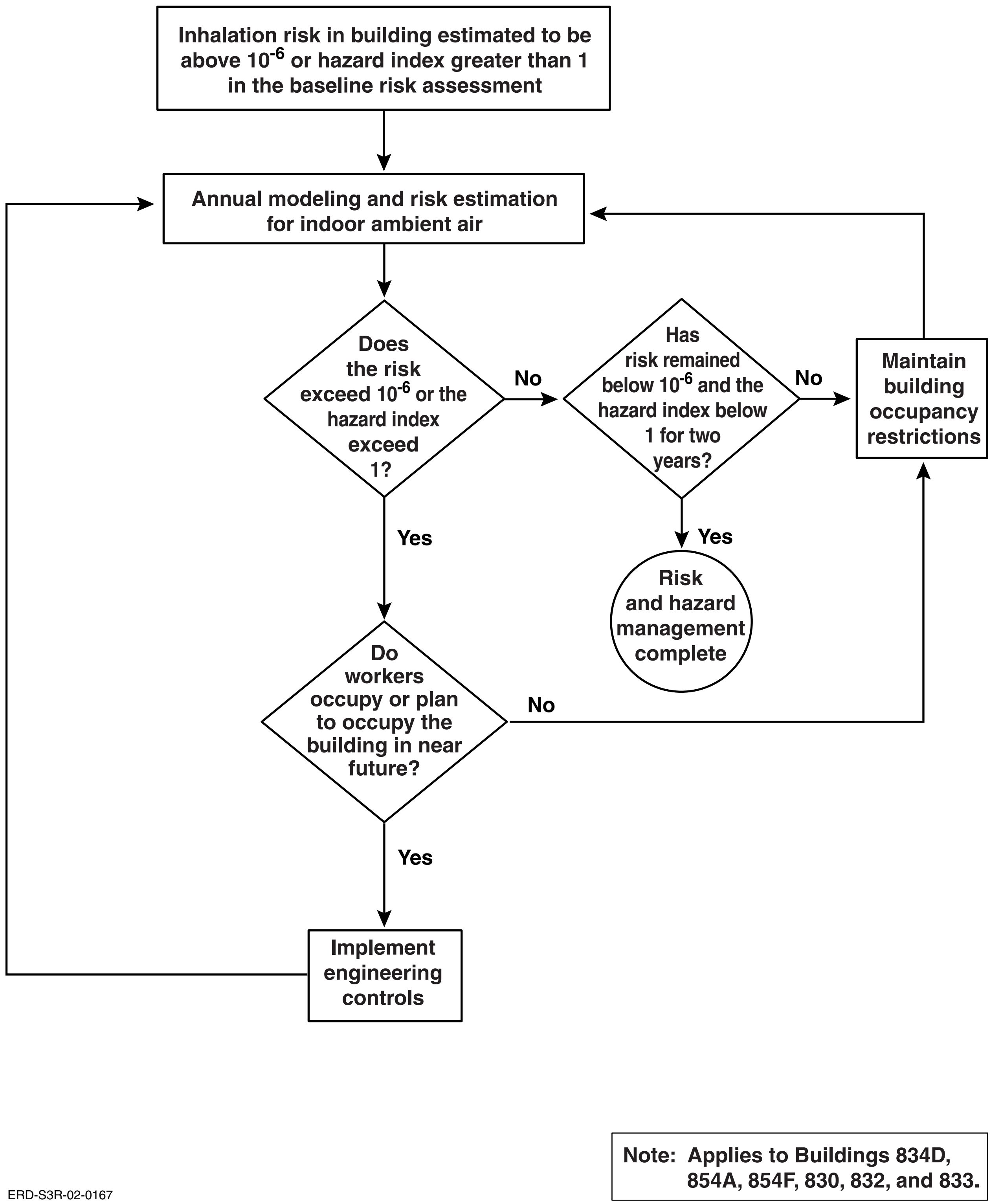

Figure 6-1. Indoor air inhalation risk management process.

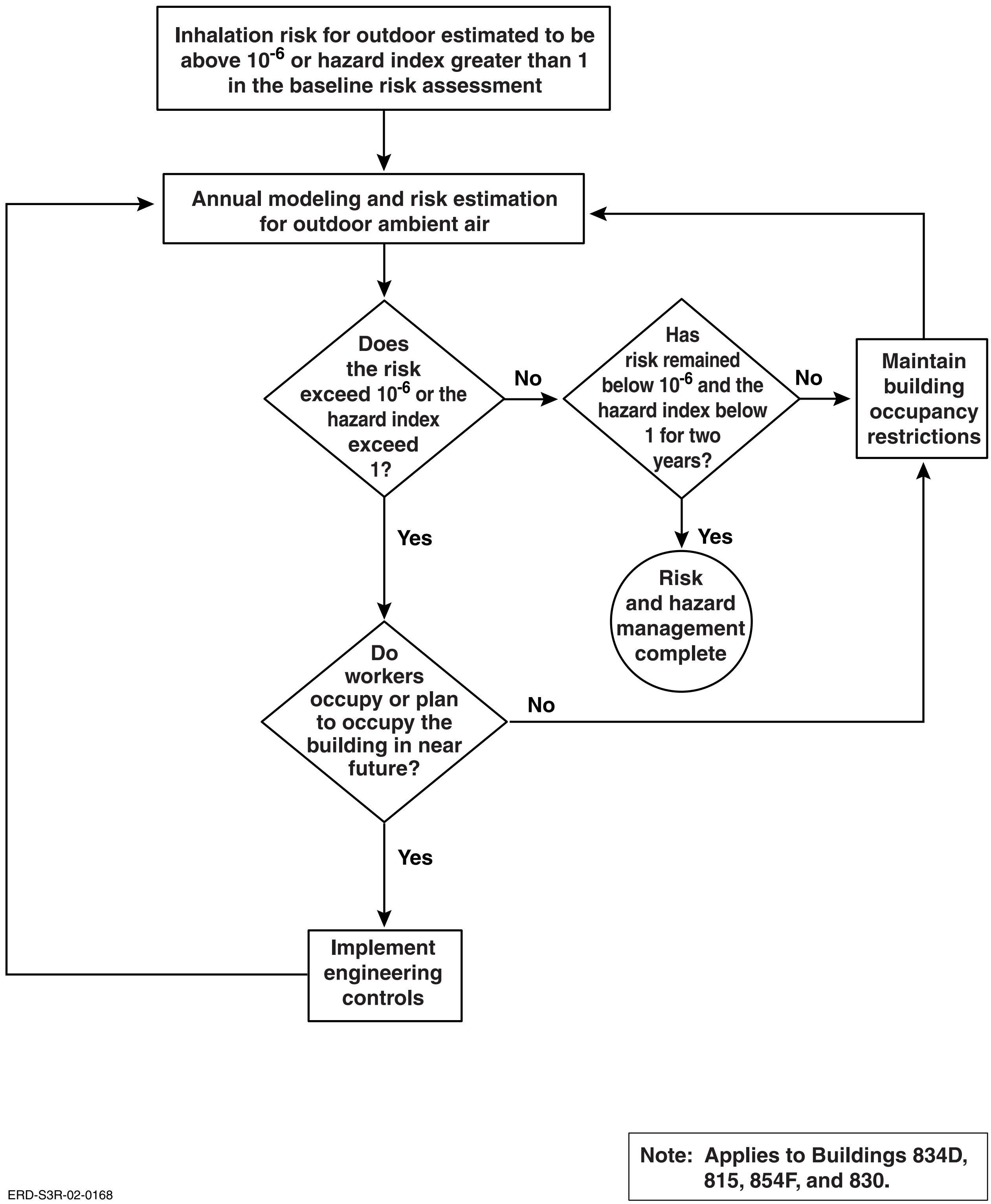

Figure 6-2. Outdoor air inhalation risk management process.

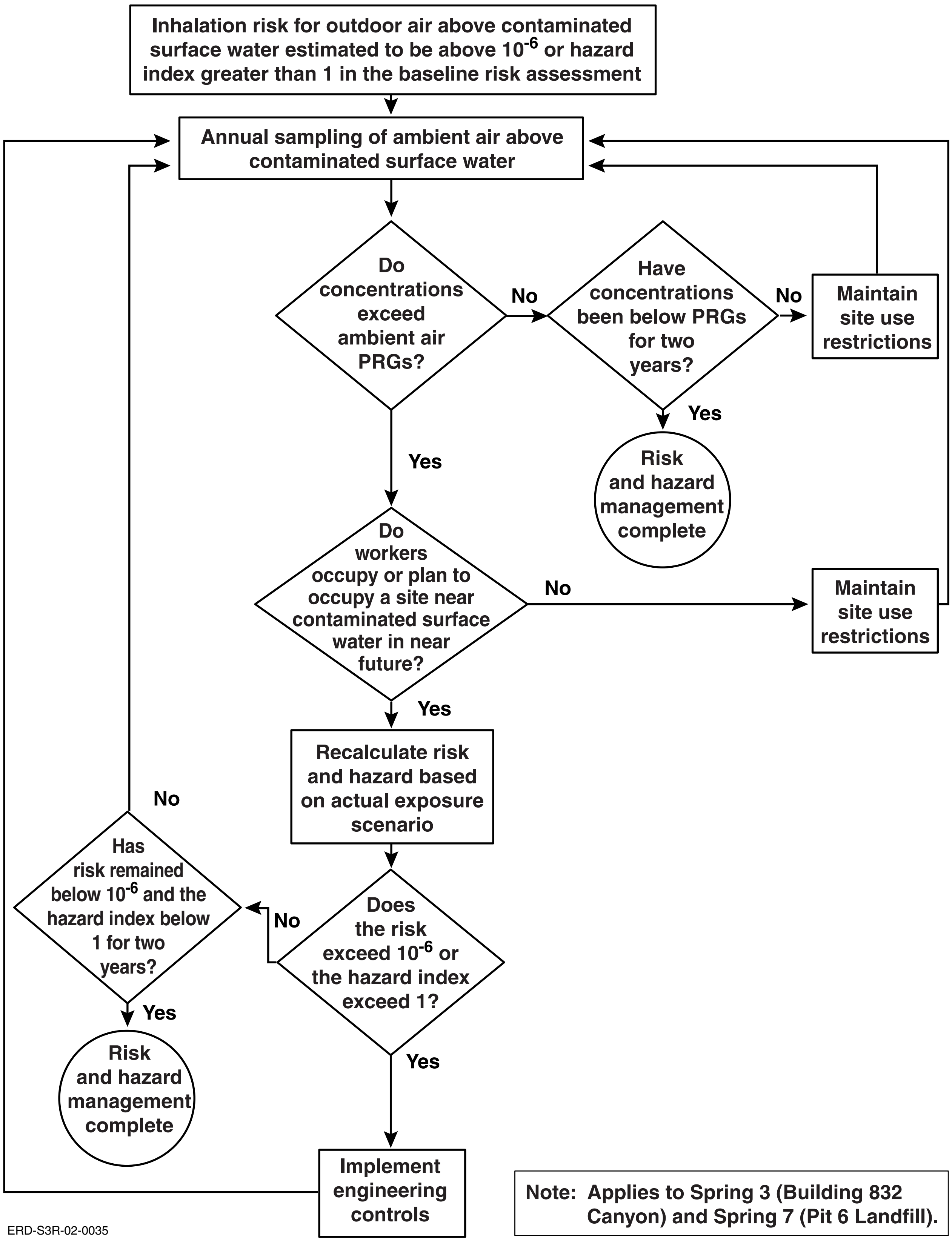

Figure 6-3. Surface water inhalation risk management process.

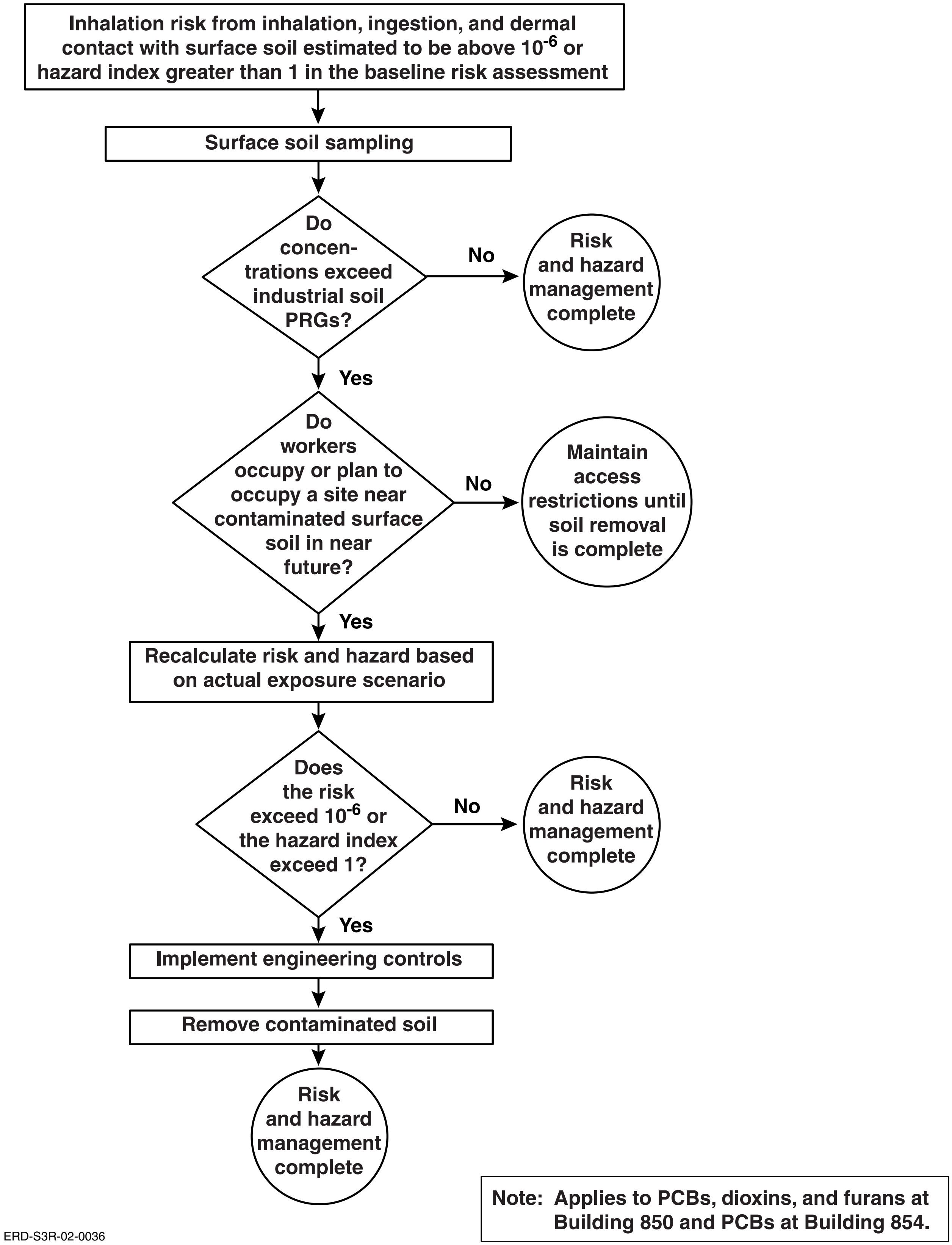

Figure 6-4. Risk management process for inhalation, ingestion, and dermal contact with surface soil contamination.

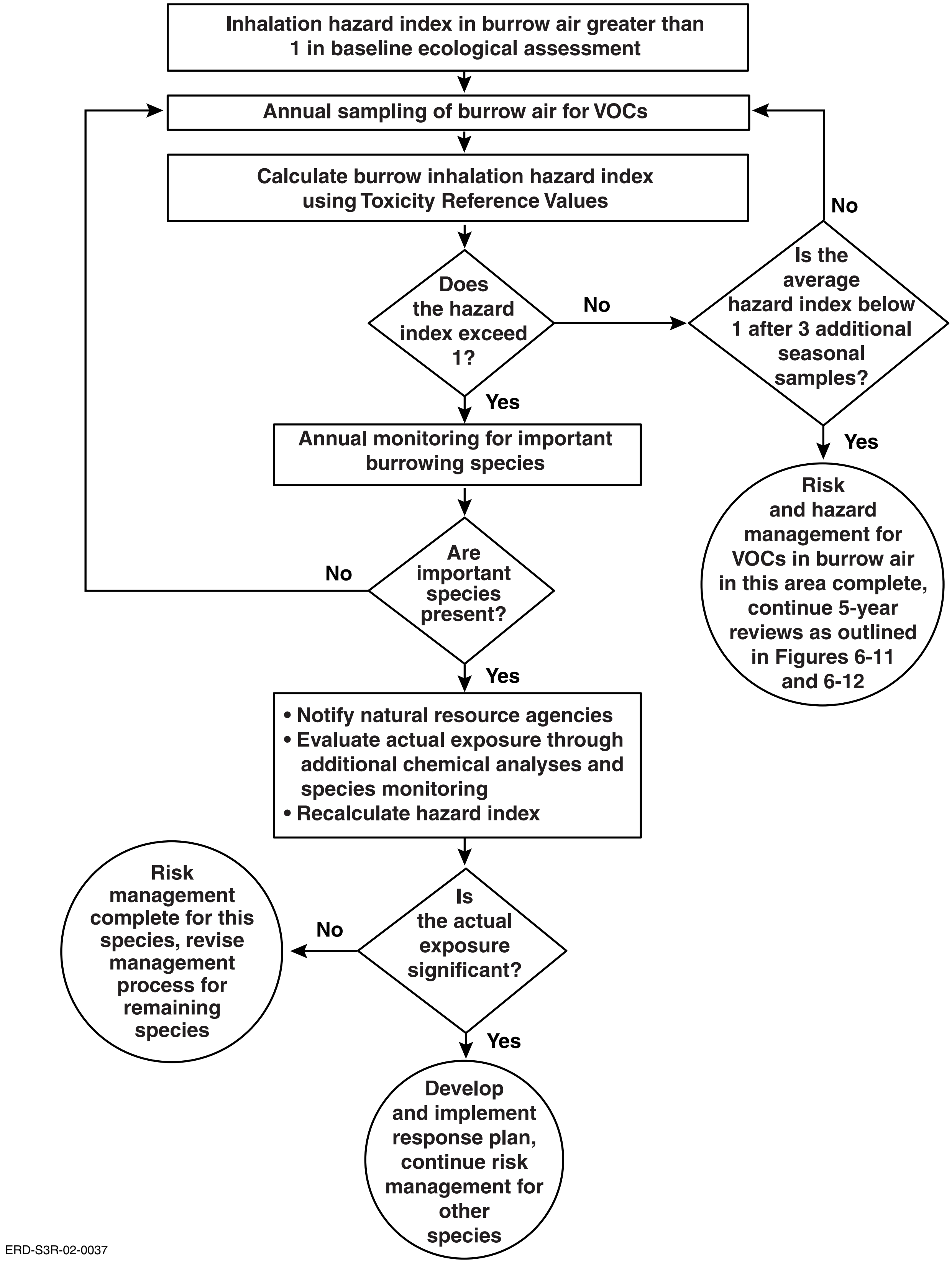

Figure 6-5. Risk management process for inhalation of VOC contaminants of concern in burrow air by fossorial vertebrates.

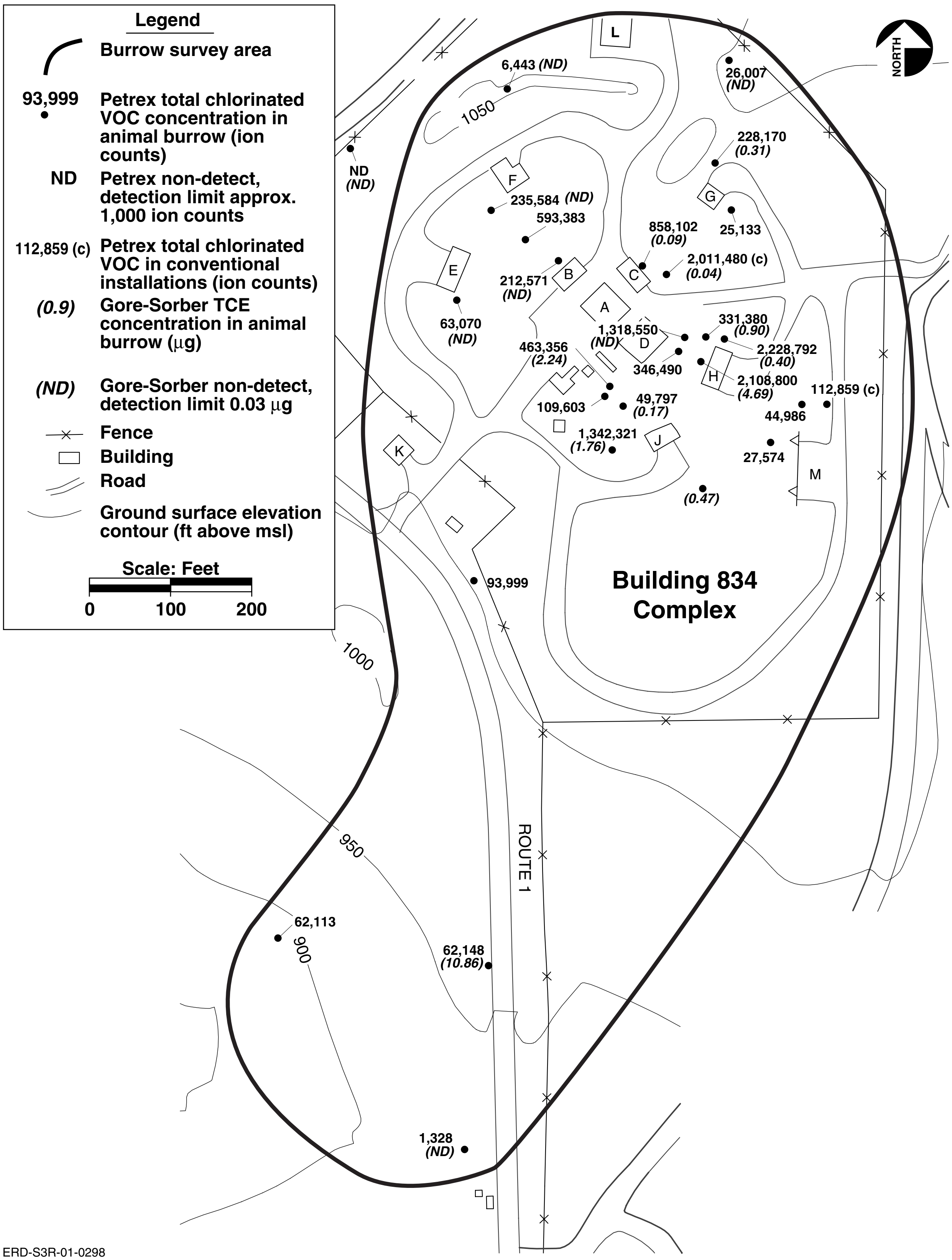

Figure 6-6. Ecological survey area for VOCs in animal burrows at Building 834.

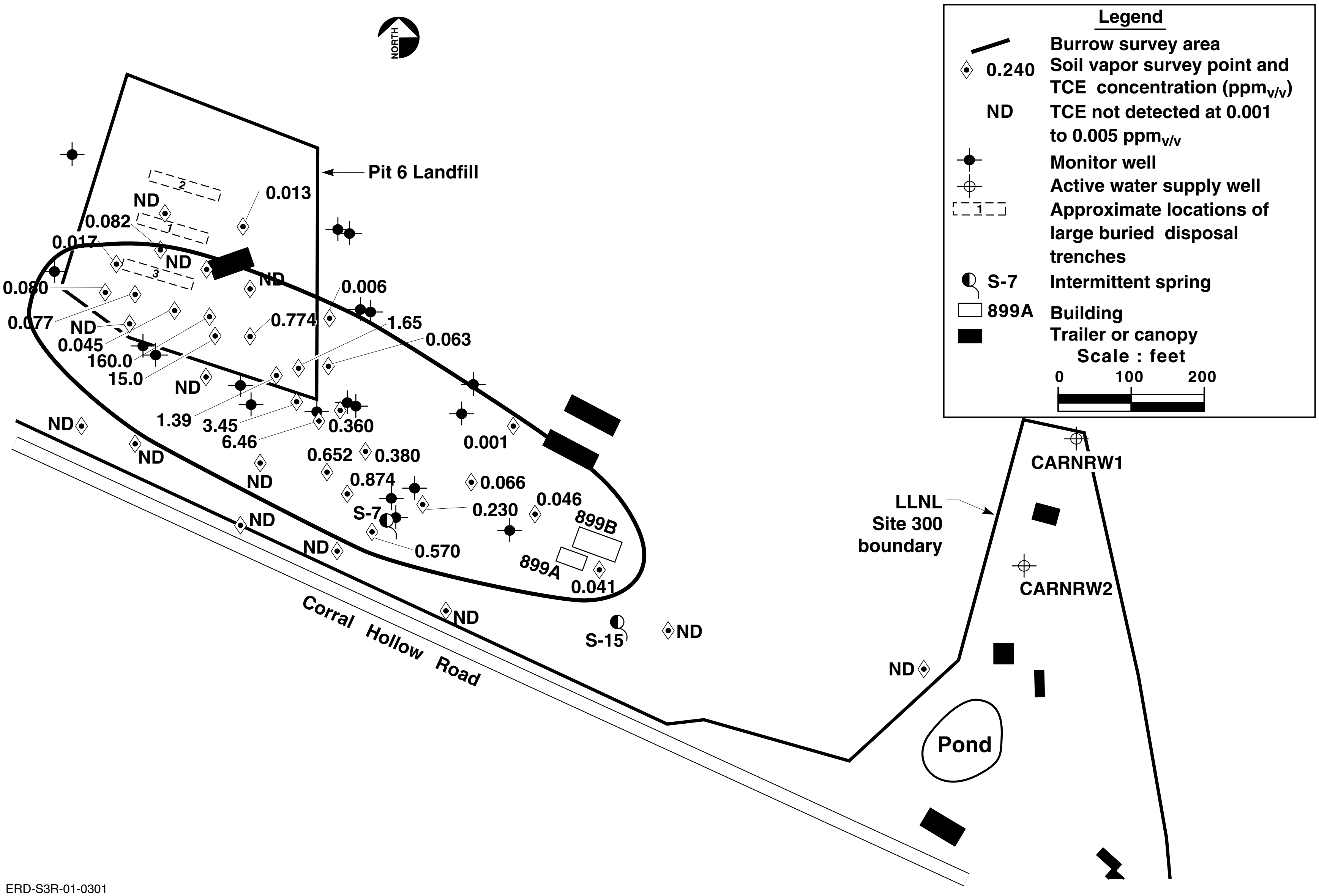

Figure 6-7. Ecological survey area for VOCs in animal burrows at the Pit 6 Landfill.

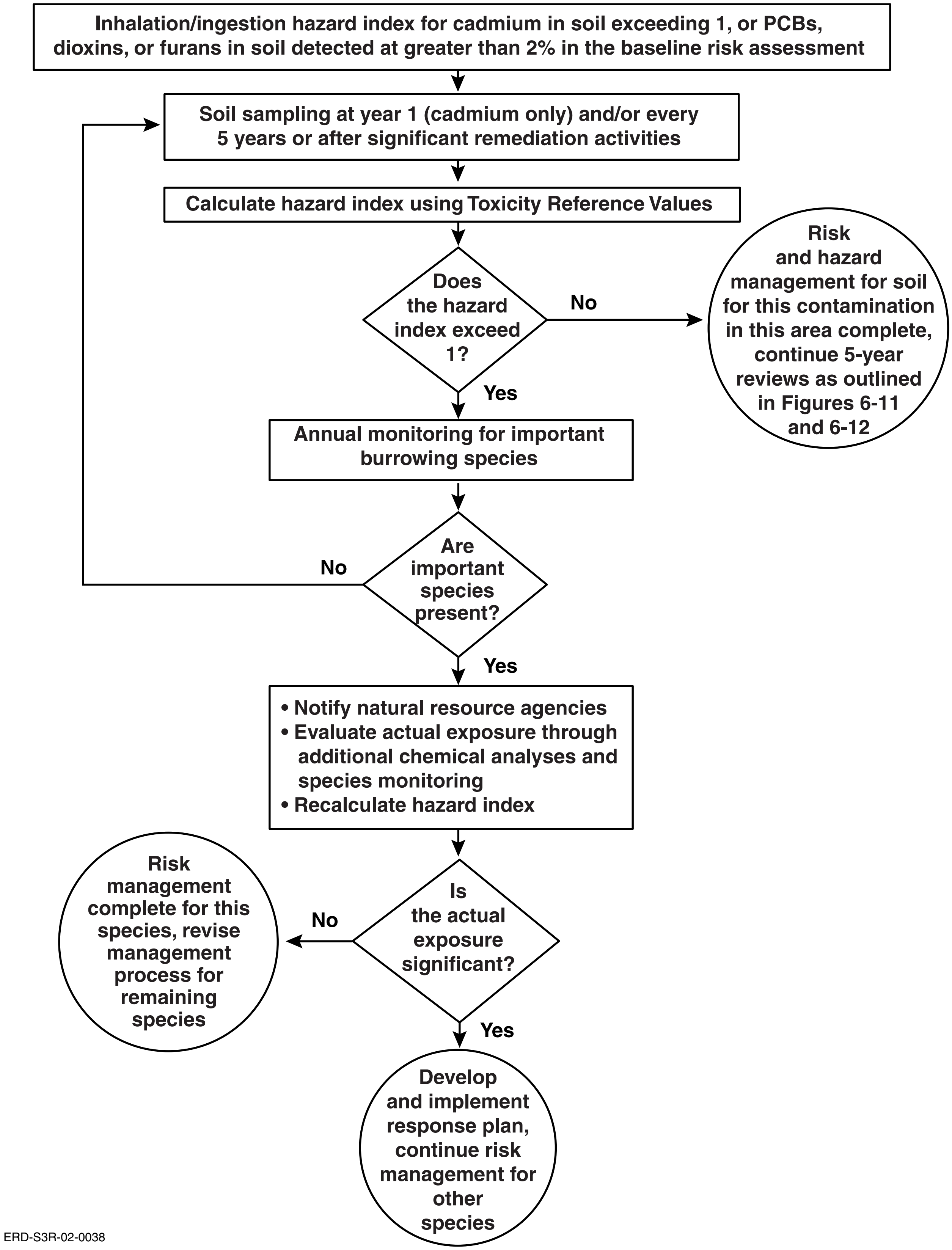

Figure 6-8. Risk management process for ecological exposure to cadmium, PCBs, dioxins, and furans in surface soil by fossorial vertebrates.

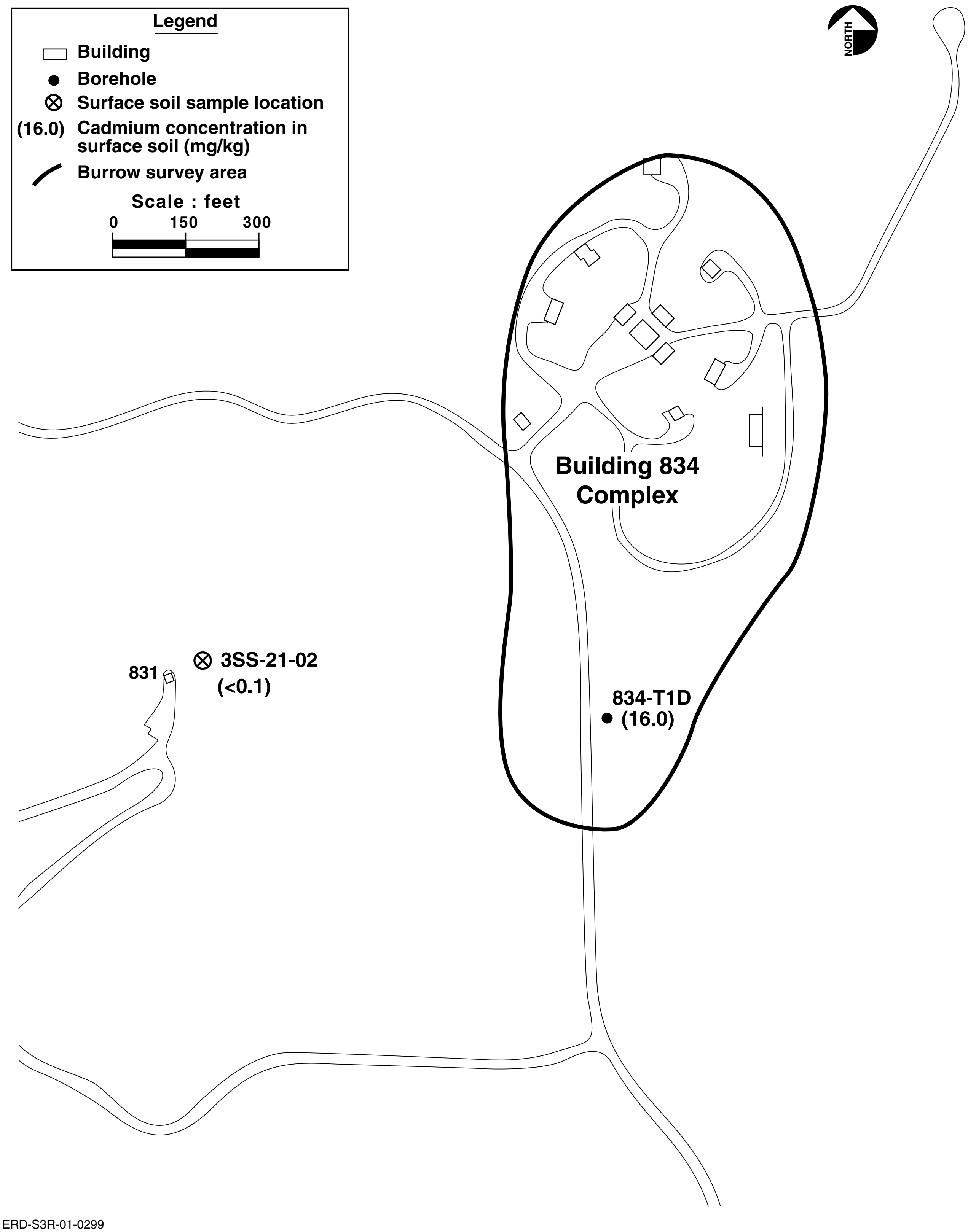

Figure 6-9. Ecological survey area for cadmium in surface soil at Building 834.

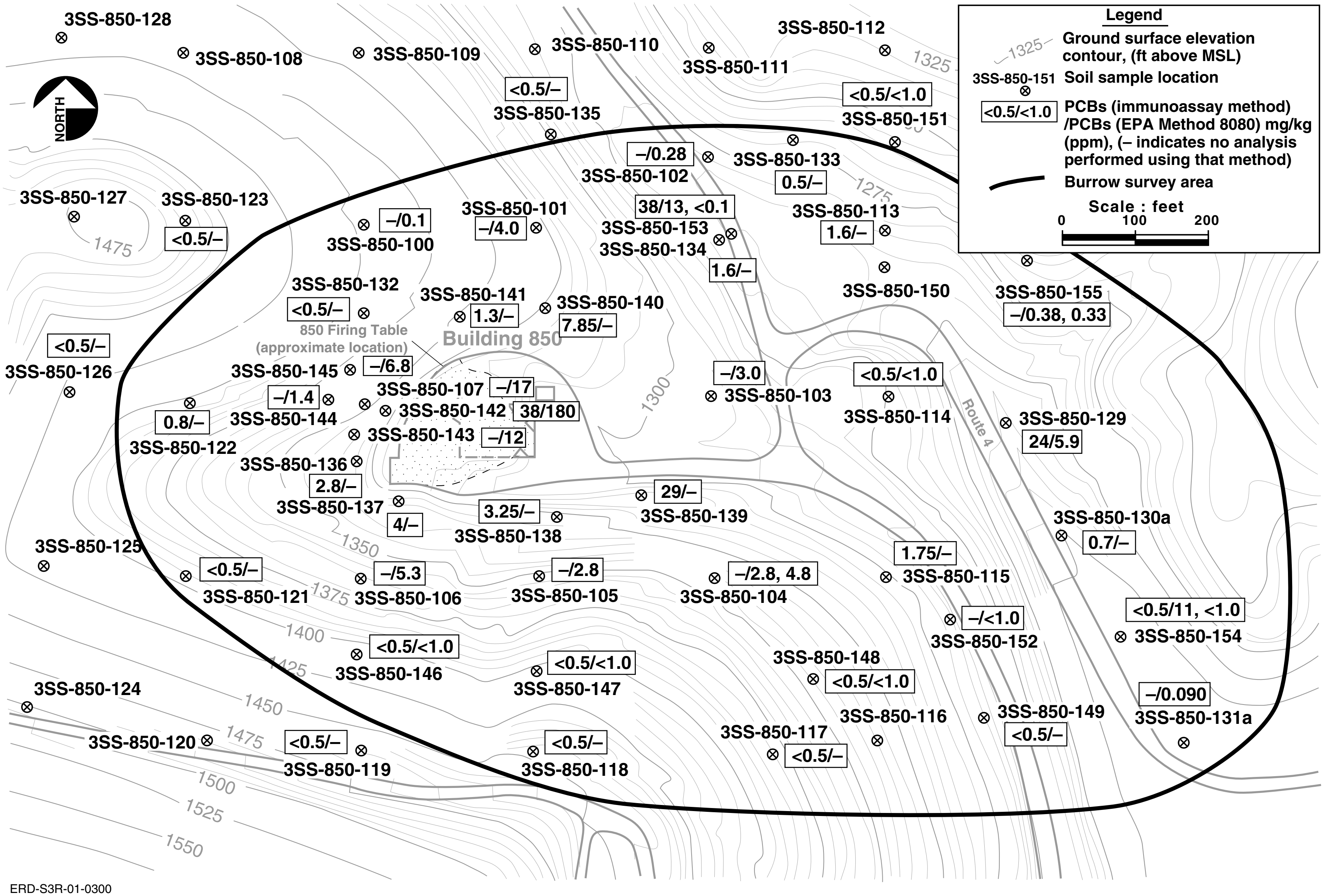

Figure 6-10. Ecological survey area for PCBs in surface soil at Building 850.

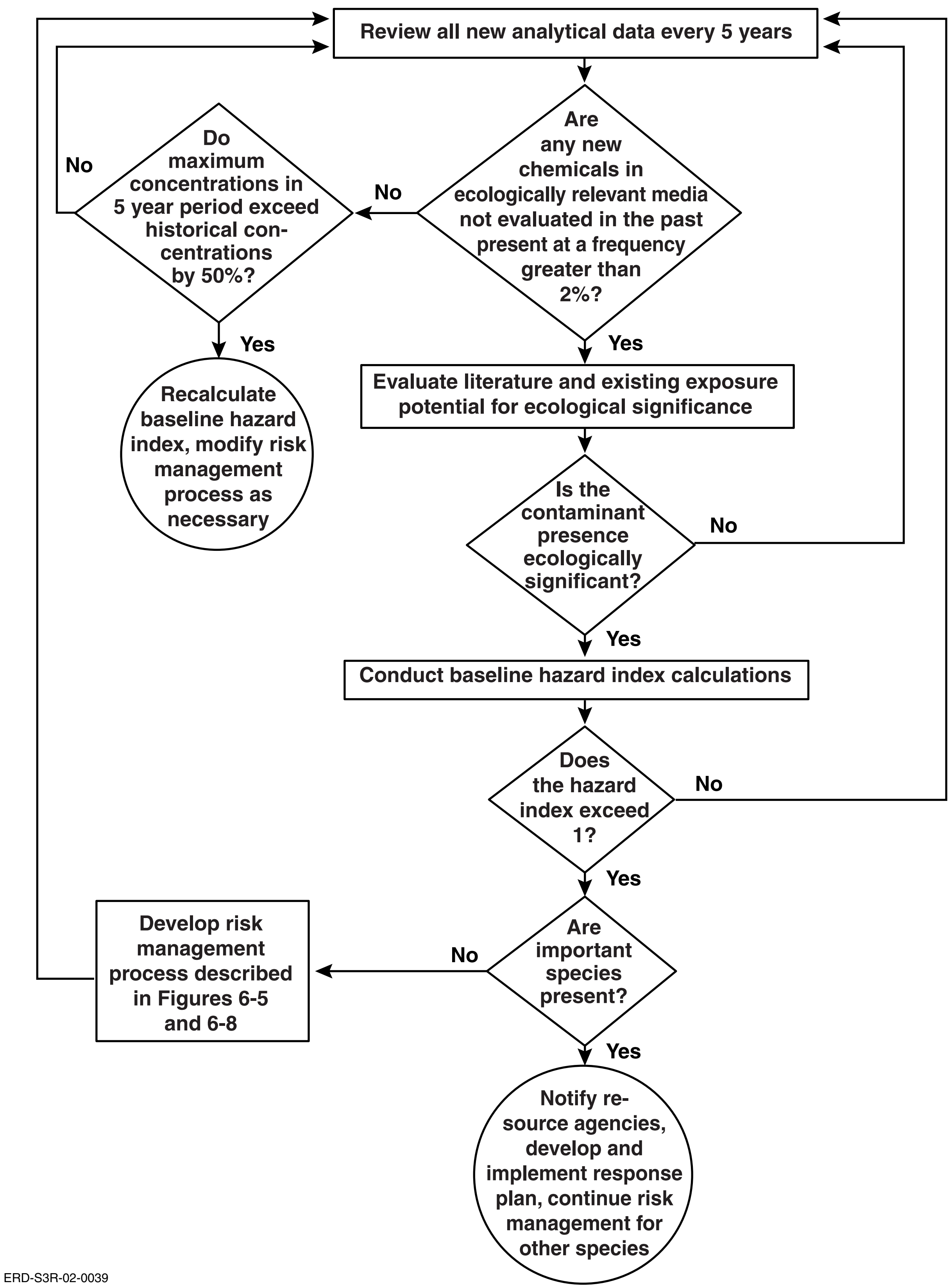

Figure 6-11. Ecological risk management process to evaluate changes in contaminant conditions.

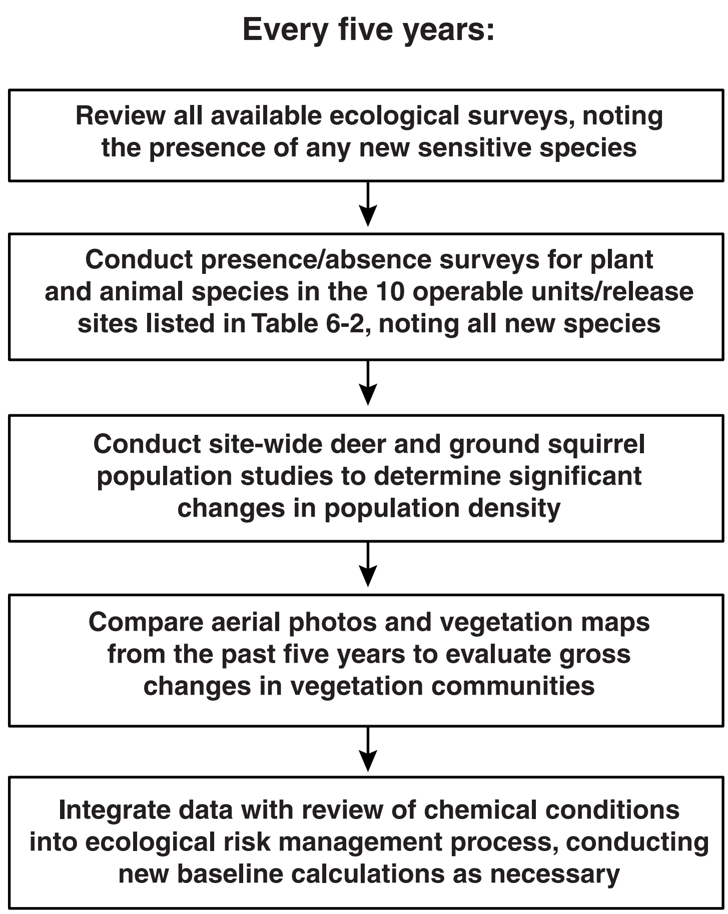

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Figure 6-12. Steps required to evaluate changes in ecological conditions.

Tables

Table 1-1. Comparison of pre- and post-CMP/CP monitoring programs.

Area or activity	Pre-CMP/CP	Post-CMP/CP
Sampling of ground water extraction and monitor wells, treatment system operation at Buildings 834, 854, 830, 832, and the HE Process Area[a]	RWQCB monitoring and reporting requirements, attached to the RWQCB Substantive Requirements.	CMP/CP Section 3 (monitor wells) and Section 5 (extraction wells and treatment systems).
Ground water treatment system discharge at Buildings 834, 854, 830, 832, and the HE Process Area[a]	RWQCB Substantive Requirements (effluent limitations).	Unaffected.
Soil vapor treatment system operation and discharge at Buildings 834, 830, 832, and 854[a]	Monitored under Permit to Operate and Permit Unit Requirements issued by the SJVUAPCD.	Unaffected, but are summarized in the CMP/CP.
Pit 6 Landfill[a]	Monitored under a CERCLA Post-Closure Plan that designated detection monitor and corrective action monitor wells.	Detection monitor wells will continue to be sampled as specified Post-Closure Plan. All corrective action monitor wells will be sampled per CMP/CP Section 3.
Building 850 Firing Table[a]	Voluntary.	CMP/CP Section 3.
Pit 2, 8, and 9 Landfills[a]	Voluntary.	CMP/CP Section 4.
Building 801 Dry Well[a]	Voluntary.	CMP/CP Section 3.
Building 833[a]	Voluntary.	CMP/CP Section 3.
Building 845 Firing Table[a]	Voluntary.	CMP/CP Section 3.
Building 851 Firing Table[a]	Voluntary.	CMP/CP Section 3.
General Services Area Operable Unit[b]	Monitoring conducted under an OU-specific ROD, CMP/CP, NPDES Permit, RWQCB Substantive Requirements.	Unaffected.
Pit 7 Landfill Complex[b]	RCRA closure of Pit 7, monitored under Waste Discharge Requirements. Releases from Pits 3, 4, and 5 under investigation.	After additional site characterization and remedy selection, the Interim ROD will be amended and a CMP/CP addendum will be issued.
Pit 1 Landfill[b]	RCRA closure, monitored under Waste Discharge Requirements.	Unaffected.
High Explosives Open Burn Facility[b]	Monitored under a RCRA Post-Closure Plan.	Unaffected.

Table 1-1. Comparison of pre- and post-CMP/CP monitoring programs. (Cont. Page 2 of 2)

Area or activity	Pre-CMP/CP	Post-CMP/CP
High Explosives Surface Water Impoundments[b]	Monitored under RWQCB Waste Discharge Requirements.	Unaffected
Building 865, Building 812, and the Sandia Test Site[b]	Monitored as part of ongoing site investigations.	When characterization is complete and remedies are selected, a CMP/CP addendum will be issued.
Surveillance monitoring of water-supply wells, air, vegetation, and storm water runoff[b]	Conducted by the LLNL Operations and Regulatory Affairs Division	Unaffected.

Notes:

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.

CMP/CP = Compliance Monitoring Plan/Contingency Plan.

NPDES = National Pollutant Discharge Elimination System.

OU = Operable unit.

RCRA = Resource Conservation and Recovery Act.

RWQCB = California Regional Water Quality Control Board.

SJVUAPCD = San Joaquin Valley Unified Air Pollution Control District.

[a] Area or activity included in the Interim Record of Decision for LLNL Site 300 (DOE, 2001).

[b] Not included in the Interim Record of Decision.

Table 3-1. Preliminary guard well sampling and analysis plan[a].

Area	Guard well	Hydrostratigraphic completion zone	Purpose	Analytes and sampling frequency
Building 834	W-834-T1	Neroly Formation lower blue sandstone (regional aquifer)	Monitor the regional aquifer for vertical contaminant migration.	*Building 834 guard wells:* VOCs (quarterly) Nitrate (semiannual) TBOS/TKEBS (annual) Diesel (annual)
	W-834-T3	Neroly Formation lower blue sandstone (regional aquifer)	Monitor the regional aquifer for vertical contaminant migration.	
Pit 6 Landfill	Proposed well cluster[b]: K6-X1 K6-X2 K6-X3	Three intervals within the Neroly Formation lower blue sandstone (regional aquifer)	Detect lateral and vertical contaminant migration that could impact the water-supply wells at the Carnegie State Vehicle Recreation Area ranger residence.	*Pit 6 Landfill guard wells:* Tritium (quarterly) VOCs (quarterly) Nitrate (semiannual) Perchlorate (semiannual)
	K6-17	Neroly Formation lower blue sandstone (regional aquifer)	Monitor the site boundary for lateral contaminant migration.	
	K6-22	Neroly Formation lower blue sandstone (regional aquifer)	Monitor the site boundary for lateral contaminant migration.	
High Explosives Process Area	W-815-08	Neroly Formation lower blue sandstone (regional aquifer)	Monitor the regional aquifer for vertical contaminant migration.	*High Explosives Process Area guard wells:* VOCs (quarterly) Nitrate (semiannual) High explosive compounds (semiannual) Perchlorate (semiannual)
	W-35B-01	Quaternary alluvium	Monitor the site boundary for lateral contaminant migration.	

Table 3-1. Preliminary guard well sampling plan. (Cont. Page 2 of 3)

Area	Guard well	Hydrostratigraphic completion zone	Purpose	Analytes and sampling frequency
High Explosives Process Area (cont.)	W-35B-02	Neroly Formation upper blue sandstone	Monitor site boundary for lateral contaminant migration.	
	W-35B-03	Neroly Formation upper blue sandstone	Monitor site boundary for lateral contaminant migration.	
	W-35B-04	Neroly Formation upper blue sandstone	Monitor the site boundary for lateral contaminant migration.	
	W-35B-05	Neroly Formation upper blue sandstone	Monitor the site boundary for lateral contaminant migration.	
	W-880-01[c]	Neroly Formation upper blue sandstone	Monitor the site boundary for lateral contaminant migration.	
	W-880-02[c]	Quaternary alluvium	Monitor the site boundary for lateral contaminant migration.	
	W-880-03[c]	Neroly Formation lower siltstone/claystone	Monitor the site boundary for lateral contaminant migration.	
	W-6H	Neroly Formation upper blue sandstone	Detect lateral contaminant migration that could impact offsite water-supply well Gallo-1.	
	W-6J	Neroly Formation upper blue sandstone	Detect lateral contaminant migration that could impact offsite water-supply well Gallo-1.	

Table 3-1. Preliminary guard well sampling plan. (Cont. Page 3 of 3)

Area	Guard well	Hydrostratigraphic completion zone	Purpose	Analytes and sampling frequency
Building 832 Canyon	W-830-20	Neroly Formation lower blue sandstone (regional aquifer)	Detect vertical contaminant migration that could impact onsite water-supply wells 18 and 20.	*Building 832 Canyon guard wells:* VOCs (quarterly) Nitrate (semiannual) Perchlorate (semiannual)
	Proposed well cluster[b]: W-830-X1 W-830-X2	Neroly Formation lower siltstone/claystone, Neroly Formation lower blue sandstone (regional aquifer)	Detect vertical contaminant migration that could impact onsite water-supply wells 18 and 20.	

Notes:

TBOS = Tetra-butyl-orthosilicate.

TKEBS = Tetra-kis-2-ethylbutylorthosilicate.

VOCs = Volatile organic compounds.

Analytical methods:

VOCs	U.S. EPA Method 601
High explosive compounds	U.S. EPA Method 8330
Nitrate	U.S. EPA Method E300.0
Perchlorate	U.S. EPA Method E300.0
TBOS/TKEBS	U.S. EPA Method 8015 (modified)
Tritium	U.S. EPA Method E906
Diesel	U.S. EPA Method 8015

[a] Final guard well selection, analytes, and sampling frequency will be defined in detailed sampling and analysis plans.

[b] Proposed wells not yet installed are designated by -X1, -X2 in the well name.

[c] Wells W-880-01, W-880-02, and W-880-03 also serve as guard wells for the Building 832 Canyon.

Guard wells for the General Services Area are established in the Compliance Monitoring Plan contained as an appendix within the Remedial Design document for this operable unit (Rueth et al., 1998) and are not included in this table.

Table 3-2. Preliminary Ground and Surface Water Monitoring Program analytes[a].

Area	VOCs	High explosive compounds	Nitrate	Perchlorate	TBOS/ TKEBS	Tritium	Uranium	PCBs	BTEX	Diesel
Building 834	Primary COC		Secondary COC		Secondary COC				Secondary COC	Secondary COC
Pit 6 Landfill	Primary COC		Secondary COC	Secondary COC		Primary COC				
HE Process Area	Primary COC	Secondary COC	Secondary COC	Secondary COC						
Building 850			Secondary COC			Primary COC	Secondary COC	Vadose zone COC		
Building 854	Primary COC		Secondary COC	Secondary COC				Vadose zone COC		
Building 830	Primary COC	Vadose zone COC	Secondary COC	Secondary COC						
Building 832	Primary COC		Secondary COC	Secondary COC						
Building 801	Primary COC		Secondary COC	Secondary COC						
Building 833	Primary COC									
Building 845		Vadose zone COC					Vadose zone COC			
Building 851	Vadose zone COC					Secondary COC	Primary COC			

Notes:

BTEX = Benzene, toluene, ethylbenzene, xylene.

COC = Contaminant of concern.

PCBs = Polychlorinated diphenyls.

TBOS = Tetra-butyl-orthosilicate.

TKEBS = Tetra-kis-2-ethylbutylorthosilicate.

VOCs = Volatile organic compounds.

Analytical methods:

VOCs	U.S. EPA Method 601
High explosive compounds	U.S. EPA Method 8330
Nitrate	U.S. EPA Method E300.0
Perchlorate	U.S. EPA Method E300.0
TBOS/TKEBS	U.S. EPA Method 8015 (modified)
Tritium	U.S. EPA Method E906
Uranium	U.S. EPA Method 200.7 (annual), Alpha spectroscopy (biennial)
PCBs	U.S. EPA Method E8082
BTEX	U.S. EPA Method 602
Diesel	U.S. EPA Method 8015

[a] Final analytes for the Ground and Surface Water Monitoring Program will be defined in detailed sampling and analysis plans.

Table 4-1. Preliminary detection monitoring sampling and analysis plan for the Pit 2, 8, and 9 Landfills[a].

Analyte	Frequency	Analytical method
Tritium	Quarterly	U.S. EPA Method E906
Volatile organic compounds	Annual	U.S. EPA Methods 601/602 or 624
Fluoride	Annual	U.S. EPA Method 340.2
High explosive compounds	Annual	U.S. EPA Method 8330
Nitrate	Annual	U.S. EPA Method E300.0
Perchlorate	Annual	U.S. EPA Method E300.0
Uranium and thorium isotopes	Biennial	Alpha spectrometry
Title 26 metals plus uranium, thorium, lithium, and beryllium	Annual	U.S. EPA Method 200.7

[a] Final detection monitoring well selection will be defined in detailed sampling and analysis plans.

Table 5-1. Preliminary ground water treatment facility sampling and analysis plan[a].

	Analyte						
Ground water treatment facility	**VOCs**	**Perchlorate**	**Nitrate**	**High explosive compounds**	**TBOS/TKEBS**	**BTEX**	**Diesel**
Building 834:							
B834-SRC	✓		✓		✓		✓
High Explosives Process Area:							
B815-SRC	✓	✓	✓	✓			
B815-PRX	✓	✓	✓	✓			
B815-DIS	✓		✓				
B815-DSB	✓						
B817-SRC	✓	✓	✓	✓			
B817-PRX	✓	✓	✓	✓			
B829-SRC	✓	✓	✓				
Building 832 Canyon:							
B832-SRC	✓	✓	✓				
B832-PRX	✓	✓	✓				
B832-DIS	✓	✓	✓				
B830-SRC	✓	✓	✓				
B830-PRXN	✓	✓					
B830-DIS	✓		✓				
B830-DISS	✓	✓	✓				
Building 854:							
B854-SRC	✓	✓	✓				
B854-PRX	✓	✓	✓				

Notes appear on the following page.

Table 5-1. Preliminary ground water treatment facility sampling and analysis plan[a]. (Cont. Page 2 of 2)

Notes:

BTEX = Benzene, toluene, ethylbenzene, xylene.

TBOS = Tetra-butyl-orthosilicate.

TKEBS = Tetra-kis-2-ethylbutylorthosilicate.

VOCs = Volatile organic compounds.

Analytic methods:

VOCs	U.S. EPA Method 601
Perchlorate	U.S. EPA Method E300.0
Nitrate	U.S. EPA Method E300.0
High explosive compounds	U.S. EPA Method 8330
TBOS/TKEBS	U.S. EPA Method 8015 (modified)
BTEX	U.S. EPA Method 602
Diesel	U.S. EPA Method 8015

All influent and effluent samples will also be analyzed for pH.

Influent samples will be collected quarterly, and effluent samples will be collected monthly.

[a] **Final analyte list will be defined in detailed sampling and analysis plans.**

Table 6-1. Summary of human health risks and hazards identified in the Site 300 baseline risk assessment.

Area	Exposure media: pathway	Contaminant	Baseline risk	Baseline hazard quotient	Comments
Building 834	Volatilization from subsurface soil: Inhalation inside Building 834D	TCE	9×10^{-4}	35	Building used only for storage.
		PCE	1×10^{-4}	0.7	
		Cumulative risk, hazard index:	*1×10^{-3}*	*35.7*	
Building 834	Volatilization from subsurface soil: Inhalation outside Building 834D	TCE	6×10^{-4}	21	No full-time use.
		PCE	8×10^{-5}	0.4	
		Cumulative risk, hazard index:	*7×10^{-4}*	*21.4*	
Pit 6 Landfill	Volatilization from subsurface soil: Inhalation at landfill	VOCs	5×10^{-6}	<1	Landfill capped in 1998.
		Cumulative risk, hazard index:	*5×10^{-6}*	*<1*	
Pit 6 Landfill	Volatilization from surface water: Inhalation at Spring 7	TCE	3×10^{-5}	1.1	Current concentrations below baseline.
		PCE	1×10^{-6}	<1	One detection in last 10 years.
		1,2-DCA	3×10^{-6}	NC	Not detected for over 10 years. No hazard PRG available.
		Chloroform	3×10^{-6}	<1	Not detected for over 10 years.
		Cumulative risk, hazard index:	*4×10^{-5}*	*1.1*	
Pit 6 Landfill	Volatilization from surface water: Inhalation at SVRA pond	TCE	2×10^{-6}	<1	Not detected in SVRA pond.
		Cumulative risk, hazard index:	*2×10^{-6}*	*<1*	
HE Process Area	Volatilization from subsurface soil: Inhalation outside Building 815	TCE	4×10^{-6}	<1	
		PCE	1×10^{-6}	<1	
		Cumulative risk, hazard index:	*5×10^{-6}*	*<1*	
HE Process Area	Volatilization from surface water: Inhalation at Spring 5	1,1-DCE	8×10^{-6}	<1	Spring 5 represented by well W-817-03A. Not detected since 1987.
		TCE	5×10^{-6}	<1	Current concentration below baseline.
		Cumulative risk, hazard index:	*1×10^{-5}*	*<1*	

Table 6-1. Summary of human health risks and hazards identified in the Site 300 baseline risk assessment. (Cont. page 2 of 3)

Area	Exposure media and pathway	Contaminant	Baseline risk	Baseline hazard quotient	Comments
HE Process Area	Ground water: Ingestion at hypothetical well at site boundary	1,1-DCE	5×10^{-6}	<1	Modeling based on pre-1993 concentrations for VOCs, all currently below baseline.
		TCE	3×10^{-6}	<1	
		RDX	2×10^{-6}	<1	
	Cumulative risk, hazard index:		*1×10^{-5}*	*<1*	
Building 850	Surface soil: Inhalation, ingestion, and dermal contact in Building 850 area	PCBs	5×10^{-3}	NC	No hazard PRG available.
		Dioxins and furans	1×10^{-4}	NC	No hazard PRG available.
	Cumulative risk, hazard index:		*5×10^{-3}*	*NC*	
Building 854	Surface soil: Inhalation, ingestion, and dermal contact in Building 854 area	PCBs: Arochlor 1242, 1248	7×10^{-5}	NC	No hazard PRG available.
	Cumulative risk, hazard index:		*7×10^{-5}*	*NC*	
Building 854	Volatilization from subsurface soil: Inhalation inside Building 854F	Chloroform	5×10^{-6}	<1	Based on 1996 ambient air sample.
		TCE	3×10^{-7}	NC	Based on 1996 ambient air sample.
		Other VOCs	4×10^{-6}	<1	Not detected, risk calculated using detection limits.
	Cumulative risk, hazard index:		*9×10^{-6}*	*<1*	
Building 854	Volatilization from subsurface soil: Inhalation outside Building 854F	Chloroform	9×10^{-6}	<1	Based on 1996 ambient air sample.
		1,2-DCA	1×10^{-6}	<1	Not detected in soil.
	Cumulative risk, hazard index:		*1×10^{-5}*	*<1*	
Building 854	Volatilization from subsurface soil: Inhalation inside Building 854A	Six VOCs	1×10^{-6}	<1	Not detected, risk calculated using detection limits.
	Cumulative risk, hazard index:		*1×10^{-6}*	*<1*	
Building 830	Volatilization from subsurface soil: Inhalation inside Building 830	Vinyl chloride	2×10^{-6}	NC	Based on 1996 ambient air sample. Not detected in air flux measurements.
		TCE	3×10^{-7}	NC	

Table 6-1. Summary of human health risks and hazards identified in the Site 300 baseline risk assessment. (Cont. page 3 of 3)

Area	Exposure media and pathway	Contaminant	Baseline risk	Baseline hazard quotient	Comments
		Cumulative risk, hazard index:	*2×10^{-6}*	*NC*	
Building 830	Volatilization from subsurface soil: Inhalation outside Building 830	Chloroform	4×10^{-6}	NC	Based on 1996 ambient air samples.
		1,2-DCA	4×10^{-6}	NC	Not detected in vadose zone or in air flux measurements.
		Vinyl chloride	2×10^{-6}	NC	Not detected in vadose zone or in air flux measurements.
		Cumulative risk, hazard index:	*1×10^{-5}*	*NC*	
Building 832	Volatilization from subsurface soil: Inhalation inside Building 832F	Dichloro-propane	3×10^{-6}	NC	Based on 1996 ambient air samples. Not detected in air flux measurements.
		Cumulative risk, hazard index:	*3×10^{-6}*	*NC*	
Building 832 Canyon	Volatilization from surface water: Inhalation at Spring 3	TCE	6×10^{-5}	2.3	Current concentrations below baseline.
		PCE	5×10^{-6}	<1	Not detected in last 5 years.
		Cumulative risk, hazard index:	*6×10^{-5}*	*2.3*	
Building 833	Volatilization from subsurface soil: Inhalation inside Building 833	TCE	6×10^{-7}	<1	
		Chloroform	6×10^{-7}	<1	
		Cumulative risk, hazard index:	*1×10^{-6}*	*<1*	

Notes:

Only exposure pathways where the cumulative risk exceeded 10^{-6} or the hazard index exceeded 1 are shown. Data are from Webster-Scholten (1994).

DCA = Dichloroethane.
PCBs = Polychlorinated biphenyls.
PCE = Tetrachloroethylene.
PRG = U.S. EPA Preliminary Remediation Goal.
NC = Not calculated.
RDX = Research Department Explosive.
SVRA = Carnegie State Vehicular Recreation Area.
TCE = Trichloroethylene.
VOCs = Volatile organic compounds.

Table 6-2. Summary of hazards to ecological receptors identified in the Site 300 baseline risk assessment.

Area	Exposure pathway	Receptor	Contaminant	Baseline hazard quotient	Comments
Building 834	Inhalation	Individual ground squirrel (J&A)	TCE	>1	Surveys found no impact to the population.
	Inhalation	Individual kit fox (J&A)	TCE	>1	Surveys found no evidence of kit fox in area
	Inhalation	Individual ground squirrel (J&A)	PCE	>1	Surveys found no impact to the population.
	Inhalation	Individual kit fox (J&A)	PCE	>1	Surveys found no evidence of kit fox in area
	Oral ingestion	Individual adult ground squirrels	Cadmium	>1	Surveys found no impact to the population.
	Oral ingestion	Individual deer (J&A)	Cadmium	>1	Surveys found no impact to the population.
	Oral ingestion	Individual adult kit fox	Cadmium	>1	Surveys found no evidence of kit fox in area
Pit 6 Landfill	Inhalation	Individual juvenile ground squirrel	TCE	>1	Surveys found no impact to the population.
	Inhalation	Individual kit fox (J&A)	TCE	>1	Surveys found no evidence of kit fox in area
	Inhalation	Individual juvenile ground squirrel	PCE	>1	Surveys found no impact to the population.
	Inhalation	Individual juvenile kit fox	PCE	>1	Surveys found no evidence of kit fox in area
	Inhalation	Individual adult ground squirrels	Total VOCs	>1	Surveys found no impact to the population.
	Inhalation	Individual adult kit fox	Total VOCs	>1	Surveys found no evidence of kit fox in area
High Explosives Process Area	Oral and inhalation	Individual adult ground squirrels	Cadmium	>1	Surveys found no impact to the population.
	Oral and inhalation	Individual juvenile deer	Cadmium	>1	Surveys found no impact to the population.
	Oral and inhalation	Individual adult deer	Cadmium	>1	Surveys found no impact to the population.
	Aquatic toxicity at Spring 5	–	Copper	>1	No surface water currently present.

Table 6-2. Summary of hazards to ecological receptors identified in the Site 300 baseline risk assessment. (Cont. page 2 of 3)

Area	Exposure pathway	Receptor	Contaminant	Baseline hazard quotient	Comments
Building 850 Area	Oral and inhalation	Individual adult ground squirrels	Cadmium	>1	Surveys found no impact to the population.
	Oral and inhalation	Individual deer (J&A)	Cadmium	>1	Surveys found no impact to the population.
	Oral and inhalation	Individual ground squirrels	PCBs, dioxins, and furans	NC	Hazard indices were not calculated, but a literature review indicated individual anima were potentially at risk due to the ability of these compounds to bioaccumulate. Surveys found no impact to ground squirrel populations.
	Oral and inhalation	Individual deer	PCBs, dioxins, and furans	NC	Hazard indices were not calculated, but a literature review indicated individual anima were potentially at risk due to the ability of these compounds to bioaccumulate. Surveys found no impact to deer populations.
	Oral and inhalation	Individual kit fox	PCBs, dioxins, and furans	NC	Hazard indices were not calculated, but a literature review indicated individual anima were potentially at risk due to the ability of these compounds to bioaccumulate. Surveys found no evidence of kit fox in the area.
	Oral	Adult ground squirrels	Copper and cadmium	>1	Surveys found no impact to the population.
	Aquatic toxicity at Spring 6	–	Copper and zinc	>1	Bioassays indicate no hazard.
Building 854				NC	Majority of area paved, no ecological habitat
Building 832 Canyon	All	All	All	<1	
Building 801	Oral and inhalation	Individual adult ground squirrels	Cadmium	>1	Surveys found no impact to the population.
	Oral and inhalation	Individual deer (J&A)	Cadmium	>1	Surveys found no impact to the population.
Building 802 Firing Table	All	All	All	<1	
Building 833	All	All	All	<1	
Building 845 Firing Table	–	–	–	NC	Data from this area added to other individua populations throughout the East and West Firing Areas.
Building 851 Firing Table	Oral and inhalation	Individual adult ground squirrels	Cadmium	>1	Surveys found no impact to the population.
	Oral and inhalation	Individual deer (J&A)	Cadmium	>1	Surveys found no impact to the population.

Notes appear on the following page.

Table 6-2. Summary of hazards to ecological receptors identified in the Site 300 baseline risk assessment. (Cont. page 3 of 3)

Notes:

J&A = Juvenile and adult.
NC = Hazard quotients not calculated.
PCBs = Polychlorinated biphenyls.
PCE = Tetrachloroethylene.
TCE = Trichloroethylene.
VOCs = Volatile organic compounds.

Data are from the Final Site-Wide Remedial Investigation Report (Webster-Scholten, 1994) Tables 6-74, 6-118, and 6-119.

Table 6-3. Risk and hazard management components of the selected interim remedies.

Area	Risk and hazard management scope
Building 834	• Maintain building occupancy and land use restrictions in the vicinity of Building 834D and install warning signs. If modeling and risk estimation for indoor air within Building 834D indicates that risks currently exceed 10^{-6} or the HI exceeds 1, institute restrictions in building use or, if building use is again anticipated, install a building ventilation system and operate it whenever the building is occupied. • Develop and implement a risk and hazard monitoring and assessment program: 1. Estimate risk for outdoor ambient air annually for VOCs near Building 834D; until risk $<10^{-6}$ and HI <1 for at least 2 years. 2. Estimate risk for indoor ambient air annually for VOCs in Building 834D; until risk $<10^{-6}$ and HI <1 for at least 2 years. 3. Conduct annual wildlife surveys to evaluate the presence of the San Joaquin kit fox and other important (i.e., special status) burrowing species where the hazard indices for VOCs and cadmium exceed 1. Should important burrowing species be found, action described in Sections 6.2.1 and 6.2.2 will be taken. 4. Perform additional ecological surveys and data review once every five years as described in Section 6.2.3. 5. Integrate these data into risk assessment calculations to determine any changes in risks and hazards. 6. Review these data to evaluate compliance with RAOs. • Develop and implement Operational Safety Procedures for all remedial actions where risks can be foreseen.
Pit 6 Landfill	• Maintain land use restrictions in the vicinity of the Pit 6 Landfill and install warning signs. • Develop and implement a risk and hazard monitoring and assessment program: 1. Inspect Spring 7 in conjunction with quarterly ground water monitoring of the Pit 6 Landfill to determine if the spring is flowing. Ambient air sampling would be conducted only if water is flowing. 2. Conduct annual wildlife surveys to evaluate the presence of the San Joaquin kit fox and other important (i.e., special status) burrowing species where the hazard index for VOCs exceeds 1. Should important burrowing species be found, action described in Section 6.2.1 will be taken. 3. Perform additional ecological surveys and data review once every five years as described in Section 6.2.3. 4. Integrate new data into risk assessment calculations to determine any changes in risks and hazards. 5. Review these data to evaluate compliance with RAOs. • Develop and implement Operational Safety Procedures for all remedial actions where risks can be foreseen.

Table 6-3. Risk and hazard management components of the selected interim remedies. (Cont. Page 2 of 4).

Area	Risk and hazard management scope
HE Process Area	• **Implement building occupancy and land use restrictions in the vicinity of Building 815 and Spring 5 and install warning signs, as necessary to prevent exposure.** • **Develop and implement a risk and hazard monitoring and assessment program:** 1. **Estimate risk for outdoor ambient air annually for VOCs near Building 815, until risk is <10^{-6} for at least two years.** 2. **Sample outdoor ambient air annually for VOCs near Spring 5, if water is flowing.** 3. **Perform ecological surveys and data review once every 5 years, as described in Section 6.2.3.** 4. **Integrate these data into risk assessment calculations to determine any changes in risks and hazards.** 5. **Review these data to evaluate compliance with RAOs.** • **Develop and implement Operational Safety Procedures for all remedial actions where risks can be foreseen.**
Building 850	• **Maintain land use restrictions in the vicinity of the Building 850 firing table and install warning signs.** • **Develop and implement a risk and hazard monitoring and assessment program:** 1. **Sample surface soil for PCBs near the Building 850 firing table.** 2. **Sample surface soil for dioxins and furans near the Building 850 firing table.** 3. **Conduct annual wildlife surveys to evaluate the presence of any important (i.e., special status) species while PCBs, dioxins, and furans remain at hazardous concentrations. Should important burrowing species be found, activities described in Section 6.2.2 will be taken.** 4. **Perform additional ecological surveys and data review once every five years as described in Section 6.2.3.** 5. **Integrate these data into risk assessment calculations to determine any changes in risks and hazards.** 6. **Review these data to evaluate compliance with RAOs.** • **Develop and implement Operational Safety Procedures for all remedial actions where risks can be foreseen.**
Building 854	• **Maintain building occupancy and land use restrictions in the vicinity of Building 854F and install warning signs as necessary to prevent exposure. If modeling and risk estimation for indoor air within Building 854A or 854F indicates that risks currently exceed 10^{-6} or the HI exceeds 1, institute building restrictions or, if building use is again anticipated, install a building ventilation system and operate it whenever the building is occupied.** • **Develop and implement a risk and hazard monitoring and assessment program:** 1. **Estimate risk for indoor ambient air annually for VOCs in Building 854F and Building 854A, until risk is <10^{-6} and HI is <1 for at least two years.** 2. **Sample surface soil for PCBs in the Building 854 complex and evaluate whether soil removal is warranted.** 3. **Perform ecological surveys and data reviews once every 5 years, as described in Section 6.2.3.**

Table 6-3. Risk and hazard management components of the selected interim remedies. (Cont. Page 3 of 4).

Area	Risk and hazard management scope
Building 854 (cont.)	4. Integrate these data into risk assessment calculations to determine any changes in risks and hazards. 5. Review these data to evaluate compliance with RAOs. • Develop and implement Operational Safety Procedures for all remedial actions where risks can be foreseen.
Building 832 Canyon	• Maintain land use restrictions in the vicinity of Building 830 and 832. If modeling and risk estimation for indoor air within Building 833 indicates that risks currently exceed 1×10^{-6} or the HI exceeds 1, institute building restrictions or, if building use is again anticipated, install a building ventilation system and operate it whenever the building is occupied. • Develop and implement a risk and hazard monitoring and assessment program: 1. Estimate risk for outdoor ambient air annually for VOCs near Building 830, until risk is $<10^{-6}$ for at least two years. 2. Estimate risk for indoor ambient air annually for VOCs in Building 830, until risk is $<10^{-6}$ for at least two years. 3. Sample outdoor ambient air annually for VOCs near Spring 3, until risk is $<10^{-6}$ and HI <1 for at least two years. 4. Perform ecological surveys and data review once every 5 years, as described in Section 6.2.3. 5. Integrate these data into risk assessment calculations to determine any changes in risks and hazards. 6. Review these data to evaluate compliance with RAOs. • Develop and implement Operational Safety Procedures for all remedial actions where risks can be foreseen.
Building 833	• Implement building occupancy restrictions in the vicinity of Building 833 and install warning signs, if necessary to prevent exposure. If modeling and risk estimation for indoor air within Building 833 indicates that risks currently exceed 1×10^{-6} or the HI exceeds 1, institute building restrictions or, if building use is again anticipated, install a building ventilation system and operate it whenever the building is occupied. • Develop and implement a risk and hazard monitoring and assessment program: 1. Estimate risk for indoor ambient air annually for VOCs in Building 833, until risk is $<10^{-6}$. 2. Perform ecological surveys and data review once every 5 years, as described in Section 6.2.3. 3. Integrate these data into risk assessment calculations to determine any changes in risks and hazards. 4. Review these data to evaluate compliance with RAOs. • Develop and implement Operational Safety Procedures for all remedial actions where risks can be foreseen.

Notes appear on the following page.

Table 6-3. Risk and hazard management components of the selected interim remedies. (Cont. Page 4 of 4).

Notes:

HI = Hazard index.
OU = Operable unit.
PCBs = Polychlorinated biphenyls.
RAOs = Remedial action objectives.
VOCs = Volatile organic compounds.

Table 6-4. Sampling and analysis plan for VOCs in outdoor air near contaminated springs (human health).

Survey area	**Spring 3 (Building 832 Canyon): 288 ft^2** **Spring 5 (High Explosives Process Area): Area variable depending on flow rate** **Spring 7 (Pit 6 Landfill): 155 ft^2**
Number of samples	**One time-integrated sample per contaminated spring**
Sampling method	**Air sampling using SUMMA canisters per LLNL SOP 1.11 (Dibley and Depue, 2000) and U.S. EPA SOP 14.1.2 (VOC Sampling with SUMMA Canisters Using Method TO-14 (1996). Vacuum is used to draw air from outdoor air above contaminated spring into SUMMA canister. Air sample will be drawn at a height of approximately 4.5 to 5.5 ft above the spring surface to simulate worker exposure conditions. Grab samples at 10 to 30 seconds per sample will be collected over an 8-hour time period to collect a time-integrated sample over an 8-hr "work" day.**
Sample container	**SUMMA canister**
Preservative	**None**
Analytical method	**U.S. EPA TO-14**
Holding time	**14 days**
Detection limit	**0.02 ppb (volumetric)**
Field QC samples	**10% co-located samples**

Table 6-5. Preliminary sampling and analysis plan for VOCs in animal burrow air (ecological).

Survey area	Building 834: 738,000 ft^2 Pit 6: 217,000 ft^2
Number of samples	Dependent upon the number of burrows in survey area
Burrow selection	Burrow diameter of 3–4 inches (sufficient for use by current special status species); depth of burrow at least 2 ft (i.e., should not be caved)
Sampling method	Modified active soil vapor using SUMMA canisters (Dibley and Depue 2000, SOPs 1.10 and 1.11). Soil vapor point is attached to sampling rod and inserted at least 2 ft into burrow; teflon tubing is attached to free end of rod and attached to valve of evacuated SUMMA canister; valve is opened to draw air from burrow into canister
Sample container	SUMMA canister
Preservative	None
Analytical method	U.S. EPA TO-14
Holding time	14 days
Detection limit	0.02 ppb (volumetric)
Field QC samples	10% co-located samples

Note:

A detailed sampling and analysis plan will be created prior to sampling.

Table 6-6. Example of assumptions to be used in estimating exposure of kit fox to contaminants.

Biological parameters for kit fox[a]	Adults	Juveniles
Body weight (kg)	2.15	0.79
Air intake (m^3/d)	1.5	0.8
Incidental soil ingestion (kg/d)	0.0049	0.0028
Fraction of time in contaminated area	1	1
Fraction of time above ground	0.2	0
Fraction of time below ground	0.8	1
Fraction of contaminant absorbed from air	0.5[b]	0.5[b]
Adult prey intake (assumed to be ground squirrel) (kg/d)	0.175	Not applicable
Juvenile milk intake (kg/d)	Not applicable	0.103
Site Physical Parameters		
Above ground air particulate loadings (kg/m^3)	2.3×10^{-8}	
Below ground air particulate loadings (kg/m^3)	1.0×10^{-7}	
Chemical-Specific Parameters	Cadmium	PCBs/dioxins/furans
Soil to ground squirrel biotransfer factor	0.44[c]	To be determined
Adult milk to juvenile biotransfer factor	6.2×10^{-5}	To be determined

[a] Similar data will be developed for other species of concern identified to be present through site-specific surveys. Data are from Webster-Scholten (1994) unless otherwise noted.

[b] This factor allows for the incorporation of inhalation exposure with oral exposure for comparison to oral Toxicity Reference Values.

[c] From Bench et al. (2001).

Table 6-7. Oral Toxicity Reference Values for fossorial mammalian vertebrates[a].

Chemical	Test species	Toxicity Reference Value mg/kg•day	Toxic endpoint	Reference
Trichloroethylene	Mouse	0.7[b]	Hepatoxicity	Buben and O'flaherty (1985), referenced in Sample et al. (1996).
Tetrachloroethylene	Mouse	1.4[c]	Hepatoxicity	Buben and O'flaherty (1985), referenced in Sample et al. (1996).
Cadmium	Mouse	0.06[d]	Reproduction	Engineering Field Activity West (1997).
PCB (Arochlor 1254)	Mouse	0.36[e]	Reproduction	Engineering Field Activity West (1997).
Dioxin (2,3,7,8-TCDD)	Rat	0.000001[e]	Reproduction	Murray et al. (1979), referenced in Sample et al. (1996).

[a] Toxicity Reference Values will be developed for other non-vertebrate species of concern identified through site-specific surveys. Inhalation exposures are accounted for by assuming half (0.5) of contaminant exposure from inhalation is retained.

[b] Value used in Webster-Scholten (1994) was 24 mg/kg•day based on increased liver weight in laboratory rats found by Tucker et al. (1982).

[c] Value used in Webster-Scholten (1994) was 14 mg/kg•day based on sub-chronic No Observed Adverse Effect Level (NOAEL) for hepatotoxicity in laboratory mice found by Buben and O'flaherty (1985). A chronic NOAEL was calculated by Sample et al. (1996).

[d] Value used in Webster-Scholten (1994) was 0.0055 mg/kg•d based on multigenerational reproductive effects in laboratory mice found by Wills et al. (1981). This study was found by Sample et al. (1996) to result in such conservative values that cleanup of cadmium in soil below background would be necessary. Sample et al. (1996) uses Sutou et al. (1980) NOAEL of 1 mg/kg•d.

[e] Hazard quotients were not previously calculated for these contaminants.

Table 6-8. Preliminary sampling and analysis plan for cadmium in surface soil (ecological).

Survey area	**Building 834: 700,000 ft^2**
Number of samples	**20 (minimum)**
Sampling method	**Hand trowel (Dibley and Depue, 2000, SOP 1.12), remove surface vegetation, collect soil from top 6 inches**
Sample container	**500 ml glass wide-mouth jar**
Analytical method	**U.S. EPA 6010**
Preservative	**None**
Holding time	**6 months**
Detection limit	**0.5 mg/kg**
Field QC samples	**10% co-located samples**

Note:

A detailed sampling and analysis plan will be created prior to sampling.

Table 6-9. Preliminary sampling and analysis plan for PCBs, dioxins, and furans in surface soil (ecological).

Survey area	**Building 850 area: 1,200,000 ft^2**
Number of samples	**40 (minimum)**
Sampling method	**Hand trowel (Dibley and Depue, 2000, SOP 1.12), remove surface vegetation, collect soil from top 6 inches**
Sample container	**500 ml glass wide-mouth jar**
Preservative	**Chill to 4°C**
Analytical method	**Immunoassay (PCBs); U.S. EPA 8082 (PCBs); U.S. EPA 8290 (dioxins and furans)**
Holding time	**14 days to extraction, 40 days for extract (U.S. EPA Methods 8082 and 8290)**
Detection limit	**0.5 mg/kg (immunoassay)/0.002 mg/kg (8082)/10 ppt (8290)**
Field QC samples	**10% co-located samples**

Note:

ppt = Parts per trillion.

A detailed sampling and analysis plan will be created prior to sampling.

Table 8-1. LLNL Environmental Restoration Division Standard Operating Procedures.

SOP Number	Title	Version
SOP-1.1	Field Borehole Logging	Rev. 4
SOP-1.2	Borehole Sampling of Unconsolidated Sediments and Rock	Rev. 4
SOP-1.3	Drilling	Rev. 4
SOP-1.4	Monitor Well Installation	Rev. 4
SOP-1.5	Monitor Well Development	Rev. 4
SOP-1.6	Borehole Geophysical Logging	Rev. 4
SOP-1.7	Well Closures	Rev. 2
SOP-1.8	Disposal of Investigation-Derived Wastes	Rev. 3
SOP-1.9	Lysimeter Soil Moisture Sampling	Rev. 3
SOP-1.10	Soil Vapor Surveys	Rev. 4
SOP-1.11	Soil Surface Flux Monitoring of Gaseous Emission	Rev. 1
SOP-1.12	Surface Soil Sampling	Rev. 1
SOP-1.13	SIMCO Drill Rig Operation	Rev. 0
SOP 1.15	Well Site Core Handling	Rev. 1
SOP 1.16	Four Wheel All Terrain Vehicle (ATV) Operation	Rev. 0
SOP 1.17	Treatment Facility Vapor Sampling	Rev 1
SOP 1.18	Deployment, Retrieval, Sampling, and Maintenance of Instrumented Membrane Technology (IMT) Borehole-Liner Systems	Rev. 1
SOP-2.1	Presample Purging of Wells	Rev. 5
SOP-2.2	Field Measurements on Surface and Ground Waters	Rev. 3
SOP-2.3	Sampling Monitor Wells with Bladder and Electric Submersible Pumps	Rev. 4
SOP-2.4	Sampling Monitor Wells with a Bailer	Rev. 5
SOP-2.5	Surface Water Sampling	Rev. 0
SOP-2.6	Sampling for Volatile Organic Compounds	Rev. 4
SOP-2.7	Presample Purging and Sampling of Low-Yielding Monitor Wells	Rev. 4
SOP-2.8	Installation of Dedicated Sampling Pumps	Rev. 4
SOP-2.9	Sampling for Tritium in Ground Water	Rev. 4
SOP-2.10	Well Disinfection and Coliform Bacteria Sampling	Rev. 2
SOP-2.11	Developing Ground Water Monitoring Sampling Schedules	Rev. 2
SOP-2.12	Ground Water Monitor Well and Equipment Maintenance	Rev. 1
SOP-2.13	Barcad Sampling	Rev. 1
SOP-3.1	Water-Level Measurement	Rev. 5
SOP-3.2	Pressure Transducer Calibration	Rev. 2
SOP-3.3	Hydraulic Testing (Slug/Bail)	Rev. 2
SOP-3.4	Hydraulic Testing (Pumping)	Rev. 2
SOP-4.1	General Instructions for Field Personnel	Rev. 5

Table 8-1. LLNL Environmental Restoration Division Standard Operating Procedures. (Cont Page 2 of 2)

SOP Number	Title	Version
SOP-4.2	Sample Control and Documentation	Rev. 5
SOP-4.3	Sample Containers and Preservation	Rev. 4
SOP-4.4	Guide to the Handling, Packaging, and Shipping of Samples	Rev. 4
SOP-4.5	General Equipment Decontamination	Rev. 4
SOP-4.6	QA/QC Objectives for Non-Radiological Data Generated by Analytical Laboratories	Rev. 4
SOP-4-7A	Livermore Site Treatment and Disposal of Well Development and Well Purger Fluids	Rev. 4
SOP-4.7B	Site 300 Treatment and Disposal of Well Development and Well Purge Fluids	Rev. 3
SOP-4.8	Calibration/Verification and Maintenance of Field Instruments Used in Measuring Parameters of Surface Water, Ground Water, and Soils	Rev. 5
SOP-4.9	Collection of Field QC Samples	Rev. 4
SOP-4.12	Quality Improvement Forms (QIFs)	Rev. 1
SOP-4.13	Standard Operating Procedure Process	Rev. 1
SOP 4.14	Mapping with the Trimble Pathfinder Pro XR GPS System	Rev. 0
SOP-4.15	ERD Self-assessments and Walk-abouts	Rev. 0
SOP-4.16	ERD Lockout/Tag Program	Rev. 0
SOP-4.17	Change of Water Phase Granular Activated Carbon	Rev. 0
SOP-5.1	Data Management Printed Analytical Result Receipt and Processing	Rev. 2
SOP-5.2	Data Management Chain-of-Custody Receipt and Processing	Rev. 1
SOP-5.3	Data Management Electronic Analytical Result Receipt and Processing for Sample Analysis Data	Rev. 1
SOP-5.4	Data Management Hand Entry of Analytical Results	Rev. 1
SOP-5.5	Data Management Revision Receipt and Processing	Rev. 1
SOP-5.6	Ground Water Elevation Reports	Rev. 0
SOP-5.8	Field Logbook Control	Rev. 2
SOP-5.10	Data Management Receipt and Processing of Lithologic Data by Electronic Transfer	Rev. 2
SOP-5.14	Issuing New Parameter Codes	Rev. 0
SOP-5.15	Livermore Site Routine Groundwater Sampling Plan Preparation	Rev. 0
SOP-5.20	Cost Effective Sampling (CES) Algorithm Preparation	Rev. 0
SOP-5.21	Outlier Identification Program	Rev. 0
	SOP Glossary	Rev. 4

Table 10-1. Summary of Site 300 remediation contingencies and potential responses.

Contingency	Possible response
Technical	
Insufficient hydraulic containment.	Adjust extraction flow rates and/or number/location of extraction wells.
Increasing chemical concentration.	Adjust extraction flow rates and/or number/location of wells. Assess potential impacts and conduct source investigations, if necessary.
New impact to regional water-supply aquifers.	Notify regulators and well owners (if any), evaluate cause of impact, prepare action plan, and discuss with stakeholders.
Monitored Natural Attenuation and/or No Further Action are ineffective.	Evaluate causes, potential impacts, and propose alternatives to regulators.
Modeling assumptions no longer valid.	Update conceptual model and validations.
Chemicals in vadose zone impact ground water.	Where vadose zone cleanup is in progress, modify remediation system, if possible. If no vadose zone remediation in progress, conduct source investigation and/or implement remedial action, if necessary.
Contaminants that present health or ecological risk remain after soil/sand pile removal (Building 850).	Evaluate risk and transport and develop alternatives including capping, institutional controls, and additional removal for discussion with regulators.
New contaminant sources discovered, new releases and/or contaminants detected.	Conduct source investigations where necessary to assess extent of contamination. If ground water is impacted, modify the remedial action plan, if needed. If ground water is not impacted, conduct transport modeling to evaluate need for vadose zone remediation. Propose actions to regulators as needed.
Improved remediation technologies are developed.	Conduct cost-benefit analysis and employ economical- and technology-based actions that are acceptable.
Uncontrollable events impact monitoring and/or remediation efforts.	Assess damage to infrastructure and, if appropriate, modify, replace, or decommission monitoring and/or remediation system(s).
Logistical	
Personnel changes.	Employ phase-in/phase-out period, if appropriate, to ensure smooth transitions during personnel changes. Review project documentation at transitions and learn current positions on site-related issues that have major impacts.
Insufficient funding affects planned remediation.	Follow established Site 300 priority list. If necessary, milestone dates will be revised through coordination with the regulatory agencies.
Regulations change and/or meeting them is infeasible.	Include DOE, LLNL, regulators, and the community in the process to determine if and how regulatory changes affect the Site 300 cleanup.

Table 10-1. Summary of Site 300 remediation contingencies and potential responses. (Cont. Page 2 of 2)

Contingency	Possible response
Land/ground water use and demand affect monitoring/remediation.	**Alter the remedial pumping scheme, and/or negotiate with land owners. Provide alternative water supply or implement contingency point-of-use treatment at existing water-supply wells, if necessary.**
Changes in building access restrictions/use.	**Assess risk and consider engineered controls if needed.**
Future property transfer from DOE.	**Follow Site 300 Federal Facilities Agreement Requirements regarding notifications and deed restrictions.**
Changes to the mission and operation of LLNL.	**Future mission and operation of LLNL will include CERCLA compliance and cleanup implementation as specified in the Site 300 Federal Facility Agreement and the Site 300 Record of Decision.**